NCSM Journal

of Mathematics Education Leadership

WINTER/SPRING 2014 VOL. 15, NO. 1

National Council of Supervisors of Mathematics www.mathedleadership.org

Table of Contents

Learning to Lead Professional Learning Communities in Mathematics

Karin Brodie, Nicholas Molefe, Flourencia Lourens
School of Education, University of the Witwatersrand, Johannesburg

Professional learning communities are increasingly seen as a generative and sustainable method of in-service teacher development. Professional learning communities are situated in teachers' work and support teachers in using their experience, evidence from their classrooms, their own and their colleagues' insights, and knowledge from research to decide what they need to learn and how they can learn it. Teachers monitor their own and their learners' learning in ongoing ways and engage in inquiry into their own practices and knowledge through deepening cycles of analysis, reflection and action, interrogating current practice and exploring alternatives. For Katz and Earl (2010) professional learning communities are "fundamentally about learning – learning for pupils as well as learning for teachers, learning for leaders, and learning for schools" (p. 28). Curry (2008) argued that an underlying principle of professional learning communities is that "schools cannot be intellectually engaging places for students unless their teachers are likewise actively engaged in learning, thinking, reading and discussing" (p. 735). The collective nature of professional learning communities is important. Teachers collaborate and learn together about how their learners' needs can influence and improve their practice and create collective improvements in their practices.

Professional learning communities can be established both within and across schools and within and across subjects and/or grade levels in a school. In each case, the community explores different issues and links their explorations to school or subject practices in different ways. In mathematics, professional learning communities tend to focus on teachers' content and pedagogical content knowledge. In order to develop their own problem-solving skills and greater flexibility in working with learners, teachers focus in some cases on rich problems in mathematics, how they would solve them, and how learners solve them, (Borko, Jacobs, Eiteljorg, & Pittman, 2008). In other cases, teachers focus on their own instructional practices, through lesson planning and reflection, making sure to notice and attend to learners' mathematical thinking in the lessons (Horn, 2005; Stephan, Akyuz, McManus, & Smith, 2012).

There are strong theoretical arguments for professional learning communities and some evidence that they do produce improved teaching practices and learner achievement (Boaler & Staples, 2008; Katz & Earl, 2010). There is also a growing body of research on how successful communities work (e.g., Curry, 2008; Horn, 2005) and the difficulties in sustaining them, particularly in high schools (McLaughlin & Talbert, 2001). A key element in sustaining professional learning communities is leadership of the communities (Stephan et al., 2012; Stoll, Bolam, McMahon, Wallace, & Thomas, 2006). However, very little has been written, however, on how leaders learn to lead professional learning communities. In this article, we focus on how a group of facilitators of professional learning communities worked collectively as a professional learning community in order to learn together to become better facilitators. We draw on data from a professional development project in which we work, the Data Informed

Practice Improvement Project (DIPIP), to describe and analyze some of our learning as leaders[1].

Leadership in Professional Learning Communities

Leadership of professional learning communities is central to their success (Boudett, City, & Murnane, 2008; Katz, Earl, & Ben Jaafar, 2009; Stephan et al., 2012). The functions of leaders can vary, depending on the nature of the community, however two key, interrelated roles have been established as important. The first is creating a culture of inquiry, where teachers work together to understand challenges in their schools more deeply and to support each other in addressing the challenges (Curry, 2008; Katz et al., 2009). By inquiry we mean using data from classrooms to interrogate and challenge current thinking, knowledge, and practice, and to explore alternatives. Inquiry includes critique which involves looking at strengths and weaknesses, posing questions about practice and knowledge, and suggesting ways of building on strengths and improving weaknesses. The second role for facilitators is to support teachers in focusing on their students' knowledge, and subsequently their own knowledge and teaching practices (Boudett et al., 2008; Elliott et al., 2009).

