

# Administrative Supports and Curricular Challenges: New Teachers Enacting and Sustaining Inquiry in Schools

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## Abstract

This article draws on interviews with a recent graduate of an inquiry-based initial teacher education program, and on video data collected in his Grade 6 classroom, to explore the extent to which he was able to enact inquiry-based teaching approaches in his teaching of mathematics and to consider the kinds of resources (administrative and curricular) necessary to sustain and enhance such practices in today's schools. The findings support existing literature noting the importance of a supportive and knowledgeable school principal and extend that literature to detail the kinds of support that make a difference in sustaining, in particular, inquiry-oriented teaching practices. The study also draws attention to the need for further research concerning the kinds of curricular support materials necessary to help new teachers who are attempting to enact such practices to thrive in schools.

**Keywords:** Inquiry-based teaching and learning, mathematics teaching, novice teachers

## Résumé

Cet article s'appuie sur des entretiens avec un jeune diplômé d'un programme de formation initiale des enseignants basé sur l'investigation, et sur les données vidéo enregistrées dans sa classe de 6e année, le but étant d'étudier dans quelle mesure il était capable d'adopter des approches pédagogiques basées sur l'investigation dans son enseignement des mathématiques et de prendre en compte les types de ressources (administratives et curriculaires) nécessaires au maintien et à l'amélioration de ces pratiques dans les écoles d'aujourd'hui. Les résultats soutiennent la documentation actuelle constatant l'importance d'un directeur d'école qualifié et sur lequel on peut compter, en allant même plus loin et en détaillant les types de soutien pour améliorer, soutenir et maintenir, en particulier, les pratiques pédagogiques axées sur l'investigation. L'étude attire également l'attention sur la nécessité de poursuivre les recherches concernant les types de supports pédagogiques nécessaires pour aider et encourager les nouveaux enseignants qui tentent d'adopter de telles pratiques dans les écoles.

**Mots-clés:** Enseignement et apprentissage basés sur l'investigation, l'enseignement des mathématiques, enseignants débutants

## Administrative Supports and Curricular Challenges: New Teachers Enacting and Sustaining Inquiry in Schools

### Introduction

Within the literature on newly-graduated teachers' experiences of beginning to teach (e.g., Grossman & Thompson, 2008; Scherff, 2008), studies show that conditions in schools are often challenging for new teachers and that many leave the profession after only a few years (Scherff, 2008). The kinds of challenges new teachers face include dealing with classroom management issues, curriculum planning and implementation, conducting assessments, and workload issues (Kyriacou & Kunc, 2007; Roehrig, Pressley, & Talotta, 2002); however, mentoring is starting to emerge as a significant support for new teachers in helping them navigate these early challenges (Roehrig, Bohn, Turner, & Pressley, 2008; Schmidt, 2008). Clearly, mentoring has proven helpful in some cases; however, not all new teachers benefit from mentoring (Roehrig et al., 2008) and the *kind* of mentoring they receive might be critical if what new teachers are intending is to shape practices different from those they predominantly see around them in schools. In fact, there are relatively few studies that specifically document beginning teachers' experiences of trying to teach through inquiry, and we do not know enough about the kinds of conditions in school that might enable new teachers to thrive as they learn to shape such practices nor about the kinds of curriculum resources needed to sustain such work. This article provides an analysis of one beginning teacher's experience of trying to enact and sustain inquiry-based teaching in a school setting.

### Theoretical Framework—A Phronetic Approach to Teaching

Despite the extensive efforts of pre-service teacher education (Darling-Hammond & Bransford, 2005), technical modes of teaching—which valorize prediction, measurement, and control in the classroom—still dominate K-12 education in North America. In the area of mathematics instruction, for example, research conducted in the United States by Jacobs, Hiebert, Givvin, Hollingsworth, Garnier, & Wearne (2006) and others (e.g., Hiebert & Stigler, 2000) has shown that current teaching approaches are more like the kind of traditional teaching reported for most of the past century (Cuban, 1993) than the kind of teaching promoted by mathematics educators and mathematics education leadership organisations such as the National Council of Teachers of Mathematics (e.g., NCTM, 2000). Dunne (2005) notes that a technical perspective on teaching

seeks to extract from [practice] a rational core that can be made transparent and replicable...[so that] what is essential in the knowledge and skill can be abstracted for encapsulation in explicit, generalisable formulae, procedures, or rules—which can in turn be applied to the various situations and circumstances that arise in the practice, so as to meet the problems they present. (p. 375)

This technical approach to teaching contrasts with Aristotle's notion of *phronesis*, or practical wisdom, which emphasizes the importance of judgment in context. "This is knowledge not as a possession...but as invested in action" (Dunne & Pendlebury, 2002, p. 198). In this frame, less emphasis is placed on the applying of generalized knowledge (such as knowledge of efficient routines for pacing lessons or managing children) and more on the ability to bring general and

particular—theory and practice—“into illuminating connection with each other” (Dunne, 2005, p. 376). Dunne posits, “This requires perceptiveness in [the] reading of particular situations as much as flexibility in... ‘possessing’ and ‘applying’ the general knowledge” (p. 376).

