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Building Alliances: A partnership between a middle school mathematics teacher and a researcher

Anthony M. A. Fernandes

University of North Carolina Charlotte
Abstract

This case study examines the evolution of a partnership between a middle school mathematics teacher and a university researcher as we had discussions based on the content and teaching of mathematics. The evolution of the partnership occurred through three stages, determined by the content-teaching tensions. The first stage focused on the mathematics content, with the agenda being set and run by the researcher. The second stage gave rise to the content-teaching tensions as the teacher shifted the discussions from the content to her immediate planning needs. Appropriate management of the tensions gave rise to the third stage, with the teacher assuming a proactive role in the discussions on lesson design and teaching. The goals of the partnership shifted from individualistic to the common goal of implementing a reform curriculum in the classroom. The shift in the partnership can be attributed to the adoption of the reform curriculum by the teacher and the effective management of tensions by both partners.

Keywords: Collaborations, Mathematics Education, Mathematics teachers, Partnerships, Professional development, Tensions, University researcher.
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The Reform (NCTM, 2000) vision seeks to move mathematics teaching away from a focus on ‘transfer’ of knowledge to a teaching philosophy that has its underpinnings in constructivism (von Glasersfeld, 1995). Teachers adopting the reform approach are encouraged to guide students in construction of their own knowledge by engaging them in challenging mathematical activities, where the students invent procedures, justify the validity of their procedures, and communicate their ideas to peers (NCTM, 2000; Simon, 1997). The teacher also negotiates a classroom culture that encourages students to discuss and build on each other’s ideas and collectively work towards understanding mathematics.

Teachers require a deep and flexible understanding of mathematics to implement the reform vision and this is beyond teachers’ experiences in pre-service education courses (Ball, 2000a; NCTM, 2000). This calls for long term ongoing professional development and there have been some models in place that have focused on areas like teacher knowledge (Birchak et al., 1998; Cohen, 2004), instruction (Fernandez, 2002), instruction and student thinking (Cobb, Wood, & Yackel, 1990), and student thinking (Fennema et al., 1996). Most of these models of professional development have involved prolonged interactions between teachers and researchers, but there has been a lack of an in-depth examination of the collaboration. Cuban (1992) has indicated that teachers and researchers could clash as a result of their conflicting cultural values. Researchers value “reflection, rigorous analysis, and scientifically produced research” (Cuban, 1992, p. 8), whereas the teachers value action and knowledge that is “concrete, relevant, drawn from experience, and applied to practical dilemmas of teaching and learning” (Cuban, 1992, p. 8). Hence the collaboration between researchers and teachers cannot
be assumed. This study seeks to examine the evolution of a partnership between a middle school mathematics teacher and a researcher as we came together to discuss the content and teaching. In this exploratory qualitative case study (Merriam, 1998), I seek to answer the following questions:

What is the nature of a partnership between a middle school mathematics teacher and a researcher centered on conversations about the mathematics content and teaching?

In particular:

How does the nature of the partnership evolve over time? How does the partnership contribute to mathematical and pedagogical issues that arise in planning and teaching?

What are the constraints on the teacher and the researcher in such a partnership?

Tensions in Collaborations

Tensions are integral to collaborations between researchers and teachers and have been well documented (Cole, 1989; Cuban, 1992; Johnston, 1997; Lampert, 1991; Miller, 1995; Olson, 1997; Putnam & Borko, 2000; Sirotnik & Goodland, 1988; Winitsky, Stoddard, & O'Keefe, 1992). These tensions arise out of the different cultural systems prevalent in universities and schools. Researchers are accustomed to working in a relatively autonomous environment with plenty of resources, while teachers are constrained by the great deal of accountability and the shortage of resources, especially time. Other differences arise out of varied approaches that may be adopted towards issues, with researchers gravitating towards a theoretical view based on data collection and analysis and teachers adopting a practical action oriented approach based on experience (Cuban, 1992; Erickson, Brandes, Mitchell, & Mitchell, 2005; Olson, 1997; Toomey et al., 2005). Johnston (1997) also claimed the tussle between hierarchy and mutuality between teachers and researchers was a major source of tensions. Olson (1997) cited the traditional hierarchical nature of learning as a factor that could contribute to
tensions between teachers and researchers, since there was an assumption that research knowledge could be ‘transferred’ from the researchers to the teachers (Bickel & Hattrup, 1995). In summary, the tensions will be part of collaborations and effective management of the tensions is crucial for progress.

Managing the Tensions

Two views have been taken towards tensions, the first focused on resolving the tensions to achieve parity between the researchers and teachers (Cole, 1989; Cole & Knowles, 1993; Henderson & Hawthorne, 1995; Knight, Wiseman, & Smith, 1992) and the second view sought to maintain ‘productive tensions’ to facilitate learning through dialogue (Clark et al., 1996; Elbow, 1986; Johnston, 1997; Kreisberg, 1992; Zeichner, 1991).

