

A PARTNERSHIP BETWEEN A MIDDLE SCHOOL MATHEMATICS TEACHER AND A UNIVERSITY RESEARCHER CENTERED ON CONTENT AND TEACHING

Anthony M.A. Fernandes
University of Arizona
azmafam@math.arizona.edu

This case study examines the evolution of a partnership between a middle school mathematics teacher and a university researcher as we discussed content and teaching. Resolutions of content-teaching tensions moved the partnership through three stages, from a focus on the content, to discussions of lesson design as the teacher gradually adopted the Connected Mathematics curriculum. Our goals changed from individualistic to a more shared vision derived through implementation of activities/problems and focusing on student thinking. The shift in the partnership can be attributed to the adoption of the Connected Mathematics curriculum by the teacher and the effective management of the dialectic tensions of acceptance/judgment, dependence/independence, affection/instrumentality and expressiveness/protectiveness by both partners.

The current push for reform mathematics seeks to break away from the traditional “banking” concept of education (Freire, 1970) where the students are viewed as receptacles that need to be “filled” by the teacher via showing and telling, and instead move towards an approach informed by constructivism (von Glasersfeld, 1995). There is a call for students to actively construct their knowledge as part of a classroom community by engaging in challenging problems, inventing procedures, justifying the validity of these procedures and communicating these ideas to peers (NCTM, 2000; Simon, 1997).

Teaching with the reform vision outlined above is a challenge for teachers and calls for a deep and flexible knowledge of mathematics which goes beyond what teachers learn in their pre-service teacher education (NCTM, 2000). There is a need for ongoing professional development that might include a number of models that focus on various aspects such as, teacher knowledge (e.g. Developing Mathematical Ideas seminars [Cohen, 2004]), instruction, (e.g. Japanese Lesson Study [Fernandez, 2002]), student thinking (e.g. Cognitively Guided Instruction [Fennema et al., 1996]), and a combination of instruction and student thinking (e.g. Purdue Problem-Centered Mathematics Project [Cobb, Wood, & Yackel 1990]). All these examples of professional development involved prolonged interactions between teachers and researcher(s), but there is a lack of an in-depth examination of the collaboration between the researcher(s) and teachers and the evolution of this collaboration over time. This exploratory qualitative case study (Merriam, 1988) examines the simplest case (one-on-one) of collaboration between a middle school mathematics teacher and a university researcher as we come together for the ongoing professional development of the teacher. The study examines how the partnership evolves over time and its influence on the teacher’s planning and teaching.

Theoretical Framework

Collaborations between schools and universities have evolved in various ways and two major divisions, cited in the literature, are based on the organizational structure of the collaborations like Professional Development Schools (Handler & Ravid, 2001) and others that focus on the relationships in the collaborations such as symbiotic partnerships and organic partnerships (Whitford, Schlechty, & Shelor, 1987). Symbiotic partnerships

(Goodlad, 1988; Whitford et al., 1987) involved unlike partners who came together for the mutual satisfaction of their goals. Further, each partner displayed enough selflessness to ensure the satisfaction of the others goals. Schools and universities, like all institutions, deteriorate when things are left unattended, and Goodlad (1988) suggested symbiotic partnerships between these institutions as a way for renewal through varied expertise and a continuous flow of new ideas.

Organic partnerships involved partners who performed unique functions but had common goals. The common goals were made explicit and neither partner 'owned' the goals. This differed from symbiotic partnerships, where the goals were owned by one of the partners. Whitford et al. (1987) pointed to professionalization of teaching as an example of an issue that was 'boundary spanning' and could foster organic partnerships. Here the two institutions could be jointly responsible for the development of teachers from the recruitment, selection, preparation to the ongoing professional development.

Collaborations between members of the university and schools are a challenge to build and sustain as learning relationships have been traditionally hierarchical rather than collaborative (Olson, 1987). To face this challenge, Cole and Knowles (1993) assumed that the teacher and researcher should negotiate all stages of the research work to reflect true collaboration. However, others (Clark et al., 1996) feel that by involving the teachers, with their busy schedules, in all aspects of the research, benefited the researcher more than the teacher since publications are viewed more favorably in the university than in the school. Instead Clark et al. (1996) argued that true collaboration arose out of dialogue between the partners that led to understanding of each others roles. They argue that there should be a push for shared understanding rather than shared work.