Successful professional learning communities require both critique and care (Hargreaves, 2008; Jaworski, 2006). Successful leaders create the conditions for critique and care by being both critical and caring themselves. Critique is necessary if communities are to shift established practices for the benefit of learners and care is necessary to prevent critique from producing defensiveness. Katz et al. (2009) argued that leaders can "observe what may not be apparent to insiders, facilitate reflection on issues, ask questions, probe for justification and evidence to support perceptions, and help reformulate interpretations" (pp. 90–91). Furthermore, leaders "are not afraid to challenge assumptions, beliefs or simplistic interpretations, and they do so in a non-judgemental and helpful way" (p. 91). However, the extent to which leaders are able to manifest both critique and care varies among leaders and across the situations in which they work. The dynamics of some communities might make critique and care more difficult to establish and sustain, and the same community might present different challenges at different times. Brodie and Shalem (2011) described the co-development of challenge and solidarity in professional learning communities. Solidarity arises in the community through discussion of shared problems and issues in relation to learners and the curriculum and through similar histories as teachers and learners. Solidarity supports challenges to particular teaching practices and creates possibilities for improvement.

While critique and care are necessary, they are not sufficient for successful professional learning communities in mathematics. A crucial element is the focus of the community, in our case the teachers' mathematical and pedagogical content knowledge. Managing the balance between the culture of the community and the substantive learning that needs to take place is complex work for leaders of professional learning communities and needs to be learned by current and potential leaders of professional learning communities. Little has been written about how leaders of professional learning communities learn to do their work, particularly where the goal is improved mathematics learning and practice for teachers and learners. One important principle that has informed our work is that leaders of professional learning communities need the support of their own professional learning community of leaders of professional learning communities (Nelson, Slavit, Perkins, & Hathorn, 2008). In this article, we discuss the work of such a community, of which the three authors are members. We draw on vignettes from two professional learning communities of high school mathematics teachers, for which two of us were facilitators, as an example of how we bring challenging issues to our community, analyze and reflect on them, and then take our learning back to our work as leaders.

Theoretical and Analytic Framework

The theoretical framework that guides our work as leaders and researchers of professional learning communities is Wenger's (1998) theory of situated learning. Wenger argued that people learn through making meaning of activity and practice and through developing identities in relation to meaning, practice, and learning. Wenger (1998) posited three elements that underpin a community of practice:

- mutual engagement – participants engage in actions whose meanings they negotiate with one another;

[1] We acknowledge that there are varying roles for leaders in professional learning communities and that facilitation is one such role. Stoll et al. (2006) distinguished pedagogic and strategic leadership. In this article, we use leader and facilitator interchangeably because we function both as strategic and pedagogic leaders.

- joint enterprise – the enterprise is collectively defined by the participants and constitutes their response to their conditions; and
- shared repertoire – this includes practices or concepts that the community produces or adopts as they make meanings in their situations.

Wenger (1998) asserted that mutual engagement does not require homogeneity; a joint enterprise does not mean participants always agree – in fact, disagreement can be viewed as a productive part of the enterprise; and shared practice does not imply harmony. What is important is that the joint enterprise, and particularly its meaning for the participants, is negotiated collectively through ongoing participation in the community. This applies to both professional learning communities of mathematics teachers and to our professional learning community of leaders.

In the professional learning communities that we lead, teachers choose episodes from their own teaching to bring to their communities for discussion, in order to inquire collaboratively into their practices. As facilitators, we do the same: we choose episodes from these meetings in order to enquire collaboratively into our practices and to improve them. These episodes serve as a mechanism for mutual engagements and developing a shared enterprise. As we talk and write about these episodes, we develop new ways of understanding the facilitation process. A key part of the process has been the development of a set of facilitation moves or practices in which we see ourselves engaged or think we could have engaged. These moves serve as a *shared repertoire* and are organized into four key areas: general management, inquiry, content and building the community.

General management refers to having everything set up for meetings, taking notes of key points to follow up during the meeting, and making sure to attend to project goals. We will not discuss the area of general management in this article. Rather, we will focus on the three other aspects of our role: building inquiry (i.e., interrogating practice and knowledge and exploring alternatives); developing mathematical content in the community; and building the ways in which the community works together, with critique, care, challenge, and solidarity. These areas might complement or be in tension with each other, as will be seen in the vignettes that follow. In looking at these vignettes, we reflect on what actually transpired, what worked well and what did not work so well, what we learned from that episode and what could have been done differently. In our own community, we employ the same principles of inquiry, knowledge, critique, and care that we try to build in the communities with which we work.