The teacher education program in which student teacher Noah, the focus of this article, participated embraces *phronesis* “and in doing so attempts to prepare teachers that can dwell within the rough ground of experience, appreciate its complexity and deep interpretability, and respond ethically” (Phelan, 2005a, p. 62). In other words, the program attempts to develop a capacity for *discernment* (Dunne & Pendlebury, 2002). “Discernment speaks to a teacher’s capacity to see the significance of a situation, to imagine various possibilities for action and to judge ethically how one ought to act on any given occasion” (Phelan, 2005a, p. 62). Given these philosophical underpinnings, a phronetic approach to teaching therefore calls forth from practitioners a set of capacities and practices that differ strongly from those valued within a technical rationalist frame (Dunne & Pendlebury, 2002). This cluster of practices is commonly referred to as an *inquiry-based* approach.

## Literature Review

### Inquiry-based practices.

Inquiry-based practice, in various guises and with multiple descriptors, is emerging as a popular approach to teaching and learning in many fields, including K-12 education (see, e.g., Elbers, 2003; Davis, Sumara, & Luce-Kapler, 2008; Houssart, 2001; Jardine, Clifford, & Friesen, 2003; Moscovici & Holmlund Nelson, 1998) and a number of post-secondary disciplines, particularly those in professional domains (see, e.g., Hayes, 2002; Phelan, 2005b; Plowright & Watkins, 2004; Schulz & Mandzuk, 2005). Many of the practices now clustered within the term ‘inquiry-based’ have a basis in Dewey’s philosophy of learning, and can be traced through the constructivist movement and are reflected in many reform efforts in North American curricula [e.g., in the US-based National Council of Teachers of Mathematics ‘Standards’ documents (NCTM, 2000) and in Canadian curricula, e.g., the new Alberta Program of Studies for Mathematics K-9, (Alberta Education, 2007) and the new Alberta Program of Studies for Social Studies K-12 (Alberta Education, 2005)].

There are various kinds of teacher knowledge, practices, and dispositions typically attributed to inquiry including:

- knowing how to ‘teach for understanding’ (Lampert & Ball, 1998; NCTM, 2000; Skemp, 1978);
- the ability to understand and draw out the deep structure of the discipline so that learners learn to reason and connect ideas (Puntambekar, Stylianou, & Goldstein, 2007);
- responsiveness to students (Lampert & Ball, 1998; Moscovici & Holmlund Nelson, 1998);
- a commitment to exploring student thinking as well as skill in probing and making sense of students’ ideas (Lampert, 2001; Lampert & Ball, 1998; NCTM, 2000);
- being comfortable with ambiguity and uncertainty (Lampert & Ball, 1998; Phelan, 2005a, 2005b);
- understanding the provisional nature of knowledge and the complexity of the teaching/learning relationship (Dunne, 1997; Lampert & Ball, 1998; Phelan, 2005a, 2005b);

- a commitment to building a community of inquiry in the classroom (Alberta Learning, 2004; Phelan, 2005a); as well as
- a host of social and personal capacities such as care and concern for others (Noddings, 2005; Palmer, 1998).

Inquiry learning is also emerging as an important orientation for teacher education programs (Darling-Hammond & Bransford, 2005). However, while accounts of teacher education students' experiences of learning through inquiry are growing (Nicol, 2006; Phelan, 2005b; Schulz & Mandzuk, 2005), there is still much to be learned about how such students understand and use their knowledge of inquiry in classrooms once they graduate from initial teacher education programs. I have considered elsewhere (Towers, 2008) challenges of collaboration and developing communities of inquiry in schools that the beginning teachers in my study experienced as they worked to enact an inquiry-based approach in their classrooms and here I build on those earlier findings to reveal and analyze some of the administrative and curricular supports for, and challenges to, initiating and sustaining inquiry-based practice in schools.

### **Principals supporting new teachers.**

Brown and Wynn (2007) report that beginning teachers continue to exit the profession in alarming numbers but that principals with an awareness of issues affecting new teachers, with a pro-active approach in supporting new teachers, and with a commitment to professional growth for themselves, their students, and their teachers (new and veteran alike) are retaining teachers at a higher rate than their peers (Brown & Wynn, 2009). Moir (2009), reporting on a study of two decades of teacher induction, found that good principals create a culture of learning, that effective induction programs combine high-quality mentoring with communities of practice, and that teaching conditions matter in supporting and keeping new teachers. Roberson and Roberson (2009) suggest that the principal is the critical factor in new teacher success and, in particular, point to the importance of providing meaningful, instructive feedback to new teachers. Similarly, Wood (2005) notes that two of the five key roles of the principal in new teacher induction are as instructional leader and as advocate for novice teachers. In the Canadian context, Cole (1993) studied 23 school principals and vice-principals in Ontario and found a number of issues of concern for principals relating to teacher induction, including the challenge of balancing the roles of mentor to and evaluator of new teachers and that of obtaining guidance and support for their own role.