Tensions are a common theme in collaborations between unlike partners and resolving these tensions can be critical in moving the partnership forward. Some studies (Freedman & Salmon, 2001) have examined the evolution of partnership through the lens of dialectical tensions of acceptance/judgment, dependence/independence, affection/instrumentality and expressiveness/protectiveness (Rawlins, 1992). The dialectic of acceptance/judgment referred to the tension between evaluating and holding the other partner to standards or accepting them with their strengths and weaknesses. The freedom to be independent but also to be there in times of need for the other partner is the dialectic of dependence/independence. Affection/instrumentality referred to the rendering of help for the other partner as opposed to expecting the favor returned. The efforts that the partners make to balance restraint and candor, so that it furthers trust, is captured by the dialectic of expressiveness/protectiveness. Day (1991) cited attributes like a caring nature contribute to resolving tensions and sustaining longer ethical collaborations where concerns of the teacher are addressed.

Methods

A qualitative case study (Merriam, 1988) approach was used to work, over a period of three months, with a mathematics teacher (Linda) in a middle school in the south west of the country. Linda was part of a middle school cohort in a large National Science Foundation funded project at the university. She was introduced to me (the researcher) by one of the Principal Investigators of this research project.

Meetings with Linda involved classroom observations in her mathematics class (her 7th grade class for two months and her 6th grade class for another month). Immediately after the classroom observation, Linda and I met, during her planning period, to have our discussions. I collected data for a total of 35 classroom observations and 32 planning period discussions respectively. Linda's instructional moves in the classroom and the group interactions of the students at my table were the major focus of my classroom observations. Three major content

areas namely, probability, functions, and statistics were discussed in the planning period discussions, prior to the implementation of these topics in the classroom. The planning period generally started with posing a problem or activity for Linda and then discussions took place around issues that came up. The problems were chosen from the *Connected Mathematics Project* (CMP) curriculum and other resources (e.g. *Mathematics for Elementary School Teachers* [Bassarear, 2005]). Lesson planning was also done at appropriate times and discussions of the students thinking also entered into the conversations. Field notes were taken of all classroom observations and discussions in the planning period were audio or video recorded or both. All our discussions in the planning period (a total of 32) were transcribed and data analysis was done in NVivo7 (QSR International, 2006) by isolating themes that reflected engagement and interactions of Linda and myself. The content-teaching tensions (discussed below) were identified as a key component in describing the stages of the partnership.

Results

Based on our interactions, the partnership evolved in three stages. The first stage was characterized by our discussions around the mathematics content. I introduced Linda to probability, which was a topic she would be teaching in the coming weeks. We discussed problems from the seventh-grade *Connected Mathematics Project* (CMP) curriculum and *Mathematics for Elementary School Teachers* (Bassarear, 2005) that emphasized problem solving and conceptual connections. Linda would attempt a problem and then we would have a discussion based on her work. The level of difficulty of the problems was such that they could be adjusted to the level of the students, if Linda chose to do the activity/problem in the class. For example, the Tile problem involved finding the fraction of tiles of a color in a bucket, given that there were tiles of three colors. Linda first did this activity as part of our discussion in the planning period and later chose this activity to introduce her students to the concepts of experimental and theoretical probabilities and their connection. In the first stage I controlled the agenda of our discussions and Linda participated in the activities/problems. She would share her thinking, answer questions I posed, and inquire about mathematics that was unclear. I dominated the first lesson that Linda planned at this stage (Tile problem) by reminding Linda of the important aspects of the problem that she should ensure her students understood. Linda did not have ownership over the activity and relied on remembering the important aspects as she attempted to transfer these to her students. After debriefing this lesson, I suggested that Linda do another activity with her students to ensure that they grappled with the concepts of experimental and theoretical probability. Linda's lessons at this stage were typically outlined based on the Performance Objectives (POs) of the State Standards as directed by the school district; student thinking was not a prominent focus although we would discuss the performance of the students on an activity.