Our Context

We work in a mathematics teacher professional development project in Johannesburg, South Africa, called the Data Informed Practice Improvement Project (DIPIP), which establishes and develops professional learning communities of mathematics teachers within and across schools. We currently work with six communities in nine schools, involving 34 mathematics teachers. The schools are located in areas that serve learners of low socio-economic status, most of whom are black. Since the advent of democracy in 1994, promises of improved education for the majority of black learners have not materialised and mathematics achievement and understanding remain low in most communities (Reddy, 2006), severely affecting the life chances of learners from these communities. A myriad of teacher development programs have not succeeded in improving the quality of teaching and learning in schools that serve the poor (Reddy, 2006), and it is hoped that professional learning communities working together in ongoing ways in schools might do so (Department of Basic Education & Department of Higher Education and Training, 2011). The experiences of our project suggest that while professional learning communities can embody the substantive democratic principles of critique, care, and improved knowledge, it takes substantial time, effort, and learning on the part of all members, particularly leaders, to make sure that the communities develop and reflect these values.

The schools in which we work are all functional, however they have minimal material. They have supportive principals and heads of mathematics and a minimum of four mathematics teachers from grade 8 to grade 11. They are also in close proximity to each other. Community meetings take place in the schools and we try to build ways of working that will sustain the communities over the long term. The teachers meet once a week for two hours to work on the project activities. A cycle of activities includes: analysing learner errors on a test; interviewing selected learners to understand particular errors on particular test items in more depth; deciding which key concepts underlie the learners' errors; reading and discussing papers on these concepts; planning lessons to engage with the

prevalent errors; teaching and videotaping the lessons; reflecting on the videotaped lessons; and choosing episodes from the lessons to discuss in the community (see Brodie and Shalem (2011) for more detail on the activities). At various points in the cycle, teachers from different communities come together in joint meetings, where they present aspects of their work to each other and give and receive feedback.

In the first year of the project, the facilitators worked closely with the teachers, attending every meeting and taking the entire responsibility for facilitation. After the first year, we gradually withdrew guidance. The communities chose one or two school-based facilitators, who took responsibility for facilitation and we gradually reduced the number of meetings we attended. When we did attend, we observed the facilitator and discussed the meeting with her/him afterwards as a means of support. We also conducted facilitator-training sessions once a month for the school-based facilitators[2]. The vignettes discussed in this article occurred during the first year, when we were still taking responsibility for the facilitation.

The university-based facilitators met weekly for two hours in project team meetings. The project team consisted of the three authors and two other facilitators and formed a professional learning community for the facilitators. During these meetings, we planned the activities, developed the protocols that we used for each activity, discussed the extent to which we and the communities managed to stay focused on program goals, discussed our facilitation strategies, and reflected on what happened in previous meetings, with the aim of improving the activities, the protocols and our roles as leaders of the communities. These meetings established our joint enterprise and mutual engagement in an ongoing manner, and we developed shared repertoires for engaging with each other and the communities. At regular intervals, we presented and analyzed vignettes, such as the two described in this article, in order to promote our own inquiry practices. In order to create sustained leadership in the communities, we recognized that how we learned as leaders needs to become a feature of how subsequent leaders will learn. Therefore, we analyzed our practice as leaders for our own learning and to anticipate the needs of and provide learning opportunities for future leaders in the communities[3].

The systematic nature of our regular meetings allowed for another important feature of professional learning communities: between the official meetings, impromptu and informal meetings occurred, to discuss issues as they arose. The two incidents described in the featured vignettes were first discussed in this impromptu way and allowed one facilitator to learn immediately from the experiences of another. Thereafter, they were brought to a regular meeting for more systematic discussion and analysis, which appears in this paper.

The Vignettes

VIGNETTE ONE

The first incident took place in a community of six teachers: Dimpho, Chamu, Mapula, Khumo, Mandla, and Funeka[4]. Dimpho presented an episode where a learner had written an answer of 10 cm + h cm as an answer to a question about heights, and the teacher simplified it to (10+h) cm. As the community was about to move on to the next episode, the facilitator mentioned, "Remember you're not taking out centimeters as a common factor there." Dimpho agreed, but Chamu did not and a long discussion ensued, mainly between the facilitator and Chamu, with some contributions from Dimpho and Mandla. The facilitator's main argument was that centimeters are a unit of measurement and not a variable, and therefore cannot be operated on in the same way as a variable. Chamu presented a number of arguments, including: the units are multiplied by the number (i.e., h cm is the same as h x cm); km/hour is obtained when dividing distance by time and km by hours; and the unit of measurement for area, cm^2, is obtained by multiplying centimeters by centimeters. The facilitator argued that you multiply the numbers but not the units and that cm^2 is a unit for area, not the result of multiplication. He also argued that kilometers per hour can be interpreted as the number of kilometers travelled in an hour.

