LEARNING FROM A PROFESSIONAL DEVELOPMENT DESIGN EXPERIMENT: INSTITUTIONAL CONTEXT OF TEACHING

JANA VISNOVSKA
The University of Queensland
j.visnovska@uq.edu.au

QING ZHAO
Vanderbilt University
qing.zhao@vanderbilt.edu

In this paper we report our learning as researchers from a 5-year professional development design experiment. At its completion, we identified five strands of support as being essential to mathematics teachers' learning. However, when planning the design experiment based on prior research, we only explicitly considered two of these strands—*Building Mathematical Competence* and *Focus on Student Reasoning*. The significance of three more strands of support became evident during the course of the experiment. We document the emergence of one of these strands, *Understanding the Institutional Context of Teaching,* by focusing on *pivotal episodes* from the experiment.

Introduction

Effectively supporting mathematics teachers' professional learning is a complex endeavour (Ball & Cohen, 1999; Goos, Dole, & Makar, 2007; Little, 1993; Simon, 2000). Research indicates that effective professional development (PD) programs should have a *longitudinal*, ongoing character as well as a *focus on content* (Askew, Brown, Rhodes, Johnson, & Wiliam, 1997; Carpenter et al., 2004) in order to support significant, generative teacher learning. However, detailed analyses of the means of support used in longitudinal PD programs are largely missing (Little, 2002). By reporting such analysis, our goal is to contribute to teacher development theory (cf. Cobb, Zhao, & Dean, 2009) relevant to supporting the learning of teachers within high-stakes accountability environment.

The case for our discussion is a 5-year PD program[1] developed as part of a PD design experiment (cf. Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003), conducted with a group of middle years mathematics teachers from a USA school district[2] with a high-stakes accountability program[3]. The PD goal was to "help teachers develop

[1] The PD program included a two-day summer institute and three one-day work-sessions during the first year of the study, a three-day summer institute and six one-day sessions during each of the subsequent four years, and a concluding three-day summer institute.

[2] In the USA, school district is an important, independent, administrative unit whose policies can have a significant influence on teachers' instructional practices.

[3] The presented study was a part of a larger research project. The research team included Paul Cobb, Kay McClain, Chrystal Dean, Teruni Lamberg, Melissa Gresalfi, Lori Tyler, Jana Visnovska, and Qing Zhao. In addition to the authors' analyses, this paper draws on dissertation analysis developed by Dean (2005). The preparation of this paper was supported in part by The University of Queensland under NSRSU grant No. 2009002594.

instructional practices in which they induct their students into the ways of reasoning of the discipline by building systematically on their current mathematical activity" (Cobb & McClain, 2001, p. 207). At the beginning of the design experiment and based on prior research in the field, Cobb and McClain (2001) outlined the initial conjectured trajectory for the teachers' learning (cf. Simon, 1995) and the means by which this learning would be supported. Two key strands of support were initially identified: *Building Mathematical Competence* and *Focus on Student Reasoning*. While the first directly addressed the need for PD to focus on mathematical content, the second aimed at supporting mathematics teachers' pedagogical reasoning and practices (e.g., Fennema et al., 1996; Franke & Kazemi, 2001a). As we argued elsewhere, both these strands proved to be critical in supporting the teachers' learning (Dean, 2005; Visnovska, 2009). However, additional directions of support were instrumental.

In this paper, we document how a specific new strand of support, *Understanding the Institutional Context of Teaching*, emerged in working with the teachers[4]. We first explain that the research team conceptualised teacher learning as situated within institutional context of teachers' schools and the district from the outset (Cobb & McClain, 2001; Cobb, McClain, Lamberg, & Dean, 2003), yet did not view institutional context as an explicit strand of support in facilitating changes in teachers' views of mathematics teaching. We then present *pivotal episodes* (cf. Cobb, Stephan, McClain, & Gravemeijer, 2001) from PD sessions that, in retrospect, provided insight into the emergence of this strand of support and its importance.

Data and method of analysis

The data consisted of video-recordings of all PD sessions, field notes of these sessions, copies of the teachers' work, and a debriefing and planning research log. We analysed the data using an adaptation of constant comparative method described by Cobb and Whitenack (1996) that involves testing and revising tentative conjectures while working through the data chronologically. As new episodes are analysed, they are compared with conjectured themes or categories, resulting in a set of the theoretical assertions that remain grounded in the data[5].