Cole and Knowles (1993) assumed a hermeneutic perspective, and sought to resolve the tensions through parity between the teachers and researchers. They focused on the distribution of work in the collaboration and conjectured that true collaboration was achieved through a move away from the traditional model of the researcher having sole control over the research. Instead of excluding the teacher’s participation in the research, it was recommended that the teacher be involved in the major phases of research like planning, data collection, data analysis, and reporting. Cole and Knowles (1993) indicated that a lack of conscious effort to negotiate the involvement of the teacher from the beginning of the project and in all phases, led to a breakdown of communication and hence the collaboration. Although, they also claim that the teachers should not be involved in all the phases of research just for the sake of it. Further, participation needs to be negotiated between the partners. Involving the teacher as an equal partner was also emphasized by others in the literature (Blond & Webb, 1997; Cole, 1989; Hord, 1981; Oja & Pine, 1987; Smulyan, 1987; Tikunoff & Ward, 1983).
In the second perspective for negotiating tensions, other researchers (Clark et al., 1996; Kreisberg, 1992) argued that mutuality between the partners was difficult to achieve in all aspects of the research, since this forced the teachers to enact the roles of the researchers in addition to their own roles as teachers. For example, the teacher would have to take time out to write a report that is more valuable for the researcher in the context of the institutional demand to publish. Instead of sharing the work, Clark et al. (1996) cited dialogue between the partners as the major focus of the collaboration and through this dialogue there should be mutual professional development for both partners. Thus parity between the partners was achieved not by “doing the same work” but rather by “understanding the work of one another” (p. 196).

John-Steiner (2000) outlined complementarity collaborations as collaboration where the differences between the partners were valued. In these collaborations the workload was distributed between the partners based on their strengths, negotiated through dialogue. Further, through sustained engagement, there was mutual appropriation both intellectually and emotionally by the partners. Besides sharing their skills, the partners also shared the risks involved in the project and the different views actually helped to fuel the creative work in the collaboration. John-Steiner (2000) pointed to the friendship between the physicists Einstein and Bohr, despite opposition in their theoretical views, as an example of complementarity collaboration. Einstein’s opposition caused Bohr to refine his theory and make it better by accommodating Einstein’s views.

Researchers (Johnston, 1997; Johnston & Kerper, 1996; Olson, 1997) have warned against the danger of achieving mutuality at the expense of eliminating other views in favor of the dominant view. Instead of adopting one view, the tensions should create a problem solving space for the co-construction of new knowledge through multiple voices in dialogue (Castle,
1997; Elbow, 1986; John-Steiner, 2000; Johnston, 1997; Olson, 1997; Zeichner, 1991). In this process each partner took the risk of having their ideas transformed through the discussion as the partners jointly co-constructed possibilities that neither partner could have envisioned before the collaboration. Further, the co-construction of knowledge enabled personal learning and growth and all participants would come out of the collaboration feeling that they benefited from the process. The latter was more important than just having the same goals (Castle, 1997; Clark et al., 1996; Day, 1991; Elbow, 1986; Johnston, 1997; Zeichner, 1991).

Support for dialogue required an ethic of care and trust among the partners. Marlow and Kyle (2005) advocated a nature of care and collegiality based on the Hawaiian principle of *Kuleana* between the participants. This referred to a sense of caring, a sense of advocacy, an emphasis of relationship, and the concerns for the needs and feelings of the partners involved that went beyond the institutional needs. Day (1991) also cited attributes of a caring nature and human relating skills, where the researcher did not take advantage of the teacher, as aspects that cultivated the collaboration. In a similar vein, Bikel and Hattrupp (1995), called for a degree of honesty and readiness to make mid-course changes as affective factors that moved the collaboration forward.

*The Methods*

The qualitative case study approach (Merriam, 1998) was used for this study with the teacher (Linda) and me forming the dyad which was the unit of analysis. Linda’s school was located in the south west of the country, in a predominantly working class Latino neighborhood. The demographics of the school included 76% Latinos, 12% White, 6% Native American, 5% Black, and 1% Asian. Seventy-four percent of the student body was on free or reduced lunch, and 14% were English Language Learners (ELL). Ninety three percent of the ELLs spoke
Spanish. Data for the study was collected over a period of four months although my informa
tions interactions with Linda were spread over nine months. Linda arranged my observations
immediately before her planning period and this enabled us to have one-on-one discussions after
she taught. I observed Linda’s seventh and sixth grade classes and there were between 19 and 24
students in each class. The students were seated in groups of three or four to facilitate
discussions.

**Linda’s Background**

Linda grew up in the same town in which the school was located. She attended the local
community college part time and took general courses that could be transferred to the university.
After four years she joined the Elementary Education program at the local university and was
certified to teach kindergarten through eighth grade at the end of three years. During her years in
the community college, Linda regularly volunteered at an elementary school and this was a big
motivation for her choosing to do an education degree and become a teacher. After her degree,
she taught kindergarten for six years and then joined her current job as a mathematics teacher in
the middle school. In the elementary school she used a reform curriculum *Investigations* (TERC,
1998) and hence was not new to ideas of reform. Linda had positive experiences in mathematics
throughout and she also preferred to teach just mathematics. At the time of our meeting, Linda
had been at the current middle school for eight years and was teaching the sixth and seventh
grades classes along with a Yearbook class. Although she loved being a teacher, there were a
number of challenges in her work. Some of them, in her view, were the growing lack of respect
that the students had for the teachers and the lack of parental involvement. In some instances it
was impossible to contact parents whose children were failing throughout the year. Other
pressures were the increasing accountability requirements due to Federal policies. For example,
detailed plans for improving failing students had to be made and submitted to the school. The parents of the failing students had to be aware of the plans, but it was a challenge to contact them to sign-off on the plans. These challenges took time away from the planning of lessons. Another challenge was addressing all the topics in the curriculum in the given time frame. Linda could not be sure if she had spent enough time on a topic so that the students had the opportunity to build the required concepts.