During the discussion, Mandla asked, "So if we're not taking out the common factor, what are we doing?"

[2] The dynamics of this handover process are currently being researched by the third author and will not be discussed here.

[3] Some of these discussions feature as case studies in our training program for school-based facilitators.

[4] All the teachers' names are pseudonyms.

Dimpho raised two points. First, she wondered whether it was possible to write 2 km/3 hours. Second, she reminded the community that teachers often use language that can be misleading, for example, "centimeters times centimeters equals centimeters squared." Chamu argued that it is correct to write "centimeters times centimeters equals centimeters squared" and that it helps learners to get correct answers. The facilitator argued that even though incorrect reasoning might produce correct answers, the idea is for learners to reason correctly.

During the episode, the discussion at times was heated, with both Chamu and the facilitator showing discomfort in what they said and in their tones of voice. At one point Chamu asked, "What you are saying is that I am wrong to multiply centimeters by centimeters." The facilitator agreed and said that he also used to think that units could be multiplied and divided but has since become convinced that it does not make sense. He gave the example that two rands[5] is written as R2 and it does not mean R multiplied by two. Later, Chamu said, "I think I'm being misunderstood here," and tried to give more examples to convince the others. At that point, the facilitator became frustrated and asked, "Do you understand what the word 'unit' means?" At the end of the discussion, the facilitator acknowledged that the community was not convinced and said that he would bring some readings for further discussion the next week.

The facilitator felt frustrated after the meeting and needed to reflect on it with the community of facilitators. He sent a text message to the other facilitators, asking for a discussion about why it is not possible to multiply units of measurement. Another facilitator consulted two other people and came to the meeting with an understanding of basic and derived units of measurement. The basic units include the SI units of length (meter), mass (gram) and time (seconds); all other units are derived from these. For example, area is measured in square meters and one square meter is defined by the area covered if you have a square of one meter by one meter. One meter per second (m/s) is defined as the velocity it takes to cover a distance of one meter in one second. The facilitators flagged this incident to be written up and discussed at a later point, in order to look at the interactions between Chamu and the facilitator and to think about ways in which the facilitator could have worked more inclusively with the rest of the community in order to defuse the tension and help with the difficult concept.

VIGNETTE TWO

The second incident took place a few days later in a different community, where there were six teachers: Constance, Lindiwe, Zandile, Bongi, Mavis, and Lethu. There was no expectation that a similar issue would arise. However, Lindiwe shared an episode in which she was discussing the formula for area and in response to a question learners gave an area of 24 cm^2. She asked the class whether it could be 24 cm, to which the learners called out "no." She explained to the class that "centimeters times centimeters equals centimeters squared."

The facilitator asked the community what they thought of Lindiwe's statement and as with the previous incident (in Vignette One), there was some agreement and disagreement among the teachers. Lethu argued strongly that if the dimensions of a rectangle are 3 m by 4 m then the area is calculated by multiplying 3 by 4 and meters by meters to get meters squared. The facilitator commented that Lethu was seeing the unit of measurement as a variable and both Lethu and Lindiwe agreed that they were. The facilitator asked, "What does meeters squared mean?" Mavis answered that it is "a block with area of one meter squared" and explained that in primary school, learners use a block with an area of 1 cm^2 to determine the area of a rectangle and count the blocks to get the area. Lindiwe became despondent and asked a number of times, "But why are we squaring it?" and "Why is the unit squared?" The facilitator and different community members then explained different ways of determining area of different shapes, including shapes with curved boundaries, without multiplying dimensions. Lindiwe again insisted, " I understand the blocks but I need to know where the square comes from." At that point, the facilitator suggested that they leave the discussion and come back to it at the following meeting. She was concerned that Lindiwe was upset and wanted to move on to the preparation for the joint meeting with other schools the following week. During the week, the teachers continued the discussion (which we do not have on record) and in joint meeting the following week, Lindiwe acknowledged her original error. She explained that originally she regarded meters squared as the answer to the multiplication "meter times meter." Although she understood the concept of an area with dimensions 1 meter by 1 meter, she did not

[5] "Rand" is the South African currency.

understand the role of the unit for area. Through the discussions with her colleagues, Lindiwe came to understand that the difference between obtaining area through multiplication and the use of the unit. She also realized that a meter (m) cannot be treated like a variable *m*.