However, it is clear from the literature that not all school principals are actively involved in supporting and mentoring the new teachers in their buildings. A 1999 report on the Beginning Teacher Induction Program in New Brunswick noted that levels of principal involvement in mentoring of new teachers varied considerably, and that over half of the principals studied were either not, or only minimally, involved (Scott, 1999). Given the above summary of the significant role of the principal in new teacher induction, and given the data I present in this paper concerning the important role of the principal in providing support for new teachers enacting innovative practices, this is a worrying finding. It implies that further research is needed that explores the role of Canadian school principals in fostering innovative teaching practices such as teaching through inquiry, especially as these are enacted by new and vulnerable members of the profession. This paper provides an initial response to this need.

### **New teachers and curriculum.**

Also of significance to the findings I present in this article is the question of how new teachers use (and learn to use) curriculum materials. Over two decades ago, Shulman (1986) noted the importance of several forms of teacher knowledge. While much has been made of one important form of teacher knowledge that Shulman identified (pedagogical content knowledge—the ways of representing and formulating a subject that make it comprehensible to others) less attention has been paid to the form he termed *curricular knowledge*. By curricular knowledge, Shulman meant knowledge of the full range of programs designed for teaching a particular subject or topic, the variety of instructional materials available, and the set of indications and contraindications for the use of particular curriculum materials in particular circumstances. In addition, Shulman included knowledge of what he termed lateral and vertical curriculum knowledge—that is, the ability to relate the topics under study to topics or issues being discussed at the same time in the students' other subjects, and those topics and issues that have been and will be taught in the same subject area during the preceding and later years in school. Some work has been done in this area in the intervening years. Ball & Cohen (1996), Davis & Krajcik (2005), and Remillard (2000) all note the importance of educative curriculum materials (those intended to educate teachers, for instance by helping teachers to anticipate student thinking and to consider how to relate units throughout the year). Chieu, Weiss, and Herbst (2009) created animated representations of classroom events and used these representations to investigate practicing teachers' learning and knowledge, claiming that the animations provided opportunities for teachers to share and discuss their common practical knowledge of their profession, and hence learn about different alternatives to a given teaching situation or problem.

Such work reveals teachers' learning about a small portion of what Shulman termed curricular knowledge—the variety of instructional material and approaches possible for a given topic. However, how teachers learn to develop lateral and vertical curricular knowledge remains obscure. Researchers recognize that for many new teachers, mathematics textbooks (designed for K-12 classroom use) contribute a significant source of curriculum guidance that may contribute to the development of curriculum knowledge. For example, Nicol and Crespo (2006) studied pre-service teachers' engagements with mathematics textbooks and found that for each of the pre-service teachers they studied, once on practicum placement, the textbook "became the curriculum guide" (p. 342) though only one of the participants used the textbook to inspire her own units of study in what Nicol and Crespo label a 'creative' way that brought forth opportunities to consider connections within and beyond mathematical topics (vertical and lateral curriculum knowledge). Overall, the pre-service teachers in Nicol and Crespo's study reported finding little in the way of curriculum materials that supported their attempts to make *sense* of what they were expected to teach—for example, to enrich or personalize the mathematics. It is such sense-making that might contribute to the *deep* understanding of mathematics required to use curriculum materials flexibly to support student understanding and the *rich* understanding of mathematics required to embed the curriculum concepts laterally and vertically (in Shulman's terms). These concerns about teachers', and particularly new teachers', selection, use, and understanding of curriculum materials for teaching links to the significant body of new research concerning the phenomenon of *mathematics for teaching*. This emerging body of literature builds on Shulman's (1986) work and significantly extends it (Davis, 2010; Davis & Simmt, 2006; Hill, 2010; Hill & Ball, 2004; Silverman & Thompson, 2008; Towers & Martin, 2009). Mathematics for teaching, also referred to as mathematical knowledge for teaching in the literature, refers to the special knowledge that teachers of mathematics must

hold that extends beyond technical content knowledge. It includes, for example, knowing not only procedures for solving problems but also understanding and being able to explain why those procedures work, knowledge of student understanding (and common misunderstandings), and the capacity to interpret—and perceive the generalizability of—students' novel solution methods, to name just three of the dimensions of mathematics for teaching that have been identified. This form of mathematical knowledge is particular to teaching and is not necessary for 'users' of mathematics in other professions.