Initial focus on institutional context: Framing the PD design experiment

In planning the PD design experiment, Cobb and McClain (2001) conceptualised teaching mathematics as a distributed activity, shaped by the types of tools that were made accessible to teachers as well as the institutional context in which teachers worked. Rounds of data collection were conducted to document the institutional context of the teachers' work. These included interviews with the teachers and the key school and district administrators, and were used to understand (a) how the activity of teaching

[4] The additional 2 strands of support that emerged from our work with teachers were *Building Teacher Community* and *Focus on Student Engagement* (for partial analysis see Visnovska & Cobb, 2009). Importantly, all 5 strands were interrelated and mutually reinforcing in supporting the learning of teacher group.

[5] Given the scope of this paper, we include representative teacher comments and interactions where possible as we build our argument. These examples do not provide a complete evidence base for the presented claims. References to our published work and dissertations indicate where more systematic evidence for the claims can be found.

mathematics was accomplished at the school and district levels and (b) what supports and constraints the teachers experienced in their work (Cobb, McClain, et al., 2003).

Oriented by this conceptualisation of teaching, in the initial PD sessions we included PD activities, in which teachers shared their views of their institutional context with us. We used these conversations to tune the initial PD design, by better understanding how the teachers reasoned about mathematics and mathematics teaching at the time. For instance, the persistent pressures for improving achievement on standardised tests helped us understand why it was reasonable for the teachers to focus on students "getting" the solution methods that lead to correct outcomes. Only much later in our collaboration with the teachers, through the analyses of the actual learning of the teacher group, did we realise that this initial attention to institutional context and the conversations we had with the teachers facilitated a number of changes that proved essential to teachers' learning. Specifically, through these conversations, the teacher group was supported to (a) "deprivatise" their teaching practices, that is, start to publicly discuss and critique their teaching, and (b) come to view changes to their current ways of teaching as both necessary and, more importantly, feasible in their schools. In addition, the group recognition of institutional context as a means to understand and transform how mathematics was taught in the district later contributed to the process of (c) inducting new members to the group, thus supporting the continuation of group learning. In the ensuing sections, we discuss how each of the three changes was realised in our work with the teachers, and build an argument for considering institutional context strand of support when designing PD programs.

Deprivatising teachers' instructional practices

The institutional context in which the teachers worked was characterised by high-stakes accountability and lack of formal and informal professional support (Cobb, McClain, et al., 2003). As a result, the teachers worked in almost complete isolation. When they initially participated in the PD sessions, it was both alien and uncomfortable for them to talk about their teaching openly without feeling they were being judged and their professional status threatened. However, in order for the teachers to engage productively in PD inquiries into classroom teaching (Ball & Cohen, 1999; Borko, 2004), it was imperative that they deprivatised their teaching practices.

In retrospect, the explicit conversations about institutional context that we had with the teachers were instrumental in the deprivatisation process. At the time, we included these conversations to deepen *our* understanding of how the schools and the district organised for mathematics teaching. The retrospective analysis revealed a pivotal episode that took place in year 1, session 3. During this work session, the teachers brought in their students' written work from a statistical task on life span of batteries and were asked to investigate how these students reasoned statistically. This, for the teachers, appeared to be a high-risk activity, perceived as a way to evaluate their instructional practices. As they carefully treaded the terrain, issues pertaining to the institutional setting dominated the discussion.

> Naomi: … we were doing this [statistical task in my classroom] yesterday, my principal came in, she saw me at the overhead and the room was kind of dark and the kids were talking about batteries. And she is looking at me like "[Standardised tests] and you are talking about batteries?"

Amy: My principal took flack because the superintendent came in to my room and I was teaching Roman Numerals and they are not on the [standardised test]. I don't care.

Significantly, while expressing frustrations about pressures they felt, the teachers started to ask each other for advice. This was the *first* instance in which the teachers openly discussed events from their classrooms.

Rachel: [to Amy]…you were saying that you would give a kid a half an hour to get a kid to discuss something that you asked them. I agree with that totally, but … well my principal would say, "You are not covering all your topics". I agree, I want kids to explain things, but administrators would say, when they come in to observe your class, and I have had several to observe my class, they say "You are taking too long on this. You should ask them, maybe wait two or three minutes and then move on". So sometimes you can't get into that deep discussion because of time limits, because of behavior.

Amy: Part of it is the fact that I have been at this a lot longer than you and I know they ain't gonna bother me.