Analysis of the Vignettes

We analyzed the vignettes from three perspectives: opening and maintaining inquiry; focusing on teachers' and learners' mathematical knowledge; and building community. Our analysis suggested similarities and differences across the two incidents, and also demonstrated how learning happened among the facilitators, both between the incidents and after reflecting on them.

VIGNETTE ONE ANALYSIS

Opening and maintaining inquiry. In the first incident, a chance mention of a mathematical point by the facilitator led to a sustained discussion and inquiry into mathematical content knowledge. We recognized that inquiry took place because members of the community took different positions in the discussion: they agreed and disagreed with each other; they marshalled different principles and examples to make their arguments; and, significantly, a teacher was not afraid to challenge the facilitator. The fact that a dissenting voice to an incidental remark led to inquiry was significant and suggested that inquiry was an established method of working in the community. On reflection, however, the facilitator was concerned that the discussion had become a dialogue between himself and Chamu and that most of the teachers had left the meeting unsure of the mathematics.

Focusing on teachers' and learners' mathematical knowledge. In relation to content, the facilitator recognized that the teacher was seeing the units as a variable, similar to when teachers argue that $3a + 2b$ is three apples plus two bananas, which "cannot be added."[6] This issue had been discussed many times in our communities (see Brodie (2013) for an example) and the teachers often referred to it. The fact that the facilitator made the initial remark about units in passing, suggested that he was aware that this was a similar case to looking at variables as "things" and that the teachers would know this from the previous discussions. However, the fact that he made the remark at all suggested that he thought it would be useful to say it, possibly to remind teachers of the important conceptual point. He was surprised by the discussion and the major disagreement about the content.

Building community. In relation to building community, the facilitator was concerned about the dynamics in the interaction. There was clearly some evidence of a community where at least one member could challenge the facilitator, was not afraid of arguing for his position, and maintained his position in the face of strong challenges by the facilitator and one other teacher. This teacher clearly felt misunderstood, however, and no other teachers supported him. Therefore, in this case we had challenge without solidarity (Brodie & Shalem, 2011) and critique without care. The facilitator felt challenged in this incident, in three ways. First, he was not able to convey his understanding of the mathematics in ways that supported Chamu and most of the other teachers to come to a deeper understanding of the use of units of measurement. Second, although he was confident in his own mathematical understanding, he felt challenged in that the key principles of the project were being undermined, i.e., that we do not look for procedural short cuts at the expense of conceptual understanding. Third, he was concerned that a focus on one important aspect of our project—content knowledge—might have undermined another—building community. He was so concerned about the mathematical content during the meeting that he gave less attention to how the community was functioning. His appeal to an authority, that of written texts, as a possibility to break the deadlock came from a sense that he needed to develop the content knowledge and had not managed to do so.

VIGNETTE TWO ANALYSIS

Inquiry and focus. In the second incident, although the facilitator was not expecting a similar discussion, when it arose she had thought about the issues and therefore could respond differently. She asked the community what they thought and elicited both agreement and disagreement for the teacher's position. One other community member supported the teacher throughout the discussion. There was inquiry in this community, with agreements and disagreements being justified, other examples given, and references to learners' prior learning. A key facilitator move in this case was to ask what the unit m^2 means. This move had two consequences. First, it allowed another teacher to argue with Lindiwe and Lethu rather than with

[6] A popular metaphor among South African teachers when teaching how to simplify algebraic expressions.

the facilitator. Second, it focused on the key mathematical concept that needed to be discussed. In this case, both solidarity and challenge were present in a balance that made for more productive learning. Mathematically, the focus on the unit of measurement of area as a derived unit allowed Lindiwe to pinpoint what she did not understand: that she could not see the relationship between measuring area with unit square blocks and calculating area by multiplying.