My Background

My perspectives of mathematics education have been influenced by my own schooling (in India) where there was strict discipline and high expectations at school. The classes were lecture driven, with the teacher dominating discourse and student interactions limited to answering the teacher’s questions. It was normal for students to interact outside the classroom where informal networks would form to discuss challenging problems in the homework. I learned mathematics in the traditional way, attuning to lectures and solving assigned problems. Grades determined promotion to the next class and it was not uncommon for students to repeat a grade. Admission to college was determined by the scores in the national board exams. Later, my own learning experiences would impact my teaching experiences, notably in the area of maintaining high expectations from the students through allowing them to solve challenging problems.

Besides my own learning experiences, another major influence on my teaching perspective occurred in the doctoral program in Mathematics Education here in the US. I was exposed to the Principles and Standards of School Mathematics (NCTM, 2000) and as a graduate teaching assistant, I was teaching the content courses to pre-service elementary and middle school teachers. In this course the instructors were expected to model the vision laid out in the
Standards and engage the students in activities that would build on their prior knowledge to construct mathematical concepts. I had to learn to deviate from my lesson plan on numerous instances when the students brought up ideas that I had to tie into the lesson at hand. I also had to learn to manage the norms in the classroom where the teacher was not the center of the classroom. These teaching experiences, further readings, and conversations with experienced mathematics educators in the department contributed to my current beliefs about teaching and learning.

History of the Dyad

I was introduced to Linda by one of the principal investigators of the Center for the Mathematics Education of Latinos/as (CEMELA) project. Linda was part of the first CEMELA cohort of middle school teachers attending classes that focused on mathematics content and Latino students, at the university. Linda aimed to become a highly qualified teacher and this was her major reason for joining the cohort even though her school was not a partner school of CEMELA. She recognized that her mathematics background could be improved and expressed a desire to learn more mathematics and become a better teacher. The Principle Investigator of the project was impressed with Linda’s motivation to learn more mathematics and this factored heavily in her decision to recommend for me to work with Linda. I related the goals of the study to Linda in our first meeting and these included helping her learn mathematics content connected to her curriculum and observe the evolution of our partnership. I also outlined the benefits that she and the students could derive from my help in the classroom. She wanted the study to focus on her as a learner in our one-on-one discussions and was reluctant to be videotaped in the classroom.
We began communication with each other around the beginning of January and I visited her classroom at the end of January. I continued to visit Linda’s classroom informally until the beginning of the study in mid-March. These initial visits were to observe the classroom setting, Linda’s style of teaching, and to interact and build rapport with Linda and the students. Linda used our meetings to ask for suggestions about good tasks that she could supplement her regular curriculum *Middle School Mathematics* (Charles et al., 1999). I recommended the Connected Mathematics (CMP) curriculum (Lappan, Fitzgerald, Friel, Fey, & Phillips, 1998) as a possible source for good tasks. Linda occasionally started using these tasks with her students and presented the problems on the overhead, since the students did not have the CMP texts.

**My Roles**

My roles were split between my time in the classroom as a participant-observer and as a facilitator in our one-on-one discussions. I took field notes on the instructional moves that Linda made in the classroom in terms of the routines that she had in place, the tasks that she assigned and set-up for the students and her interactions with them as they worked on the task. The field notes also helped in reflecting on the current work that Linda was doing and allowed me to plan future possibilities.

The four major topics that Linda and I discussed were probability (seventh grade), functions (seventh grade), statistics (sixth grade) and algebra (sixth grade). Simon’s (1997) ideas about teaching with a constructivist perspective guided my interactions with Linda as I tried to pose problems and facilitate discussions around these problems. My goal was to challenge Linda’s thinking in ways that would enable her to ‘unpack’ (Ball & Bass, 2000) the mathematics concepts. Linda would inform me in advance about the topic that the class would be teaching and I would plan activities or problems for our discussions and some for her to work on.
independently. Based on our discussions of the problems, I would decide if Linda needed to
work on additional material that might further support her understanding of the central
mathematical ideas. Later in the study, the discussions were based on the needs of Linda and my
role changed to preparing a broad range of activities and problems. I read widely on the topic of
focus in the classroom and also watched professional teaching videos (Annenberg Media, 2001)
for ideas that could be useful in our discussions. The activities that I chose or assigned for our
one-on-one discussions were sometimes modified for use in the classroom, but this was not my
explicit intention at the outset of the study. The focus in the beginning was Linda’s growth as a
mathematics learner.

I supported Linda with planning of lessons especially if they were based on an activity
that we had discussed. After implementation, we would usually debrief about the issues that
arose from the classroom and these issues would inform further planning. I generally sought to
focus Linda’s attention to the mathematics and connections that were present in the activity and
how this related to our one-on-one discussions.