## Methods

### Context of the study.

The purposes of the research project from which data for this article were taken were to explore the experiences of pre-service teachers learning to teach mathematics within an inquiry-based teacher education program, to identify what they learned about mathematics and mathematics teaching as a result of their experiences, to begin to determine how these new teachers used what they had learned in their first year of teaching, and to inquire into the difference that an inquiry-based teacher education program might make in shaping teachers of mathematics. This manuscript focuses on the data relating to how the new teachers used what they had learned about teaching mathematics during their first year of teaching. Participants in this research study were enrolled in a two-year Bachelor of Education After-Degree program that is founded on inquiry-based, learner-focused, and field-oriented principles and practices (see Phelan, 2005a, for a broader description of the structure and guiding philosophy of the program)<sup>1</sup>. Within this program, student teachers are taught in small groups, usually between 15 and 22, collaboration is encouraged, the entire program is non-graded, and much of the curriculum is case-based. Student teachers complete three major field placements—two in school settings and one in a community or workplace setting. They are in schools continually during the program, sometimes for two days per week and sometimes for full immersion, but whether they are in school or on campus the focus of the program's teacher educators is on integrating theory and practice so that each informs the other.

In the first semester of the program, which focuses on the theme of *Learning and Teaching*, all students (secondary and elementary together) participate in weekly Case Tutorials, with written case studies focusing on 'learners and learning' and 'teachers and teaching.' Students (again secondary and elementary combined) also participate in weekly Professional Inquiry Seminars designed to help students interrogate their assumptions and biases and begin to formulate their identities as beginning teachers. Students are in schools two days per week for half the semester, and in a Community/Workplace placement two days per week for the remainder of the semester—this latter element designed to help students explore and begin to understand the diversity of spaces in which educational experiences take place in our society. A weekly, two-hour, on-campus Field Inquiry Seminar in Semester 1 supports and guides the work of the student teachers in their various field placements, and here students are separated into early childhood, elementary, and secondary routes. Students are encouraged to understand their time in schools and classrooms as a text to be interpreted and as a form of inquiry into what it means to learn to teach rather than as a space in which to simply practice being a teacher, and it is perhaps this emphasis more than any other that gradually, over the two

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<sup>1</sup> The description that follows relates to the structure of the program at the time of the research study, though various elements of the program changed over the ensuing years and indeed the entire program has now been dismantled in the face of ideological opposition to its existence.

years of the program, helps beginning teachers learn to teach phonetically. In the second semester of the program, within the theme *Curriculum Content and Curriculum Contexts*, students continue in their school placements two days per week, with an additional week-long immersion near the end of the semester, and this work continues to be supported by a weekly Field Inquiry Seminar on campus at the university. Students participate in two weekly, three-hour Case Tutorials in this semester (separated by specialist route). In the third semester of the program, within the theme *Praxis*, students participate in a major field placement in a school (typically in a different grade division, socio-economic region of the city, etc., than their first-year placement). Students are in schools four days per week for much of the semester, and this work is supported by a weekly, three-hour, on-campus Field Inquiry Seminar that also integrates a Case Tutorial component, wherein students are asked to develop ‘living cases’ derived from their practices in schools. Within Semester 3 students also experience a full-time, three-week immersion in schools. In the final semester of the program, focusing on the theme *Integration*, students engage in three weekly, three-hour, on-campus components—a Professional Inquiry Seminar that further develops the aims of the Semester 1 Professional Inquiry Seminar, a Case Tutorial, and a Special Topics Seminar, all of which engage both elementary and secondary route students together. The Special Topics Seminar requires students to complete a research-based independent inquiry assignment that includes opportunities for students to return to their schools in the role of action researcher to further analyze issues of teaching and learning in context. This seminar is also the only space in which the students have choice in the program, and many opt to engage in deeper study of the various curricula areas they may be asked to teach in their beginning practice in schools.

The participants in the research study were students who opted to participate in my own Special Topics Seminar in the final semester that focused on teaching mathematics through inquiry. Participants in the seminar, and in the research, were drawn from early childhood, elementary, and secondary routes in the program. During the seminar, student teachers were exposed to current research on teaching mathematics through inquiry, and the weekly seminars were also structured around mathematics tasks that required participants to engage in learning mathematics through inquiry.

### **Data collection and analysis.**

To conduct the research, I videotaped 12 of the 13 three-hour teaching sessions<sup>2</sup> during the final semester of the program in the Special Topics Seminar focusing on teaching mathematics through inquiry, focusing the camera both on myself and on small groups of volunteer student teachers (12 in total) as they worked on the mathematics and pedagogy tasks. I also interviewed nine of these volunteer students once they had completed the program in the spring (the remaining three being unavailable to continue with the research after the end of the teacher education program). I then followed three of these beginning teachers, Noah being one, as they embarked upon their first year of teaching and continued to interview them during the year.<sup>3</sup> I and/or my research assistant also videotaped their mathematics teaching throughout the

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<sup>2</sup> The first class session was not videotaped in order to allow students to discuss the research study and make informed choices about whether, and to what extent, to participate.

<sup>3</sup> The three students were ‘chosen’ for accessibility reasons rather than because they had shown particular skills in, or understanding of, inquiry-based practice. For instance, though some students volunteered to be videotaped in their first-year classrooms, their school principals would not allow the research to proceed (citing it as too much pressure for a beginning teacher). In addition, I was unable to include in the school-based component of the

year, averaging nine videotaped lessons per teacher between September and June. We also conducted task-based interviews at the end of the year with some of the children who had been videotaped in the classroom, in order to gain more information about the children's mathematical understanding.