Building community. In relation to community, the teachers were willing to challenge each other and the facilitator. Teachers supported each other, suggesting that both challenge and solidarity were present, as well as critique and care. Lindiwe was despondent, not because members of the community disagreed with her but because she did not understand the mathematics. When asked by the community of facilitators why she did not follow this up, the facilitator reminded us of a previous vignette that we had analyzed. In that instance, leaving an issue unresolved at the end of a meeting allowed the teachers to think about it during the week and come to the following meeting having done the work of convincing themselves and each other (see Brodie, 2013 for more detail). The same happened here.

Learning from the Vignettes

The above analysis suggests a deepening of our knowledge of facilitation, in relation to both focuses of our role, developing a culture of collaborative inquiry and developing mathematical knowledge for teaching. We can articulate the following key aspects of what we have learned and their implications for our facilitation practices.

The different features of communities may be in tension with each other.

In the first vignette, a focus on content knowledge led to defensiveness of one community member while in the second vignette it led to despondence. It has long been acknowledged in the literature that it is difficult for teachers, whose professionalism is linked with their knowledge of mathematics, to admit to gaps in their knowledge and so such feelings are to be expected. The issue for facilitators is how to deal with such feelings when they arise. In the first vignette, the support and care that might have reduced the teacher's defensiveness was not present in the community. The facilitator's choice to focus on the content helped to sustain inquiry in the community but did not help to build cohesion and solidarity among community members. In the second vignette, there was support for the teacher, and while the inquiry during the meeting did not help with her feelings of despondence, the sustained inquiry and support after the meeting did support her to resolve her knowledge and her feelings.

The second vignette shows that all three features of the community (i.e., inquiry, content, and building community) need to work together for successful learning experiences. The first vignette demonstrates that if the features do not support each other, learning may not happen. The facilitator's role is to be aware of these three features: whether or not they are all present, and if not, whether the consequences are negative for the work of the community. If the facilitator believes that one or more of the features is not as prominent as it could be, her/his role would be to work out how to restore the balance. In the first vignette, the facilitator recognized that his focus on the content precluded him from focusing on the community and he could have worked with both together.

We can step back in order to go forward.

Based on her previous learning and the discussion after the first incident, the second facilitator made a crucial decision: to stop pursuing the discussion in the meeting. She did this out of care for the teacher's despondence and because she wanted the community to focus on their preparation for the next meeting. The community continued the discussion during the week, without the facilitator, and resolved the issue. The first facilitator also ended the discussion, hoping instead to appeal to other knowledge authorities. Upon reflection, it was not clear whether he could have done this earlier, because the teacher was insistent on arguing his point. Our reflection on these vignettes, as well as previous ones, suggests that we need to give teachers opportunity and time for their learning to happen. The work in professional learning community meetings can be intense, as the two vignettes demonstrate. Some downtime may be needed to process the ideas and to discuss with colleagues over more extended periods. The fact that the issues from the meetings are continued into school time, suggests that a key element of professional learning communities is being promoted, that teacher learning pervades the school (Stoll et al., 2006), rather than only happening in specified teacher development contexts.

Regarding our facilitation practices, we can learn to end discussions at strategic points, noting that we are doing so and indicating that the community can return to the

discussion at a later time. We can suggest that the community continue the discussion between meetings and draw on resources from elsewhere. Someone in the community should take responsibility for remembering to bring up the discussion at the next appropriate time.

Listening to teachers and ourselves is complex and difficult.

A key element of any teaching situation is listening carefully and interpreting what the teachers are saying in relation to their contexts (Davis, 1997). For facilitators, this involves listening, not only to the teachers but also to ourselves as we facilitate, and noticing what we say and the effects of our contributions on the community and the inquiry. In the first vignette, the facilitator made the key mathematical points, but was distracted by the teacher's continued use of examples and therefore did not take time to make sure that all the teachers were on board with the mathematics. A dialogue developed which was not conducive to anyone's learning. The facilitator himself became somewhat emotionally involved, because he was concerned that some of the key principles of the project and previous learning were not being applied. In the second vignette, the facilitator listened carefully and interpreted the emotional states of the teachers. She was able to take a step back and support the teachers to move forward. She was able to listen because of prior reflections on her practice and because she had thought through the mathematical issues with her colleagues prior to the meeting.