The second stage was characterized by the appearance of content-teaching tensions in our discourse. This tension represented a sudden change in our conversation, initiated by Linda, from a discussion about the mathematics to her immediate planning needs. For example, in the following conversation about word problems, I emphasized the need for procedures in the promotion of algebraic thinking and Linda suddenly changed the topic of discussion to her planning needs.

Anthony : ... just doing the word problems and knowing how to represent them won't get you to the solution because you still have to solve, you have to manipulate the [expressions](Linda interrupts)

Linda: Now going back to...the lollipop problem. If I were to do that on Monday, just give them some fun before I leave...I mean it's basically what we have done.

But how can I set it so that it is adding something else to it?

The above discussion is representative of the sudden change in our discourse from a discussion of mathematics content towards the specific planning of a lesson that Linda wanted to teach. This interaction contrasted with similar interactions in the first stage where Linda would not interrupt our discussions with planning needs. With the appearance of tensions the discourse moved towards teaching and sometimes there was a tendency to dwell on logistical issues of implementation. In these instances, I tried to ensure that we refocused on the mathematics content. I did this by discussing the mathematics that arose in an activity/problem that Linda wanted to discuss. In general, the mathematical issues were intertwined with discussions of planning and this was also a characteristic that was present in the next stage of our partnership. At this stage Linda anticipated me to provide guidance in teaching issues that arose in the class. This would be different in the next stage as Linda took a more proactive role in thinking and resolving teaching issues that arose in her class.

The third stage was characterized by a move towards resolution of the content-teaching tensions as Linda assumed a proactive role in controlling the agenda. She adapted problems for her class and reflected on the difficulties that arose in the class discussions. I assumed the role of being a resource for Linda by suggesting activities, supporting her decisions, giving feedback for her ideas, and answering her questions. For example, in our discussion on Statistics, Linda expressed a desire to do an activity with the students that would build on their previous lessons on various data representations. We decided to brainstorm and came up with a number of activities that Linda evaluated by considering ‘what if’ moves (The ‘what if’ move involved Linda reflecting on the activity from the students’ point of view and conjecturing about possible difficulties the students would encounter). Finally, Linda adapted the Hat problem to the Shoe problem. The Hat problem involved a person starting a hat shop who had to determine the number of hats he should purchase, given that hats came in lots of a thousand. The Shoe problem was similar, but involved shoe sizes of middle school students.

The planning of the Shoe lesson contrasted to the role that Linda assumed in the planning of a lesson in the first stage where she accepted my suggestions without a lot of discussion. Further, in this stage the activities were not adopted directly from the curriculum but were adapted to suit Linda’s and the students’ needs.

The activities that Linda assigned from the CMP differed from the textbook problems that the students were doing before the study, as a result there were student difficulties that had to be resolved. In the previous stages Linda would seek my guidance in resolving these issues but in the third stage Linda attempted to resolve these issues on her own. Reflecting on some of the challenges of the Shoe problem, Linda related the following:

L: Then I’m thinking to myself, how much of it do I do as a whole group because then they [the students] 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.

This episode was typical at this stage in the partnership when Linda was actively reflecting on the students’ thinking and the amount of guidance that she was providing them. This differed to her reaction in the second stage when she anticipated me to provide guidance in resolving teaching issues that arose in the class. Tasks were just not selected if they just satisfied the POs, like the first stage; instead the tasks were also analyzed more closely from the students’ point of view and implementation in the classroom.

Discussion

The evolution of the partnership in this study through the three stages, reflects an evolution from a symbiotic partnership to an organic one (Goodlad, 1988; Whitford et al.,

1987). The partnership began as a symbiotic one with Linda's goals being to further her understanding in the mathematics that she taught and my goal was to expose Linda to the important mathematical ideas and examine the evolution of our partnership as we had these content discussions. These goals are reflected in our interactions at the first stage where the mathematics content was at the core of our discussions. We both made efforts to ensure that the other person achieved their goals. Gradually, as Linda chose to adopt the CMP curriculum (even though this was not the original goal of my study), she had more pressing questions about the activities and implementing them in the classroom. This can be seen in the content-teaching tensions that arose in the second stage of the partnership. Our content discussions were interrupted by Linda who wanted to discuss a specific activity she wanted to implement in her classroom. In the third stage, Linda and I both focused on the CMP curriculum and the issues that arose in the classroom during implementation. Thus we moved to an organic partnership with the common goal being the implementation of the curriculum and reflecting on the related classroom issues that arose as a result. In the process, Linda focused a lot more on the student thinking and chose to implement activity/problems could further their thinking.

