Running Head: Understanding of Inquiry

Student Teachers' Understanding of Inquiry Instruction

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Abstract

Curriculum reform emphasizes the importance of inquiry instruction for learners. For inquiry-oriented curriculum to occur, attention must be focused on teacher education. Using a mixed-methods design, I investigated if and how groups of student teachers who receive different types of exposure to inquiry differ in their understanding of inquiry instruction. Preservice teachers' descriptions of inquiry experiences in their teacher-preparation program contextualized the results. Considerable effort was given in the first phase of this study to establish the reliability and validity of the *Strategic Demands of Inquiry* questionnaire.

Participants were from McGill University, Montreal, and included preservice teachers in the Bachelor of Education program, Continuing Education students enrolled in an inquiry-based course, and Honours Psychology students engaged in research. Data sources included the *Strategic Demands of Inquiry* questionnaire and an interview schedule.

Groups who had different types of exposure to the inquiry approach varied in how they understand inquiry instruction. Fourth-year Elementary preservice teachers held more sophisticated conceptualizations of the inquiry approach and greater appreciation for the components involved in carrying out an inquiry curriculum compared to first-year Elementary preservice teachers. After the completion of an inquiry-oriented course, Continuing Education students (including experienced teachers) were similar to fourth-year Elementary student teachers in conceptualizing and identifying important components of inquiry instruction. First-year Elementary and Secondary student teachers were different in their views of inquiry instruction. Finally, Honours Psychology

students, who were engaged in scholarly research, held sophisticated conceptualizations of the inquiry approach. However, they did not use this knowledge of the inquiry method as extensively as fourth-year preservice teachers to identify important aspects of inquiry instruction. Therefore, although experience with the inquiry method may be necessary for conceptualizing inquiry as a pedagogical approach, it is not sufficient to enable undergraduates to identify important aspects of planning, enacting, and evaluating an inquiry curriculum.

These findings point to the importance of the Bachelor of Education program in advancing knowledge about inquiry instruction. Fourth-year student teachers reported experiences with the inquiry approach that influenced their understanding of this method. This study also provided evidence for the construct validity of the *Strategic Demands of Inquiry* questionnaire.

Résumé

La réforme du curriculum a mis l'accent sur l'importance de l'apprentissage s'appuyant sur l'enquête pour les apprenants. Pour qu'un curriculum fondé sur l'emploi de l'enquête puisse prendre place, une attention particulière doit être portée sur l'éducation initiale du professeur. J'ai fait enquête à savoir si, et comment, des groupes de professeurs ayant été exposés diversement à la méthode de l'enquête perçoivent celle-ci de façon différente. J'ai aussi examiné les descriptions de l'utilisation de cette méthode chez des enseignants en formation dans des programmes préparatoires à l'enseignement afin de mettre en contexte les résultats obtenus. Un effort considérable a été fait au cours de cette première phase de ma recherche pour établir la fiabilité et la validité du questionnaire intitulé *Strategic Demands of Inquiry* (*Demandes stratégiques de l'enquête).*

Les participants étaient étudiants de l'Université McGill (Montréal, Québec), incluant des professeurs en formation issus du niveau baccalauréat du programme en Éducation, des étudiants de psychologie inscrits en spécialisation, en cours de rédaction d'un mémoire et participant de ce fait dans une démarche d'enquête, de même que des étudiants d'un cours de formation continue inscrits à un cours d'un trimestre axé sur la méthode de l'enquête. Les sources des données colligées sont le questionnaire intitulé *Strategic Demands of Inquiry (Demandes stratégiques de l'enquête)* ainsi qu'une série d'entrevues à l'horaire. Les données ont été analysées quantitativement et qualitativement à partir d'un modèle mixte de recherche.

Les groupes qui ont été exposés différemment à divers types d'approche de la méthode de l'enquête ont démontré des variations quant à leur compréhension de

l'enseignement utilisant cette méthode. Les étudiants de quatrième année en formation pour l'élémentaire ont fait montre de conceptualisations plus sophistiquées quant à l'enquête à titre d'approche pédagogique; ce sont aussi ces derniers qui ont montré la plus grande appréciation des exigences stratégiques impliquées dans la préparation, la mise en place et l'évaluation d'un curriculum s'appuyant sur l'enquête, en comparaison avec des élèves de première année universitaire, toujours dans le domaine de la formation pour l'élémentaire. Après avoir complété un cours d'un trimestre axé sur la méthode de l'enquête, les étudiants en formation continue (incluant des enseignants d'expérience) en arrivaient à des résultats similaires dans leur conceptualisation d'une approche utilisant l'enquête et dans leur identification des composantes importantes d'une telle méthode telle qu'elle pourrait être utilisée dans un contexte de salle de classe à titre d'enseignants au primaire sortant d'un programme préparatoire à l'enseignement. Les enseignants en formation dans des programmes préparatoires à l'enseignement au primaire et au secondaire ont manifesté des divergences de vues quant à l'efficacité d'une méthode d'enseignement par l'enquête. Enfin, les étudiants de psychologie inscrits en spécialisation et participant à des recherches dans le milieu académique, ont fait montre de conceptualisations sophistiquées quant à la méthode de l'enquête. Cependant, ils n'ont pas fait une utilisation aussi importante de cette méthode que les étudiants de quatrième année du programme de formation en Éducation dans le but d'identifier les aspects importants de l'enseignement par l'enquête. En conséquent, si l'expérience avec cette méthode peut être nécessaire pour conceptualiser l'enquête en tant qu'approche pédagogique, elle n'est pas suffisante pour permettre aux étudiants de premier cycle

d'identifier les aspects importants de la planification, de la mise en place et de l'évaluation de cet enseignement.

Ces découvertes montrent l'importance du programme de baccalauréat en Éducation pour faire avancer la connaissance au sujet de l'enquête comme outil d'enseignement. En effet, les étudiants de quatrième année qui enseignaient ont rapporté des expériences avec la méthode de l'enquête qui ont influencé leur compréhension de celle-ci. La présente recherche a aussi fourni le témoin de la validité de la conception du questionnaire des *Strategic Demands of Inquiry* était avérée.

Table of Contents

Page

List of Tables

List of Figures

Chapter 1

Background

Research Topic and Problem

Curriculum reform emphasizes the importance of teachers and learners engaging in inquiry-based teaching and learning. "A central concern for educators in the 21st century must be to develop in learners the personal resources to work effectively within contexts of change, paradox, and uncertainty" (Reid & O'Donoghue, 2004, p. 564). The Quebec Ministry of Education, Leisure, and Sports (MELS) recognized this need and in 1997 put forth its reform recommendations. Educational reform expects teachers to be reflective practitioners, to educate diverse learners, and to understand and teach subject matter in ways different from those in which they were educated themselves (Ball & Cohen, 1999).

> Teaching for problem solving, invention, and application of knowledge requires teachers with deep and flexible knowledge of subject matter who understand how to represent ideas in powerful ways and can organize a productive learning process of students who start with different levels and kinds of prior knowledge, assess how and what students are learning, and adapt instruction to different learning approaches. (Darling-Hammond, 2000, pp. 166-167)

Curriculum reform in Quebec requires that teachers and students engage in inquiry-oriented teaching and learning to promote the type of learning outcomes that are associated with this changing context.

Inquiry has been defined by the National Research Council (NRC) as "a set of interrelated processes by which scientists and students pose questions about the natural

world and investigate phenomena; in doing so, students acquire knowledge and develop a rich understanding of concepts, principles, models, and theories" (NRC, 1996, p. 214). This definition of inquiry learning and teaching is limited to the view of science inquiry and does not take into account inquiry instruction more generally or in other areas such as English, mathematics, or history where students and teachers engage in investigations about a wide variety of phenomena. The NRC definition is also in some ways incomplete in terms of a pedagogical approach. Inquiry-oriented instruction also involves both teachers and learners co-constructing parts of the curriculum, asking questions that do not have known answers, planning and carrying out solutions, and sharing and reviewing results (Shore, Aulls, & Rejskind, 2000). This approach enables students to actively produce knowledge, and expands the teacher's role well beyond conveying knowledge. The inquiry-driven approach has its roots in cognitive and social-constructivist theories of education (e.g., Bruner, 1960; Dewey, 1938; Vygotsky, 1978). Because the idea of learners creating their own knowledge is fundamental to constructivism, the notion of learners posing their own questions is central to inquiry. In sum, the inquiry-learning process involves "higher-order thinking; classifying, interpreting, analyzing, summarizing, synthesizing, evaluating, decision-making, and metacognitive skills . . . [and] at the very heart of inquiry: questioning" (Martinello, 1998, p. 164).

For inquiry instruction to prevail and become standard, attention must be focused on preservice teacher education and on continuing professional education for existing teachers. Moreover, attention should be given to the influential role of beliefs in teacher development (Bullough, 1997a). That is, in order to understand preservice and in-service teachers' understanding of and practice with inquiry-based learning and teaching, we

need to focus on their perceptions and conceptualizations of the inquiry-driven instructional process. This is because, in order to carry out reforms in education, preservice and in-service teachers need to re-examine their beliefs and practices which are likely to be dissonant with those required by new reforms (Hashweh, 2003).

The majority of student teachers in Quebec, where this study took place, and in "western" societies, more generally, have been schooled in the traditional, teacher-directed approach and are now expected to carry out curriculum reform having had little or no experience with this type of instruction. It would be unreasonable to expect that they will easily and spontaneously adopt the idea of using inquiry instruction, or feel either trained in or competent enough to use this approach (Windschitl, 2003). We need to know what type of preservice experiences can effectively develop inquiry-oriented teachers (Martinello, 1998).

Most of the research on inquiry in teacher education has focused on intervention strategies--courses that promote inquiry-driven learning--and the impact these have on preservice teachers' understanding of the subject matter or on their views of teaching and learning in general. However, because of an absence of empirical research on preservice and in-service teachers' conceptualizations of inquiry generally, inquiry instructional approaches, and how to learn how to inquire specifically, it remains unclear how preservice teachers conceptualize and understand the processes involved in inquiry instruction, as well as what experiences, both program and personal, are related to different conceptualizations of inquiry.

The present study is an exploratory, rather than a confirmatory study. I aim to investigate, using a mixed-model design (Cresswell, 2003), different groups of student

teachers' conceptualizations of inquiry as a curriculum process. I am interested in the conceptualizations of inquiry instruction that student teachers hold, and whether they are related to the value they place on different elements involved in planning and carrying out an inquiry-oriented classroom. Moreover, I aim to provide a rich and detailed description of the environment, as perceived by the student teachers themselves, in which they have developed these beliefs and values.

At present, there is no one adequate model or theory supported by empirical evidence to explain how student teachers learn about inquiry instruction. Social-constructivist theories of learning provide a lens through which to examine this process, and the conceptual literature on student teachers' beliefs provides an explanatory framework for understanding student teachers' thinking generally that may have implications for the success of inquiry preservice teacher training. Specifically, I shall elaborate on social-constructivist theory and student teachers' beliefs, and how these perspectives will provide lenses through which to view this study. I will then review the relevant empirical literature to contextualize the present study.

Theoretical Foundation: Social Constructivism

Social constructivism is a theoretical approach to understanding learning and meaning-making. This is an appropriate viewpoint from which to theorize for the present study because I am examining the conceptualizations of inquiry instruction held by student teachers during their teacher preparation. The social-constructivist view of learning focuses on how the individual learner constructs his or her knowledge, but also stresses the importance of social factors involved in the learning process (Blumenfeld, Marx, Patrick, Krajcik, & Soloway, 1997; Phillips, 1995). Compared to Piagetian

psychological constructivism, which views the meaning-making process as individualistic, Vygotsky's social constructivism sees the social element as instrumental in the construction of knowledge (Richardson, 1997). This means student teachers' conceptualizations of inquiry as an instructional process need to be understood as being contextualized and embedded within the teacher-education program. It suggests that we cannot really understand student teachers' conceptualizations without also understanding one of the contexts in which these conceptualizations are formed or take place.

Social constructivism views the process of constructing knowledge as active in terms of social processes (Phillips, 1995). One of these processes involves language and dialogue. From this perspective, individuals acquire knowledge by engaging in social discourse, where they learn from their peers and more experienced members of the culture or group (Driver, Asoko, Leach, Mortimer, & Scott, 1994). A second process involves activities. According to Driver et al., by engaging in authentic, meaningful activities that are structured by a more experienced member of a culture or group, a learner can begin to internalize meanings. Environments that foster inquiry can occur at home, in the place of work, at all levels of formal schooling, and with the support of a wide variety of models. Considering the teacher-preparation program, in particular, from this perspective, student teachers would learn about inquiry instruction by actually engaging in inquiry themselves. Preservice teacher-preparation programs that foster this growth would be social in nature and the professors would provide scaffolding.

Within this framework knowledge is viewed as a socially constructed construct. Meaning is negotiated, and not defined by an individual. In an educational context specifically, this suggests that students and teachers construct knowledge together.

Knowledge or meaning is not defined by the teacher alone and transmitted to the student, neither is it completely defined by the student through an individual process. The approach used in this study is to attempt to understand the nature of student teachers' conceptualizations of inquiry instruction in terms of the variability, commonalities, and differences that exist, and in terms of how they perceive the importance of various intellectual tasks or roles in planning, enacting, and evaluating an inquiry curriculum. I aim to explore in-depth student teachers' understanding of inquiry as an instructional process. This exploratory purpose is appropriate because the study of student teachers' conceptualizations of inquiry instruction is relatively uncharted.

In terms of methodology, the use of a mixed-methods design allows for the examination of relationships among the "psychological, social, and cultural aspects, and to shift the focus to foreground any of these, depending on the purpose" (Marshall, 1996, p. 238). It also permits the focus on individual processes and the social context. This is important because theorizing from a social-constructivist perspective means considering the social interactions and the social context in the study of student teachers' understanding of engaging in inquiry teaching and learning. The mixed-methods design is also appropriate given the exploratory nature of this study because it allows for description. I aim to describe in-depth student teachers' understanding of inquiry instruction.

Explanatory Framework: Teacher Thinking

The research on prospective teachers' beliefs provides the most appropriate explanatory framework for the present study because, in the last decade, beliefs have been shown to be an important construct of interest in examining student teachers'

thinking, classroom practices, change, and learning to teach (Richardson, 1996). From a social-constructivist perspective, the beliefs' conceptual framework provides a model of the nature of beliefs, how they are formed, and how they may be influenced or impacted upon. Especially during times of curricular reform, when teachers and student teachers are required to re-examine their traditional knowledge and practice, it becomes especially pertinent to look at teachers' beliefs and perceptions (Hashweh, 2003). Moreover, according to Clark and Peterson (1986), teachers' general knowledge consists of theories and beliefs that influence their perceptions, plans, and actions. Therefore, the more we learn about teachers' beliefs about or conceptualizations of inquiry pedagogy, the closer we will come to understanding how to help them make the transition to the inquiry approach that is part of the Quebec curriculum reform (where this study took place) and many others.

According to Pajares (1992) "beliefs are created through a process of enculturation and social construction" (p. 316). This claim falls within a social-constructivist perspective of learning. Richardson (1996) characterized this process by three categories of experience that serve as the origins of beliefs: (a) personal history; (b) experience with schooling and instruction; and (c) experience with formal knowledge. This suggests that, when studying teacher thinking, it is important to consider the source of student teachers' beliefs and theories, in terms of their personal history, previous schooling, and university-based experiences.

There are four main findings with regard to the nature of beliefs and belief systems that will help in explaining and understanding the findings in the current study. Kane, Sandretto, and Heath (2002) outlined these findings below as a way to structure

their review of the literature on teachers' and student teachers' beliefs and knowledge. Their review of this literature was within the context of their larger study of professors' beliefs and practices. I will elaborate on each of these points in order to illustrate how this conceptual framework is pertinent to the present study. I include in this section review articles summarizing and critiquing research. I describe these authors' arguments to show the conversations taking place in this domain of research, rather than to show the exact research findings from particular studies. Given that the particular studies' findings are not critical to conceptualizations of inquiry instruction (the focus of this thesis) this type of review of the literature to explain my conceptual framework was appropriate.

1. Student teachers enter teacher-preparation programs with pre-established beliefs.
2. These beliefs serve as filters that affect how and what student teachers learn in the teacher-preparation program.
3. Student teachers' beliefs are highly stable and resistant to change.
4. These beliefs are often tacit or implicit and difficult to articulate.

Student teachers enter teacher-preparation programs with pre-established beliefs. The consensus in the learning-to-teach and teacher-belief research is that student teachers enter their teacher-education programs with pre-existing, well-established beliefs about teaching and learning (Bullough, 1997a, 1997b; Fang, 1996; Kagan, 1992a, 1992b; Pajares, 1992; Richardson, 1996). More precisely, they hold beliefs about students, subject matter, classrooms, and themselves as teachers when they enter their preparation programs (Clark, 1988; Kagan, 1992a, 1992b).

In an attempt to investigate the ways in which prospective teachers' beliefs influence learning to teach in teacher-education programs designed for conceptual

change, Richardson (1996) reviewed the learning-to-teach literature. In her analysis of entering student teachers' beliefs, Richardson concluded that "the conceptions of schooling held by entering students are that the teacher hands knowledge to students and learning involves memorizing and the content of the curriculum" (p. 108). This suggests that student teachers are likely to enter teacher-education programs with traditional and transmission-oriented views of teaching and learning. These findings are consistent with Feiman-Nemser and Buchmann's (1989) assertion that "prospective teachers are not blank slates; they come to their professional studies with ideas and commitments that are likely to affect their learning to teach . . . thus, learning outcomes in teacher education are a function of both what programs offer and what people bring" (p. 368). Moreover, in a separate review of the learning-to-teach literature, Kagan (1992b) found that the beliefs that student teachers brought to their teacher-education program were, for the most part, derived from their prior experience as pupils. Accordingly, it seems reasonable to assume that student teachers entering the Bachelor of Education program at McGill University come with pre-existing ideas about inquiry learning and teaching which are likely rooted in their school-based experiences as pupils.

Beliefs serve as filters that affect how and what student teachers learn in their teacher-preparation programs. From a constructivist view of learning, pre-existing beliefs and knowledge frame or shape how and what information student teachers learn in their preparation programs (Nespor, 1987; Richardson, 1996). Beliefs are believed to function as filters, which let in new knowledge determined compatible with current beliefs, and filter out new information deemed incompatible with pre-existing beliefs (Bullough, 1997a; Kagan, 1992a, 1992b; Kane et al., 2002).

Given that many student teachers are likely to enter teacher-education programs with traditional, transmission-oriented views of teaching and learning, this raises the question of how student teachers' negotiate learning contemporary views of education. Richardson (1996) reviewed studies that highlighted the strong influence of beliefs in learning to teach. For example, in the studies she described, student teachers' entering beliefs that were more traditional in nature and in contradiction to the reflective or constructivist approach of the teacher-education program, were the most influential contributor to how and what student teachers learned, reducing the students' receptiveness to the professor's ideas, and leading to difficulties understanding constructivist-oriented views of teaching. These findings suggest that within programs that attempt to promote reflection and constructivist philosophies, which is in line with educational reform attempts in Quebec and other places, student teachers' beliefs about learning and teaching which are more traditional in nature (i.e., reflecting direct instruction), influence how and what they learn, and can make understanding of more contemporary views of education difficult. Moreover, these findings suggest that student teachers' conceptualizations of inquiry pedagogy will influence the value that they place on specific intellectual tasks involved in the inquiry instructional process that may not be involved in concepts and facts learned by rote.

Student teachers' beliefs are highly stable and resistant to change. Not only do student teachers enter teacher-education programs with well-established beliefs that influence what and how they learn in their program, these beliefs are believed to be, by many researchers, robust and resistant to change (e.g., Block & Hazelip, 1995; Bullough, 1997a, 1997b; Clark, 1988; Kagan, 1992a, 1992b; Kane, 1992; Richardson, 1996). In an

examination of the state of the literature on professional growth among prospective teachers and the implications of the research on teacher beliefs, Kagan (1992a, 1992b) highlighted the durability of beliefs. In her review, she consistently found that prospective teachers tend to enter and leave their teacher-education programs with the same beliefs about teaching and learning. That is, rather than modifying or altering their beliefs throughout teacher preparation, student teachers seem to use the information from their courses to confirm their pre-existing beliefs, thus becoming more attached to them over time. She attributed the lack of change, in part, to the student-teaching field experience that she described as involving little cognitive engagement. Moreover, Kagan reviewed studies that concluded that changes in beliefs were not likely to be affected by reading and applying the findings of educational research as is often required as part of the education coursework. Similarly, Clark (1988) discussed the practical implications of the teacher-thinking research for preparation programs and noted that student teachers' beliefs are not easily changed by the typical teaching methods employed in teacher-education programs, such as, lecture, reading, discussion, practice, and evaluation. Lastly, according to Richardson (1996) teacher-education programs are a weak influence compared to other factors, namely personal history and previous schooling.