Data Collection

Data for this study was collected over a period of about four months in 2006; two
months in Linda’s seventh grade class and another two months in her sixth grade class. The
entire data set consisted of 35 classroom observations and 32 after class (one-on-one) discussions
(ACDs). The classroom observations were recorded in field notes and the discussions with Linda
were either audio and/or video-taped. I maintained a research journal through the course of the
study to record my reflections about our interactions.
**Data Analysis**

To study my partnership with Linda, I had to create the conditions for our interactions and then researched the evolution of the partnership. Since I initiated, and then had a major responsibility in the phenomenon that I was going to study, my role was that of an insider (Ball, 2000b). As an insider a major issue was a separation of my roles as a researcher and as a facilitator. During my interactions with Linda and planning for our meetings, my role was that of a facilitator. On the other hand, I assumed the role of a researcher when writing my journal entries. This enabled me to maintain separate roles and prevented constant switching. Besides ongoing data analysis, I did a large part of the data analysis in retrospect as the role of a researcher.

Symbolic Interactionism (Blumer, 1969) was an overarching theoretical framework that guided this study and the data analysis in particular. I assumed that individuals act towards objects (could be another person) based on the meaning that they assigned to them and that these meanings were socially negotiated through interactions in language. Further, these meanings could be dealt with and modified via thought. I focused on having mathematical conversations with Linda and assumed that she would appropriate the mathematics and would ‘emerge’ from the constant back and forth in social interactions. At the same time I would also appropriate her ideas through our discourse. By analyzing the nature of our interactions, through the written transcripts, I hoped to track the emergence of our individual selves and thus trace the evolution of the partnership.

My data analysis followed a cycle of data organization, transcription, reading, coding, and description (Creswell, 1998). I used NVivo 7 to organize the transcribed audio and video files from our one-on-one discussion and then coded this data. I focused on the interactions
between Linda and myself and coded our communication in categories like Linda answers my questions, Linda on student thinking, I teach or I suggest. These were particular instances of broader categories of Linda’s interactions and My interactions. Going through the entire set of transcriptions, I noted that in the beginning our interactions were based on the mathematical content, usually initiated by me and Linda’s responses were usually trying to make sense of my utterances. Towards the end the discourse was dialogic in nature (Linell, 1998) with the ideas being co-created by Linda and myself and the topics consisted of mathematics content and teaching. I also noted that the disconnect code, which marked the occurrences of sudden shifts in the nature of the discourse from a more general mathematical topic to something specific about planning of an activity, played a significant role in the transition of our partnership. I reexamined the nature of our interactions before and after the cluster of disconnect codes and interpreted our partnership as having progressed through three stages. I triangulated these stages with entries from my reflective journal where I noted Linda’s push to discuss teaching issues and my dilemma at balancing the discussion of mathematics content with her teaching needs. The data did not fit neatly into the three stages and there was evidence of overlap in stages and a blurring of boundaries. I worked closely with my dissertation supervisor to determine the reasonableness of my coding and interpretation of the data. I also shared my interpretation with Linda who agreed with my conclusions. Once I theorized the partnership evolving through three stages, I went over the data again and examined how the partnership contributed to the mathematical and pedagogical issues in planning and teaching by focusing on our interactions around tasks that occurred in the above defined stages.
Evolution of the Partnership

Stage 1

The agenda at this stage was determined by me. I introduced Linda to probability, which was a topic she planned to teach in the coming weeks. We discussed probability through problems in the *Connected Mathematics Project* (CMP) curriculum (Lappan et al., 1998) and *Mathematics for Elementary School Teachers* (Bassarear, 2005). Our sessions involved Linda working on problems that emphasized problem solving and conceptual connections; our discussions revolved around her solutions or attempts. I answered Linda’s questions, guided her thinking through questioning, explained a concept or discussed general ideas in mathematics or teaching. Linda assumed the role of a teacher-as-learner as she answered questions I posed, clarified concepts, and verified steps in her solutions to the problems we discussed.

I dominated the discourse and this was also the case when Linda was ready to plan for her first probability lesson. I suggested the Tile Problem which involved the students finding the fraction of blue, green, and yellow tiles that were present in the bag. Linda agreed that this problem, which we had discussed in one of our prior sessions, would be appropriate for the students. However, Linda was reluctant to design her own activity based on the above ideas and insisted on using the teacher’s guide to designing the lesson. She decided to follow the procedures outlined in the manual and have the students answer the questions that were laid out. We also had a discussion about the Performance Objectives (POs) that would be ‘covered’ through this activity and Linda appreciated the fact that multiple POs were addressed. I outlined the important concepts for Linda to focus on like the higher the number of trials, the closer one would get to the actual fraction of a color. Linda mentioned that it was hard to keep track of all the things that she had to mention in class. I interpreted this as Linda not having ownership over
the activity and relying on remembering important aspects that she would present to her students. On enactment, the students followed the procedures, but did not explore the important ideas of experimental and theoretical probability. After debriefing, Linda attempted to address these aspects in the next lesson by revisiting ideas through a similar problem.

In general, during the first stage, Linda assumed the role of a learner as we engaged the mathematical content. Linda did not bring up issues of teaching and planning unless I queried her about planning or commented on a teaching episode that I observed in the classroom.

**Stage 2**

This short stage was characterized by the appearance of content-teaching tensions in our larger discussions of the content. These tensions arose as a result of the tussle between my goal to discuss the mathematics content and Linda’s need to discuss the planning of a lesson. For example, in the discussion below about algebraic word problems, I was emphasizing the need for the students to interpret the verbal description into appropriate symbols and have proficiency in solving the equations. Linda then suddenly changed the topic of discussion to the specific planning of a lesson.