[Teachers laugh, some express agreement with Amy.] …

Rachel: Well how do you like, if you are talking to one particular student, for example, you are talking to me and I am hesitant about talking to you, how do you keep the rest of the class engaged? Because sometimes if I am focusing on one particular student, the rest of the students are like, okay ...

Amy: Simply the force of my personality to a certain extent. They know, that in this class everyone has a right to speak and everyone has a right to make a mistake. And everyone has a right to an opinion. And by God, if I am going to listen to yours, you are going to listen to his. It is just a matter of directing them...

In retrospect, this and similar conversations in a number of subsequent PD sessions helped teachers realise that they had experienced similar challenges and frustrations in their classrooms, and that these were related to the institutional context in which they worked. In a sense, teachers too began to view teaching as distributed. This allowed them to feel less judged when opening up their classrooms for discussions of their teaching, as they no longer felt the responsibility for failures to be solely theirs.

Cultivating a sense of feasibility of change

In our view, effective PD programs should proactively cultivate teachers' "reason and motivation to want to change the way they teach mathematics" (Cobb & McClain, 2001, p. 208). In our own and others' prior work, the teachers were successfully supported to develop such need by engaging in activities in which they realised that what their students understood mathematically as a result of their instruction was different from what was intended (e.g., Fennema et al., 1996). This led the teachers to question the teaching practices responsible for such learning and motivated them to work on improving these practices.

In contrast, the teachers in the PD program reported here initially considered it impossible to alter the ways they taught because, in their experience, the ways they

taught were mandated by their schools[6]. Even after the teachers established that there was a contradiction between teaching for understanding and *content coverage* approach (for which they were accountable to their principals), they did not come to believe that it was feasible to change their practices and did not become interested in scrutinising them. To the teachers, institutional pressures of their work appeared to be given and not susceptible to change. From our perspective as researchers, it became critical to cultivate both teachers' motivation and sense that it was feasible to change their teaching practices.

This led us to introduce PD activities in which we proactively challenged these teachers' views. In retrospect, two episodes were pivotal and we introduce one of them here. At the end of session 5 in year 2, we proposed a possible future project for the group: generating evidence to show school leaders that covering content does not help students learn mathematics. The teachers picked up the proposal and, in a quick progression, brainstormed ideas for getting the principals involved in thinking about mathematics teaching and learning more deeply.

Wesley:	I just had an idea: think about it. The middle school principals are going to be here on the 19th. Maybe if they are here for food, maybe we could be in here with them to convince them we are doing something good.
Ruth:	It is a small group of them. But they are going to be looking at the schools. …
Naomi:	So maybe we should be doing an activity while they are here and invite them to come see the activity.
Muriel:	Or with the kids?
Researcher:	Or what the kids are doing.
Muriel:	Yeah, I'd like for them to see what the kids are really thinking [mathematically, like when we interviewed students in last PD session]. …
Naomi:	I bet they would be surprised.
Researcher:	I bet they would… That idea might have merit … Letting them know that the 6th grade teachers are doing what [principals] are telling them: they are covering the material, they are reviewing, but [in 7th grade students need to learn it again anew].
Muriel:	I would like for them to see it and then hear the discussion afterwards.

In the subsequent months, the teachers proactively pursued opportunities to engage with the school leaders, continued to plan for the joint PD activity, and framed these efforts as an avenue to justify to the school leaders the need for resources (e.g., time to collaborate) to improve students' mathematics learning and performance.

While five school leaders eventually attended PD session 6 in year 3[7], the changes in teachers' perceptions of feasibility of changing how they taught mathematics were obvious form the very beginning of year 3. Despite the fact that there were no discernible changes in institutional context and the teachers continued to be dissatisfied with the situation in their schools, they no longer merely shared their complaints.

[6] The analysis of the institutional context (Cobb, McClain, et al., 2003) corroborated the teachers' reports. The school leaders viewed teaching mathematics as a straightforward endeavor and responded to accountability pressures of state-mandated achievement tests by monitoring teachers' content coverage. Some of them conducted daily drop-in visits in teachers' classrooms to check whether appropriate objectives were being covered. As a result, the teachers viewed themselves as having little control over both goals of mathematics instruction and how these goals should be accomplished in their classrooms.

[7] It is indicative of the institutional context that it took the teachers and district mathematics coordinator more than one year to succeed in securing the school leaders' participation.

Instead, they planned what they could do in order to change their school leaders' views. The teachers came to realise that they collectively had a better understanding of how mathematics should be taught compared to their school leaders and were thus better positioned to guide instructional improvement. This motivated the teachers to foster their professionalism by scrutinising their practices and developing more effective ways of teaching for mathematical understanding.