Although numerous researchers have conducted studies that support the idea that beliefs are extremely difficult if not impossible to change, there is another camp of researchers who have found evidence that teacher-education programs do have an impact and can influence student teachers' beliefs. In his introduction to a special issue of the *European Journal of Teacher Education* on student teachers' beliefs, Tillema (1997) explained that the studies within the issue show that change in student teachers' beliefs

does occur. However, he noted that the change was not always in a unidirectional or expected manner, and change did not occur in the same way for each student teacher. Tillema (1997) argued that "beliefs grow and change over time, depending upon external input and influences that can alter them, and are certainly not fixed or stable. However, this does not mean to say that these beliefs are easy to change, rather that teachers hold onto certain beliefs as being central to their teaching, reasoning, and action" (p. 211).

It is more likely that beliefs can be considered to be highly stable and resistant, but not impossible, to change. From a constructivist perspective, a less problematic alternative to changing beliefs is to build upon the beliefs that already exist. For example, in their review of the research on the process of learning to teach, Wideen, Mayer-Smith, and Moon (1998) concluded that programs are more likely to impact on preservice teachers' thinking where student teachers are given the opportunity to examine their prior beliefs from the beginning, where a longer duration (i.e., year-long programs) is involved, and where a consistency of approach is carried through courses and professors. With regard to the present study, although I am not examining change, this discussion is relevant because it points to the importance of examining the interrelationships of various influences on student teacher's beliefs, such as courses, programs, and previous experience. Moreover, these findings might help to explain any differences (or lack thereof) between groups of student teachers in their perceptions of the nature of the inquiry instructional process.

Beliefs are often tacit or implicit and difficult to articulate. It is widely accepted in the learning-to-teach and student-teacher belief literature that preservice teachers' beliefs are often tacit or implicit, and may be held unconsciously. Thus, they might be

difficult to articulate (e.g., Clark, 1988; Kagan, 1992a; Nespor, 1987; Pajares, 1992). As a result, beliefs must be inferred or reconstructed by researchers. The problem with methods for examining beliefs is that no "gold standard" exists for eliciting and interpreting valid and reliable self-reports about individuals' thinking (Clark & Peterson, 1986).

Kagan (1990) summarized and critiqued many methods for assessing beliefs and concluded that multiple measures need to be used in determining teachers' thinking. This is consistent with Lincoln and Guba's (1985) assertion that qualitative data are judged by their trustworthiness, and one of the steps in meeting this criterion is to use multiple methods of data collection that enable triangulation of the data. According to Kagan (1990), "the use of multimethod approaches appears to be superior, not simply because they allow triangulation of data but because they are more likely to capture the complex, multifaceted aspects of teaching and learning" (p. 459). Richardson and Anders (1994) also recommended methodology that would be appropriate for examining beliefs and conceptualizations including an open-ended, qualitative approach to research, the collection of rich data, and the use of multiple measures of cognitive processes. Similarly, Pajares (1992) argued that "additional measures . . . must be included if richer and more accurate inferences are to be made" (p. 327). For Wideen et al. (1998), an ecological approach that includes a more eclectic methodology consistent with constructivist theory is essential in assessing knowledge and beliefs. In sum, to examine student teachers' conceptualizations of the inquiry approach, it is important to use multiple methods to measure understanding and values, and to contextualize knowledge and beliefs by looking at the larger environment. The present study uses a mixed-methods design, which

is consistent with contemporary views and recommended methodology for assessing student teachers' conceptualizations.

Review of the Literature

In order to place the present study in context, I shall now turn to a review of the empirical literature on student teachers' conceptualizations of inquiry teaching and learning. One growing trend in the studies reviewed here, is the more recent emphasis on combining quantitative and qualitative approaches. Be that as it may, I was unable to find even one study that explicitly used a mixed-methods design. Given that preservice teachers' understanding of the inquiry approach is a relatively unexplored phenomenon, I broadened my search of the inquiry literature to include a look at attitudes towards and perceptions of the inquiry method as well as different elements related to inquiry instruction.

Student teachers' attitudes towards inquiry. Research on student teachers' attitudes towards inquiry-driven learning and teaching dates back at least to the 1970s, when developments in science and mathematics represented a movement toward inquiry-oriented instruction. These early studies suggested that preservice teachers tend to have positive attitudes toward inquiry learning and teaching. However, the exact nature of their perceptions, or their inclination to use inquiry methods in their actual teaching remained an unexplored area of research until more recently.

In an investigation of elementary student teachers' preferences for cognitive styles associated with inquiry learning, Atwood and Rogers (1974) studied 201 juniors and seniors enrolled in an inquiry-oriented science and social-science methods course. Preservice teachers' scores on the *Cognitive Preference Examination-II* (CPE-II) survey,

which they completed at the beginning and end of the semester, reflected a shift away from memory for factual information toward application and questioning of information. During a time when reform began emphasizing the use of inquiry instruction as a teaching and learning tool, knowing preservice teachers' attitudes towards these approaches became important. Although this was a significant step in the field, missing from this study was an examination into what might account for the shift in perceptions. Moreover, it would be important to know exactly what student teachers' attitudes and beliefs about inquiry instruction are, in order to help them make the transition to becoming inquiry-oriented teachers.

Newton (1971) examined this phenomenon. He investigated the reactions of 73 university secondary-science methods instructors and 203 secondary-science student teachers from 37 colleges across the United States to the new inquiry-oriented science courses. Based on survey and interview data, Newton discovered that, although instructors believed in the value and importance of the new inquiry-oriented science courses, they saw problems with how the new approach was being implemented, if it was being implemented at all. Thus, the instructors found it difficult to educate their students in the new trend when there was limited support for inquiry-science instruction in the schools where they would be teaching. Secondary-science student teachers also reported seeing the value of inquiry-based learning and teaching but indicated several reasons why the approach would not work. For example, common attitudes were that inquiry-driven learning is time-consuming, peripheral, secondary, and only appropriate for certain students. It seems that the student teachers were learning about the importance of inquiry-driven science instruction, but were not experiencing the approach themselves in their

teacher-education programs. This study points to the potential importance of experience with inquiry in the preparation of inquiry-oriented teachers, and how lack of experience might be associated with certain beliefs.

These early studies provided a first glimpse into preservice teachers' perceptions of inquiry-oriented instruction. The findings suggest that student teachers have positive attitudes towards inquiry learning and teaching, but may also be skeptical and doubtful about effectively implementing it in their teaching. This research stopped short of determining what factors might be associated with particular perceptions, and of investigating preservice teachers' knowledge about or understanding of the inquiry instructional process. The present study aims to extend these findings by examining student teachers' conceptualizations of the inquiry process as it might be enacted in classrooms, and by placing these findings in the larger context of preservice teachers' preparation-program experiences with inquiry.

More recently, Damnjanovic (1999) compared secondary preservice and in-service teachers' attitudes towards inquiry learning in science. Participants included 73 secondary preservice science- and mathematics-education majors across all four years of the program and 90 in-service secondary-school science teachers enrolled in a summer course focusing on inquiry instruction. Responses to the *Science Attitude Survey* indicated that in-service teachers held more positive views regarding the process of inquiry and inquiry teaching than did preservice teachers. This suggests that experience may play an important role in teachers' perceptions of the inquiry approach; however, it is unclear what kind of experience is valuable. As Damnjanovic noted, it may be that the in-service teachers in this study were a select group of educators who had a greater

appreciation for the inquiry method given their enrollment in summer courses focusing on inquiry instruction.

Student teachers' conceptualizations of inquiry. Given the resurgent emphasis on inquiry-oriented learning and teaching in schools and in teacher education, it seems reasonable to expect that examining conceptualizations of inquiry pedagogy might inform approaches to inquiry in teacher education. Several studies have begun to examine this idea and show that student teachers distinguish inquiry from other methods of instruction, hold beliefs about who can participate in inquiry, hold different conceptions than their professors about the notion of inquiry as a community, hold inquiry misconceptions, and hold conceptions that range from simple to complex about the nature of the scientific inquiry process.

In tracking 30 elementary preservice teachers in their final year of an undergraduate program, Davidson and Bruce (1993) investigated the development of preservice teachers' theories about inquiry. Participants were enrolled in a Year-Long Project (YLP) program consisting of placement in elementary-school classrooms to create teaching kits with the teachers, three Block classes (one for language and literacy, one for curriculum and instruction, and one for inquiry), and 10 weeks of full-time student-teaching placements. Davidson and Bruce (1993) focused on the Inquiry Block class because instructors and students in this course were engaged in a six-month, complex dialogue about the meaning of "what is inquiry" (p. 6). The instructors of this block created an open-ended syllabus, took a unified approach and integrated the topics for study, and provided students with opportunities to be active inquirers. Data sources included observations, student assignments, journals, and interviews. The authors

selected seven students, who they felt represented the range of student perspectives toward inquiry, to study in greater detail. Data were analyzed qualitatively.

The majority of student teachers had very little prior experience with inquiry and found the idea incongruent with the ways they had been taught as pupils and as student teachers, as well as with the way they pictured themselves teaching. The student teachers created their own meanings for inquiry, which Davidson and Bruce (1993) placed on a continuum, with inquiry-as-a-method at one extreme and inquiry-as-a-philosophy at the other. They found student teachers' definitions were the culmination of both personal and social factors. Preservice teachers belonged to multiple discourse communities during the year, which, as the authors discovered, acted either as a constraint in the development of students' understanding of inquiry by mitigating against exploration and reflection, or as a support, by encouraging students to take new risks. Student teachers' theories about inquiry were also closely related to their pre-existing beliefs about specific disciplinary areas, so that ideas about inquiry were not consistent across disciplines.

One issue that created concern for the student teachers was their confusion about what to teach first: the basics or the inquiry? From what we know about student teachers' beliefs about teaching and learning in general, this dilemma was likely tied to their pre-existing beliefs about teaching and learning that were rooted in their prior experience as pupils. They held notions that espoused the idea that in each field there is a fundamental body of basic knowledge and one must teach or learn this information from the bottom up. In contrast, in inquiry instruction Davidson and Bruce (1993) described the acquisition of knowledge as a spiraling, interweaving process. The authors also found that the issue of basics was closely related to the student teachers' beliefs about, and

confidence in themselves as teachers. For example, several student teachers felt too limited by their own lack of mathematics skills to effectively engage pupils in inquiry-oriented activities. Another concern about the inquiry approach for student teachers was the possible political implications of planning and carrying out an inquiry-oriented classroom. In considering an inquiry stance, student teachers had to examine their political values and how their explorations might affect their future job security, insofar as they were dependent on recommendations of educators, many of whom were not familiar with the inquiry approach.

In this qualitative study, Davidson and Bruce (1993) identified several significant findings; however, they did not discuss or provide in any great detail the evidence supporting their conclusions. Nevertheless, this report provides valuable information about the process student teachers experience in coming to understand the inquiry approach.

While Davidson and Bruce (1993) focused on process, other researchers have investigated the exact nature of student teachers' perceptions of inquiry instruction. For example, Aulls and Peetush (2005) analyzed preservice teachers' essay descriptions of good instruction as a basis for determining if and how student teachers perceive good teachers as different from good inquiry teachers. Twenty-one student essays were analyzed qualitatively to determine if the instruction they described met the properties of inquiry instruction as outlined by experts in the literature and operationally defined by the researchers. They used open-coding and pattern-matching procedures to analyze the data. Aulls and Peetush identified 13 good-instruction descriptions and eight good-inquiry-instruction cases.

Student teachers distinguished good inquiry and good non-inquiry instruction on the basis of the number and kinds of teacher and student roles as well as the types of instructional activities. Specifically, student teachers perceived good inquiry teachers as playing more and different roles than good teachers, as well as students playing more roles in inquiry classrooms. For example, compared to good non-inquiry teachers, good inquiry teachers were perceived as facilitators, evaluators, and elicitors of student responses. Unique roles played by students in inquiry-oriented classrooms were understander and problem solver. In addition, certain activities, such as conducting experiments, making observations, and playing image-evoking games were only reported in inquiry-based classrooms. The quality of discussion was also different in inquiry and non-inquiry instruction. Good inquiry instruction included a shared conversation or dialogue between the teacher and students, whereas in good non-inquiry instruction, the responsibility of discussion fell solely to the teacher. Aulls and Peetush (2005) concluded that "these qualitative differences found in students' descriptions of good inquiry instruction support the argument that there are substantial qualitative differences between good instruction and good inquiry instruction" (p. 22). In that study, the researchers separated the descriptions of good instruction into inquiry and non-inquiry categories. It is not known whether the student teachers considered their descriptions to be examples of good inquiry or good non-inquiry instruction. This raises the question of whether or not student teachers can explicitly identify and conceptualize inquiry instruction as distinct from other types of instruction.

Aulls (2005b) examined student teachers' beliefs about who can participate in inquiry-oriented classrooms. This study was an inductive and exploratory case study in

which the student teachers' own language was used to derive the major categories of what they perceive as inquiry learning and teaching. Participants were 160 student teachers enrolled in a first-year Educational Psychology course. One of the questions respondents were asked to respond to on an inquiry questionnaire was "In what ways might students of different abilities vary in the nature and frequency of their participation in inquiry-based instruction in a classroom? Reply from the view of a teacher" (p. 5). The majority of preservice teachers did not see ability to be related to participation in inquiry instruction. Of the 38% of student teachers who did view such a relationship, all indicated that inquiry instruction is more suited to high-ability pupils.

Researchers have also looked at student teachers' perceptions of the notion of a community of inquiry, which is a critical facet of inquiry in education. Farr Darling (2001) examined the conceptual tensions that arise from various understandings participants have of community and inquiry. Participants were in a one-year elementary teacher-education program emphasizing a community of inquiry. Farr Darling found that instructors saw inquiry as the central purpose of the community, but some students believed mutual support (i.e., a community of compassion) was paramount while other students believed they had entered a credentialing community. Each of these understandings resulted in a different degree or kind of participation.

Other researchers have examined student teachers' beliefs about inquiry teaching. Reiff (2002) compared preservice teachers' beliefs about inquiry teaching before, during, and after their third-year student-teaching placement. Participants were 48 junior-level student teachers enrolled in an inquiry-oriented elementary-science methods course. As part of the course, student teachers went on field placement where they were expected to

use inquiry-based teaching methods to teach their science lessons. Reiff assessed conceptualizations of inquiry by analyzing student teachers' journal reflections for patterns. Initially, preservice teachers' definitions of inquiry focused on the role of the teacher in the inquiry process and they described it as a guide or a facilitator; however, later reflections revealed that they had been confused about what these roles really entailed. Although student teachers' definitions of inquiry did not change, their attitudes toward teaching did. More specifically, "many [student teachers] stated that instead of changing their definition of inquiry, their definition expanded, became clearer, or held deeper meaning for them" (Reiff, 2002, p. 13). In their final reflections, several preservice teachers admitted to feeling more skeptical about teaching through inquiry than they had been before the field placement.

Reiff (2002) identified several misconceptions held by the student teachers about inquiry teaching, including the idea that inquiry requires more time and effort than other strategies, the notion that the scientific method does not include inquiry, the idea that questions have only right or wrong answers, and finally, that inquiry teaching is chaotic. It appears as though student teachers were able to work through these misconceptions during their field placement and through their reflective writing. These findings point to the importance of eliciting preservice teachers' beliefs about inquiry teaching and challenging them in order to develop expertise as inquiry-oriented teachers.

Another line of inquiry focuses on student teachers' conceptualizations of the nature of the inquiry process. Windschitl (2000, 2002, 2003) conducted a series of three studies looking at conceptualizations of inquiry as a hypothesis testing model (i.e., developing questions and testing hypotheses) held by three cohorts of student teachers

enrolled in a secondary science-methods course as part of a Master's in Teaching degree. All students entered this program with Bachelor's degrees in science. As part of the course requirements, student teachers discussed their understanding of inquiry, carried out a one- to two-month independent investigation, maintained a reflective journal and record of events, and participated in class activities designed to complement the inquiry project. After the course they completed a nine-week student-teaching placement. Windschitl used a multiple-case study approach to analyzing student teachers' written descriptions of the relationship between the phases of inquiry, metaphors for the inquiry process, journal entries, responses to a *Nature of Science* questionnaire, post-inquiry interviews about personal history with inquiry and perceptions about their own inquiry project, as well as field supervisors' observations on the use of inquiry-based teaching methods by the participants while they were in the field.

In the first study, 12 student teachers' written descriptions of the relationship between the phases of inquiry (i.e., hypothesis testing) and their metaphors for the inquiry process were analyzed for thematic content (Windschitl, 2000). Student teachers' characterizations of the inquiry process fell into three groups. The first group ($n = 5$) perceived "inquiry as a linear process" (p. 6) that consists of simple stepwise actions from one distinct phase to the next until the process is complete. They suggested equally simplistic metaphors, such as building a pyramid layer by layer or walking up a set of stairs. In contrast, the second group ($n = 3$) characterized "inquiry as a bi-directional process" (p. 6) in which problems encountered during the process require the inquirer to return to previous phases and re-think or re-design the project. These individuals invoked more complex metaphors that involved taking one step forward and two steps back. The

third group ($n = 4$) described "inquiry as a process involving mutually interdependent considerations," (p. 6) as well as phases that are interconnected and need to be considered simultaneously at the outset of the inquiry. This group used the most complex metaphors, such as a multi-track roller-coaster ride with alternate routes, or of a detective entertaining multiple hypotheses while examining a crime scene.

Windschitl (2000) also found that student teachers' conceptualizations of inquiry were linked to how they conducted their inquiry project and how they planned to use inquiry in their own teaching. The clearest difference was between the first and third groups. Individuals who held simple conceptualizations of inquiry rarely mentioned problems in conducting their independent investigations and reported plans to use overt guidance and direct instruction to help their future students complete an inquiry project. Individuals with complex understandings of the nature of the inquiry process reported encountering more and different types of problems during their inquiry project than the first group, and intended in their future teaching to create opportunities for classroom dialogue as well as classroom activities aimed at helping students make sense of the inquiry process.

In the second study, Windschitl (2003) examined how student teachers' conceptualizations of the nature of inquiry influenced and were influenced by their experience conducting an inquiry project. He also investigated how these conceptualizations and inquiry-project experiences translated into student-teaching practice. Preservice teachers' pre-project conceptualizations of the nature of the inquiry process were related to how they perceived and conducted their own inquiry project in so far as individuals with more complex conceptualizations were more aware of the

obstacles in carrying out an inquiry project and were more reflective throughout the inquiry experience. Individuals with more simple pre-project conceptualizations tended to gloss over problems they encountered in their inquiry project and did not reflect greatly about the process. The project experience had an impact on the conceptualizations of inquiry held by the preservice teachers who already had complex understandings of the nature of the inquiry process. Participants who held simple conceptualizations of inquiry were less likely to change their views. Moreover, preservice teachers who eventually used inquiry-based teaching methods in their student-teaching placement were not those who held sophisticated conceptualizations of inquiry, but were instead those individuals who had considerable previous undergraduate or professional experiences with authentic science research. These findings suggest that a university-based inquiry project alone is "not enough to ensure that preservice teachers feel competent or disposed to use inquiry in classrooms" (Windschitl, 2003, p. 139).

In the third study, Windschitl (2002) based his analysis of preservice teachers' conceptualizations of inquiry on James Gee's (1999, as cited in Windschitl, 2002) theoretical and methodological tools of "cultural models" and "situated meanings" (p. 4). From this perspective, participants' conceptualizations, explanations, models, or theories about inquiry were referred to and understood as cultural models. Using this explanatory framework, Windschitl examined how preservice teachers use cultural models of inquiry within independent investigative experiences, and what cultural models and inquiry experiences are linked with preservice teachers' use of inquiry in their own teaching.

Analysis of 12 student teachers' journals and interview data revealed that they understood science inquiry "to be more than posing and finding the answer to a question"

(Windschitl, 2002, p. 11). Additional properties of their conceptualizations were congruent with authentic science inquiry (e.g., inquiry involves asking questions, designing studies, and collecting and analyzing data), while other descriptors represented a more limited view of scientific inquiry (e.g., there is a scientific method, inquiry must be a comparison between two groups, and inquiry is analogous to experiment). Moreover, Windschitl found that several of the most common conceptual properties were misrepresentations of some of the most fundamental aspects of inquiry (e.g., a hypothesis is a guess about an outcome, but is not necessarily part of a larger explanatory framework). Windschitl felt the most serious shortcoming in preservice teachers' models of inquiry was the absence of theory. Despite holding sophisticated epistemological views with regard to the nature of science, preservice teachers "did not make methodological connections that the investigations should be based on some explanatory premise and the goal of inquiry is to refute, revise, or support scientific models" (Windschitl, 2002, p. 11). Data from this cohort also confirmed previous findings (Windschitl 2000, 2003) that research experience, and not models of inquiry, is linked with the use of inquiry teaching during student teaching.

In sum, Windschitl's (2000, 2002, 2003) research has shown that preservice teachers hold conceptualizations or models of inquiry ranging from simple to complex that include properties which are congruent with authentic inquiry, represent a limited view of inquiry, and misrepresent inquiry. The conceptions that preservice teachers hold about the nature of the scientific inquiry process influence how they conduct their own independent inquiry investigations. Moreover, the experience of carrying out an independent investigation sharpens the inquiry conceptions held by preservice teachers

who already had complex understandings of scientific inquiry. Finally, it seems that significant experience with authentic scientific research, and not complexity of conceptualizations of inquiry, is linked with actual use of inquiry methods in teaching.