A: … just doing the word problems [I meant just writing the relationships between the variables] and knowing how to represent them won’t get you to the solution because you still have to solve the [equations]

L: (Interrupting) Now going back to your, to the Lollipop problem, if I were to do that on Monday you know, just give them some fun before I leave. I mean it’s basically what we have done (right) but how can I set it so that it is adding something else to it? (Video transcript, 4/20/06)
The above discussion represented a sudden shift in our discourse from a broader discussion of algebra, towards the specific planning of a lesson that Linda wanted to teach. I interpreted these occasions as Linda’s need to tie in her planning with our discussions of the content. A major reason for this may have been the shortage of time and her need to use the planning period to prepare for the upcoming lessons, rather than just having content discussions. This stage contrasted with our interactions in the first stage where Linda would not interrupt our discussions with planning needs.

Our discourse shifted from the content to aspects of teaching, there was a chance that our focus could shift to the logistics of planning. I tried to intervene in these instances to bring the mathematics back to our discussion. I was concerned that our discussions would move away from the mathematics and would not help Linda’s initial goals. Thus at this stage, Linda’s need to plan and my focus on the mathematics had to be negotiated.

In planning lessons at this stage, Linda chose all the tasks for her class and in some cases these were the tasks that we had worked on in our prior one-on-one discussions. Linda used me as a resource to bounce off her teaching ideas to make sure that they were mathematically sound. For example, she chose the Lollipop activity which involved the students determining the time it would take to suck a lollipop by recording 8 measures of the circumference after 30 second intervals and using the line of best fit. The students would assume that the initial circumference at \( t = 0 \) was one of the points on the line and they would ‘eyeball’ and draw the line that was closest (vertical distance) or passed through as many points as possible. One of the mathematical issues that arose in the planning of this lesson was to find the time it would take to suck a lollipop that was six times the circumference of the original lollipop. Our discussion built on the equation \( C = -0.4t + 6.3 \) [Initial circumference 6.5 in, - 0.4 was the slope of the line] which
Linda had previously derived by working through the activity. She noted that we would get a negative value for time if we simply substituted \( C = 6(6.5) \) in the equation and worked out the value of \( t \). Instead Linda pointed out that an alternative way of examining this problem by shifting the graph, parallel to itself and upwards so that the \( y \)-intercept was six times the value of the initial circumference (Refer to Figure 1 below).

**INSERT FIGURE 1 ABOUT HERE**

This stage also differed, from the first, in the nature of teaching discussions raised by Linda. For example, in the Lollipop problem, some students came up with the graph below (Figure 2) and could not find the time it would take to suck the lollipop, since there was no \( t \)-intercept. Linda discussed the guidance that she ought to provide the students and in the process we discussed issues of scale and proportionality.

**INSERT FIGURE 2 ABOUT HERE**

In summary, this stage was characterized by the appearance of the content-teaching tensions, the push towards discussions of teaching, and my concern about moving away from the mathematics. Further, this stage contrasted from the previous one as Linda sought my guidance on mathematical issues that arose in her planning and teaching. There was a thrust on Linda’s part for knowing the correct solution to problems that we discussed and even problems that she intended to use in the classroom.

**Stage 3**

This stage was characterized by a move towards managing the content-teaching tensions, from the second stage. There was a shift in the discourse towards planning lessons and debriefing issues that arose in the classroom. The mathematics content was intertwined with the discussions of planning and student thinking. At this stage, there was evidence of Linda taking an active role
in adapting problems for the class. For example, Linda expressed a desire to do an activity with the students that would build on their previous lessons on data representations. I offered some suggestions and Linda analyzed these critically by making ‘what if’ moves, which involved her assuming the role of the students, hypothesizing their engagement in the activities, and possible ways that these activities would unfold in the classroom. It was through this process that she adapted my suggestion of the Hat problem into the Shoe problem, for use in the classroom. The Hat problem (adapted from Annenberg Media [2001]) involved determining the number of hats of each size that had to be purchased, given that hats came in lots of a thousand. The Shoe problem was similar, but involved purchasing shoes of various sizes for middle school students.

In her planning at this stage Linda paid attention to her students’ thinking and chose tasks that went beyond satisfying the POs to encompass students’ thinking and classroom pedagogical issues. For example, Linda observed that the students would think of the median to be in the center of a line plot. In order to perturb this notion, she chose to assign them the Median problem where the students were required to construct a line plot of 22 names that varied in lengths from 10 to 21 and had a median length of 10. Linda’s planning at this stage could be contrasted with the previous stages in the active role she took in bringing up the mathematical issues for discussion.

Linda reflected on her teaching and in the case of the Shoe problem, she shared the teaching issues that arose as she tried to implement the problem. As the students attempted to work on the problem, Linda was surprised by their inability to make a frequency chart which they learned recently. Instead, she had expected them to be challenged by the proportional reasoning required in the problem, which was not the case.
L: Because right away when I said we have 20 pairs of shoes how many need to be 5 size 5 you … that was easy for them. But getting them to just put the frequency chart that was a struggle (laughs). I mean a real struggle. Then I’m thinking to myself, well how much of it do I do as a whole group because then they are just going to emulate what I’m doing and not going to think about it themselves. So I kind of just played with it all day long. Some classes I went as far as making a frequency chart. (Audio transcript, 08/28/06)

This episode represented a different dimension that was present at this stage in the partnership as Linda actively reflected on the students’ thinking and the amount of guidance that she was providing them. She also attempted to resolve the perturbation on her own, unlike earlier stages when she would consult with me. Even though this characteristic was observed, there was also evidence at this stage of Linda falling back on her old teaching methods when there was a time crunch. This happened as she was teaching fractions and she outlined the rules for the students to follow as they had to add fractions.