Key Elements for the Movement

The first stage of this study was important in setting the pace for the rest of the study. Linda was introduced to the mathematics content through various resources that included the CMP curriculum. As Linda grappled with the mathematical ideas, she realized the potential of the curriculum for her students. Linda saw how multiple POs were addressed, simultaneously the conceptual understanding of the students could be developed, and connections could be made between and within topics. Thus she felt that her students would have the opportunity of understanding by building and strengthening their internal networks (Hiebert & Carpenter, 1992). Linda also saw the value of these activities in preparing the students for the assessments and addressing the time pressures that she faced in covering the content. She felt the problem solving activities would be more engaging to the students than their regular textbook exercises. The first stage went a long way in establishing the credibility of the CMP as a valid curriculum in her class. Further, I was also there to help her with the initial start up and address problems that arose. The first stage was crucial in Linda choosing the CMP curriculum and as a result determined the path that our partnership took over time.

Another important factor for the progress in our partnership was the collegiality in our relationship facilitated by effective management of the dialectic tensions (Rawlins, 1992). Tensions of acceptance/judgment arose in our 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. Later in the study Linda mentioned that she was reluctant to talk too much in the classroom as she was afraid of making an error in the mathematics in front of me as she perceived me as the 'expert'. In our interactions around the content, I made an effort not to appear to be judging Linda's mathematics knowledge. As a result, I would provide a lot of guidance if Linda expressed difficulty with the content. In the last stage, with our improved understanding of each other, I waited longer for Linda to come up with solutions independently. As our discussions shifted to teaching and the student thinking, Linda gained more confidence as she could contribute a lot to the discussions. Two factors that could have contributed to building trust and acceptance in Linda were (a) acknowledging errors that I made in the mathematics content; and (b) recognizing that she knew more about her classroom and students. I encouraged her to share her knowledge of the classroom and students as part of the discussions and explicitly recognized her contribution.

Linda and I entered into the partnership by choice and there was freedom of independence but also a commitment to some level of dependence on each other. Linda felt free to cancel

our session if she had other work that needed attention and I accepted these instances as part of the study. This went a long way in establishing a trusting relationship and managing the dependence/independence tensions. I was there to support Linda when she wanted suggestions or asked me to comment on activities/problems that she chose for the class. I could also depend on Linda for allowing me to work with her and she was also open to implementing our discussed ideas in the classroom. Thus we could both express our dependence and independence in this partnership.

The dialectical tension of affection/instrumentality features prominently in general in the work between teachers and researchers, as there is a tendency to view the teacher as being useful in getting the research done. In our partnership, Linda asked me to outline the benefits that she would get in working with me and I gave two namely, learning more mathematics and supporting her in classroom. These were the conditions on which the study started and trust was built by adhering to these conditions during the course of the study. In thinking about this dialectic, I questioned myself after the appearance of the content-teaching tensions in the second stage and decided to deviate from my research agenda in an attempt to resolve these tensions. Thus Linda took control in the final stage and our collaboration grew. Although it was difficult to initially resolve stresses about this particular research model; this partnership allowed me to take risks and support our relationship professionally.

The dialectic of expressiveness/protectiveness played out with more protectiveness in the first stage and more expressiveness in the last stage as we established trust. 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. The wait time, that I allowed for Linda to solve a problem independently in the after class discussions, increased as the study progressed. Later in the partnership I could be more candid in my suggestions about the mathematical issues and her teaching in the classroom.

Acknowledgment

This research was supported by the National Science Foundation under Grant No. ESI-0424983.

Conclusions

The partnership highlights the importance that a reform curriculum or new innovation could play in mediating the relationship between a teacher and researcher. Balancing the dialectic tensions (Rawlins, 1992) contributes to relationship building and provides the language for expanding the construct of collegiality in collaborative research. In this study the teacher chose to adopt the reform curriculum over the traditional curriculum and was the only teacher to do so in the school. This has potential for further study as she influences the other teachers and could provide the blue print for ongoing professional development.