The present study builds on the findings of the research described above, as well as the methodology employed in those studies. For example, in the present study I explore student teachers' conceptualizations of inquiry pedagogy and examine if the conceptualizations individuals hold are related to the value they place on different elements involved in the inquiry instructional process. I do this using both qualitative and quantitative data-collection and data-analysis methods. Moreover, I attempt to provide evidence of construct validity and internal consistency for an instrument that researchers could use to measure conceptualizations of inquiry. Windschitl (2003) acknowledged the need for better instruments. This line of inquiry is in its infancy and has yet to offer a readily administrable research tool for measuring understanding of inquiry engagement.

Understanding of the strategic demands of inquiry. Recognizing this shortfall, our research lab, in an initiative led by Shore, created a criterion-referenced questionnaire, *Strategic Demands of Inquiry*, that is designed to assess which strategic demands are perceived as important by teachers, parents, and students prior to and while engaging in inquiry-driven learning (Boisvert & Roumain, 2000). Strategic demands refer to different components or elements of involvement in inquiry-based instruction that require specific intellectual skills and decisions regarding process and motivation. Boisvert and Roumain (2000) reviewed the inquiry literature and found several consistent themes across the different conceptualizations of inquiry, the importance of using inquiry, how to build an inquiry curriculum, and what strategic demands are required for effective inquiry

instruction. They used each theme to generate one to three specific items. Thus, each item on the questionnaire corresponds (i.e., is criterion-referenced) to a strategic demand the literature deems important in inquiry instruction. The items on the questionnaire follow a purposeful order. Items one through 29 tap into preparation for the inquiry project; items 30 to 73 address actual work on the inquiry project (i.e., enactment); and items 74 to 79 focus on reflection after the inquiry project. The respondent is asked to rate the value of each item on the questionnaire on a scale from zero ("not at all important") to 10 ("very much so important"). The questionnaire operates on an item-by-item level and does not offer a total inquiry score. Three complementary versions of this questionnaire exist, one for teachers, one for parents, and one for students.

Data based on this questionnaire have been able to inform us of valuable differences between groups regarding their perceptions of the importance of the intellectual tasks involved in inquiry-driven learning. For example, Christou (2001) compared the replies of five groups of elementary students varying in age and ability. Group 1 consisted of Cycle 1 (grades 1 and 2) high-ability students who had completed an after-school enrichment program promoting inquiry-driven learning. Group 2 consisted of high-ability students waiting to be served in the enrichment program. Groups 3, 4, and 5 were composed of typically developing children in regular Cycle 1, Cycle 2, and Cycle 3 classrooms respectively. The questionnaire was administered verbally by the researcher during class time. The brief exposure to inquiry learning in the enrichment program did not enhance the cognitive understanding of the strategic demands of inquiry in the comparison of the two groups of high-ability Cycle 1 (grades 1 and 2) students. However, Christou did find that age and ability differences were related to different

patterns of replies. Young elementary-school children were able to recognize, understand, and differentiate the strategic demands of inquiry, which demonstrates that this instrument can be used with young children, with teacher involvement, as early as Cycle 1.

In an effort to examine whether teachers and parents have similar or different perceptions of the intellectual demands required for inquiry-based learning, Syer and Shore (2001) asked members of the National Association of Gifted Children (NAGC) to complete the *Strategic Demands of Inquiry* questionnaire on-line. NAGC members were mailed a letter inviting them to participate in this study by visiting a specific URL address and identifying themselves as parents, teachers, or consultants. Parents were directly taken to the parent version of the questionnaire, while teachers and consultants were brought to the teacher version of the questionnaire. Participants were asked to rate the importance of each element of inquiry instruction on a scale from zero to 10. Parents and teachers generally held a different understanding of the strategic demands of inquiry. Specifically, parents tended to give lower ratings of importance than teachers to items reflecting pedagogical elements of inquiry, emphasizing group work or the social construction of knowledge, endorsing joint cognitive construction of knowledge, and on items emphasizing reflection on the inquiry process. The most important intellectual demands for inquiry perceived by parents involved understanding instructions, the goal of the task, and key concepts. While these were also rated highly by teachers, they were not most central. Teachers most highly endorsed intellectual demands that may reflect their expertise in education, namely pedagogical-type tasks, including the student asking questions, accepting that more than one solution might be appropriate, and extending

inquiry beyond the classroom, as well as the teacher providing a nurturing and creative environment, and encouraging creative risk taking.

This instrument has not been used with preservice teachers before now. In the present study I assess different groups of student teachers using the *Strategic Demands of Inquiry* questionnaire. There has been little research conducted on the difference between groups of student teachers in terms of their perceptions about the inquiry approach. The two groups most commonly compared are elementary and secondary student teachers.

Differences between elementary and secondary preservice teachers. We have long known that elementary and secondary student teachers enter their programs with different characteristics and dispositions (e.g., Book & Freeman, 1986). Researchers have also examined differences between the two groups in terms of their attitudes towards elements involved in inquiry-oriented learning and teaching, and how these perceptions might be related to their teacher-preparation programs.

Lazarowitz, Barufaldi, and Hunstberger (1978) investigated elementary-science and secondary-science student teacher characteristics and how these related to attitudes toward inquiry. Participants were 98 elementary-science student teachers and 44 secondary-science student teachers enrolled in methods courses in which they were trained in inquiry-oriented instruction. Attitudes were measured at the beginning and end of a semester using the *Inquiry Science Teaching Strategies* (ISTS) questionnaire. The primary author developed this 40-item Likert-style inventory tapping into perceptions about the importance of items to science teaching.

For elementary-science student teachers, higher desire to teach, higher GPA, high academic status, older age, and more semester hours in education were associated with

more favorable attitudes towards inquiry strategies. In contrast, secondary-science student teachers who had more semester hours in science courses held more favorable attitudes toward inquiry. By the end of their methods courses both groups were found to have more positive attitudes towards inquiry instruction. These findings indicate that positive attitudes towards the inquiry approach are formed differently for elementary-science and secondary-science student teachers--specifically through their background in educational courses for elementary-science student teachers, and through their knowledge and experience in science, and their experience in methods courses for the secondary-science student teachers.

Researchers have not only looked at attitudes toward inquiry teaching, but also toward research, which is critical to inquiry-based instruction. Gitlin, Barlow, Burban, Kauchak, and Stevens (1999) examined elementary and secondary preservice teachers' attitude and thinking about research. Questionnaire and interview data indicated that, while all preservice teachers entered the inquiry-oriented preparation program believing that research should be pragmatic and focus on effective methods, the elementary cohort focused on being critical consumers of research, and left the program criticizing research for its lack of accessibility. In contrast, secondary student teachers used a balanced approach that emphasized both becoming a critical consumer of research and the doing of action research, and left the program criticizing the lack of time to engage in research. Further, conducting action research seemed to have an effect on secondary preservice teachers' thinking about research. Nevertheless, both programs only had a modest influence on preservice teachers' thinking.

Other researchers have examined the difference between elementary and

secondary student teachers' beliefs about another concept essential to reform and linked to inquiry teaching, namely integration of subjects. Reinke and Moseley (2002) examined 211 elementary and secondary student teachers' beliefs and perceptions about integrated teaching as they progressed through their teacher-education program. The researchers assessed perceptions of integration using a 22-item Likert-type scale divided into five categories that potentially impact beliefs about integration including (a) disposition, (b) knowledge, (c) support, (d) resources, and (e) time. Preservice teachers completed the survey three times throughout two years: at the very beginning of their program, after completing their course work, and upon completion of their student-teaching placement.

Overall, student teachers' attitudes toward integration became significantly more positive between the beginning of the program and the completion of coursework; however, there was very little change in perceptions between the conclusion of coursework and the end of student teaching. More specifically, elementary student teachers had markedly higher total scores and subscores in each of the five categories of the survey at the beginning and at the end of coursework. This statistical difference remained for all of the five categories, with the exception of Support, at the end of student teaching. These results were obtained by independent t-tests and effect sizes were not reported. The authors believed that the differences between the two groups were, in part, a reflection of the curriculum of the elementary program compared to the secondary program. Elementary preservice teachers took more courses in pedagogy and methodology, all of which had the tenets of integration built in to them. In contrast, secondary preservice teachers only had method courses in their specific subject area, which seems to have lead to a more narrow view of subject integration. It appears that the

structure and content of elementary and secondary programs might be related to the reinforcement of reform issues.

In sum, elementary and secondary preservice teachers appear to enter their preparation programs holding different perceptions from each other (Gitlin et al., 1999; Reinke & Moseley, 2002); however, the ways in which these perceptions develop from that point forward seem to be linked to, or the result of, differences in their teacher-education programs' structure and content. While the researchers of these studies focused on attitudes towards the inquiry approach, research, and integration, what remains unknown is how elementary and secondary student teachers' conceptualize the inquiry instructional process, and how these conceptualizations are similar or different.

Differences between freshmen and senior preservice teachers. There is a paucity of research examining, either longitudinally or cross-sectionally, differences between preservice teachers entering and exiting teacher-preparation programs in terms of their understanding of inquiry teaching and learning. The majority of researchers have looked at the impact of short-term interventions on perceptions of inquiry-related concepts. I have described these studies in more detail in earlier sections of this review. For example, Atwood and Rogers (1974) and Lazarowitz et al. (1978) investigated preservice teachers' attitudes about inquiry-oriented learning styles and about the inquiry approach, respectively, at the beginning and end of a semester-long methods course. These studies employed a repeated-measures design and a quantitative method. More recently, Reiff (2002) compared elementary preservice teachers' beliefs about inquiry teaching before, during, and after their third-year student-teaching placement which encouraged the use of inquiry-oriented teaching. In addition, Windschitl (2000, 2002, 2003) investigated

Master's in Teaching preservice teachers' conceptualizations of the inquiry process while they were enrolled in an inquiry-oriented science-methods course followed by a nine-week teaching placement. These researchers employed qualitative methods in their designs. In general, they found changes in the preservice teachers' ways of thinking.

Other researchers have lengthened the period of examination to include the study of post-bachelor's teacher-training programs, which are typically one to two years in length. For example, Gitlin et al. (1999) investigated a cohort of preservice teachers' perceptions of research when they entered and exited the preparation program. The length of this program was not clearly stated, but seems to have been about one year in length and included a 20-week field placement. Reinke and Mosely (2002) measured preservice teachers' beliefs about integration over the course of two years: at the beginning of their preparation program, after completing their course work, and upon completion of their student-teaching placement. These researchers relied primarily on survey data, but Gitlin et al., also used interview data. Reinke and Mosely also reported differences in preservice teachers' thinking about inquiry-related concepts at different points in time.

The present study expands on this research by employing a mixed-methods and cross-sectional design. Within this design, I aim to describe in depth the teacher-preparation program as experienced by student teachers, in order to better understand the context in which their conceptualizations take place. The present study also expands on the research described here because it includes two comparison groups that differed in their type of exposure to the inquiry approach, but who are not preservice teachers.

University-based experience contributing to conceptions of inquiry. It is generally accepted that student teachers' beliefs and conceptualizations are not easily changed

when they begin their teacher education. It takes a long time to change, develop, or impact preservice teachers' perceptions. Moreover, time alone is not sufficient; rather we need to look at the environment in which student teachers are being educated to contextualize their learning. Several studies have begun to examine the development of student teachers' conceptualizations about teaching and how the teacher-education program mediates this development. Although no research has been done on student teachers' understanding of inquiry instruction, specifically, researchers have looked at student teachers' perceptions of pedagogy in inquiry-oriented programs, as well as conceptions of teaching within constructivist- and reflection-oriented programs. I shall discuss these studies next.

Hill (2000) described a teacher-education program and its success in promoting elementary and secondary preservice teachers' pedagogical attitudes. Participants were 59 undergraduate and postgraduate students in a 16-week experimental version of an educational psychology tutorial that encouraged a community-of-inquiry format. The program aimed to foster student teachers' "intellectual functioning in terms of developing their critical and reflective judgment; tolerance of doubt, ambiguity, and complexity; awareness of self-agency; and so forth" (Hill, 2000, p. 50). The course was based in school settings in order to better link together theory and practice, and was organized according to Moore and Taylor's (1991) Developmental Instructional Model (DIM; as cited in Hill, 2000). The control group was comprised of 60 undergraduate and postgraduate students in a separate section of the course that was not based on the DIM model. Qualitative and quantitative data included questionnaires, semi-structured

interviews, and the Measure of Intellectual Development (MID)--an essay-format instrument designed to assess intellectual growth.

Half of the student teachers in the experimental program experienced a shift away from an authority-centered idea of pedagogy to a more flexible, democratic, autonomy-supportive view. In addition, 24% reported an increased sense of personal agency. The control group showed no such changes. The triangulation of the quantitative and qualitative data supported these findings. Hill (2000) concluded that intellectual growth was "more likely to occur, or to occur more rapidly, in contexts that allow students to experience powerful emotional and intellectual challenges within a supportive context, and to engage in a continuing cycle in which meaningful practice is built upon theory and is reflected upon with peers and university tutor within a critical framework" (p. 61). In the present study, I aim to build on these findings by examining the difference between student teachers' in the general Bachelor of Education program, students enrolled in an intensive inquiry-oriented course, and senior Psychology Honours students who have inquiry experience in the form of completing research (i.e., their Honours thesis), in terms of their conceptualizations of inquiry pedagogy.

In an effort to outline the problems involved in teaching preservice teachers concepts that are tied to their instructional practice, Smagorinsky, Cook, and Johnson (2003) reviewed case-study research they had conducted on elementary- and secondary-English student teachers who had just completed their teacher preparation. The researchers were interested in program-level problems that interfered with the student teachers' ability to form coherent conceptions of teaching. Data sources included interviews, observations of student teaching, course syllabi, and concept maps. Data

collection took place before and during the student-teaching placement, and the first-year in-service teaching experience.

The elementary education program stressed a single conceptual emphasis throughout the program, namely Piagetian constructivism. There was no primary conceptual emphasis in the secondary-English program. Although student teachers graduating from the constructivist-oriented elementary program espoused constructivism, they had difficulty developing a coherent concept of constructivist teaching. The researchers attributed this difficulty, in part, to the lack of consistency in definition and practice among the program faculty. In contrast, student teachers graduating from the secondary-English program had no consistent focus or teaching philosophy. Given what the authors referred to as the "structural fragmentation" (Zeichner & Gore, 1990; as cited in Smagorinsky et al., 2003, p. 1422) of the secondary-English program, this finding was not surprising. The secondary-English program was structurally fragmented because a sustained and consistent focus over time and settings on a certain pedagogical approach was absent. Such fragmentation, the authors argued, does not allow student teachers' concepts to develop in complexity. In addition, elementary student teachers returned to their programs for conceptual understanding and reinforcement, whereas secondary-English teachers tended to learn their conceptions of teaching at their student-teaching sites.

As I described earlier in this review, other researchers have also found differences in elementary and secondary student teachers' conceptualizations, which they too attributed to the differences in program structure and content. For example, Lazarowitz et al. (1978) found that the key program component associated with positive attitudes about

the inquiry approach for elementary-science student teachers was their education courses. In contrast, the key program components for secondary-science student teachers associated with positive attitudes towards inquiry were their subject-matter and methods courses. In both groups, methodology courses appear to have been key factors contributing to student teachers' beliefs about pedagogy.

Perhaps coursework in general impacts student teachers' beliefs. Recall that Reinke and Mosely (2002) found student teachers' perceptions of integrated teaching were significantly different between the time they entered the teacher-preparation program and the completion of their coursework, and perceptions remained stable to the end of their student teaching. Even at the end of coursework, however, elementary student teachers held more positive views of integration than secondary student teachers. The authors speculated that the courses in pedagogy and methodology which had the philosophy of integration interwoven throughout, were instrumental in the elementary student teachers' perceptions. The secondary program was more fragmented and isolated, in that student teachers in this program only had methods courses in their specific subject areas. This line of thinking is consistent with Smagorinsky et al.'s (2003) findings which suggested that student teachers graduating from the secondary education program held no consistent focus or teaching philosophy because their program was structurally fragmented and did not stress a certain pedagogical approach.

Another university-based experience that might contribute to understanding inquiry is research experience. As noted earlier, Gitlin et al. (1999) found that having conducted action research during the teacher-preparation program seemed to have an effect on student teachers' beliefs about research. More specifically, secondary student

teachers, who had engaged in action research, exited the preparation program holding more elaborate beliefs about research (including an emphasis on becoming a critical consumer of research and criticizing the lack of time to do research) compared to elementary student teachers, who had not engaged in action research, and whose views of research focused solely on being consumers of research. In addition, Windschitl (2003) examined how conceptualizations of the inquiry process are related to conducting an inquiry project. As described in more detail previously, Windschitl found that the project experience impacted on the conceptualizations of the inquiry process held by those preservice teachers who already had a complex understanding of the inquiry process, but not those who had a simple understanding of the process. These findings point to the important role that doing research has in contributing to understanding of and eventual practice with the inquiry method. That is, practice is essential to the development of competency in the inquiry method.

Together, the studies described above indicate the value of studying student teachers' conceptualizations within the context of teacher-preparation programs because the program can beneficially mediate their conceptual development. Considering the entire learning-to-teach environment is consistent with the recommendations put forth by Wideen et al. (1998) to increase the ecological validity of student-teacher perceptions and with a social-constructivist view of learning.

Personal experience contributing to conceptions of inquiry. From my search of the literature, it seems that very few, if any researchers explicitly focus on the personal experience of student teachers' with inquiry. Instead, the investigation of this factor seems to be a by-product. For example, Crawford (1999) documented the field

experiences of one preservice teacher enrolled in a one-year Master's in Teaching program who was above average in her ability to plan and carry out inquiry-oriented instruction. Crawford was interested in determining which factors influenced this preservice teacher's decisions and successes. Data were analyzed qualitatively and included classroom observations, semi-structured interviews, unstructured interviews, and the student teacher's work and reflections.

Crawford (1999) found six key factors that appeared to support this student teacher in her efforts to plan and enact inquiry instruction, including previous research experience, previous experience with inquiry instruction, having a mentor, reflection, having a clear vision of her objectives, and collaboration with outside resources. The preservice teachers' prior research experience came from working ten years in commercial and university laboratories in which she conducted studies and experiments. Her previous experience with inquiry instruction came from volunteering as a teaching assistant in an inquiry-oriented classroom before entering the Master's in Teaching program. Her mentor was the cooperating teacher for the student-teaching placement in which the preservice teacher engaged her students in inquiry-based learning. Crawford concluded from this case study "that preservice teachers, given certain caveats and adequate support, can feasibly create inquiry-based environments similar to those advocated in the *National Science Education Standards*" (1999, p. 189). This claim seems misleading, however, because the preservice teacher in this case study was atypical in her ability to plan and sustain an inquiry-oriented classroom, as well as in her background, which consisted of significant experience with research and inquiry instruction. It seems that, in this case personal experience, as opposed to program-based

experiences, was related to eventual use of inquiry methods in teaching.

Recall also, Windschitl (2000, 2002, 2003) found that substantial experience with authentic or professional research, and not complexity of conceptualization of inquiry, was linked to the use of inquiry teaching. Crawford's (1999) and Windschitl's findings suggest a notable relationship between personal experience with inquiry research and eventual inquiry teaching. What remains unclear is the exact nature of the relationship between personal experience with inquiry research and the conceptions student teachers' hold about the nature of the inquiry process.

School-based experience contributing to conceptions of inquiry. We have long known that student teachers' beliefs about teaching and learning are rooted in their past experiences as pupils (e.g., Bullough, 1997a; 1997b; Fang, 1996; Kagan, 1992a; Pajares, 1992; Richardson, 1996); however, there have been very few studies examining the link between student teachers' early educational experiences with inquiry specifically and their current conceptualizations of inquiry (Aulls, 2005b).

Aulls (2005b) examined what student teachers say they have experienced as inquiry occasions at different levels of schooling. This was a qualitative study in which 160 preservice teachers' own language was used to derive the major categories of what they viewed as inquiry occasions across levels of schooling. They completed an inquiry questionnaire that asked them to respond to specific questions as well as to recall and describe what happened as inquiry instruction at four levels of formal schooling (elementary, secondary, college, and university).

The preservice teachers described a total of 825 inquiry experiences across each level of schooling. Each occasion for inquiry had nine properties that were derived from

open-coding procedures. Aulls discovered that the nature of inquiry occasions experienced by student teachers changed gradually from elementary school to university. For example, there seems to be a shift in the formats for inquiry, from science fairs in elementary school to research papers at university. In addition, participation in inquiry gradually becomes more student-directed. Lastly, the nature of inquiry changes from discovery in elementary school, to problem solving in the secondary grades, and to research and problem solving at college and university. The typical student teacher in this study had been exposed to inquiry instruction at least once each school year; however, only 38% of participants reported that they themselves had initiated an inquiry, which raises the question of how likely preservice teachers are able to see themselves as inquirers and inquiry-oriented teachers.