**Constraints in the Partnership**

*Initial Planning*

The initial stage of the partnership had elements of uncertainty as I was developing a rapport with Linda. I experimented with the initial activities based on prior research (Ball, 2000a; Ball & Bass, 2000; Schifter & Fosnot, 1993), Linda’s prior knowledge and her current teaching needs. The problems also had to challenge her appropriately and illustrate powerful connections in mathematics. Further, informed by my observations of Linda’s classroom, most of the problems could either be modified or used directly in her teaching.
Selecting activities that would meet the criteria was a challenge and I examined various sources such as professional development books and videos, pre-service teacher education textbooks, college texts, and curriculum materials. I also used my own knowledge and experience in teaching mathematics. I decided to combine the research based activities in the CMP curriculum (Lappan et al., 1998) with activities from Bassarear (2005). These activities allowed for mathematical discussion around important concepts, illustrated connections to other parts of the curriculum, and had the potential to challenge Linda.

*Balancing*

The dynamic nature of the partnership brought up a number of issues in the first and third stages that had to be handled. In the first stage, based on Linda’s request for content development, I wanted abstraction to be the underlying focus of our work so that she could build connections between seemingly different problems. As we worked together, Linda would seek to think in concrete terms and examples; this caused me to reassess the problems that I chose for our discussion. For example, in probability we performed an experiment to understand the experimental and theoretical probabilities (concrete), but we also worked on problems where Linda was required to use appropriate symbolic representations (abstract), set up equations, and solve them using her prior knowledge. In some cases we had to review prior knowledge (e.g. the quadratic formula). I had to balance both aspects of the abstract and concrete in the discussions and this caused me to pay close attention to Linda’s observed thinking of any problem.

In the third stage, the nature of our discussions changed to a focus on lesson planning as Linda assumed a proactive role. My role shifted from a facilitator to a supportive role and responded to Linda’s needs. Our experiences in teaching, led to different teaching perspectives that arose in our discussions. My experiences were based mostly in teaching at the university...
where students generally engaged in problem-solving and off-task behavior was rare. Further, it was easier for me to assign higher level tasks, despite the occasional resistance. Linda’s perspective was developed through her teaching in schools where her students entered the 6th grade without being proficient in some concepts discussed in the 5th grade (e.g. fractions) and it was challenging to assign tasks of higher demand. Further, it was a challenge to get her current students to work as a group and engage in the mathematics. The students would seek her help when they encountered difficulties and would not try to resolve it in their groups. As a result, Linda would consider the classroom management during our planning sessions. In the following section of discourse, related to the Shoe problem, Linda wanted the students to fill out a table where they would avoid the use of percents and fractions. She was concerned that they had not covered these topics in class and the students might not recall these from their previous grade.

L: Now we haven’t gone into percentages or anything. So what would be the most efficient way to show them [how to solve the problem without percents]? I haven’t formally covered it this year.

A: They know like things from fifth grade?

L: Oh, I hope so (laughs) that’s the goal. So formally I haven’t shown it to them. So what would be (A interrupts)

A: I was thinking, should you just leave it as a “what fraction of” … then you can teach them ok if you have … one-tenth of 100 or 200?

L: They won’t know ... that.

A: One-tenth of?

L: I don’t think so.

A: Yeah?
L: I don’t THINK so!

(pause)

A: Cause did they do fractions, I can’t remember? From last year?

L: They should know fractions, but I don’t know …. So still going through a whole cycle, what would be the best way to get to that section if they don’t remember? (Audio transcript, 8/28/06)

The tension in our approaches comes through as I want Linda to use fractions and she sought to avoid their use. Linda assumed that the students would struggle with the fractions and sought to bypass this by modifying the activity to eliminate the fractions. I was trying to examine how the students could grapple with fractions instead of avoiding them. Episodes like these were interesting points for our learning; however, they were also points where careful negotiation was required to move the partnership forward.

Assessments

The current high stakes testing environment constrained Linda’s teaching since she always had one eye on preparing the students for the test. Combined with a shortage of time, assessments played a big role in topics that were emphasized with the students. For example, the assessments had more questions on fractions than probability and Linda mentioned that she emphasized fractions, given that she could not ‘cover’ the entire curriculum for the exam. Below, Linda elaborated on these thoughts.

L: Yeah but probability wasn’t one of those power questions … where there are a lot of them so you want to focus on that to boost your score so like let’s say the regular year, if you don’t have enough time, probability would be the topic to be thrown out … so I am
not as experienced in teaching probability as I am fractions…because you know fractions is always on the test … so fractions, fractions, fractions! (Video transcript, 3/23/06)

This passage revealed that the relative importance of topics was driven by the content in the tests. Fractions got the bulk of attention and topics like probability got marginalized. Thus the high stakes test had a major impact on what mathematics got to the floor and the students’ opportunities to learn. Combined with the shortage of time, Linda was usually faced with the dilemma of either continuing with a new topic or consolidating the students’ current knowledge.