References

- Bassarear, T. (2005). *Mathematics for elementary school teachers* (3rd ed.). Boston: Houghton Mifflin.
- Clark, C., Moss, P. A., Goering, S., Herter, R. J., Lamar, B., et al. (1996). Collaborations as dialogue: Teachers and researchers engaged in conversation and professional development. *American Educational Research Journal*, 33(1), 473-495.
- Cobb, P., Wood, T., & Yackel, E. (1990). Classrooms as learning environments for teachers and researchers. In R.B. Davis, C.A. Maher, & N. Noddings (Eds.), *Constructivist views on teaching and learning mathematics* (Journal for Research in Mathematics Education Monograph No. 4, pp. 125-146). Reston, VA: National Council of Teachers of

Mathematics.

- Cohen, S. (2004). *Teachers' professional development and the elementary mathematics classroom: Bringing understandings to light*. Mahwah, NJ: Erlbaum.
- Cole, A. & Knowles, G. J. (1993). Teacher development partnership: A focus on methods and issues. *American Educational Research Journal*, 30(3), 193-231.
- Day, C. (1991). Roles and relationships in qualitative research on teachers' thinking: A reconsideration. *Teaching & Teacher Education*, 7(5/6), 537-547.
- Fennema, E., Carpenter, T. P., Franke, M. L., Levi, L., Jacobs, V. R., & Empson, S. B. (1996). A longitudinal study of learning to use children's thinking in mathematics instruction. *Journal for Research in Mathematics Education*, 27(4), 403-434.
- Fernandez, C. (2002). Learning from Japanese approaches to professional development: The case of lesson study. *Journal of Teacher Education*, 53(5), 393-405.
- Freedman, R. & Salmon, D. (2001). The dialectic nature of research collaborations: A relational literacy curriculum. In R. Ravid, & M. G. Handler (Eds.), *The many faces of school-university collaboration* (pp. 3-10). Englewood, CO: Teacher Ideas Press.
- Freire, P. (1970). *Pedagogy of the oppressed*. New York: The Seabury Press.
- Goodlad, J. I. (1988). School-university partnerships for educational renewal: Rationale and concepts. In K. A. Sirotnik & J. I. Goodlad (Eds.), *School-university partnerships in action: Concepts, cases, and concerns* (pp. 3-31). New York: Teachers College Press.
- Handler, M. G., & Ravid, R. (2001). Models of school-university collaboration. In R. Ravid, & M. G. Handler (Eds.), *The many faces of school-university collaboration* (pp. 3-10). Englewood, CO: Teacher Ideas Press.
- Hiebert, J., & Carpenter, T. P. (1992). Learning and teaching with understanding. In D. Grouws (Ed.), *Handbook for research on mathematics teaching and learning* (pp. 65-97). New York: MacMillan.
- Merriam, S. (1988). *Case study research in education: A qualitative approach*. San Francisco: Jossey-Bass.
- National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics*. Reston, VA: Author.
- Olson, M. (1987). An epistemological shift. In H. Christiansen, L. Goulet, C. Krentz, & M. Maeers (Eds.), *Recreating relationships: Collaboration and educational reform* (pp. 13-25). Albany, NY: State University of New York Press.
- QSR International (2006). NVivo7 [Qualitative data analysis software]. Victoria, Australia.
- Rawlins, W. K. (1992). *Friendship matters: Communication, dialectics and the life course*. New York: Walter
- Simon, M. (1997). Developing new models of mathematics teaching: An imperative for research on mathematics teacher development. In E. Fennema, & B. S. Nelson (Eds.), *Mathematics teacher in transition* (pp. 55-86). Mahwah, NJ: Erlbaum.
- von Glasersfeld, E. (1995). A constructivist approach to teaching. In L. P. Steffe & J. Gale (Eds.), *Constructivism in education* (pp. 3-15). Hillsdale, NJ: Erlbaum.
- Whitford, B. L., Schlechty, P. C., & Shelor, L. G. (1987). Sustaining action research through collaboration: Inquiries for invention. *Peabody Journal of Education*, 64(3), 151-169.