Preservice teachers' views about themselves as inquirers and inquiry-oriented teachers seem to be rooted in their early schooling. Eick and Reed (2002) examined the role of learning histories on the formation of early role identity as inquiry-oriented science teachers, as well how these role identities influenced the ability of student teachers to implement the inquiry approach in their student teaching. The researchers used a multicase-study research design in which 12 student teachers (three consecutive cohorts of four teachers each) in a secondary science-education program participated. Participants were selected based on rankings by professors for high potential for the use of inquiry instruction during student teaching. The two most extreme cases were used to illustrate the findings in this study. The student teachers were enrolled in a university program that emphasized guided or structured inquiry and participated in the study during their 10-week placement. Three fifth-year students participated; however, the level of the

other participants was not described. Data sources for personal histories included interview and reflective responses, which were coded for personal-history issues using a grounded theory approach. Personal learning histories included those experiences and influences up to the point of entering student teaching. Finally, the researchers performed a cross-case analysis in search of common themes that could describe the nature of the influence of personal history on role identity.

Preservice teachers predisposed to inquiry-oriented teaching as pupils had stronger role identities as inquiry-oriented science teachers and were more likely to implement inquiry-oriented instruction during their student teaching. Past schooling experiences that supported strong inquiry identities also included model science courses for teachers, varied teaching and work experience, and experience doing science with scientists. In addition, they found that an individual's personal learning style filtered the critical aspects of the inquiry-oriented science teacher-education program. In sum, the authors found support for the idea that school-based experiences are persistent and influence how and what student teachers' will learn and internalize in their teacher-education program about inquiry-oriented instruction.

Aulls (2005a) also examined the role of past schooling that might be associated with the formation of student teachers' identity as inquirers. Specifically, he investigated some of the basic factors that might be related to the number of inquiry occasions that preservice teachers recall at different levels of formal schooling prior to entering a teacher-education program. Data, in the form of specific items and short essays, were collected over two years from 160 Bachelor of Education students in two consecutive cohorts of a first-year Educational Psychology course. The most notable result was that

only 26% of student teachers considered themselves inquirers, despite having had past experience with inquiry. This is consistent with research by Windschitl (2003) who found that only 20% of preservice students enrolled in a Master's of Teaching science-methods course had ever conducted an independent investigation at any level of science education.

Aulls (2005a) also found that the mean number of recalled inquiry occasions and the opportunity to be mentored into inquiry learning is significantly related to subject and level of schooling. Specifically, social studies and English were associated with more inquiry experiences than science and mathematics across all levels of schooling, and more reports of inquiry instruction occurred in secondary school. Moreover, preservice teachers who reported having had a mentor also reported significantly more inquiry occasions at the elementary and secondary levels and were more likely to consider themselves inquirers. Finally, preservice teachers' self-perceptions of themselves as inquirers alone, taking a research methods course in CEGEP, and either in combination with the total number of reported inquiry occasions, predicted whether or not a student teacher had done a thesis prior to entering a teacher-education program. These findings point to the importance of various elements, most notably having a mentor, in preservice teachers' experiences as pupils with inquiry that are associated with self-perceptions of themselves as inquirers.

Together, Aulls's (2005a, 2005b) and Eick and Reed's (2002) studies point to the important role of preservice teachers' inquiry-oriented school-based experiences in learning about inquiry-oriented instruction at the university level, conceptualizations about inquiry pedagogy, as well as becoming an inquiry-oriented teacher. The present study extends these findings by attempting to examine the university-based program, as

experienced and perceived by student teachers, that contextualizes preservice teachers' conceptualizations about the nature of the inquiry process.

Research Questions

Evidence for the construct validity of the Strategic Demands of Inquiry questionnaire. Although researchers studying student teacher's understanding of the inquiry approach have made substantial gains, several important gaps remain in the field. First, a valid instrument for measuring conceptualizations of inquiry does not yet exist. Attitudes have been measured using a variety of instruments, typically Likert-scale in nature (e.g., Atwood & Rogers, 1974; Damjanovic, 1999; Lazarowitz et al., 1978; Reinke & Mosely, 2002). Other researchers have inferred conceptions from qualitative data such as journal reflections, metaphors, and essays (e.g., Aulls 2005a, 2005b; Aulls & Peetush, 2005; Davidson & Bruce, 1993; Reiff, 2002; Windschitl, 2000). In other cases, researchers have used the combination of surveys and interviews, or other qualitative data to measure perceptions of inquiry (e.g., Gitlin et al., 1999; Hill, 2000; Newton, 1971; Windschitl, 2002, 2003). What is encouraging about the methods many researchers in the field are employing is that they are consistent with recommendations put forth by researchers studying teacher thinking and student teachers' beliefs in general, namely, to use multiple methods. Nonetheless, no two researchers in the studies I reviewed used the same instrument. At the most basic level of the present study I aim to find further evidence of construct validity for the *Strategic Demands of Inquiry* questionnaire, which includes an open-ended question (qualitative data) and a rating scale (quantitative data). My specific research questions are (a) What is the internal structure of the *Strategic Demands of Inquiry* questionnaire and how does it relate to what would be expected?,

and (b) Are all the items on the questionnaire measuring the same thing, namely an overarching construct called inquiry instruction? This will be the first time the instrument has been used with student teachers, and with a sufficiently large sample to examine its internal structure.

Primary research question. Another gap in the literature is whether or not different groups of student teachers who are exposed to the inquiry approach in different ways have different understandings of inquiry instruction. Most of the research focuses on student teachers in a particular course or program and whether there is a change in the perceptions student teachers hold upon completion of the class or year. Researchers have focused on student teachers' ability to distinguish inquiry from other methods of instruction, beliefs about who can participate in inquiry instruction, perceptions of inquiry as a community, inquiry misconceptions, and theories about the nature of the science inquiry process (e.g., Aulls 2005a; Aulls & Peetush, 2005; Farr Darling, 2001, Reiff, 2002; Windschitl, 2000, 2002, 2003). There is an absence in the inquiry literature and learning-to-teach literature on pre-service teachers' understanding of inquiry as an instructional process.

For this reason, the present study is an exploratory one. I attempt to understand how student teachers' conceptualize inquiry as a pedagogical approach in terms of the variability, commonalities, and differences that exist between groups of student teachers who have different exposure to the inquiry approach. I also investigate how these different groups of student teachers understand or perceive the importance of various components involved in carrying out an inquiry curriculum. In addition, I aim to examine whether the conceptualizations held by student teachers are related to the value they place

on different intellectual tasks involved in planning, enacting, and reflecting in an inquiry classroom. This leads to my major research question, Do groups of student teachers who receive different types of exposure to the inquiry approach differ in their understanding of inquiry instruction?

I am interested in the conceptions held by different groups of student teachers in terms of their type of exposure to inquiry, namely the differences between elementary and secondary student teachers, first-year and fourth-year student teachers, students (including in-service teachers) in an inquiry-oriented course, and non-student teachers who engage in inquiry research but are not learning about the inquiry approach. Since the present study is exploratory in nature, I do not set out to evaluate or judge conceptualizations of inquiry, nor to test or refute any specific hypotheses. Nevertheless, based on the literature in this area I expect I might find some differences between these groups in terms of their understanding of inquiry instruction. Specifically, in all of the studies comparing the perceptions and beliefs of elementary and secondary student teachers, differences were found. Therefore, I expect I might find that elementary and secondary preservice teachers hold different conceptualizations of the inquiry approach.

It is widely accepted in the literature on student teachers' beliefs and perceptions that their beliefs are resistant to change and very difficult to influence in the teacher preparation program. Therefore, it will be very interesting to see whether student teachers leaving their teacher-preparation program hold different views of inquiry teaching and learning than those entering the program.

Previous research (e.g., Crawford, 1999; Gitlin et al., 1999; Windschitl, 2000, 2002, 2003) has suggested that experience with authentic inquiry research might

contribute to understanding and eventual use of inquiry instruction. Thus, I am also interested in how a comparison group of non-student teachers who have engaged in real research have similar or different conceptualizations of the inquiry approach relative to student teachers.

Data from students in the elementary and secondary teacher-education programs will inform us about how novice teachers understand the nature of the inquiry process as it might be carried out in an inquiry-oriented classroom. In light of the recent provincial curriculum reform that mandates inquiry-driven learning and teaching, this knowledge would be particularly important. Data from students obtaining an intensive inquiry experience will advance our knowledge about the relationship between specific instruction, compared to general curriculum, and student teachers' conceptualizations of the inquiry approach. This research has implications for helping teachers and learners make the transition from playing a relatively passive role in education to both becoming the center of a knowledge-producing community.

The learning-to-teach environment. From a social-constructivist perspective, and in the study of student-teacher thinking, it is important to study preservice teachers' conceptualizations within their social context to provide ecological validity (Snow, 1978). Moreover, this line of inquiry is important because we do not know what program experiences contribute to understanding inquiry teaching and learning. This leads to my final research question, What program experiences or events, as experienced by student teachers themselves, might help explain student teachers' understanding of inquiry instruction? I aim to describe the preparation program in detail, using the student teachers' own voices, in order to contextualize and help interpret my findings.

Chapter 2

Data and Methods

Research Design

This is a mixed-methods study. Mixed-methods research is an appropriate paradigm for my study because my aim is exploration. A mixed-methods design will help me meet this objective because the collection of multiple types of data is the best method leading to better understanding and useful answers (Johnson & Onwuegbuzie, 2004). I have three research objectives: (a) to provide evidence of construct validity for an instrument; (b) to examine whether and how groups of student teachers who receive different types of exposure to the inquiry approach have different understandings of inquiry as an instructional process; and (c) to describe university experiences or events that might help explain student teachers' understanding of inquiry. There are several ways in which I explored these questions, including quantitative and qualitative analyses on Likert-style questionnaire items, open-ended essay questions, and semi-structured interviews. The integration of these findings gives richness and expanded understanding to the overall findings.

Moreover, the mixed-methods research process can lead to greater ecological validity. Ecological validity concerns "the extent to which the habitats or situations compared in an experiment are representative of the populations of situations to which the investigator wishes to generalize" (Snow, 1974, p. 272). Under the mixed-methods research paradigm, this study used different methods and took detailed account of a variety of contextual and personal variables that could be threats to external validity. This research is in accord with Wideen et al.'s (1998) recommendation that "only when all the

players and landscapes that compromise the learning-to-teach environment are considered in concert will we gain a full appreciation of the separable web of relationships that constitutes the learning-to-teach ecosystem" (p. 170).

This study incorporated a modified sequential-explanatory strategy (Cresswell, 2003) in the methodology stage of the study. I combined two of Cresswell's designs together: a concurrent-triangulation strategy in one phase of the study, and a sequential-explanatory strategy in the overall design of the study. The full design is depicted in Figure 1.

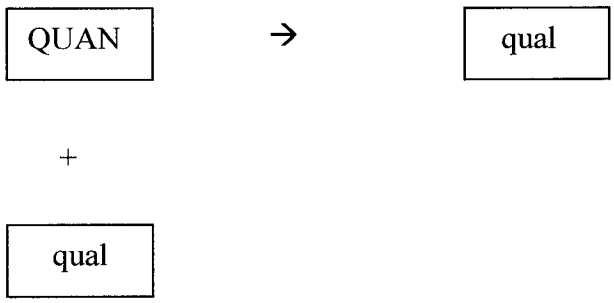

Figure 1. Modified sequential-explanatory strategy.

In this figure, a "+" indicates simultaneous data collection, an "→" denotes sequential data collection, capitalization indicates the dominant approach, and "Quan" and "Qual" stand for quantitative and qualitative, respectively (Cresswell, 2003; Johnson & Christensen, 2004; Johnson & Onwuegbuzie, 2004; Tashakkori & Teddlie, 1998).

My overall design uses a sequential-explanatory strategy because I had a two-stage data-collection process with a period of approximately six months between phases. I gave priority to the quantitative data (questionnaire that included a rating scale) collected during the first phase of data collection, and I used the qualitative data (semi-structured interview) collected during the second phase of the study to assist in

explaining and interpreting the findings of the primarily quantitative phase. During the interpretation stage of my study, I integrated data and the results obtained with the two methods. In addition, I carried out each phase of the data-collection process in order to answer a separate research question.

My design is modified because within the first phase of my data-collection process I also used a concurrent-triangulation strategy. I used two different methods, quantitative (rating scale) and qualitative (open-ended question), in an attempt to corroborate findings. I gave priority to the quantitative approach and used qualitative methods to enhance the validity of, and provide richness and explanatory power to, the quantitative findings.

This design was chosen for two reasons. First, it allowed for complementarity (Greene, Caracelli, & Graham, 1989). The dominant approach in this design was quantitative because the overall findings came from the rating scale using quantitative analysis. However, the semi-structured interview helped with the interpretation of the overall findings. In other words, the qualitative data contextualized, enhanced, and elaborated upon the quantitative data. Second, the use of both quantitative and qualitative data within one phase provided triangulation of the data (Greene et al.; Lincoln & Guba, 1985); this design provided stronger evidence for an interpretation or conclusion through convergence and corroboration of the two methods. In sum, the quantitative and qualitative research, when used together in this study, produced more complete knowledge and strengthened the knowledge claims of my study.

Population and Sample

This study was conducted with a stratified purposeful sample (Miles & Huberman, 1994). This type of sample illustrates subgroups and facilitates comparisons. I had a particular logic for the specific groups included in this study and for the comparisons between groups. Participants fell into three groups, each group having had a different type of exposure to inquiry learning and teaching. The three groups were Bachelor of Education (BEd) students in the general program, Continuing Education students receiving intensive exposure to inquiry in an inquiry-oriented course, and undergraduate Psychology Honours students who had completed research. These groups are described in more detail below.

Bachelor of Education students: Elementary and Secondary programs. The first group of participants included students in the Bachelor of Education program at McGill University. This four-year, practice-based program leads to certification and consists of academic and professional courses, including studies in pedagogy, methodology, and educational foundations, as well as a school-based practicum every year (Bachelor of Education Programs, n.d.). This study included two principal groups of BEd student teachers: students in the BEd Kindergarten and Elementary Education program and students in the BEd Secondary Education program. As of February 2004 a total of 624 students were enrolled in all years of the Kindergarten and Elementary Education program and 357 students were enrolled in all years of the Secondary Education program (Bachelor of Education Programs, n.d.). According to the program director of undergraduate programs, the view of teaching and learning that drives the education in both of these programs is largely social-constructivist in nature, with a major emphasis on

teacher reflection (C. Riches, personal communication, April, 19, 2005). These ideas are incorporated throughout the methodology courses, pedagogy courses, and professional seminars.

Although I recruited a total of 242 participants through the Bachelor of Education program, participants were excluded from the sample who were (a) in their freshman year (i.e., students from outside Quebec for whom this was a five-year program, in Year 0 and not yet actively participating in the Education program), (b) in other specialized Education programs beside Kindergarten and Elementary Education or Secondary Education (e.g., Teaching French as a Second Language), or (c) in other degrees than the Bachelor of Education (e.g., Bachelor of Arts, Diploma programs). This left a potential sample of Bachelor of Education students consisting of 199 participants.

Three groups of BEd students were retained for the study. These were first-year Kindergarten and Elementary Education students (n = 69), first-year Secondary Education students (n = 43), and fourth-year Kindergarten and Elementary Education students (n = 54). Thus the final sample of Bachelor of Education students totaled 166. See Appendix C for an explanation of the other Bachelor of Education groups dropped from this study.

The first-year Kindergarten and Elementary Education group consisted of 66 females and three males, the fourth-year Kindergarten and Elementary Education group included 50 females and four males, and the first-year Secondary Education group was comprised of 26 females and 17 males. First-year students in the Secondary Education program were enrolled in one of the following teaching subject profiles: (a) English (n = 14), (b) Social Sciences (n = 14), (c) Mathematics (n = 10), or (d) Science and

Technology ($n = 4$). One participant did not respond to this item and thus her specialty was not known.

The focus of this study is on the Kindergarten and Elementary Education program. In order to provide a context in which to better understand the results of this study I describe the Kindergarten and Elementary Education program in more detail here. According to the *McGill Faculty of Education Undergraduate Handbook for New Students 2003-2004* (McGill University Faculty of Education, 2003), the Kindergarten and Elementary Education program is comprised of an academic component (42 credits) and professional component (72 credits). Under the academic courses fall required courses including Communication in Education, Elementary School Mathematics, Elementary School Science, Geography, History, and Citizenship Education, and Religion (or equivalent). Furthermore, students select academic courses in subject areas from English Language Arts, Mathematics, Natural Sciences, Social Studies, The Arts, Physical Education, Moral and Religious Education, and French. In addition, students have six credits of elective courses. Professional courses are broken down into practicum courses (e.g., Professional Seminars and Field Experiences), foundations courses (e.g., Policy Issues in Quebec Education, Educational Psychology, Philosophical Foundations, Exceptional Students, and Instruction in Inclusive Schools), pedagogy courses (e.g., Language Arts, Teaching Mathematics, The Kindergarten Classroom, Science Teaching, Teaching Social Sciences, Integrating the Curriculum, Moral and Religious Education, and methods courses chosen from Art, Music, Drama, Physical Education, TESL, and TFSL), as well as pedagogical-support courses (e.g., Classroom Practices, Classroom-based Evaluation, Media, Technology, and Education, and Multicultural/Multiracial

Classroom). The four-year Kindergarten and Elementary Education program overview can be found in Appendix D.

Continuing Education students: Intensive inquiry exposure. The second source of data came from a group of students who received inquiry-based instruction in a single-semester Continuing Education course ($n = 21$) on gifted education. The instructor was a member of our research team (as a PhD student) and a secondary-school teacher who engaged her pupils extensively and intensively in inquiry and whose school's model (on her initiative) was based on inquiry teaching and learning. According to the instructor, the course was inquiry-oriented because she put her students in the position where they had to be self-directed learners, she played the role of facilitator and researcher, and she negotiated the curriculum with her students. In addition, the students chose to work on areas of interest to them, they worked on Renzulli Type-III activities (Renzulli & Reis, 1985) during class time individually and in groups, they did research, and through inquiry, they developed a product of personal and professional relevance and presented it to the class during a mini-conference (J. McBride, personal communication, February 26, 2005).

Students (29 female, 3 male) in this course came from various undergraduate programs ($n = 10$), post-degree diploma programs ($n = 7$), master's programs ($n = 10$), and PhD programs ($n = 2$). The educational background of three participants was unknown. Many students enrolled in this course were already licensed teachers ($n = 12$). Seven of these teachers had fewer than five years of teaching experience, four teachers had between five and 10 years of teaching experience, and one teacher had been teaching for 20 years. One of these teachers taught at the secondary level, 10 taught at the

elementary level, and one was an English as a Second Language teacher at the elementary- and high-school level.

Psychology Honours students: Comparison group. The third group of participants included undergraduates in the BA and BSc Psychology Honours program at McGill University. This group consisted of students enrolled in the Honours Research Project and Seminar (n = 7), in the Advanced Honours Seminar (n = 8), and in the Research Project and Seminar (n = 3). There was no overlap between students in these three courses.

Honours in Psychology prepares students for graduate study, and thus emphasizes practice in the research techniques. Students are accepted into Honours at the beginning of their Year 2 (equivalent to the "junior" year in the USA), and the two-year sequence of Honours courses continues through their Year 3 ("senior" or graduating year). Approximately 30 students are admitted into the Honours program each year (Bachelor of Arts: Programs in Psychology, n.d.). Students in the Research Project and Seminar course also gain practice in research techniques. They attend regular class meetings, present two or three seminars in class, and carry out a major research project under the guidance of an approved supervisor (PSYC 450D1/PSYC 450D2, n.d.).

These Psychology participants constituted a comparison group (n = 18) and were in Year 2 (n = 4) or Year 3 (n = 14). This group was made up of 17 females and one male. They were not in the Education program and thus were not student teachers. However, they were students who had engaged in research. This comparison group allowed me to examine whether simply engaging in inquiry, rather than explicitly

learning about inquiry, is related to perceptions of the strategic demands of inquiry learning and teaching and, if so, in what ways.

Data and Instrumentation

I measured understanding of the strategic demands of inquiry both quantitatively and qualitatively, namely, through questionnaire and semi-structured interview data.

Strategic Demands of Inquiry questionnaire. To explore the exact nature of the pedagogical task of inquiry, and the demands on teachers and students who engage in inquiry-driven instruction, I administered the criterion-referenced questionnaire developed by Shore and our research lab (Boisvert & Roumain, 2000) that evaluates perceptions and expectations of the strategic demands of inquiry participation (see Appendix E). The items on the questionnaire follow a purposeful order. Items one through 29 tap into preparation for the inquiry project; items 30 to 73 address actual work on the inquiry project; and items 74 to 79 focus on reflection after the inquiry project. The respondent is asked to rate the value of each item on a scale from zero ("not at all important") to 10 ("very much so important"). Key items, such as, "How important is it in inquiry-based learning and teaching for students to ask questions?" are placed without prominence in the middle of the questionnaire. On some items such as "How important is it in inquiry-based learning and teaching for students to win a prize?" low ratings are expected and are thereby able to ensure that the questions are being attended to and that there is not a response set.

I pilot-tested the instrument with two groups of Continuing Education students enrolled in two semesters (2002 and 2003) of the inquiry-oriented course. The aim of this pilot testing was to detect any problems in the instructions, ambiguity in the items, and to

determine how long it took to complete the instrument. Based on the pilot testing of this questionnaire, I modified it to ensure the actor (student or teacher) in each item was more clearly identified, and to include questions about the participants' experience with inquiry education, their own definitions of inquiry as a pedagogical approach, and about their views of good teaching and learning.