Assessments also brought up a point directly related to the activities that we were engaged in. Linda expressed concern for the CMP activities that she implemented in the classroom would not prepare the students for the assessments. Even though she expressed an interest in doing ‘hands on’ activities with the students, she had doubts that these activities were the best preparation for her students. Linda mentioned that the questions in the CMP activities were worded differently to what students might see on the assessments and thus her students would be at a disadvantage.

L: I don’t think that they need more knowledge…but I think that it’s the way that they word the test (ok). It’s a test taking skill, its practice with how to interpret the questions and I think these questions [from the CMP activities] are very different than what you are going to see on a test … I think it’s just a matter of language and getting used to the language of an exam. Seems like it’s different … (Video transcript, 3/23/06)

Later in the study Linda came to recognize the advantages of the CMP, but she would also introduce the vocabulary that the students would encounter in the exam. In conclusion, our discussions about the assessments brought out the issues that constrained Linda and allowed us to reflect on them and think about strategies around the constraints.
Time

Linda required extra commitments on her time to do the study. She was in school from 8:20 a.m. till 3:50 p.m. and had two planning periods during the day. In the first planning period Linda usually substituted in another class and the second one was used for her own planning. We initially met four days a week, but this could not be sustained as Linda would be called to substitute on one or more days. Besides teaching four mathematics classes, Linda was also in-charge of the school Yearbook and our sessions were usually interrupted by students who needed the camera or wanted to discuss aspects of their design with Linda. Linda had other administrative commitments of attending staff meetings, contacting parents of underperforming students and maintaining records. The use of activities from the CMP took up time and Linda expressed concern that she would fall behind in covering the content for the classes. For example, in the Shoe problem Linda mentioned,

L: No I know that’s good [to get the students to think as they did the CMP activities] but then in the end, now a one day activity is going to be a two day activity and it turns into a whole week and it’s like ahh! my gosh … (Audio transcript, 8/28/06)

Linda expressed her concern for the students struggling with the activity and the students taking more time than allotted. The issue of time was challenging to our partnership and a balance between the students’ understanding, the mathematics, and moving ahead with the curriculum had to be examined carefully.

Classroom Issues

The students asked Linda questions if they faced difficulty with the problem and it was a challenge to get them to discuss in their groups. Thus Linda would have to move among the groups and got overwhelmed with the number of students that were asking her questions. As
Linda was engaged with a student or a group, there was potential for the other students to engage in off-task behaviors as they waited for Linda. She tried to reinforce norms in the class that made the students discuss in their groups. These aspects impacted Linda’s view of our joint work.

Positive feedback from the students encouraged Linda and reinforced her belief in the CMP activities. An example of this was a positive response from a student who never submitted class work before, but started doing so after working on these activities. Linda credited the activities with this turn around.

L: … providing these activities, I’ve moved away from the textbook she’s doing a lot more work you know. She’s collaborating with [her partner] and she’s turning in her papers. She’s never done that before. So I don’t know if it was just the intimidation of seeing you know 30 problems on a textbook page versus seeing one or two things that they need to think about and answer. I don’t know what it is, but she wouldn’t do anything, she wouldn’t turn anything in. It was consistently a failing grade you know every quarter. (Audio transcript, 3/27/06)

Linda also got positive feedback from the students about their homework which involved a few challenging problems from the CMP as opposed to thirty problems that employed rote procedures. Combined with other positive feedback from the students, Linda’s confidence for the curriculum grew over time.

*The Movement in the Partnership*

The partnership began with our focus on individual goals as Linda sought to improve her content knowledge and my focus was directed at the evolution of the partnership. Our interactions in the first stage reflected these goals and the mathematics content was at the core of our discussions. As the partnership progressed, Linda chose to adopt the CMP curriculum in her
classroom and this raised a host of issues about the mathematics in the activities and the
classroom implementation. The appearance of the content-teaching tensions in the second stage
of the partnership reflected Linda’s need to discuss the above mentioned implementation issues.
Further, the exclusive focus on the content in the first stage gave way to an intertwining of the
mathematical and pedagogical issues in our discussions. The appearance of the tensions caused
me to rethink the focus of my work and I decided to focus on the teaching issues that were raised
by Linda. In the third stage there was evidence of dialogue and co-construction of knowledge as
we acquired the mutual goal of student learning through the successful implementation of the
CMP.

Managing the content-teaching teaching tensions at the second stage was important in
generating the dialogue in the third stage. Ignoring the tensions could have continued interactions
similar to those in the first stage and this could have contributed minimally to our learning. By
addressing the tensions, Linda felt that her classroom needs were being addressed in the
partnership and it was authentic. The tensions also brought us towards our common goal of
addressing the students’ learning through the implementation of the CMP.

*Key Elements for the Movement*

The first stage was important in setting the pace for the rest of the study. During the first
stage Linda grappled with the mathematical concepts through problems in the CMP and realized
the potential of implementing the entire curriculum in her classroom. We discussed how multiple
Performance Objectives were addressed, how the conceptual understanding of the students could
be developed, and how connections were made between and within topics through the problems.
Linda also conjectured that these activities would benefit her students in the assessments and
address the current time pressures that she faced in completing the curriculum. Further, the
students were more engaged with the CMP problems than problems from their regular textbook. The first stage went a long way in establishing the credibility of the CMP as a valid curriculum in her class.