Supporting the continuation of the teacher group

Realising the importance of explicit attention to institutional context and how it shaped the work of teaching mathematics, both the researchers and the teachers made institutional context an explicit topic of conversations when new teachers were recruited to join the group[8]. The continuing teachers named the *working on issues related to institutional context* among the 4 goals[9] of the PD work when they introduced PD goals to the newcomers during an orientation session in year 3. Sharing the group history, they also clarified that discussions of institutional context helped to build trust between teachers and researchers at the beginning of the collaboration.

> Amy: [The researchers] have provided us with a [soundboard]. … like at the very beginning, I knew we were supposed to do statistics, [a researcher] came to the first one [PD session], and we were sitting there for four hours and she listened to us complain about every single solitary thing that ever crossed our minds as we've been teaching. And I was [thinking] "When is she going to tell us to shut up, that that's not what we are here for?" And she never did. So they've always sat around and listen. They wanna know what is important to us whether it is on their agenda or not.

Continuing teachers contrasted the context of PD sessions to institutional context in their schools when they talked about the collaborative nature of the PD group, its non-threatening culture, and highlighted how this difference helped them to open up their practices to the group.

> Marci: I guess we are all comfortable with each other, and not just that, but comfortable with having people to come in and not criticise you based on what you taught, not on what their idea of teaching math is. … It is different from when the administrators may come in or even for new teachers, when a mentor is coming to observe. Because you feel that you are looking for something in particular to criticise their way or their method of teaching mathematics.

They also demonstrated the deprivatised nature of their practices by bringing their students' work and classroom video to sessions, and by talking openly about difficulties that they faced in their teaching[10].

The stories told by continuing teachers and their actions had face validity for the newcomers. While deprivatisation of teaching practices initially took more than one

[8] A group of ten teachers participated in PD program in first two years. In the remaining years, some of the teachers left the district and the PD group and others were recruited to join. For details on membership in the PD group and conceptualisation of group learning across its changes see Visnovska (2010).

[9] The other three goals teachers named were: (a) understanding students' thinking, (b) "redoing" textbook units on statistics, and (c) learning about improving lessons over time like in Japanese lesson planning (Visnovska, 2009).

[10] Two situations in which the old-timers commented on their classroom difficulties spontaneously occurred in session one, one in session two, and others occurred with a similar rate throughout the year.

year (Dean, 2005), all newcomers opened up their practices for scrutiny within their first four PD sessions (Visnovska, 2009). They also actively engaged in working on improving their teaching and shaping their institutional context, and raised no doubts about feasibility of these efforts. Successful initiation of the newcomers enabled the teacher group to continue working towards its goals across changes in the group membership (Visnovska, 2009).

Conclusions

diSessa and Cobb (2004) clarify that productive design-based theorising includes "hypothesizing and developing explanatory constructs, new categories of things in the world that help explain how it works" (p. 77). We propose that—along with longitudinal character of PD support, focus on content and on students' mathematical reasoning—attending to *institutional context of teaching* is important in both understanding and effectively supporting teachers' generative growth (cf. Franke & Kazemi, 2001b).

To substantiate this claim, we discussed three practical problems that occurred in our PD collaboration that had to be overcome for the PD program to be effective. Firstly, *deprivatising* teachers' practices was necessary if these were to become a subject of inquiry in PD sessions. Secondly, coming to see changes as *feasible* within the institutional environment was instrumental in developing teachers' genuine need and motivation for improving their teaching. Lastly, establishing *continuation* of the group learning across changes in its membership was important as the district in which we worked had relatively high teacher mobility. We have illustrated how attending to *institutional context of teaching* in the PD activities helped in addressing these practical problems.

The research team was initially unaware that conversations about institutional context would be influential in the group learning. Presented results are thus a product of genuine research team learning enabled by the retrospective analysis of the PD collaboration. We suggest that the results are most relevant to PD designers and facilitators working with teachers in similar institutional settings, and to teachers who would benefit form effective PD programs.

References

Askew, M., Brown, M., Rhodes, V., Johnson, D., & Wiliam, D. (1997). *Effective teachers of numeracy*. London: School of Education, King's College.

Ball, D. L., & Cohen, D. (1999). Developing practice, developing practitioners: Towards a practice-based theory of professional education. In G. Sykes & L. Darling-Hammond (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 3–32). San Francisco: Jossey-Bass.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher, 33*(8), 3–15.