The validity of this questionnaire rests on the content validity of each item. As an MEd project, Boisvert and Roumain (2000) reviewed the inquiry literature and found several consistent themes that arose across the different conceptualizations of inquiry. Each theme was then used as a cue to generate one to three specific items on the questionnaire. Therefore, each question captures a strategic demand, that is, an intellectual task deemed to be required in the successful integration of inquiry into teaching and learning. Data from the Syer and Shore (2001) study provided additional confirmation of content validity. Specifically, teachers in that study endorsed items on the questionnaire deemed important by the literature. For example, teachers perceived the most critical intellectual demand of engaging in inquiry as asking questions. Data from the Syer and Shore study also provided support for the construct validity and internal consistency of the questionnaire: Teachers and parents did not endorse items we did not expect them to endorse. For example, teachers and parents gave the lowest ratings of importance to "How important is it in inquiry-based learning and teaching for the student to win a prize?" This low endorsement is consistent with high ratings from teachers and parents on separate items emphasizing self-motivation and tapping into student interests. Given the recent introduction of this instrument and the lack of an alternative instrument that has proven validity and reliability, this study also provides cross-sectional data that

further validate the questionnaire.

Semi-structured interview. To further investigate participants' experiences in teacher education and in their personal history that may explain their understanding of the strategic demands of inquiry, I used a semi-structured interview with selected students (see Appendix F). The interview schedule included questions based on Aulls's (2005a, 2005b) measure, and also included questions based on the findings of the quantitative phase of the study. Aulls created and used the original version of this interview schedule as a survey to investigate inquiry occasions that students recall at different levels of formal education prior to entering a teacher-training program. As well as responding to specific questions, respondents were asked to recall and describe what happened as inquiry occasions at elementary school, secondary school, CEGEP and university.

I used an ethnographic design (Spradley, 1979) to construct the interview schedule. First, I revisited the participant's definition of inquiry. Second, I tried to substantiate those conditions that influenced the conceptions they hold by spiraling outwards from university-based experiences with inquiry, to outside the university but still within their current age to opportunities to experience inquiry in the community, and finally having them look back in their memory, going across their formal schooling, leaving the immediate and broadening the scope. This structure helped to facilitate informants' interconnecting knowledge and memories of inquiry. I used Spradley's ethnographic interview with the intention of eliciting complete search in memory about the phenomena of inquiry. I used probes at each level within the spiral, also as a way of flushing out memories.

In carrying out the interview, I began by showing participants their definition of inquiry that they wrote on the *Strategic Demands of Inquiry* questionnaire. After reading the definition, I asked participants if they still held the same definition or if they would like to change it. I also asked them to explain how they came up with their idea or definition. I gave participants a simple version of the questionnaire results with the intention of giving them direct information to increase the authenticity of their responses. I showed them a graph with each of the group's overall mean score on the *Strategic Demands of Inquiry* questionnaire and asked them to explain the findings. I used several probes (see Appendix F) to help participants respond.

Procedure and Work Schedule

As described briefly at the beginning of this chapter, this study consisted of a predominantly quantitative stage followed by a wholly qualitative stage.

Stage 1: Questionnaire data collection. During the fall and winter semesters of the 2003-2004 academic year I administered the *Strategic Demands of Inquiry* questionnaire to the three sets of participants. I identified the major groups and subgroups in which I was interested and used power analysis to determine the number of people to be included in each group. The first group of participants included BEd students in each of the four years of the program. First, I met with the director of the Bachelor of Education program to determine the best point of entry. We selected classes in each year of the program that would have the largest number of students from both the Kindergarten and Elementary Education program and the Secondary Education program, as well as professors who would be most able to accommodate my request for access to participants.

Second, I contacted the professors of those courses, explained the purpose of my study, and asked for their permission to gain access to their students. In the letter or email sent to these professors I described that participation would involve 45 minutes of their class time in one of the first few classes of the fall semester to describe the study to their class, invite them to participate, and to complete a questionnaire. I explained that at the end of the semester, I would like to come back and re-administer the questionnaire, which would entail 30 minutes of class time. If professors were not able to give me this class time, I asked if I could take 15 minutes of a class to distribute the questionnaire to students to take home to complete. I explained that the following week I would wait outside the class to collect the questionnaires.

I gained access to participants in the Bachelor of Education program in three ways. First, for six classes I administered the questionnaire to the class during class time. These classes were three sections (one Secondary Education section and two Kindergarten and Elementary Education sections) of the first-year Educational Psychology course, and three sections of the fourth-year Methods in Special Education course for Kindergarten and Elementary students. My volunteer research assistant (an undergraduate psychology student at McGill) and colleagues (other graduate students in my research lab) helped distribute the questionnaires and answer questions. I described the study, discussed the letter of informed consent (Appendix B), and explained the questionnaire instructions. We answered participants' questions about completing the questionnaire, but not about the content. For example, we did not provide a definition of inquiry-based instruction to avoid biasing the participants' replies on the questionnaire. We asked participants to complete the rating scale part of the questionnaire keeping in

mind their personal definition of the inquiry approach. The professor of each of these classes left the room in order to allow students to participate anonymously. This approach resulted in a total 208 completed questionnaires, representing 71.23% of completed questionnaires.

Second, I visited four classes for 15 minutes to describe the study, the letter of informed consent, the questionnaire instructions, and to distribute the questionnaire itself. These classes were the third-year Policy Issues in Quebec Education course (consisting of Kindergarten and Elementary Education students and Secondary students) and three sections of the third-year Professional Seminar for Secondary Education students. I asked students to complete the questionnaire and I returned to the classes the following two sessions to collect questionnaires. This method yielded 30 questionnaires, representing 10.27% of completed questionnaires.

Finally, in three classes, professors put up an acetate I had prepared describing my study and students were invited to sign up to participate. These classes were one section of the first-year Educational Psychology course, the second-year Elementary School Mathematics teaching course for Kindergarten and Elementary Education students, and one section of the fourth-year Methods in Special Education course for Kindergarten and Elementary Education students. This approach yielded one participant, representing less than 1% of completed questionnaires. I contacted this participant and arranged a time to complete the questionnaire.

For all three procedures, students interested in participating signed a sheet passed around the class and provided their email address. This allowed me to contact individuals who had expressed an interest in participating, but who had failed to submit a

questionnaire. Through these three methods I gained access to all possible groups of participants with the exception of second-year Secondary Education students.

Bachelor of Education students completed the questionnaire in the first few weeks of September 2003 and again in December 2003 through January 2004. The data included in the present study are the questionnaires completed in the beginning of the fall semester in September 2003. The reasons for not including the data from the second administration of the questionnaire at the end of the semester are described in Appendix C.

The second group of participants included students in the inquiry-oriented Continuing Education course. Participants completed the questionnaire during class time, both early in the winter semester (beginning of January 2004) and at the very end of the winter semester (late April 2004). The data from the end of the course were used in the present study to represent this group's having had completed an inquiry-oriented course.

The third group of participants included Psychology undergraduates in the two year-long Honours Research Seminars and one year-long Research Project and Seminar. To ensure that this group had completed a research project by the time they participated in the study, I administered the questionnaire in March 2004. Similar to methods used with the Bachelor of Education students, my research assistant and I contacted the professors of these three courses, describing the purpose of the study and asking permission to gain access to their students. We gained access to students in two ways. First, my research assistant and colleagues visited three classes (one section of the Honours Research Project and Seminar, the Advanced Honours Seminar, and one section of the Research Project and Seminar) for 15 minutes to describe the study, and to distribute the letter of informed consent, the questionnaire instructions, and the

questionnaire itself. Students completed the questionnaire on their own time and we returned to the class the following two sessions to collect questionnaires. This resulted in 14 completed questionnaires, representing 4.79% of completed questionnaires. Second, in one class (one section of the Honours Research Project and Seminar) the professor put up an acetate I had prepared describing my study and students signed up to participate. My research assistant and I contacted these participants and arranged a time with them to complete the questionnaire. We received four completed questionnaires from this class, representing 2.37% of completed questionnaires. We contacted individuals who had signed up to participate, but who had failed to submit a questionnaire.

Participants were offered an incentive to participate. As outlined in the letter of informed consent, participants who completed the questionnaire would have their names entered into a draw for movie tickets, and their names would be entered into a second draw if they provided an interview.

In total, approximately 660 questionnaires were distributed. The total number of completed questionnaires was 292 (44%). However, looking at the response rate in this way does not provide an accurate picture given that the exact number of participants who were invited to participate is unknown. It is not known how many students were present in each of the classes in which I either administered the questionnaire in class, I visited the class for 10 minutes, or in which the professor put up an acetate describing the study and inviting students to participate. It would have been too difficult to calculate this number because in some classes there were hundreds of students, and in all classes, class lists could not be used because not all students were present at each class. Response rates were dramatically higher for classes in which class time was made available.

Stage 2: Semi-structured interview data collection. Throughout the winter semester of the 2003-2004 academic year (January to March 2004) I conducted follow-up interviews with participants in the Bachelor of Education program. I repeated this process with Continuing Education students during the summer of 2004 once their course was finished. Because these interview data were designed to probe student teachers' personal history and program experiences with inquiry, participation of the Psychology students was not necessary at this stage. I contacted random participants who had previously indicated on the consent form that I could contact them for an interview, and then selected those who I was able to contact first and who were willing to participate. Interview participants included seven first-year Kindergarten and Elementary Education students (all female), seven first-year Secondary Education students (3 female, 4 male), 14 (seven of whose interviews were not tape-recorded) fourth-year Kindergarten and Elementary Education students (13 female, 1 male), two fourth-year Secondary Education students (1 female, 1 male), and seven Continuing Education students (6 female, 1 male). Interview participants in the first-year group and fourth-year Kindergarten and Elementary Education group were randomly selected. All participants who agreed to an interview in the fourth-year Secondary Education group and Continuing Education group were interviewed. I began by interviewing the fourth-year students and stopped interviewing once I began getting redundant data. I chose to interview 14 first-year students (seven from each program) to match the number of interviews I had for the fourth-year Kindergarten and Elementary Education group.

As much as possible, I conducted face-to-face interviews. When this was too inconvenient for the participant I conducted the interview on the telephone. I conducted

all of the first-year Education student interviews in person and all of the Continuing Education student interviews on the telephone. I conducted 13 live interviews and three telephone interviews with fourth-year students. I tape-recorded interviews (with the exception of seven fourth-year Kindergarten and Elementary Education student interviews) and transcribed each one verbatim. Seven interviews were not tape-recorded because these were the first interviews I conducted, and in the initial planning of this study I had not placed much emphasis on the interview data. However, once I realized the potential of using the participants' own words as an important source of data, as opposed to my notes on the interview protocol, I began recording. For every interview I took notes on the interview protocol (see Appendix F).

Data Analyses

As part of the mixed-methods research design, I performed quantitative and qualitative analyses to best and most fully answer my research questions. I began by evaluating the validity of the *Strategic Demands of Inquiry* questionnaire.

Quantitative analyses. For the quantitative analyses, the final sample ($N = 205$) included the following five groups of participants: (a) Year 1 Kindergarten and Elementary Education ($n = 69$), (b) Year 1 Secondary Education ($n = 43$), (c) Year 4 Kindergarten and Elementary Education ($n = 54$), (d) Continuing Education ($n = 21$), and (e) Psychology ($n = 18$).

Some participants failed to respond to a questionnaire item, thus some cases had missing values. Whenever possible, I contacted participants by e-mail and asked them to respond to the missing item. A table of missing values did not show any visible pattern of missing items. In other words, missing values were randomly scattered throughout cases

and variables. Out of the total of 205 cases, 13 (<1%) cases were missing one or more values (item responses) after attempts to fill the gaps by e-mail contact. To avoid the loss of participants, I replaced the missing values with the group's mean for that variable (questionnaire item) prior to analysis. I chose this procedure because most cases (10 out of 13, or 77%) with missing values were missing only one questionnaire item, and because this procedure is not as conservative as inserting overall mean values, which reduces variable variance (Tabachnick & Fidell, 2001b).

Evidence for the construct validity of the questionnaire. Although previous studies conducted in our research lab (e.g., Boisvert & Roumain, 2000; Christou, 2001; Syer & Shore, 2001) contributed evidence to the content validity of the *Strategic Demands of Inquiry* questionnaire, I aimed in the present study to provide evidence of construct validity and evidence of the internal structure of the questionnaire.

Descriptive statistics. To show that the *Strategic Demands of Inquiry* questionnaire is a valid measure of understanding of inquiry I chose to begin by examining the mean and standard deviation of each item. I was interested in whether the instrument behaved as expected. I systematically compared items looking for those with the five largest and smallest standard deviations, and the five highest and lowest means within groups and for the sample as a whole. This examination would tell me if respondents were ranking items in an anticipated manner.

Factor analyses. To show the internal structure of the *Strategic Demands of Inquiry* questionnaire is a valid measure of understanding of inquiry instruction I conducted Exploratory Factor Analyses (EFA) followed by Confirmatory Factor Analyses (CFA). The number of correlations among the 79 questionnaire items is very

large, and thus it is difficult to summarize by inspection what a precise pattern of correlations may represent. The EFA allowed me to determine whether there is a smaller number of underlying constructs that might account for the main sources of variation in such a complex set of correlations (Stevens, 2002). Moreover, it is unlikely that the 79 items are measuring 79 entirely independent constructs. Thus I was interested in finding some variable-reduction technique that would indicate how the variables (items) cluster or hang together. More specifically, the questionnaire items can likely be explained by a much smaller number of latent constructs, which I was interested in identifying, thus common factor analysis was a better choice than principal components analysis (Tabachnick & Fidell, 2001). In the CFA I directly tested hypotheses about the structure of the latent variables (factors) that explain the observable variables (questionnaire items) and account for their correlations (Frederiksen, 2001). These analyses consisted of several steps.

First, I eliminated items that I considered ineffectual in terms of discriminating between groups. I deleted items with the highest means and lowest standard deviations because these items were not discriminating among individuals and because there was a ceiling effect on how participants ranked items. I also deleted items that were not measuring understanding of inquiry. These items had the lowest means and the highest standard deviations. The items I eliminated are essential to the questionnaire because they measure understanding of inquiry as well as respondents' attention to the questionnaire items; however, it was appropriate to discard them for the factor analyses because the goal was data reduction and only items that discriminate among individuals should be

retained. This step reduced the number of items to be factor analyzed to 70, and resulted in the elimination of the following nine items.

1. Item 5, "How important is it in inquiry-based learning and teaching for the student to work in a nurturing and creative environment?" ($M = 9.37$, $SD = 1.14$).
2. Item 31, "How important is it in inquiry-based learning and teaching for the student to keep motivated?" ($M = 9.33$, $SD = 1.26$).
3. Item 36, "How important is it in inquiry-based learning and teaching for the student to ask questions?" ($M = 9.32$, $SD = 1.2$).
4. Item 35, "How important is it in inquiry-based learning and teaching for the teacher to give sensitive feedback, positive reinforcement, praise for persistence?" ($M = 9.17$, $SD = 1.32$).
5. Item 32, "How important is it in inquiry-based learning and teaching for the student to have self-motivation?" ($M = 9.15$, $SD = 1.32$).
6. Item 34, "How important is it in inquiry-based learning and teaching for the student to win a prize?" ($M = 3.19$, $SD = 2.63$).
7. Item 21, "How important is it in inquiry-based learning and teaching for the student to have previous experience with similar activities?" ($M = 5.11$, $SD = 2.92$).
8. Item 33, "How important is it in inquiry-based learning and teaching for the student to get a high grade?" ($M = 5.31$, $SD = 2.66$).
9. Item 8, "How important is it in inquiry-based learning and teaching for the teacher to explore his or her interest?" ($M = 6.40$, $SD = 2.66$).

Second, as another data reduction technique, I created three data sets consisting of the remaining questionnaire items. The first data set, Preparation, consisted of those remaining questionnaire items that tapped into preparing for the inquiry project (items 1 to 29). The second data set, Enactment, reflected the middle part of the questionnaire and tapped into tasks involving the implementation of an inquiry project (items 30 to 73). The third data set, Reflection, was made up of the final questionnaire items tapping into reflection on the inquiry process and product (items 74 to 79). These three data sets reflected the original design and flow of the questionnaire and allowed me to analyze more manageable chunks of data.

Third, I performed a five-group MANOVA with each of the data sets using all the questionnaire items in the data set as a dependent variable. The purpose of this step was to compute the partial correlation matrix (i.e., pooled within-group correlation matrix) for each data set. I wanted to analyze the partial correlation matrices in the factor analyses because I was including five different groups in the analyses, and pooling the results from diverse groups in factor analyses likely masks differences (Tabachnick and Fidell, 2001). The partial correlation matrix removes the effects of the group differences that mask the underlying structure of a measure because they inflate correlations.

Fourth, I performed exploratory factor analyses. I initially used principal factors extraction with promax rotation through SAS FACTOR on the partial correlation matrix for the Preparation data set, Enactment data set, and Reflection data set for the five groups of participants (Year 1 Kindergarten and Elementary Education, Year 1 Secondary Education, Year 4 Kindergarten and Elementary Education, Continuing Education, and Psychology; $N = 205$). I chose principal factors extraction because it is

widely used and is a method that provides an approximate solution (Tabachnick & Fidell, 2001). An oblique rotation (promax rotation) allowed examination of correlations among factors (Stevens, 2002; Tabachnick & Fidell). This was an appropriate rotation because the *Strategic Demands of Inquiry* questionnaire measures a unifying construct, namely understanding of the inquiry instructional process. Thus the questionnaire items were expected to be correlated, and the factors were not expected to be independent. This preliminary extraction technique provided a first approximation to the factor structure.

Once I decided on the best solution, I used maximum likelihood factor analyses with promax rotation to provide statistically optimal estimates of the parameters based on the partial correlation matrix for each of the three data sets. According to Frederiksen (2001) and Tabachnick and Fidell (2001), maximum likelihood factor extraction calculates maximum likelihood estimates of the factor loadings and unique variances for a model including a specific number of common factors. Thus, estimates are obtained that maximize the likelihood of obtaining the sample correlation matrix (in this case, the original partial correlation matrix) for a specific number of factors. It also provides likelihood-ratio tests of the goodness-of-fit of the factor model (based on the specific number of factors fit to the data). According to Frederiksen (2001), "the recommended procedure for unrestricted factor analysis is to follow up any exploratory [principal axes factor] analyses with maximum likelihood factor analysis to obtain statistically optimal fits and evaluation of goodness-of-fit of the model for a given number of factors" (module 7, Factor Analysis of Artificial Data using SAS FACTOR Procedure ¶ 2).

Consistent with the conventions used in EFA (See Stevens, 2002; Tabachnick & Fidell, 2001), I used four criteria to determine the number of factors to retain: (a) the

magnitude of the eigenvalues (greater than one); (b) the proportion of variance explained by the set of variables (at least 70%); (c) the results of the scree test (change in slope in the plot of the eigenvalues); and (d) the interpretability of the final solution. To assess the adequacy of the final solution, I examined the residuals. According to Tabachnick and Fidell, if a model accounts for the data well, the residuals are small (i.e., below .05).

Fifth, I performed the CFA through SAS CALIS using the factors derived from my EFA for each of the three data sets. The purpose of the CFA was twofold. I wanted to determine how well my models accounted for the data, and I wanted an accurate way of obtaining participants' factor scores to be used as dependent variables in a Multivariate Analysis of Variance (MANOVA). Using CFA to estimate the factor scores provides least squares estimates of the factor scores. Obtaining scores by simply summing the variable scores for a factor does not provide estimates of the constructs measured by the variables. In other words, CFA allowed me to specify the structure of the factor models, a priori, based on an empirical foundation (Stevens, 2002), namely the results of the EFA using promax rotation because the EFA results showed that the factors were correlated. The CFA also provides a test of the structure hypotheses and estimates of the factor correlations.

The criterion I used for estimating the parameters of the factor solution was the maximum likelihood criterion. The goal of estimating parameters is to minimize the difference between the observed and estimated correlation matrices (Tabachnick & Fidell, 2001). To accomplish this, maximum likelihood estimates the parameter matrices iteratively, and over successive iterations the estimates are adjusted to make the criterion a minimum (Frederiksen, 2001). Maximum likelihood is an appropriate estimation

technique because my sample size is adequate, there is no reason to suspect violation of the normality or independence assumptions, and it is presently the most widely used estimation method in CFA (Schermelleh-Engel, Moosbrugger, & Müller, 2003; Tabachnick & Fidell).

I ran different models for each of the three data sets, each time varying the factor-loading cutoff point for including variables in the model equations. I did this because I was looking for a model in which there was a balance between interpretable factors and closeness of fit. For each of the data sets I analyzed the appropriate partial correlation matrix.