Data analysis proceeded through an iterative process of viewing and reviewing the video data and supporting evidence (such as audiotaped interviews, fieldnotes, and copies of students' work on classroom mathematics tasks), following the approach described by Powell, Francisco, and Maher (2003). Initially, data were viewed in their entirety to get a sense of their content and context, without imposing a specific analytical lens. In the second stage, the video data were described through writing brief, time-coded descriptions of each video's content. The aim was both to map out the video data for further analysis and to become more familiar with the content. In stage three, the data (videotapes, coded notes, and interview transcripts) were reviewed to identify "critical events" (Maher, 2002). Stage four involved analyzing and coding these identified critical events to create rich and detailed theoretical descriptions of critical events in the process of learning to teach undertaken by a number of student teachers, over various time periods. The fifth stage of analysis involved examining closely these analyzed and coded critical events to "discern an emerging and evolving narrative about the data" (Powell, Francisco, & Maher, 2003, p. 430) from which themes are derived. One such theme is addressed in this article—the sustainability of inquiry-based teaching and learning practices in today's schools. For clarity, I draw here on the data from one research participant, Noah, though other participants expressed similar ideas and concerns relating to the challenges of sustaining inquiry-oriented practices.

### **Research participant: Noah.**

The following analyses have been developed by drawing on data collected from one beginning teacher, Noah. Noah had a background in architecture and museum education and had participated in the elementary school route within the teacher education program. At the end of his teacher education program, he secured a teaching position in a Grade 6 classroom within a Gifted Education program in an urban elementary school, though he had no specialised training in gifted education. Data were collected in this classroom throughout Noah's first year of teaching. As the focus of this article is the conditions necessary to sustain inquiry-based practices in the schools, space limitations prevent me from offering full descriptions and transcript evidence of the strength of this beginning teacher's inquiry-based classroom practices.<sup>4</sup> Nevertheless, it is important to understand some of the elements of practice that characterized his classroom. Careful analysis of the videotapes collected throughout the year in his classroom revealed a range of teaching strategies consistent with strong inquiry-based practice. Noah used varied and interesting prompts to engage learners, drew from commendable sources when planning for teaching, used students' own suggestions as prompts for mathematical investigation, connected the mathematics to other curriculum areas the students were studying, encouraged the students to work together to solve problems, showed genuine interest in students' alternative solution strategies, and made attempts to assess learning authentically.

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research those volunteers who accepted teaching positions in remote locations in distant provinces, as well as those who did not gain full-time employment until after the school-based research component had begun.

<sup>4</sup> Manuscripts that offer more detailed evidence of the inquiry-oriented classroom practices of participants in this study are available elsewhere. See, e.g., Towers (2010).



His experience was not without struggle though, and Noah commented extensively in interviews on the challenges of enacting and sustaining such sophisticated practices. Elsewhere I have discussed challenges relating to working with others and gathering around themselves a community of inquiry that Noah and others experienced (Towers, 2008). In this article I present evidence from interviews conducted throughout the year with Noah that highlights the importance of the school's administration in supporting his attempts to enact inquiry in the classroom and that documents his challenge in finding rich curriculum materials to support inquiry in mathematics.

### **Findings: Supports for, and Challenges to, Enacting Inquiry in the Classroom**

#### **A key support: The importance of a supportive and knowledgeable school administration.**

In his first year of teaching, Noah found himself in a school environment where inquiry-based practices were understood and supported by the administrative team. Like other research participants, he spoke in detail about the importance of this support to his overall well-being and his ability to sustain his practice. Noah recognised that support from his school principal was key in sustaining his attempts to engage in inquiry in the classroom. His principal had completed graduate work in our faculty, studying among curriculum specialists who worked within an interpretive frame, and he therefore understood and supported inquiry-based approaches. This was an administrator who took seriously his responsibilities as a curriculum leader and as a mentor for new teachers.

**Noah:** I was lucky enough to have an administrator who would sit in within the classroom. No pressure there! But also would watch and give me suggestions as well. But for the most part...the support was there but the suggestions were—he left it open. And I think that was positive in that it let me discover.

Noah talked in detail about the kinds of conversations he had had with his school principal that had enabled him to sustain inquiry. In the following excerpt, Noah speaks to a familiar dilemma for teachers enacting an inquiry approach—the temptation to fall back on controlling and directive teaching approaches when concerns about ‘covering’ the mandated curriculum arise—and describes how the principal intervened to prevent him from losing faith in inquiry:

**N:** There also was a point about a month ago where it was almost like I had/I'd done a lot of my ideas and I was starting to sort of run out of ideas and then I went back and I had to go back to the curriculum and [said], “Am I covering this?” And at one point I felt like, “Oh, I'm going to teach fractions now.” And actually [the principal] came back and said, “I don't want you to teach fractions.” He actually said, you know, “I don't want you to just teach fractions.” And that's all he said and I said, “You know you're right. I can't just go and teach fractions.” So there's been a lot of/ I've gotten a lot of administrative support so I haven't really gotten too down in the dumps.