The vignettes suggest that facilitators need to be in touch with their own emotions, during and after meetings. The need to create safe spaces for challenge and critique requires facilitators to be in touch with the emotions of the teachers. However, we may not be as well trained or positioned to notice our own emotions and some reflection on this at various points may help to keep the three key features supporting, rather than working against, each other.

Conclusion

Our analysis of these two vignettes illuminates two key features of our learning process: first we learn from reflecting on our own practices, and second we learn from each other's practices. We do this in our professional learning community through mutual engagement around a joint enterprise with a shared repertoire. We learn and grow together in similar ways in which we hope that the teachers with whom we work will learn and grow together. Learning is a complex process, and we engage with it on three levels: what and how learners learn in mathematics classrooms, what and how teachers learn in professional learning communities about supporting learners' mathematical learning, and what and how we learn to support teachers' learning in support of learners' learning.

References

Boaler, J., & Staples, M. (2008). Creating mathematical futures through an equitable teaching approach: The case of Railside School. *Teachers College Record, 110*, 608-645.

Borko, H., Jacobs, J., Eiteljorg, E., & Pittman, M. (2008). Video as a tool for fostering productive discussions in mathematics professional development. *Teaching and Teacher Education*, *24*, 417-436.

Boudett, K. P., City, E. A., & Murnane, R. J. (2008). Data-wise: *A step-by-step guide to using assessment results to improve teaching and learning.* Cambridge, MA: Harvard Education Press.

Brodie, K. (2013). The power of professional learning communities. *Education as Change, 17*(1), 5-18.

Brodie, K., & Shalem, Y. (2011). Accountablity conversations: Mathematics teachers learning through challenge and solidarity. *Journal for Mathematics Teacher Education*, *14*, 419-439.

Curry, M. (2008). Critical friends groups: The possibilities and limitations embedded in teacher professional communities aimed at instructional improvement and school reform. *Teachers College Record, 110*, 733-774.

Davis, B. (1997). Listening for differences: An evolving conception of mathematics teaching. *Journal for Research in Mathematics Education, 28*, 355-376.

Department of Basic Education, & Department of Higher Education and Training. (2011). *The integrated strategic planning framework for teacher education and development in South Africa.*

Elliott, R., Kazemi, E., Lesseig, K., Mumme, J., Carroll, C., & Kelley-Petersen, M. (2009). Conceptualizing the work of leading mathematical tasks in professional development. *Journal of Teacher Education, 60*, 364-379.

Hargreaves, A. (2008). Sustainable professional learning communities. In L. Stoll & K. S. Louis (Eds.), *Professional learning communities: Divergence, depth and dilemmas* (pp. 181-195). Maidenhead: Open University Press and McGraw Hill Education.

Horn, I. S. (2005). Learning on the job: A situated account of teacher learning in high school mathematics departments. *Cognition and Instruction*, 23, 207-236.

Jaworski, B. (2006). Theory and practice in mathematics teaching and development: Critical inquiry as a mode of learning in teaching. *Journal of Mathematics Teacher Education*, 9, 187-211.

Katz, S., & Earl, L. (2010). Learning about networked learning communities. *School Effectiveness and School Improvement*, 21(1), 27-51.

Katz, S., Earl, L., & Ben Jaafar, S. (2009). *Building and connecting learning communities: The power of networks for school improvement.* Thousand Oaks, CA: Corwin.

McLaughlin, M. W., & Talbert, J. E. (2001). *Professional communities and the work of high school teaching.* Chicago: University of Chicago Press.

Nelson, T. H., Slavit, D., Perkins, M., & Hathorn, T. (2008). A culture of collaborative inquiry: Learning to develop and support professional learning communities. *Teachers' College Record, 110*, 1269-1303.

Reddy, V. (2006). *Mathematics and science achievement at South African Schools in 2003.* Cape Town: Human Sciences Research Council Press.

Stephan, M., Akyuz, D., McManus, G., & Smith, J. (2012). Conditions that support the creation of mathematical communities of teacher learners. *NCSM Journal of Mathematics Education Leadership, 14*(1), 19-27.

Stoll, L., Bolam, R., McMahon, A., Wallace, M., & Thomas, S. (2006). Professional learning communities: A review of the literature. *Journal of Educational Change, 7*, 221-258.

Wenger, E. (1998). *Communities of practice: Learning, meaning and identity.* Cambridge: Cambridge University Press.