I examined several measures of fit to assess the adequacy of each model. I used the chi-square significance test derived from maximum likelihood estimation that tests the hypothesis that the population covariance matrix is equal to the model-implied covariance matrix (Schermelleh-Engel et al., 2003). A nonsignificant chi-square value indicates an acceptable model; however, this test is overly sensitive to large sample sizes, model complexity (i.e., a high number of parameters), and violation of assumptions (Schermelleh-Engel et al.; Tabachnick & Fidell, 2001). Therefore, I did not place much emphasis on the results of this test, and I considered other indices of fit. I also examined the ratio of the chi-square value to its degrees of freedom. According to Schermelleh-Engel et al., as well as Tabachnick and Fidell, a ratio between 2 and 3 is indicative of a good model.

In terms of descriptive goodness-of-fit indices, I looked at the Root Mean Square Error of Approximation (RMSEA) that is a measure of approximate or close fit and indicates an adequate model if the value is below .08, as well as the Nonnormed Fit Index

(NNFI) and the Comparative Fit Index (CFI) that assess fit relative to other models and indicate an adequate model if the values are above .95. According to Schermelleh-Engel et al. (2003), these criteria are the most commonly used and represent an adequate selection of indices because they are sensitive to model misspecification and do not depend on sample size as strongly as the chi-square test of significance. When I compared models (for the Preparation and Enactment CFA) I also looked at the Akaike Information Criterion (AIC) for the lowest value across models, which is good for comparing models that are not necessarily nested (Schermelleh-Engel et al.; Tabachnick & Fidell). Finally, I also examined the residual matrix (for values close to 0) and the distribution of residual covariances (for symmetry) as signs of fit as recommended by Tabachnick & Fidell.

Evidence for the reliability of the questionnaire. The method I chose to establish the scale's reliability included internal consistency estimates of reliability, namely whole-test reliability and split-half reliability. First, I performed these analyses for the sample as a whole (N = 205), and then separately for each of the five groups. I did this for the instrument as whole (i.e., items 1 to 79), for the Preparation segment (i.e., items 1 to 29), the Enactment segment (i.e., items 30 to 73), and the Reflection segment (i.e., items 74 to 79). For the coefficient alpha, I entered the questionnaire items in their original order. For the split-half coefficient, I split the scale into two halves such that the two halves would be as equivalent as possible. The first half included odd-numbered items, and the second half included even-numbered items. These were the most appropriate tests because most participants completed the questionnaire on a single occasion, and these methods allowed me to determine the homogeneity of the measure.

Group differences on the questionnaire. In order to examine group differences on the questionnaire I conducted three one-way MANOVAs using SAS Proc GLM, one each for the Preparation data set, Enactment data set, and Reflection data set. This allowed me to test whether there were group differences in terms of understanding of the inquiry instructional process as measured by the rating scale on the *Strategic Demands of Inquiry* questionnaire. The dependent variables in this analysis were the 14 inquiry factor scores derived through the EFA and CFA. More specifically, in the Preparation MANOVA the dependent variables were Factors 1 through 6, in the Enactment MANOVA they were Factors 7 through 12, and in the Reflection MANOVA the dependent variables included Factors 13 and 14. Performing three separate MANOVAs was a more refined analysis, and permitted me to evaluate group differences on each of the three segments of the questionnaire, thus providing richer data than one single MANOVA for the entire questionnaire.

I estimated factor scores using the regression approach. I chose this method because it is precise (Comrey & Lee, 1992), it results in the highest correlations between factor estimates and factors, and because it is the most widely used and thus best understood (Grice, 2001; Tabachnick & Fidel, 2001). The limitation of this approach is that I do not know the population values of the factor loadings or the population correlations among the factors; I only have the maximum likelihood estimates of them (C. Frederiksen, personal communication, June 17, 2005). This means that I do not have population parameters against which I can compare how well the factor scores represent the actual factors themselves. This method produces standardized scores. There are newer

methods for estimating factor scores, however, the programs for obtaining the estimates are not generally available.

MANOVA analyses. The independent variable in the MANOVA was type of exposure to inquiry (i.e., group). This variable included five levels: (a) Year 1 Kindergarten and Elementary Education (n = 69), (b) Year 1 Secondary Education (n = 43), (c) Year 4 Kindergarten and Elementary Education (n = 54), (d) Continuing Education (n = 21), and (e) Psychology (n = 18).

Although this was an exploratory study, I chose to conduct planned comparisons, as opposed to posthoc tests, to examine specific pairwise comparisons. I chose this approach because performing a smaller number of statistical tests has lower risk of spurious results (Stevens, 2002). Moreover, two groups in the analysis had fewer than 25 participants, which meant that power was low. Thus, according to Stevens, planning a small number of contrasts could improve the power. I conducted four pairwise comparisons to answer my research question: (a) Year 1 Secondary versus Year 1 Kindergarten and Elementary; (b) Year 1 Kindergarten and Elementary versus Year 4 Kindergarten and Elementary; (c) Year 4 Kindergarten and Elementary versus Continuing Education, and (d) Psychology versus Year 4 Kindergarten and Elementary. These were the most appropriate comparisons because they examined differences between each of the groups and the main group of interest, namely Year 4 Kindergarten and Elementary. I compared first-year elementary and secondary students entering the program because I wanted to know if I could combine them into one group. If not, this information would be interesting as well, because it would tell me that student-teachers entering the elementary or secondary program have different pre-existing ideas about

inquiry instruction. To evaluate the magnitude of the group difference I calculated effect sizes (i.e., ETA Squared) and interpreted them according to Kiess' (1996) criteria for a weak ($\eta^2 < 0.10$), moderate ($\eta^2 \geq 0.10$ and < 0.30), and relatively strong effect ($\eta^2 \geq 0.30$).

Discriminant analyses. As a follow-up to the MANOVAs, I conducted descriptive discriminant analysis using SAS DISCRIM for the Preparation data set, Enactment data set, and Reflection data set. The purpose of this analysis was to interpret and describe the major differences found among the groups in MANOVAs. Discriminant analysis provided me with information about how the individual factors contributed to the difference between groups and which individual factors were most important in differentiating between groups. Therefore, for each of the data sets I ran separate two-group discriminant analysis to determine the extent to which each factor contributed to the difference between the two groups on all of the factors simultaneously in each of the MANOVAs. For example, if the results of the planned comparisons in the Preparation MANOVA indicated a significant difference between the Year 1 and Year 4 Kindergarten and Elementary Education groups on all the Preparation factors combined, I ran discriminant analysis to determine which of the individual Preparation factors contributed most to this overall difference. Discriminant analysis was a more appropriate follow-up analysis than running univariate *F* tests on each of the factors because all of the factors were correlated with one another. Discriminant analysis, unlike the univariate approach, permits correlations among variables and takes these relationships into consideration (Bray & Maxwell, 1982). In discriminant analysis the dependent and

independent variables are inversed compared to the MANOVA. This means that the factor scores were used as predictors of membership into two groups.

The method I used for interpreting the discriminant functions (i.e., dimension separating the two groups) was to examine the pooled within-class (group) standardized canonical coefficients. According to Bray and Maxwell (1982) as well as Stevens (2002), these coefficients represent the relative or unique contribution of the variable (i.e., factor) to the discriminant function and are analogous to standardized regression weights (i.e., beta weights in regression analysis). In other words, they provide information concerning the degree to which each factor contributes to the discrimination between groups. Therefore, larger coefficients point to factors that contribute most to the group difference.

Qualitative analysis of the definitions of inquiry. To enhance the validity of the findings from the rating scale, I assessed understanding of inquiry as an instructional process in another way, namely, in an open-ended question asking participants to define or give their best idea of the pedagogical approach known as inquiry. The purpose of using multiple methods was to triangulate the data. Before I began this analysis, I transcribed the participants' definitions in a Word document, and identified each definition with the participants' code. I analyzed these participant definitions of inquiry using an open-coding procedure. Strauss and Corbin (1990) defined open coding as "the process of breaking down, examining, comparing, conceptualizing, and categorizing data" (p. 61). This was a five-step process.

First, I conceptualized and descriptively organized the data by placing descriptive codes (Miles & Huberman, 1984, 1994) on each definition. I created these descriptive codes using the participants' own key words to form one sentence. Student definitions

varied in the number of sentences used to express their conceptualizations; hence it was necessary to reduce some definitions more than others. In 10 out of the 205 cases, participants wrote approximately three different ideas that were difficult to summarize as one complete idea. In these instances I coded only the first idea for the purpose of consistency. Moreover, for all of the 205 definitions I did not code irrelevant information. That is, if participants wrote about the importance of inquiry-based learning and teaching, or their exposure to inquiry, or gave a specific example elaborating on their definition, I did not code this information. The purpose of this step was to organize and reduce the data so that I could classify them conceptually into categories. Moreover, I did not want the participants' ability to articulate or express themselves to be a confounding factor in the categorization process, thus reducing definitions to one grammatically correct phrase reduced this possibility. (It should be noted that at the end of the study I checked the ten definitions that were unclear and difficult to summarize. In only three out of these cases the final definition category code may have changed if I had chosen to code ideas other than the first idea written by the participant. However, any modifications would not have changed the final results of this study).

Second, I asked for an audit check by an expert in inquiry-oriented instruction and in qualitative-data analysis. The auditor checked 20% of the definitions randomly selected from each of the categories and checked for (a) the appropriateness of the reduction to a single sentence, and (b) agreement with the paraphrasing, syntax, and key words. The auditor agreed with 90% of the initial descriptive codes. For the remaining 10% we altered the descriptive code to better capture the participant's intended idea, and arrived at consensus.

Third, I categorized the data by grouping the descriptive codes into inductive categories on the basis of similarity. Each time I coded a descriptive code for a category, I compared it with the previous descriptive code in the same and different groups coded in the same category (Lincoln & Guba, 1985). I named the inductive categories by giving them in-vivo codes (Miles & Huberman, 1984, 1994). These names were based on the words and phrases used by the participants themselves in the descriptive codes I created in the first step of analysis. As I was coding I wrote notes on my ideas with the aim of uncovering properties of the emerging categories. The purpose of this reflection was to write rules for the assignment of conceptual labels to a category. I came up with 25 categories to account for the 205 definitions.

Fourth, two colleagues in our research lab and I performed inter-rater reliability on 20% of randomly selected descriptive codes to assess the inter-coder consistency of the inductive categories. Initially, we reached only 57.5% agreement; however, this low level of agreement was largely due to careless mistakes made on the part of the coders or misunderstandings. Once the coding mistakes were accounted for we reached 82.5% agreement. For the remaining 17.5% of definitions we altered the wording of categories and reached 100% agreement. After I re-worded and modified the criteria for some of the categories we performed inter-rater reliability on another 20% of randomly selected descriptive codes. This time we reached 72.5% agreement; however, in all but two cases in which there was not agreement, it was due to careless mistakes in coding. Nine descriptive codes were simply coded wrongly and in two cases the best category code was easily agreed upon. Therefore, there was 100% agreement. The final 25 inductive categories along with the descriptions of each category can be found in Appendix G.

Fifth, once all the definitional descriptive codes had been categorized and the 25 inductive categories had been found to be reliable, the next step was to analyze and interpret the data in such a way that would allow me to explore possible differences in the conceptualizations held by the various groups. I chose to examine the frequency distribution of categories for the sample ($N = 205$) as a whole and for each group separately. In addition, I looked at the range of categories that each groups' definitions covered. I also examined shifts or differences in categories between groups. More specifically, I compared the presence or absence of categories between groups and between the groups' most frequent categories of definitions. The group comparisons I examined mirrored those in the quantitative analysis. The aim of this qualitative analysis was to assign further meaning to the group differences found on the questionnaire and to provide triangulation in terms of the construct validity of the questionnaire.

Qualitative analysis of the interview data. The emphasis of this study was on the overall findings from the questionnaire data. However, to place these findings in a rich context and thus more fully answer the research questions in an ecologically valid fashion, I also performed qualitative data analyses on the interview data using the open-coding procedure. I chose to analyze only a small portion of the interview data, specifically, first-year and fourth-year Kindergarten and Elementary Education participants' descriptions of their university program experiences with inquiry education. This segment of the interview data was the most relevant to the present study in order to provide a grounded portrait of the program students experienced. I chose to include only the Kindergarten and Elementary Education student data because the largest and most

consistent quantitative difference was between first-year and fourth-year students in the Elementary Education program. This analysis was a five-step process.

First, I identified my units of analysis. I did this by selecting the samples of texts (data pieces) from the entire interview for each participant that were relevant to my pre-specified categories (i.e., University-Where, University-How, and University-Emphasis). Most of the samples of text were in response to the following questions. "Where in the education program have you been exposed, in any shape or form, to the inquiry approach?" "How was inquiry-oriented instruction taught to you? Describe the ways briefly." "How long was spent on inquiry teaching in this course?" On the interview protocols, I underlined the relevant samples of text with different colored pencils that corresponded to the different categories. These units of analysis varied from a few words to a few sentences, but were the smallest pieces of meaningful information. In some instances I dual-coded the same chunk of data. This only happened when I was coding for the Univeristy-How and University-Emphasis categories. Two segments of a chunk of information corresponded to the two different categories, but I needed to use the larger chunk as a whole in each category in order to understand the context in which the data took place. Ultimately, this dual coding was simply for organizational purposes, and once the data were organized into smaller segments, they could be coded individually.

Second, I physically grouped the coded data pieces into charts in a word processor. I created a separate word processing chart for each of the three categories. The purpose of this step was to descriptively organize my data so that I could begin to analyze it.

Third, once the data were organized descriptively into pre-identified categories, I applied descriptive codes (Miles & Huberman, 1984, 1994) to the data pieces. This step was similar to creating descriptive codes for the definitions. The descriptive codes reflected the participants' own words or phrases. The purpose of this step was to reduce the data, so that I could easily identify themes and patterns.

Fourth, I re-organized my charts and collapsed them into one. I did not include raw data in this chart, only the descriptive codes, thus reducing the data and making it more manageable. For these data I created three columns called "where" (course/instructor), "how," and "emphasis." The flow of the chart reflected the progression of the Kindergarten and Elementary Education program. This format allowed me to see the descriptive codes for "how" student teachers reported learning about inquiry and the "emphasis" the student teachers believed the instructor placed on inquiry for each course identified by the participants.

In the fifth and final stage, which was to interpret the data, I recorded my impressions. I went back to the raw data to find representative quotes to illustrate my impressions using the participants' own voices. I chose to interpret the data using this method because it was sufficient in providing a portrait of the Bachelor of Education in Kindergarten and Elementary Education program as experienced and perceived by the student teachers. Further analysis was not necessary given my mixed-methods research design and that the aim of my study was to provide validation of an instrument and to explore group differences on it. These qualitative data were important insofar as they provide a context in which to interpret the overall findings. I collected and analyzed these

data last in order to avoid bias in the interpretation of the definitions of inquiry held by participants.

Chapter 3

Context: Kindergarten and Elementary Education Program

To place the overall findings in context, I shall describe the Kindergarten and Elementary Education program in more detail, as experienced and described by Kindergarten and Elementary Education students. Based on interview data of 14 fourth-year students and seven first-year students, the following picture emerged.

Inquiry Occurrence in the Program

My interest was where inquiry occurred in the Kindergarten and Elementary Education program based on students' perspectives. According to the interview data, inquiry occurred predominantly in the pedagogy courses. In particular, students recalled being exposed to inquiry education in the Teaching Mathematics and Science Teaching courses. For example eight of the 14 fourth-year student teachers reported having been exposed to the inquiry approach in the Teaching Mathematics course and 10 of the 14 reported having had experience with inquiry instruction in the Science Teaching course. The frequency of individuals recalling inquiry instances in other courses ranged from zero to four.

Senior students also frequently reported having heard or learned about inquiry education in their third- and fourth-year Professional Seminar courses. Nine seniors in three different sections of the course recalled being exposed to the inquiry approach in the third-year Professional Seminar. Five of the 14 reported hearing or learning about inquiry in two different sections of the fourth-year Professional Seminar.

Another course in which students reported being exposed to the inquiry approach was first-year Educational Psychology. Seven fourth-year students from four different

sections of the Educational Psychology course indicated that they had been exposed to inquiry teaching and learning here. Four of the seven first-year students reported having heard about inquiry in their first semester course.

I also examined inquiry occurrences across professors. One professor's name kept coming up as someone who students recalled exposing them to inquiry education. Five different senior students reported having learned about inquiry from this professor in four different courses. This professor taught one section of the Professional Seminars in Year 1, 3 and 4, as well as the Teaching Social Sciences course in second year.

Another professor's name was also somewhat frequently mentioned. This professor was identified by one first-year student and five fourth-year students across three different courses. This professor taught Intercultural Education in first year, one section of the Third-Year Professional Seminar, and MRE in the Kindergarten and Elementary Curriculum in fourth year.

A third professor was also frequently mentioned relative to other professors. Two first-year and two fourth-year students identified this professor as someone they associated with inquiry-based instruction. This professor taught one section of the Educational Psychology course in first year, Exceptional Students in second year, and Instruction in Inclusive Schools in fourth year.

How Inquiry is Incorporated into the Program

Depending on the course and the professor, student teachers were exposed to the inquiry approach in different ways. In the Teaching Mathematics course, for example, students reported learning about inquiry by exploring manipulatives in order to become more knowledgeable about a topic, "learning by doing", hands-on learning, cooperative

learning, and by working on labs or centers and asking questions and problem solving as they would expect their pupils to do. In this course, the professor created an inquiry-learning environment and showed student teachers how to do inquiry and how to use it as an instructional approach. The following quotes are from the student interviews and were chosen to illustrate these points because they were representative of many of the replies.

> I think he wanted you to explore the materials and the manipulatives and see what would work and what would not. So I think it was inquiry based on our learnings of how mathematics works and how the kids . . . what ways works for them. (Participant EDPI3410108)

> Teaching Mathematics was arranged in that sort of situation, where we had labs and we were presented with, "okay, we're going to learn about this topic. Here's a whole bunch of stuff, play with it, explore it, and see what you can learn about this topic." (Participant EDPI3410117)

Similarly, student teachers reported that Science Teaching was an inquiry-based course. They recalled the professor modeling inquiry skills and engaging the students in discovery-based learning. They were exposed to the inquiry approach through hands-on learning, learning by doing, finding answers for themselves, doing experiments and labs, asking questions, collaborative learning, presenting to each other, completing projects, and creating inquiry-oriented lesson plans. The following quotes illustrate how student teachers perceived this to be an inquiry-oriented course.

> Well, again I don't think he--oh maybe he did say inquiry, "this is inquiry-based learning,"--but I remember exactly his lesson plan. And it was more the first few steps--he wasn't teaching a concept or a new concept, he got you right into

discovery of your own, at your own table within your groups. I remember that clearly because he made the point of stressing, "you don't go up in front of the class and start teaching the concept or whatever, but you have them discover why electricity flows and you get them to think, and then after they realize whether or not it worked or not, they know, and then that's when you teach the concept." . . . I remember he kept on stressing it, you know, "teach the class a certain way" and he let them discover and see if it works out for them, and get them to formulate their own questions, and you can go up to the students and try and put them in the right direction by asking the right questions, you know, and collaborative learning. (Participant EDPI3410108)

By making us do it. That was pretty much the way he taught the class. At one point he gave us the battery or the light bulb and the wire, you remember doing something with it, but when it came time to do it a lot of us couldn't remember how it was done so he'd just give us, you know, 10 minutes at the beginning of class to figure it out, see if you can make it light all the way up. After playing around with things then you start questioning, you know, "I got it to light up" and "why did it do that?" (Interviewer: Did he ever tell you this was inquiry?) Yes. He went around the lab and we had to do presentations, projects, where we had to use the basis of inquiry as our lesson plan. (Participant EDPI3410116)

For Science, he also, I've forgot the word for it, but he would just basically let us go out and find the answer for ourselves instead of him just giving it to us. He was always like, "okay you basically have to look for it and go for experiments to find the answer to it." (Participant EDPI34100304)

In the Professional Seminar courses, on the other hand, student teachers reported learning about the inquiry approach in a different way. They indicated having learned about inquiry through readings, assignments, and class discussions in which the professor encouraged the student teachers to use the constructivist approach, to get their pupils asking questions, and to create an inquiry-oriented learning environment in their classrooms. Some students also reported that professors used the inquiry method as their own teaching approach and thus they learned about inquiry through modeling and by being engaged in it as students. In these courses, inquiry seemed to be primarily presented as an instructional approach to be used in the classroom when the student teachers discussed their field experiences, as illustrated in the following quotes.

> I think those are the kind of things we talk about in our Professional Seminars, which go along with our stages . . . because, I mean it depends on your stage, but if that's the kind of thing you're seeing in your stage and you're reporting back in your Professional Seminar, then it will lead to a discussion as to why is important for those things to be going on. Because you can be a 2nd-year, 3rd-year, 4th-year, and you see this is what they're doing in the classroom, bring it back to your seminar, and say "well, why are they doing that?" And that's where you'll get into the discussion of, "well it's important because they need to share ideas, they need to--it has to be something they all have ownership in." That kind of thing. In the Professional Seminars it was more that we talked about that type of learning environment and creating a learning environment that's conducive to children's interest and really captivating their motivation or whatever you want to call it. So it was more of a theoretical, "you need to create this kind of atmosphere by doing

these kinds of things," which would I lead to, I guess, sort of inquiry-based learning. (Participant EDPI3410117)

The ones that actually use it in their own method of education were actually modeling it for us, by using it, like since they were applying it to their own teaching methods in their, by teaching it. Like using it to teach the concept itself. As well as the rest of the class. It's just direct modeling, so that was the major one. (Participant EDPI34100306)

In stark contrast, student teachers gained exposure to the inquiry approach in the first-year Educational Psychology course primarily through readings and professors' lectures. Student teachers recalled hearing about inquiry in connection to learning theories. Inquiry was a concept that was presented by professors in a lecture or reading.