Carpenter, T. P., Blanton, M. L., Cobb, P., Franke, M., Kaput, J. J., & McClain, K. (2004). Scaling up innovative practices in mathematics and science. Retrieved 2006, from http://www.wcer.wisc.edu/NCISLA/publications/reports/NCISLAReport1.pdf

Cobb, P., Confrey, J., diSessa, A. A., Lehrer, R., & Schauble, L. (2003). Design experiments in education research. *Educational Researcher, 32*(1), 9–13.

Cobb, P., & McClain, K. (2001). An approach for supporting teachers' learning in social context. In F. L. Lin & T. Cooney (Eds.), *Making sense of mathematics teacher education* (pp. 207–232). Dordrecht, The Netherlands: Kluwer.

Cobb, P., McClain, K., Lamberg, T., & Dean, C. (2003). Situating teachers' instructional practices in the institutional setting of the school and school district. *Educational Researcher, 32*(6), 13–24.

Cobb, P., Stephan, M., McClain, K., & Gravemeijer, K. (2001). Participating in classroom mathematical practices. *Journal of the Learning Sciences, 10*(1 & 2), 113–164.

Cobb, P., & Whitenack, J. (1996). A method for conducting longitudinal analyses of classroom videorecordings and transcript. *Educational Studies in Mathematics, 30*, 213–228.

Cobb, P., Zhao, Q., & Dean, C. (2009). Conducting design experiments to support teachers' learning: A reflection from the field. *The Journal of the Learning Sciences, 18*, 165–199.

Dean, C. (2005). *An analysis of the emergence and concurrent learning of a professional teaching community.* PhD dissertation, Vanderbilt University, Nashville, TN.

diSessa, A. A., & Cobb, P. (2004). Ontological innovation and the role of theory in design experiments. *Journal of the Learning Sciences, 13*(1), 77–103.

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*, 403–434.

Franke, M. L., & Kazemi, E. (2001a). Learning to teach mathematics: Developing a focus on students' mathematical thinking. *Theory Into Practice, 40*(2), 102–109.

Franke, M. L., & Kazemi, E. (2001b). Teaching as learning within a community of practice: Characterizing generative growth. In T. Wood, B. Nelson & J. Warfield (Eds.), *Beyond classical pedagogy in elementary mathematics: The nature of facilitative teaching* (pp. 47–74). Mahwah, NJ: Lawrence Erlbaum.

Goos, M., Dole, S., & Makar, K. (2007). Designing professional development to support teachers' learning in complex environments. *Mathematics Teacher Education and Development, 8*, 23–47.

Little, J. W. (1993). Teachers' professional development in a climate of educational reform. *Educational Evaluation and Policy, 15*(2), 129–151.

Little, J. W. (2002). Locating learning in teachers' communities of practice: Opening up problems of analysis in records of everyday work. *Teaching and Teacher Education, 18*, 917–946.

Simon, M. A. (1995). Reconstructing mathematics pedagogy from a constructivist perspective. *Journal for Research in Mathematics Education, 26*, 114–145.

Simon, M. A. (2000). Research on the development of mathematics teachers: The teacher development experiment. In A. E. Kelly & R. A. Lesh (Eds.), *Handbook of research design in mathematics and science education* (pp. 335–359). Mahwah, NJ: Erlbaum.

Simon, M. A., & Tzur, R. (1999). Explicating the teacher's perspective from the researchers' perspectives: Generating accounts of mathematics teachers' practice. *Journal for Research in Mathematics Education, 30*(3), 252–264.

Visnovska, J. (2009). *Supporting mathematics teachers' learning: Building on current instructional practices to achieve a professional development agenda.* PhD dissertation, Vanderbilt University, Nashville, TN.

Visnovska, J. (2010). Documenting the learning of teacher communities across changes in their membership. In L. Sparrow, B. Kissane, & C. Hurst (Eds.), *Shaping the future of mathematics education: Proceedings of the 33rd annual conference of the Mathematics Education Research Group of Australasia* (Vol. 2, pp. 579–586). Fremantle, WA: MERGA.

Visnovska, J., & Cobb, P. (2009). Learning about building mathematics instruction from students' reasoning: A professional development study. In R. Hunter, B. Bicknell & T. Burgess (Eds.), *Crossing divides: Proceedings of the 32nd annual conference of the Mathematics Education Research Group of Australasia* (Vol. 2, pp. 547–554). Wellington, NZ: MERGA.HH