Noah clearly felt supported by his school administration, and valued the principal's commitment to inquiry. The principal's ability to prevent Noah from slipping back into technical solutions to perplexing problems (“I don't want you to just teach fractions”) yet

“letting him discover” his own path emerged as a powerful enabling factor in Noah’s capacity to sustain inquiry in the classroom.

**A significant challenge: Finding rich curriculum materials.**

When asked about the supports he would have liked to have had in place in order to help him sustain inquiry in the classroom, Noah emphasized that a co-teaching arrangement with someone who understood and practiced inquiry would have been helpful (see Towers, 2008). He noted, “I’m trying things on my own and I’ve got the experience of one happening here.” However, Noah also noted that that an ‘expanded’ version of the curriculum would be equally valuable. By this he did not mean a more detailed curriculum document—often the (technical) solution of governmental departments when they hear from teachers that they need more help with interpreting the curriculum—but rather a source, tied to the provincial curriculum, that helped him understand the big ideas of the discipline and learn how to transform that “upper end thinking...for Grade 6.” Noah described the many hours of internet and library searching, and mathematical play, in which he had engaged throughout the year as he attempted to deepen his understanding of the discipline and find beauty in mathematics. He commented on drawing on “higher level” mathematics books, not books aimed at teachers, so that he could really try to understand the structure of the discipline. Within the seminar Noah had taken with me in his final semester in the teacher education program, I had emphasized the importance of understanding the structural relations of mathematics and Noah noted that a lot of his understandings (and indeed the classroom tasks he had used in his teaching) had come directly from that seminar. Through this experience, and his further research during his first year of teaching, he also began to recognize that there are a number of central concepts within mathematics that appear to recur throughout the centuries:

N: [I read] a lot of books. I got a history of mathematics [internet] site that I went through and I saw how they connect [ideas] and I see some of these big ideas and theorems and I think, “You know what? There’s a beautiful thing that we can do discovery through for three or four days.” A lot of it came through the [university] class. What I’m finding is it’s almost like 12 set problems that everybody comes back with—the Platos or the Sierpinskis, Pascal...and Fermat.

Noah’s pedagogical difficulty, though, once he had begun to appreciate the connectedness of mathematics, was how to teach these central concepts and big ideas within the constraints of the Grade 6 curriculum:

N: But [what then] once you’re done...play[ing] with these unproveable problems or these things?

He was looking for a way to go, in his words, “beyond the program of studies” and teach in a more connected mode, rather than the typical process of addressing unit after unit throughout the curriculum:

N: For the Grade 6, instead of saying I want you to do patterns and then I want you to do number strands, and then I want you to do...each of these...segments, each of the strands...and [you must] do it in unit blocks...I’d rather go to a concept and idea and try to do a discovery into that, as opposed to saying I’m going to teach this, you know?

And I use what ideas [I've found] and then what usually happens within the classroom is it gets adapted, it grows....And I go with it. I'll introduce an idea. I'll let them play with it. And then I come back and say, "well what exactly are you doing and how are you doing this...and what about these connections?" And the connections are becoming huge within my class.

Noah understood his responsibility to "cover the curriculum," but saw his role as much more than that:

**N:** Using the program of studies was understanding it as concept-based. Here's some of the main ideas that we're trying to get through....Take a look at the resources we have and basically cover the resource but know that we're covering the principle. And it was always teach up here [*raising his hand high in the air*], but know that you're covering here [*placing his hand palm down on the table*]...The principal says the...program of studies [is] your four basic food groups but you know, let's make a meal out of it, let's make a proper gourmet meal. And that's a beautiful analogy for me because then all of a sudden I'm thinking you know what? I want my lesson to be incredibly rich and just be/ and have the depth and have the passion and everything. And in that sense I know that I'm covering [the curriculum]. Within my lessons whether it be social studies, whether it be mathematics, if I know that I'm teaching a really, really interesting concept I know I'm covering it. I'm hoping to cover the program of studies, but the greater understanding is...more important.

Noah's case reveals that while there is the potential for new teachers to enact strong inquiry-based teaching in their first years of teaching, the difficulties of 'interpreting' mandated curricula in rich ways can be a deterrent.

### Discussion

The above data suggest that there is reason to be hopeful about the possibility of educating teachers to enact inquiry-based teaching practices, but that there is also reason to be concerned about the sustainability of those practices in K-12 schools.