"Well, taught, it came up . . . I don't remember it being exactly that, but I know it was somewhere in either his lectures or in his readings." (Participant EDPI3410104)

Not only did exposure to the inquiry approach vary as a function of course, but also as a function of professor. Student teachers repeatedly identified one professor who they perceived exposed them to the inquiry approach through group work, class discussions, assignments, projects, and under the umbrella of constructivism. Some students also viewed this professor as using the inquiry method as his own teaching approach.

He did a lot of group work as well. I felt he practiced what he preached in a way . . . He just didn't tell us what he wanted us to learn. We read and discussed among our groups. (Participant EDPI3410108)

> He didn't necessarily teach us everything that we need to know, like give us everything on the board, he wowed us to actually do the projects and then realize how this would work for our classroom. (Participant EDPI34100304)

The two other frequently identified professors simply referred to the inquiry approach in the Educational Psychology course, which students perceived as a teacher-centered course. However, students recalled these professors' other courses as more student-centered in which they learned about the inquiry approach in connection with curriculum reform in Quebec, in connection with field experiences, through readings, class discussion, assignments and presentations.

> First the professor would explain the activity that we would do, and then we'd do the activity, and then we'd talk about how and why or why not it was an effective activity, and what methods you use. (Interviewer: "Explain to me how that is inquiry.") Because we would always be questioning as we were doing. (Participant EDPI34100311)
>
> They've been talking about it but then they'll give us a couple of activities to promote what they're talking about. It's not consistently, but when they have talked about . . . they'll give us activity, like "here, I'll give you this, what do you think?" or "what questions come to your mind?" The first day he popped up with an object, an object and asked us "what it is?" (Participant EDPI3410116)
>
> We were always, every class, get into our groups and discuss. And the teacher would give us handouts about questions pertaining to the readings. And we would sort of go over the questions and make our own understanding of the readings, you know, in our groups. And then after that what happened was there was

> always a group. Every class there was a group that had to get up in front of the class and do a presentation on a particular reading, and then the whole class would basically get involved . . . had questions of students, you know, their perspectives . . . . So I think that Intercultural Education for me was inquiry-based. There was really no teacher. The teacher never really taught that class. And we were all responsible. (Participant EDPI34100311)

To elicit the information in the above section, I had asked participants how they were *taught* inquiry. I learned from their replies that this was not an appropriately worded question. A better question might have been, "how did you learn about the approach?" Student teachers recalled learning about inquiry instruction implicitly and explicitly, by being engaged in inquiry-oriented courses and as an instructional method they can use in their classrooms.

Emphasis on Inquiry in the Program

The emphasis placed on inquiry teaching and learning was also different depending on the course and professor. Student teachers recalled the Teaching Mathematics and Science Teaching courses as being inquiry-based and inquiry being a theme throughout.

> So I think throughout the whole course it was as well, it was based mainly on that, we were constantly discovering. I think we had const-, I think every lesson. It was the same model, so I think throughout the whole entire course it was based on inquiry. . . . I would say a lot less [than Science Teaching] there were centers all the time in the [Teaching Mathematics] class, but I think, I would say maybe a

few courses. Well, I think it was a theme because there were centers. (Participant EDPI3410108)

"For the Mathematics one it was the whole term because that's just way that it was taught." (Participant EDPI3410117)

Student teachers' recollections of the pervasiveness of inquiry in the Professional Seminar courses were much less consistent than in the Teaching Mathematics and Science Teaching courses. Some students reported that the topic of inquiry learning and teaching arose during a class when it happened to come up, whereas others (even in the same course) indicated that inquiry teaching and learning was a continuous theme that ran throughout. The reason for this inconsistency is not obvious, but the difference in students' perceptions could be related to the conceptualizations and meanings they hold of inquiry education.

"It was just maybe a class when it happened to come up in discussion." (Participant EDPI3410117)

Since it was like a thing that just kept popping up, I guess that it wasn't actually being taught, it was just something that was continuously coming up. Do you understand what I mean? It wasn't something being really taught. It was something that was in the background. Because it's just a theme in the background. Like no one ever teaches you how to do it. It's kind of like always something in the background to think about. (Participant EDPI34100306)

On the other hand, student teachers clearly recall that the inquiry approach was only presented in one lecture or one reading within the Educational Psychology course, as illustrated by the following quotes.

"A class or two I guess. It wasn't even a big topic." (Participant EDPE3000326)

"No maybe a day. Like one class max." (Participant EDPI3410104)

The professors most often identified by students as exposing them to the inquiry approach were remembered by some student teachers as spending part of a lecture on the approach and by others as making inquiry a theme of the course. Again, it is not clear why there was this range in recollections, but it is possibly due to the conceptualizations held by the student teachers, which would act as filter for what they remember as inquiry-based learning.

"I just always remember group work." (Participant EDPI3410108)

"It was throughout the whole semester basically." (Participant EDPI3410304)

"I'd say the whole class was based on inquiry." (Participant EDPI3410311)

"We were always, every class, get into our groups and discuss." (Participant EDPE3000201)

It's not consistently, but when they have talked about, they'll give us activity, like "here, I'll give you this, what do you think?" or "what questions come to your mind?" (Participant EDPI3410116)

The above descriptions illustrate that inquiry education is not pervasive throughout McGill University's Bachelor of Education in Kindergarten and Elementary Education. However, preservice teachers are introduced to the concept of inquiry instruction in their first semester. Moreover, starting in the second year Teaching Mathematics and Science Teaching courses, student teachers are immersed in the approach as these are perceived as inquiry-oriented courses. Student teachers seem to be able to recognize inquiry-related strategies and activities in other courses and with other

professors after this experience, although the emphasis does not seem to be as strong as in second year.

Summary

McGill University's Bachelor of Education program in Kindergarten and Elementary Education is not an inquiry-oriented program; however, there are some professors who present it as an approach to teaching and some who use it as their own teaching method. Student teachers appear to acquire the most exposure to inquiry education in their mathematics and science courses (pedagogy courses), which reflects what is happening in the literature.

Preservice teachers in the Elementary Education program at McGill University seem to learn about inquiry education in their first-year Educational Psychology course in connection with theories of learning. They read or hear about it as a concept. In second year, however, student teachers are exposed to inquiry in a different way. Some of the pedagogy-course instructors use it as their own teaching method. In this way student teachers actually engage in inquiry and learn about it as an instructional method. They are learning inquiry explicitly and implicitly. By fourth year, student teachers are able to recognize an inquiry-orientation in other courses and professors. Through class discussions in the Professional Seminars they are encouraged to try out inquiry strategies in their field placements (i.e., classrooms). This is the context in which Elementary Education preservice teachers are forming their conceptualizations about inquiry instruction.

Chapter 4

Construct Validity for the Strategic Demands of Inquiry Questionnaire

At the most basic level of this study, I aimed to provide evidence of the construct validity of the *Strategic Demands of Inquiry* questionnaire. To do this I examined the descriptive statistics, performed exploratory and confirmatory factor analyses, and examined the reliability (internal consistency) of the questionnaire.

Descriptive Statistics

The mean and standard deviation of each questionnaire item based on the entire data set pooling over groups can be seen in Appendix H. I systematically compared items looking at the five highest and lowest means and standard deviations. This comparison allowed me to determine whether individuals were responding to the questionnaire in ways that were expected. The items with the five highest mean ratings were as follows.

1. Item 5, "How important is it in inquiry-based learning and teaching for the student to work in a nurturing and creative environment?" ($M = 9.37$, $SD = 1.14$).
2. Item 31, "How important is it in inquiry-based learning and teaching for the student to keep motivated?" ($M = 9.33$, $SD = 1.26$).
3. Item 36, "How important is it in inquiry-based learning and teaching for the student to ask questions?" ($M = 9.32$, $SD = 1.2$).
4. Item 35, "How important is it in inquiry-based learning and teaching for the teacher to give sensitive feedback, positive reinforcement, praise for persistence?" ($M = 9.17$, $SD = 1.32$).
5. Item 32, "How important is it in inquiry-based learning and teaching for the student to have self-motivation?" ($M = 9.15$, $SD = 1.32$).

The participants rated working in a supportive environment, receiving feedback, student motivation, and asking questions as the most important intellectual tasks involved in the inquiry process as it might be enacted in classrooms.

As would be expected, there was considerable overlap between items with the highest means and items with the lowest standard deviations. The five items with the lowest standard deviations were the following items.

1. Item 5, "How important is it in inquiry-based learning and teaching for the student to work in a nurturing and creative environment?" ($M = 9.37$, $SD = 1.14$).
2. Item 36, "How important is it in inquiry-based learning and teaching for the student to ask questions?" ($M = 9.32$, $SD = 1.2$).
3. Item 64, "How important is it in inquiry-based learning and teaching for the student to construct new knowledge?" ($M = 8.90$, $SD = 1.23$).
4. Item 31, "How important is it in inquiry-based learning and teaching for the student to keep motivated?" ($M = 9.33$, $SD = 1.26$).
5. Item 32, "How important is it in inquiry-based learning and teaching for the student to have self-motivation?" ($M = 9.15$, $SD = 1.32$).

This means there was high agreement that working in a supportive environment, asking questions, knowledge construction, and self-motivation are central to inquiry-driven curriculum.

At the opposite extreme, the five items with the lowest mean ratings consisted of the following items.

1. Item 34, "How important is it in inquiry-based learning and teaching for the student to win a prize?" ($M = 3.19$, $SD = 2.63$).

2. Item 21, "How important is it in inquiry-based learning and teaching for the student to have previous experience with similar activities?" ($M = 5.11$, $SD = 2.92$).
3. Item 33, "How important is it in inquiry-based learning and teaching for the student to get a high grade?" ($M = 5.31$, $SD = 2.66$).
4. Item 69, "How important is it in inquiry-based learning and teaching for the student to present data in tables and graphs?" ($M = 6.20$, $SD = 2.45$).
5. Item 8, "How important is it in inquiry-based learning and teaching for the teacher to explore his or her interest?" ($M = 6.40$, $SD = 2.66$).

The participants rated earning a prize or high grade, having previous experience with similar activities, exploring the teacher's interest, and presenting data in tables and graphs as the least important strategic demands of inquiry. The high ratings on items valuing the students' self-motivation were consistent with low ratings given to items valuing students' external motivation such as winning a prize or earning a high grade. Note that these means are around the middle of the 10-point scale.

There was also a lot of overlap between items with the lowest means and highest standard deviations. The five items with the highest standard deviations were made up of the following items.

1. Item 21, "How important is it in inquiry-based learning and teaching for the student to have previous experience with similar activities?" ($M = 5.11$, $SD = 2.92$).
2. Item 33, "How important is it in inquiry-based learning and teaching for the student to get a high grade?" ($M = 5.31$, $SD = 2.66$).

3. Item 8, "How important is it in inquiry-based learning and teaching for the teacher to explore his or her interest?" ($M = 6.40$, $SD = 2.66$).
4. Item 34, "How important is it in inquiry-based learning and teaching for the student to win a prize?" ($M = 3.19$, $SD = 2.63$).
5. Item 2, "How important is it in inquiry-based learning and teaching for the student and teacher to share construction of the curriculum?" ($M = 6.75$, $SD = 2.49$).

The low level of agreement on these items may reflect participants' varying conceptions of types of inquiry, or lack of experience with such tasks. Another possible explanation for the low agreement on these items may be participants' belief systems that are likely rooted in experience with traditional teacher-centered approaches that do not value the importance of co-constructing knowledge, or participants' uncertainty about the importance of these aspects in their belief systems.

Together, the data provide some evidence of the construct validity of the *Strategic Demands of Inquiry* questionnaire. The questionnaire behaved in the expected manner. Items that the inquiry literature deemed key, such as self-motivation and asking questions, had high mean rating scores and high agreement, while items that are not emphasized in the inquiry approach, such as winning a prize, had low (mid-scale) ratings but varied agreement.

Exploratory Factor Analyses

Examination of the partial correlation matrices (Appendix I) for the Preparation data set, the Enactment data set, and the Reflection data set revealed numerous correlations in excess of .30 and some considerably higher. This is one indication that the data matrices are possibly factorable (Tabachnick & Fidell, 2001).

Preparation data factor analysis. The magnitude of the eigenvalues (see Table 1), the proportion of common factor variance (see Table 1), and the first elbow (visual break) in the scree plot suggested a two-factor model for the Preparation Data EFA. However examination of the variable loadings on the factors did not yield meaningful factors. The next drop in eigenvalues, proportion of common variance, and on the scree plot happened at the four-factor mark. However, this model was not sufficient because the element of student interest, which is central to inquiry in the literature, was not picked up in this solution. This element did not stand out until a six-factor model. Therefore, a six-factor model was the best solution.

Table 1

Preparation Eigenvalues and Proportion Values

Number of Factors	Eigenvalue	Proportion of Common Factor Variance
1	9.09	0.66
2	1.76	0.13
3	0.96	0.07
4	0.85	0.06
5	0.59	0.04
6	0.47	0.03
7	0.35	0.03
8	0.29	0.02
9	0.29	0.02
10	0.22	0.02

Loadings of variables (questionnaire items) on each of the six factors are shown in Appendix J1. I decided to use .32 as the cutoff for an item to load on a factor. This cutoff is consistent with the recommended rule-of-thumb of .30 in factor analysis (e.g., Stevens, 2002; Tabachnick & Fidell, 2001). A cutoff of .32 allowed the primary variables to load on their corresponding factor and excluded any variables that were not differentiating between groups. Factor 1 had nine loadings centered on the student understanding goals, instructions, and concepts related to the inquiry task, the student organizing the task and time, as well as the teacher being flexible with time and modeling these skills for the student. I interpreted Factor 1 as time and task organization. Factor 2 had six loadings on items related to assembling the intellectual resources to solve the problem, suggesting setting the task in context is a unique component in the preparation for inquiry. Factor 3 had three loadings on the student and teacher co-constructing knowledge, indicating a co-construction factor. Factor 4 had four loadings on the student planning to solve the problem, whereas Factor 5 had three loadings on the teacher taking into account students' interests and needs. Finally, Factor 6 had three loadings focused on the student dividing the task into steps, making a concept map, and foreseeing possible outcomes of the activity. I interpreted this factor as linking ideas including the view of the future.

Two variables did not load on any factor because they had low loadings (< .32) on several factors and thus were not differentiating between groups. These items were item 4, "How important is it in inquiry-based learning and teaching for the teacher to listen as much as he or she speaks?" and item 26, "How important is it in inquiry-based learning and teaching for the student to brainstorm his or her ideas?" Item 4 had a low

communality (.33) and item 26 had a moderate communality (.49) suggesting they measure item-specific (i.e., unique) factors. For these reasons, they were not included in the remaining analyses. These items are in the questionnaire because they measure understanding of specific aspects of strategic demands of inquiry. As shown in Appendix J1, there were five factorially complex variables, each of which loaded on two factors.

The intercorrelations of the factors (obtained using the promax method) are given in Table 2. This table gives initial estimates of factor intercorrelations. The table shows that the factors are moderately correlated, consistent with the general correlations among the items in the Preparation segment of the questionnaire.

Table 2

Preparation EFA Interfactor Correlations

	F1--Time and Task Organiz-ation	F2--Setting the Task in Context	F3--Co-Construct-ion	F4--Planning to Solve the Problem	F5--Taking into Account Students' Interests and Needs	F6--Linking Ideas Including the View of the Future
F1	1.00					
F2	.48	1.00				
F3	.32	.36	1.00			
F4	.45	.28	.16	1.00		
F5	.44	.51	.33	.20	1.00	
F6	.48	.38	.30	.33	.32	1.00

The communalities for the Preparation questionnaire items provide a conservative index of the reliability of each item. They indicate proportion of the variance that is accounted for the influence of the six factors (Frederiksen, 2001). As shown in Appendix J1, the majority of the values are high, indicating that most of the items share variance that is due to some underlying factor. Nonetheless, there were some variables (e.g., items 4, 7, 12, 24, and 25) with small communalities, which suggest the variance accounted for by these items is unique or specific to those particular items.

The six-factor model accounted for the Preparation data very well. I examined the root mean-square off-diagonal residuals (Appendix J1), which were all close to zero (< .05), indicating that the model is approximating the data acceptably. In addition, I looked at the results of the chi-square test for the significance of residuals after the extraction of the given factor. As shown in Table 3 the chi-square value for the first test ($\chi^2 = 2606.01$) was significant ($p = .0001$) indicating that there is at least one common factor in these data. The chi-square value for the second test ($\chi^2 = 314.85$) was also significant ($p = .0001$) suggesting that more than six factors are needed to explain the Preparation data. However, there was a large reduction in the chi-square values. Moreover, this test is very sensitive to sample size. Given my large sample size it is not surprising that this test rejected the null hypothesis, despite the factor-analysis solution being a good one. Moreover, I am looking for a parsimonious model and want to limit the number of factors. In sum, there does not appear to be a remaining structure that I am failing to pick up with a six-factor model.

Table 3

Chi-Square Significance Tests for Preparation EFA

Test	*df*	χ^2	*p* value
H_0: No common factors H_1: At least one common factor	325	2606.01	.0001
H_0: 6 factors are sufficient H_1: More factors are needed	184	314.85	.0001

Enactment data factor analysis. Examination of the magnitude of the eigenvalues from the principal axes factor analysis (see Table 4), the proportion of common factor variance (see Table 4), and the first elbow in the scree plot suggested a three-factor model for the Enactment EFA. The next significant drop in eigenvalues, proportion of common factor variance, and on the scree plot occurred for a six-factor model. Compared to other models, the six-factor model yielded a meaningful solution. Thus this was selected as the final model.

Table 4

Enactment Eigenvalues and Proportion Values

Number of Factors	Eigenvalue	Proportion of Common Factor Variance
1	15.90	0.63
2	2.38	0.10
3	1.64	0.07
4	0.96	0.04
5	0.81	0.03
6	0.80	0.03
7	0.64	0.03
8	0.56	0.02
9	0.52	0.02
10	0.40	0.02
11	0.39	0.02
12	0.34	0.01

The variable loadings on the factors can be found in Appendix J2 and are listed as Factors 7 through 12. Factor 7 had 16 loadings all focused on the student applying previous knowledge, constructing new knowledge, as well as understanding and sharing emotions. I interpreted Factor 7 as students' entering knowledge and affect. Factor 8 had eight loadings on the student identifying, recording, classifying, verifying, and finding patterns in data, suggesting a factor reflecting skills for collecting and analyzing data.

Factor 9 had six loadings emphasizing the student reformatting the problem, developing expectations and hypotheses, and collecting data. I interpreted this factor as defining the problem space in terms of data characteristics. Factor 10 had seven loadings on the student interacting with others in the enactment of inquiry, suggesting a factor related to the social context of solving the problem. Factor 11 had five loadings on the student communicating and presenting the results, whereas Factor 12 had three loadings tapping into the student expanding the data or information search.

One variable failed to load on any factor. The variable, item 63, "How important is it in inquiry-based learning and teaching for the student to have a mental representation of the task?" had low loadings (< .32) on several factors and a moderate communality (.57). Thus, it was excluded from the remaining analyses. This does not reflect on the importance of the information conveyed by this item. Rather it may reflect the participants' lack of sophisticated knowledge of cognitive psychology as it is applied to classroom learning. The six-factor model included eight factorially complex variables that loaded on at least two factors each. This may reflect items that represent the influence of several intercorrelations among the six factors as shown in Table 5. As is the case of the Preparation data, the factors are moderately correlated.

Table 5

Enactment EFA Interfactor Correlations

	F7--Students' Entering Knowledge and Affect	F8--Skills for Collecting and Analyzing Data	F9--Defining the Problem Space	F10--Social Context of Solving the Problem	F11--Communication of the Results	F12--Expanding the Data Search
F7	1.00					
F8	.47	1.00				
F9	.55	.46	1.00			
F10	.63	.44	.49	1.00		
F11	.39	.44	.17	.37	1.00	
F12	.40	.23	.33	.33	.26	1.00

The Enactment communality estimates (Appendix J2) are relatively high. This means that most of the Enactment questionnaire items have a high amount of common variance, which is desirable. Items with low communalities (e.g., item 37; communality estimate = .29 in Appendix J2) have high specific variance, which means that the variance being accounted for reflects qualities specific to the item itself. The participant's score on this item is not an indicator of an underlying factor common across different variables.

Examination of the root mean-square off-diagonal residuals (Appendix J2) revealed all values to be small (≤ .05), indicating that the six-factor model approximated the original Enactment data very well. Table 6 shows the chi-square significance tests for the Enactment EFA. The chi-square value for the first test ($\chi^2 = 5514.01$) was significant ($p = .0001$), indicating that there is at least one common factor in these data. The chi-square value for the second test ($\chi^2 = 1024.57$) was also significant ($p = .0001$), suggesting that more than six factors are needed to explain the Enactment data. As explained previously for the Preparation EFA, this test was sensitive to my large sample size, and needs to be interpreted carefully. Together these findings suggest that I am not failing to pick up any remaining structure and that a six-factor model adequately accounts for the Enactment data.