The movement in the partnership can also be attributed to affective factors like collegiality and trust (Day, 1991; Marlow, Kyed, & Connors, 2005) which can be viewed, in more detail, through Rawlins (1992) framework of dialectic tensions. Rawlins (1992) outlined four major dialectic tensions that either fostered or hindered a relationship, namely, dialectics of acceptance and judgment, affection and instrumentality, expressiveness and protectiveness, and dependence and independence.

The dialectic of judgment and acceptance referred to the tension between holding the other partner to standards or accepting them with their strengths and weaknesses. Discussions of the mathematics content may have been perceived by Linda as an evaluation of her mathematical knowledge and there was potential for our partnership to stall. Linda mentioned that she was reluctant to “talk too much” in the classroom as she was reluctant to make a mathematical error in front of me, the “expert”. In our interactions about the content, I had to be careful not to appear to be judging Linda’s knowledge. Later in the study, Linda gained more confidence as she led our discussions about teaching and the students’ thinking. Acknowledging her contributions paved the way for acceptance.

Further trust with Linda was built through attending to the dialectical tension of affection and instrumentality by ensuring that her needs were at the fore of our work in the partnership. I was eager to counter the traditional view that researchers used the teachers for their research only. However, by attending to Linda’s needs I came into apparent conflict with my goals of discussing the mathematics content and I was concerned that our teaching discussions would side
track our focus from the mathematics. However, a balance between our needs was achieved as the mathematics was interwoven in the teaching discussions. Our common goal of facilitating the CMP curriculum in the classroom was instrumental in achieving this trust and mutuality.

The dialectic of expressiveness and protectiveness played a role though the entire collaboration with both of us being protective in the beginning, but more open about our views as we attained a closer relationship. In the first stage it was better to exercise restraint with respect to Linda’s mathematical knowledge so that there was a degree of trust established before I could be expressive about errors that she made. Later in the study, I could challenge Linda to solve problems independently and could be candid in my suggestions about the mathematical and teaching issues that arose.

The dialectic of independence and dependence played out with more independence in the beginning as we assumed separate goals and later moved towards interdependence as we pooled our resources to achieve a common goal. Even though we had independent goals initially, we depended on each other for achieving these goals. In aspects of teaching, Linda had autonomy over the topics and activities that she chose to implement in the classroom.

The shift in the partnership through the three stages, by maintaining the balance of the four dialectical tensions, addressed the hierarchical nature of the traditional learning relationship (Olson, 1997). Our work in a safe zone brought together the research and practical knowledge and alluded to the complementary nature of our partnership (John-Steiner, 2000). In the process we were “provided with a way to reconstruct [our] past knowledge and imagine future possibilities” (Olson, 1997, p. 24). Collaboration was achieved by understanding the work of the other partner through joint reflection and discussion and hence mirrored the ideas of Clarke et al. (1996). I consider our interactions to be true dialogue as we achieved goals beyond what either
of us had envisioned initially (Johnston, 1997), namely the implementation of the CMP in the classroom.

Implications

In this study neither Linda nor I envisioned the central role that the CMP curriculum would play and the eventual adoption of the curriculum. It is possible that Linda’s experience with *Investigations* (TERC, 1998) enabled her to take a favorable stance towards the CMP. Further, our work in the first stage, the students’ positive feedback, and my support could have factored in to make her decision. New curriculum is usually handed down to teachers and they do not get the time and support needed to test it out in their classroom. This study points to one way that teachers could be initiated into the reform curriculum and supported in taking risks by the researchers.

Dialogue played a big role in managing and learning from the tensions. Traditionally, research in mathematics teacher education has not explored the potential of engaging the teachers in genuine dialogue, since the researchers have come to the study with a pre-determined agenda for professional development based on prior research. As a result, there has been less focus on engaging the needs of the teacher and more emphasis on the teacher fitting a pre-existing model. By operating with a fixed research agenda, the co-operation of the teachers could be got for a limited period of time but it would be harder to sustain this development in the absence of the researcher. Collaborative work needs to pay attention to the goals of the teacher and the researcher’s goals needs to be weaved into this fabric. In this case study there was evidence of Linda’s growth as a reflective teacher as she continued using the reform materials in her classroom and discussed her experiences in our occasional conversations.
This study highlights the aspects of an individual partnership between one teacher and one researcher. The next challenge would be to scale this up to a researcher working with a group of teachers. It would be interesting to note the tensions that would arise in this case and the evolution of the group as a whole.
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Contact Details:
Anthony M. A. Fernandes
University of North Carolina Charlotte
9201 University City Blvd.
376 Fretwell Building
Charlotte, NC 28262

Emails: anthony.fernandes@uncc.edu; azmafam@yahoo.com

Phone: 520-461-4596
References


Appendices

[Insert appendices here]
Author Note

[Insert Author Note here]
Footnotes

[Insert footnotes here, do not use Word's footnoting function]
Table [Insert table number here]

[Insert table title here]

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Figure Captions

Figure 1. Lollipop problem, time for 1 unit & 6 units

Figure 2: Lollipop problem, Circumference vs Time
1. Circumference (inches) vs. Time (minutes)

2. Circumference (inches) vs. Time (minutes)