#### **The importance of a supportive and knowledgeable school administration.**

Large-scale research conducted in Germany (cited by Korthagen & Kessels, 1999, p. 5) showed that teachers pass through a distinct attitude shift in their first year of teaching, adjusting to, and adopting, practices common in the schools rather than enacting the research-based practices they had been taught about during their teacher education. Such research findings are particularly troublesome when considering the potential drift away from inquiry approaches, as such teaching can be difficult to describe to others (especially others who approach teaching very differently) (Smits, Towers, Panayotidis, & Lund, 2008; Towers, 2008, 2010), and challenging to enact (Schulz & Mandzuk, 2005) even without the pressures of scrutiny and surveillance typically placed on new teachers. In contrast, the practices of all the new teachers I followed could be characterized as inquiry-based, despite the challenges reported above and in some cases despite resistance from other teachers in the schools (see, e.g., Smits, Towers, Panayotidis, & Lund, 2008; Towers, 2008, 2010). One of the most significant factors in their success was the role of the school administration. By chance (given

that the participants did not know at the time of beginning the study where they might find themselves in their first year of teaching) all of the new teachers in whose first-year classrooms I videotaped found themselves in schools with administrators who supported inquiry-based teaching and learning, though to varying degrees. Noah's case provides clear evidence of the importance of a school principal who understands inquiry and can step in at the right moment to prevent a new and unsure teacher from becoming caught up in traditional school practices. Indeed, as Noah has reported to me recently as part of ongoing interviews about his practice for a related, longitudinal research study, this principal defended Noah's practice during his first few vulnerable weeks in the school when other teachers came to complain to the principal that "whatever [Noah] is doing in there, it's not teaching." While there are certainly many good reasons to include peer-mentoring relationships in schools as part of new teacher induction, the above discussion suggests that it might be critical to ensure that the principal him- or herself is responsible for mentorship of new teachers in the case where the new teacher is experimenting with innovative practices. By virtue of his/her role, the principal has the power to interrupt counter-narratives of what counts as "good" practice that can emerge among teachers who see inquiry approaches as threatening to their own capabilities, as representing weak practice, or as simply incomprehensible as teaching (such as the teachers who complained to Noah's principal).

Elsewhere, though, researchers suggest that even when new teachers find themselves in a school with an administration that supports inquiry, they often abandon inquiry-based approaches to teaching that they may have learned about in their teacher education programs and drift towards the more traditional practices they see around them (see, e.g., Schultz & Mandzuk, 2005). It is important, therefore, to consider further what might have enabled Noah (and the other graduates of our program [see also Smits, Towers, Panayotidis, & Lund, 2008; Towers, 2008, 2010]) to sustain inquiry approaches in their settings.

In Noah's case, there are several significant conditions that the data suggest contributed to the sustaining of his inquiry approach. These include the specific nature of the teacher preparation program through which he was educated, Noah's own dispositions for teaching, and various school-based conditions such as the nature of the (gifted) students he found himself teaching, and some of the other professionals around him in the school. Space limitations prevent me from considering all of these conditions in this single paper, though I am continuing to develop analyses of the role they played. Here, I focus explicitly on school-based conditions for Noah's success and, in particular, the role of the school principal.

What is striking about Noah's commentary on the role of his school principal is the specific nature of his principal's support. Noah's principal did not simply hold a benevolent disposition towards Noah's attempts to teach through inquiry. Noah reported that the principal spent lots of time in his classroom, observing, interacting with students, and later discussing his ideas and processes with Noah. While on the one hand Noah felt some of the pressure of being watched so closely (as we see in his tongue-in-cheek comment, "No pressure there!"), this close scrutiny also provided the ground for the mentoring role played by the principal. This mentorship was not based on context-less conversations about theoretical principles of inquiry, but on the difficult and time-consuming work of analyzing and discussing Noah's teaching. A phronetic approach to teaching requires discernment and rests on judgment in context (Dunne & Pendlebury, 2002). Theory and practice must be made to bump up against one another and, as Dunne (2005) notes, this requires perceptiveness in the reading of particular situations as much as flexibility in holding and applying theoretical knowledge. The frequent presence of the principal in Noah's classroom provided both parties with rich examples of inquiry-based

practice (the successful and the troublesome) on which to ground their conversations and on which the principal could base his decisions about how and when to offer guidance. The principal's intimate knowledge of Noah's classroom enabled him to actively interrupt Noah's mid-year dip of confidence in the inquiry approach and encourage him not to "just teach fractions." This case suggests that it is important that school principals establish a presence in new teachers' classrooms in order to develop the necessary understanding to know how and when to guide these vulnerable members of the profession and ensure they sustain inquiry-based approaches.

While a great deal of attention is currently being paid to the complexities of the role of the school principal, much of this research focuses on the administrative and management dimensions of their role rather than the curriculum-leadership dimension. There are notable exceptions, though. For example, Ross and Gray (2006) discuss the importance of the school principal in creating the organizational conditions through which teaching and learning might be enhanced. The role of the principal as curriculum leader in promoting inquiry-based practices in K-12 schools is the focus of some of my ongoing research (see, e.g., Towers & Panayotidis, in press), however given the data provided here I believe this particular aspect of the principal's role (the support and promotion of inquiry-based teaching and learning practices in K-12 schools) has received insufficient attention in the educational leadership field and there is scope for much additional research.

### **The challenge of finding rich curriculum materials.**

Noah's struggle to translate his learning about "higher-level mathematics" for the classroom reminds us that, as Dunne (1997), drawing on Aristotle, points out, "What makes knowledge theoretically powerful does not coincide with what makes it practically effective" (p. 282). A new and important body of research is emerging that attends to the specific knowledge (mathematics) teachers need for teaching (Ball, 2000; Ball & Bass, 2000, 2003; Davis, 2010; Davis & Simmt, 2006; Delaney, Ball, Hill, Schilling, & Zopf, 2008; Silverman & Thompson, 2008), and that is beginning to extend Shulman's (1986) important work on how such math knowledge is developed, held, and used in teaching (e.g., Ball, 2000; Towers & Martin, 2009). This work is beginning to reveal the full complexity of the relationship between content knowledge and pedagogical knowledge.

Noah's sometimes lonely struggle with the ideas of mathematics is, of course, inseparable from the inquiry in which his students will engage in the classroom, not a precursor to inquiry that can be eased, replaced, usurped, or erased by finding exactly the 'right' curriculum support document. Knowing this, and seeing in his descriptions of practice a desire for richness and connectedness, I have hope for his future practice. Indeed, it is interesting to note that Noah did not simply seek ready-made lesson plans or simplifications of curriculum topics. His impulse was, in fact, quite the opposite. He sought an "expanded" version of the curriculum document, one that might help him understand the big ideas of the discipline and find the beauty within them. This is an impulse that is beginning to gain traction among engaged teachers (see, e.g., McLeod, 2010)—one that suggests that the mathematics for teaching required for inquiry-oriented teaching may be of a different nature than that required for more conventional mathematics teaching. In particular, Noah's search for the connectedness of mathematical concepts indicates that Shulman's (1986) curricular knowledge—and especially lateral and vertical curricular knowledge—may warrant more attention. Noah actively worked to integrate his teaching of mathematics with his teaching of other disciplines, exercising what Shulman (1986) would call lateral curriculum knowledge, for example

integrating his students' study of the development of ideas of democracy in ancient Greece (a topic in the Grade 6 Program of Study for Social Studies) with study of significant ideas in mathematics that were developing at the same time (i.e., a focus on Zeno's paradox and the notion of the infinite, which connects to the 'Chance and Uncertainty' strand of the Grade 6 mathematics curriculum). He also spent a great deal of time working to connect the elementary ideas embedded in the Grade 6 curriculum to the "big ideas and theorems" of the discipline, exercising his capacity for vertical curriculum knowledge. There is, therefore, at the heart of Noah's dilemma, a challenge for mathematics teacher education, and for the field of teacher education more broadly, to explore the kinds of curriculum resources that might best aid beginning (and more experienced) teachers not simply to deliver curriculum but to enact and sustain rich, inquiry-based practices in today's classrooms. Noah's desire for support materials for inquiry was a theme that was echoed by other research participants, and has prompted me to launch an investigation into the kinds of curriculum support materials that graduates of an inquiry-based teacher education program use, value, and need to support their attempts to engage in inquiry with children in schools. The full findings of this study are forthcoming (see Towers & Rapke, 2011 for initial findings) and will extend the emerging body of knowledge in this area (see, e.g., Nicol & Crespo, 2006; Remillard, 2000; Van Zoest & Stokero, 2006).

### **Summary**

The analysis presented here indicates the importance of a supportive and knowledgeable school principal, in particular one who is willing to spend considerable time in a new teacher's classroom, actively engage in analysis of the new teacher's teaching, deflect opposition to innovative (and not always immediately successful) inquiry-based practices, and, as Wood (2005) suggests, act as an advocate for the new teacher. Such leadership practices make a difference in sustaining inquiry-oriented teaching.

The study also draws attention to the need for further research concerning the kinds of curricular support materials necessary to help new teachers who are attempting to enact inquiry-oriented practices to thrive in schools. Work in initial teacher education that helps new teachers to develop a connected view of mathematics that supports lateral and vertical curriculum knowledge is especially significant.

### **Conclusion**

As a research community, we have a way to go yet in fully understanding the challenges of enacting inquiry-based approaches in school classrooms. In particular, we need to know more about how new teachers use their theoretical knowledge in practice, how they find and use materials that enable them to bring inquiry alive in a mathematics classroom, and what kinds of materials they need to support their own professional learning. Despite the challenges Noah experienced in relation to these aspects of practice, a significant condition that may help to sustain inquiry-based approaches in the classroom has emerged from this study—a supportive and knowledgeable school administration, and in particular a school principal willing to commit to the extensive responsibility of mentoring new teachers in inquiry-based practices. Such support, together with the beginning teachers' own commitment to, and knowledge of, inquiry-based practice, provides a framework for the sustaining of inquiry-based practices. By enhancing administrative support, and by working with school leaders to help

them understand and be able to foster inquiry-based approaches, we may be able to enhance the experience for new teachers committed to an inquiry-driven orientation to practice.

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