Table 6

Chi-Square Significance Tests for Enactment EFA

Test	*df*	χ^2	*p* value
H_0: No common factors H_1: At least one common factor	703	5514.01	.0001
H_0: 6 factors are sufficient H_1: More factors are needed	490	1024.57	.0001

Reflection data factor analysis. One underlying factor really stood out in the Reflection EFA based on examination of the magnitude of the eigenvalues (see Table 7), the proportion of common factor variance (see Table 7), and the first elbow in the scree plot. However, a two-factor solution was more meaningful. The items that loaded on the

first factor were meaningfully different than the items that loaded on the second factor. In other words, it made more sense to differentiate between items that tap into explanation, reflection and evaluation versus items that tap into questioning the results and asking follow-up questions. Therefore, the solution selected was a two-factor model. When I tried to calculate maximum likelihood estimates for this data set I was not able to obtain a solution within the acceptable boundaries. That is, one of the communalities was equal to or greater than one. This is an instance of a "Heywood case" (Tabachnick & Fidell, 2001). I continued to conduct the confirmatory factor analysis using the two-factor model because the results of the principal factors extraction with promax rotation indicated the model was a good fit to the data.

Table 7

Reflection Eigenvalues and Proportion Values

Number of Factors	Eigenvalue	Proportion of Common Factor Variance
1	3.60	1.01
2	0.24	0.07
3	0.03	0.01
4	-0.02	-0.01
5	-0.11	-0.03
6	-0.18	-0.05

Variable loadings on factors are shown in Appendix J3 and are listed as Factors 13 and 14. Factor 13 had four variable loadings and seemed to suggest a factor reflecting

explanation, reflection, and evaluation of the inquiry process. In contrast, Factor 14 had two variable loadings indicative of a factor reflecting questioning the results and follow-up questions. The two-factor model accurately approximated the correlations among the variables, and all items loaded on a single factor. The interfactor correlation between Factor 13--Explanation, Reflection, and Evaluation, and Factor 14--Questioning the Results and Follow-up Questions was 0.73. The communality coefficients for the Reflection questionnaire items (Appendix J3) are all high, indicating that all of these items reflect the influence of the factors.

The two-factor model accounts for the Reflection data very well. I examined the root mean-square off-diagonal residuals (Appendix J3), which were all close to zero. I did not have the results of the chi-square significance tests because maximum likelihood factor extraction performs these tests and I did not use this method for the Reflection data set.

Confirmatory Factor Analyses

Based on the results from my EFA, I performed CFA on the Preparation data set, Enactment data set, and Reflection data set using maximum likelihood estimation through SAS Calis. The variables that served as indicators for a factor were above the .32 cut-off that I had employed in the EFA.

Preparation model. The hypothesized Preparation model included 24 observable variables (questionnaire items) and 6 latent variables (factors). Factor 1, interpreted as Time and Task Organization included nine indicators (items 11, 12, 13, 14, 15, 18, 19, 20, and 25). Factor 2, called Setting the Task in Context, included five indicators (items 6, 20, 22, 23, and 24). Factor 3, named Co-Construction, was comprised of three

indicators (items 1, 2, and 3). Factor 4, interpreted as Planning to Solve the Problem, had four indicators (items 22, 27, 28, and 29). Factor 5--Taking into Account Students' Interests and Needs, included three indicators (items 7, 9, and 10). Finally, the sixth factor, interpreted as Linking Ideas Including the View of the Future, was comprised of three indicators (items 15, 16, and 17). EFA results showed that the six factors are inter-correlated.

An examination of the fit indices in Table 8 for the six-factor Preparation model with variable loadings cutoff at .32 suggested an acceptable model. While the chi-square value ($\chi^2 = 484.22$) was significant ($p = .0001$), this is likely due to sample size. On the other hand, the ratio of the chi-square value and the degrees of freedom ($\chi^2/df = 2.09$) and the RMSEA CI (.06 to .08) were adequate. The NNFI (.89) and the CFI (.89) were approaching levels of adequacy. Taking into consideration that the models in the CFA were not theoretically driven, the Preparation model really is accounting for the data quite well. Moreover, Schermelleh-Engel et al. (2003) noted that the cutoffs are arbitrary and should not be taken too seriously. One raw residual was greater than 2.0 (between item 11 and item 6), while at least nine others were greater than 1.0, suggesting the model is not estimating the relationship between some variables very well. However, distribution of the standardized residuals appeared symmetrical, which is ideal.

I compared the Preparation model with one alternative to see how another model accounted for the data. The alternative model was the same six-factor model, however, I decreased the cutoff to .25 for a variable to load onto a factor. The alternative model included an additional factor loading for two of the observable variables (or indicators for

factors), so that these variables loaded on more than one factor. The original Preparation model was the most parsimonious, however, it was less complex.

Investigation of the indices of fit in Table 8 suggested that increasing the number of variables did not necessarily provide a better model. Based on the ratio of the chi-square value to the degrees of freedom, RMSEA, NNFI, CFI, and AIC, the baseline Preparation model was a better fit than the alternative model.

Table 8

Goodness-of-Fit Indices for Preparation Models

Fit Index	Preparation Model (variable loadings $\geq .32$)	Alternative Model (variable loadings $\geq .25$)
χ^2 (*df*)	484.22 (232)	567.44 (254)
p value	.0001	.0001
χ^2/df	2.09	2.23
RMSEA	0.07	0.08
90% CI	0.06 to 0.08	0.07 to 0.09
NNFI	0.89	0.87
CFI	0.89	0.87
AIC	20.22	59.44

In sum, the Preparation model, in which variable loadings were cut off at .32, approximates the original data satisfactorily. There would be nothing to gain in accepting the alternative model, in which variables loadings were cut off at .25. In addition, the factors and their indicators make sense using the .32 cutoff as I explained in the EFA

results. It did not make sense to include more variables on certain factors because either the variables were not differentiating between groups, or the variables already loaded on a more appropriate factor. Examination of the communality estimates for this solution as shown in Table 9, are, for the most part, moderate to high, indicating that most of the variables share variance that is due to the underlying factor. Therefore, the final solution was to choose the original six-factor Preparation model with 24 observable variables. The factor loadings for this final solution are given in Table 9.

Table 9

Preparation CFA Variable Loadings on Factors

Factor	Variable	Variable Loading (Weight)	Communality Estimate
1	Item 11	0.61	0.37
	Item 12	0.52	0.27
	Item 13	0.69	0.48
	Item 14	0.80	0.65
	Item 15	0.54	0.56
	Item 18	0.72	0.53
	Item 19	0.69	0.48
	Item 20	0.32	0.49
	Item 25	0.61	0.37
	Item 27	0.40	0.61
	Item 29	0.21	0.64

2	Item 6	0.67	0.46
	Item 20	0.45	0.49
	Item 22	0.46	0.49
	Item 23	0.78	0.61
	Item 24	0.53	0.28
3	Item 1	0.62	0.39
	Item 2	0.81	0.66
	Item 3	0.77	0.59
4	Item 22	0.37	0.49
	Item 27	0.46	0.61
	Item 28	0.87	0.76
	Item 29	0.65	0.64
5	Item 7	0.50	0.25
	Item 9	0.64	0.41
	Item 10	0.71	0.51
6	Item 15	0.28	0.56
	Item 16	0.79	0.63
	Item17	0.66	0.44

Table 10 shows the correlations among the six fitted factors. Consistent with the EFA results and with the design of the questionnaire, the six factors are, for the most part, moderately correlated.

Table 10

Preparation CFA Interfactor Correlations

	F1--Time and Task Organiz-ation	F2--Setting the Task in Context	F3--Co-Construct-ion	F4--Planning to Solve the Problem	F5--Taking into Account Students' Interests and Needs	F6--Linking Ideas Including the View of the Future
F1	1.00					
F2	.61	1.00				
F3	.39	.51	1.00			
F4	.62	.42	.30	1.00		
F5	.72	.71	.61	.51	1.00	
F6	.68	.61	.38	.63	.74	1.00

Enactment model. The hypothesized Enactment model had 37 observable variables and assessed whether these variable could be explained by six latent variables. The six factors included Factor 7, called Students' Entering Knowledge and Affect, with 16 indicators (items 30, 38, 39, 49, 50, 51 to 55, 57, 64 to 67, and 72). Factor 8, named Skills for Collecting and Analyzing Data, included eight indicators (items 43 to 46, 52, 56, 58, and 73). Factor 9, interpreted as Defining the Problem Space in Terms of Data Characteristics, had six indicators (items 37, 40 to 44). Factor 10, called Social Context of Solving the Problem, had seven indicators (items 47, 59 to 62, 70, and 71). Factor 11,

named Communication of the Results, included five indicators (items 66 to 70). Lastly, Factor 12, named Expanding the Data Search, had three indicators (items 47 to 49). I assumed the six Enactment factors were inter-correlated according to my EFA findings.

Inspection of the fit indices as shown in Table 11 indicated conflicting results. On the one hand, the RMSEA CI (.08-.09) and the ratio of the chi-square value to the degrees of freedom ($\chi^2/df = 2.46$) indicated an adequate model. However, the CFI (.82) and the NNFI (.83) were below the conventional standard for an acceptable model. That said, the Enactment model is likely accounting for the data well enough, given that the cutoffs are arbitrarily chosen and because "fit indices may be affected by model misspecification, small-sample bias, violation of normality and independence, and estimation-method effects" (Schermelleh-Engel et al., p. 52-53). There were several large residual values, suggesting that the model is not estimating the relationship between certain variables well. Despite this, the distribution of standardized residuals was symmetrical and centered around zero, suggesting a good fit to the data.

I compared the Enactment model to two other less parsimonious, but more complex models. Alternative A consisted of estimates of two additional factor indicators (loadings of observable variables on the factors) because I lowered the cutoff to .30 for a variable to load on a factor. Alternative B included estimation of 12 additional factor loadings. These alternatives allowed certain variables to load on more than one factor. I did not lower the cutoff any further because I risked over-fitting the model.

Table 11

Goodness-of-Fit Indices for Enactment Models

Fit Index	Enactment Model (variable loadings ≥ .32)	Alternative A (variable loadings ≥ .30)	Alternative B (variable loadings ≥ .25)
χ^2 (*df*)	1493.15 (606)	1463.11 (604)	1468.4 (631)
p value	.0001	.0001	.0001
χ^2/df	2.46	2.42	2.33
RMSEA	0.08	0.08	0.08
90% CI	0.08 to 0.09	0.08 to 0.09	0.07 to 0.09
NNFI	0.83	0.83	0.84
CFI	0.82	0.83	0.84
AIC	281.15	255.11	206.40

Based on the results shown in Table 11, there appears to be very little gained in choosing a more complex model. The RMSEA values were the same for each model, and the NNFI and CFI values only increased up to .02 decimal points for the alternatives. There was very little difference in the size and distribution of residuals between the models. However, the ratio of the chi-square value to the degrees of freedom as well as the AIC value for the Enactment model were larger relative to Alternative A and Alternative B, suggesting it is less desirable model. That said, in selecting the original Enactment model, which is already a good enough model, I would have consistent cutoff points (.32) for variable loadings across the three data sets (Preparation, Enactment,

Reflection). Moreover, the Enactment model is the most parsimonious. A more complex model is not necessary given that the variables already load on most appropriate factors. Finally, I would not be losing much in terms of goodness-of-fit by choosing the original Enactment model compared to Alternative A and Alternative B. Therefore, it makes the most sense to keep the original six-factor Enactment model as the final solution. The factor loadings for this final solution are given in Table 12.

Table 12

Enactment CFA Variable Loadings on Factors

Factor	Variable	Variable Loading (Weight)	Communality Estimate
7	Item 30	0.66	0.44
	Item 38	0.72	0.52
	Item 39	0.72	0.52
	Item 49	0.60	0.47
	Item 50	0.63	0.40
	Item 51	0.68	0.46
	Item 52	0.45	0.38
	Item 53	0.78	0.61
	Item 54	0.75	0.65
	Item 55	0.73	0.53
	Item 57	0.68	0.47
	Item 64	0.69	0.48
	Item 65	0.68	0.46

	Item 66	0.46	0.49
	Item 67	0.42	0.56
	Item 72	0.66	0.44
8	Item 43	0.48	0.64
	Item 44	0.38	0.60
	Item 45	0.86	0.73
	Item 46	0.91	0.83
	Item 52	0.23	0.38
	Item 56	0.79	0.63
	Item 58	0.80	0.65
	Item 73	0.76	0.57
9	Item 37	0.51	0.26
	Item 40	0.59	0.35
	Item 41	0.80	0.65
	Item 42	0.80	0.63
	Item 43	0.41	0.64
	Item 44	0.49	0.60
10	Item 47	0.54	0.48
	Item 59	0.64	0.41
	Item 60	0.75	0.56
	Item 61	0.80	0.64
	Item 62	0.79	0.62
	Item 70	0.30	0.52

	Item 71	0.78	0.61
11	Item 66	0.36	0.49
	Item 67	0.46	0.56
	Item 68	0.83	0.68
	Item 69	0.67	0.45
	Item 70	0.53	0.52
12	Item 47	0.26	0.48
	Item 48	1.11	1.23
	Item 49	0.17	0.47

Table 13 shows the correlations among the six fitted factors. The six factors in the final solution are, for the most part, moderately correlated.

Table 13

Enactment CFA Interfactor Correlations

	F7--Students' Entering Knowledge and Affect	F8--Skills for Collecting and Analyzing Data	F9--Defining the Problem Space	F10--Social Context of Solving the Problem	F11--Communication of the Results	F12--Expanding the Data Search
F7	1.00					
F8	.61	1.00				
F9	.73	.58	1.00			
F10	.83	.63	.66	1.00		
F11	.45	.67	.26	.48	1.00	
F12	.42	.37	.31	.41	.42	1.00

Reflection model. The Reflection model that I tested had six manifest variables (questionnaire items), and assessed whether these variables could be explained by two latent variables (factors). Items 74, 76, 77, and 78 served as indicators of Factor 13, interpreted as Explanation, Reflection and Evaluation. Items 75 and 79 served as indicators of Factor 14, called Questioning the Results and Follow-Up Questions. The two factors are inter-correlated.

The fit indices, as shown in Table 14, indicated that the Reflection model matches the observed data very well. The chi-square value ($\chi^2 = 21.92$) was significant ($p = .005$),

however, this test has several shortcomings and thus I considered other indices. The ratio of the chi-square value to the degrees of freedom ($\chi^2/df = 2.74$) and the RMSEA CI (.05 to .14) suggested an adequate fit, while the NNFI (.98) and the CFI (.98) suggested an excellent fit.

Table 14

Goodness-of-Fit Indices for the Reflection Model

Fit Index	Reflection Model
χ^2 (*df*)	21.92 (8)
p value	0.005
χ^2/df	2.74
RMSEA	0.09
90% CI	0.05 to 0.14
NNFI	0.98
CFI	0.98

The residual matrix indicated an absence of any relationships that were not being adequately represented. All of the residual correlations were close to zero and were evenly distributed. Since it appears as though the relationships between the variables were being accounted for, this lends additional support for the Reflection model fitting the data well. I did not compare Reflection models because all of the initial variable loadings from the EFA and shown in Appendix J3 were very high (> .62) and all the variables were accounted for (i.e., the evaluation of fit was good). The communality estimates (see Table 15) are all moderate to high, which means the variables account for a

substantial amount of shared variance due to an underlying factor. The Reflection factors fitted in the final solution are highly correlated (.81). Table 15 gives the factor loadings for this solution.

Table 15

Reflection CFA Variable Loadings on Factors

Factor	Variable	Variable Loading (Weight)	Communality Estimate
13	Item 74	0.72	0.52
	Item 76	0.91	0.82
	Item 77	0.84	0.70
	Item 78	0.75	0.56
14	Item 75	0.94	0.89
	Item 79	0.73	0.53

Reliability Analysis

I computed two internal-consistency estimates of reliability for the *Strategic Demands of Inquiry* questionnaire: coefficient alpha and split-half coefficient expressed as Cronbach Alpha, and the Unequal- or Equal-Length Spearman-Brown Coefficient, respectively. Table 16 shows the reliability estimates for the total sample and for each group for the instrument as a whole, for the Preparation segment, the Enactment segment, and the Reflection segment. The Cronbach Alpha values ranged from .81 to .97 indicating that the scale responses are highly reliable for respondents. The Unequal- and Equal-Length Spearman-Brown Coefficients ranged from .83 to .99 indicating excellent

reliability estimates. The high internal consistency estimates for this scale indicate that the *Strategic Demands of Inquiry* questionnaire is a highly homogenous measure with all items measuring a single over-arching construct, namely understanding of the strategic demands of engaging in inquiry teaching and learning. Moreover, each segment of the questionnaire (Preparation, Enactment, and Reflection) is highly homogenous in and of themselves. This is what we would expect given the intentional and criterion-referenced design of the questionnaire to measure the different elements that make up understanding of inquiry-driven instruction, including preparation, enactment, and reflection phases. This finding is also consistent with the EFA results indicating inter-correlations among the factors.

Table 16

Internal-Consistency Reliability Estimates

Group	Whole (items 1 to 79)		Preparation (items 1 to 29)		Enactment (items 30 to 73)		Reflection (items 74 to 79)	
	Alpha	Split-Half	Alpha	Split-Half	Alpha	Split-Half	Alpha	Split-Half
Sample as a whole (N = 205)	.97	.98	.93	.96	.96	.98	.90	.86
Year 1 Elementary (n = 69)	.98	.98	.94	.95	.96	.98	.85	.84
Year 1 Secondary (n = 43)	.96	.99	.91	.97	.95	.99	.86	.83
Year 4 Elementary (n = 54)	.97	.98	.92	.95	.95	.98	.87	.89
Continuing Education (n = 21)	.95	.98	.85	.93	.92	.95	.81	.88
Psychology (n = 18)	.98	.99	.92	.96	.97	.99	.89	.92

Summary

An important aim of the present study was to find further evidence of validity for the *Strategic Demands of Inquiry* questionnaire. Examination of variable means and variances, results of the EFA and CFA, and analysis of the reliability estimates of the questionnaire indicated that the *Strategic Demands of Inquiry* questionnaire has strong construct validity and high internal consistency.

The underlying structure of the *Strategic Demands of Inquiry* questionnaire is shown in Appendix J. In pooling together the EFA results of the three data sets (Preparation, Enactment, and Reflection), I found a total of 14 factors underlying the *Strategic Demands of Inquiry* questionnaire. As noted previously in this chapter, all the factors within each segment of the questionnaire (Preparation, Enactment, and Reflection) had high intercorrelation values. This makes sense, given that the questionnaire was designed to measure an over-arching construct, namely, understanding of the different elements of inquiry instruction.

The use of CFA to assess the hypothesized structure of the *Strategic Demands of Inquiry* questionnaire was largely supportive. Six-factor models accounted for the Preparation data set and the Enactment data sets well, where the cutoff point for a variable to load on a factor was .32. The two-factor model for the Reflection data set was an excellent fit to the data.

The final list of factors along with a description of each factor (based on the items that loaded on the factor) is shown below in Table 17. These factors complement the definitions of inquiry as described in the inquiry literature. In terms of the historical roots of inquiry teaching and learning, Factor 3--Co-Construction and Factor 10--Social

Context of Solving the Problem clearly reflect the social-constructivist nature of education in so far as the student and teacher co-construct the inquiry curriculum and the student collaborates with others to gain a better understanding of the data and results. One factor in particular, Factor 7--Students' Entering Knowledge and Affect, captures the essence of cognitive and social-constructivist views of education because it focuses on pre-existing knowledge and how that impacts on the acquisition of new knowledge. Further, there is a strong emotional component underlying these cognitive processes.

The cognitive theories' influence can also be seen in Factor 2--Setting the Task in Context and Factor 6--Linking Ideas Including View of the Future, in which the emphasis is on the student connecting pre-existing knowledge to new knowledge, organizing new concepts into webs, and linking new knowledge to everyday life. In addition, Factor 13--Explanation, Reflection, and Evaluation, which involves metacognitive skills and consciousness of the learning process, is another factor that reflects the cognitive roots of inquiry.

In each of the factors the student's active role in knowledge acquisition is highlighted, which is deemed central to inquiry education by the National Research Council (1996). Moreover, Factor 7--Students' Entering Knowledge and Affect explicitly states that the student is responsible for constructing his or her own knowledge.

Many of the factors tap into the various interrelated research processes involved in inquiry teaching and learning as described by Shore, Aulls, and Rejskind (2000) as well as Marinello (1998). For example, Factors 1--Time and Task Organization and 4--Planning to Solve the Problem emphasize the planning involved in preparing for an inquiry project in terms of time, space, plans, and problem-solving strategies. Factor 3--

Co-Construction and Factor 14--Questioning the Results and Follow-Up Questions include the element of the generation of a question in the inquiry process. Factors 8--Skills for Collecting Data and Analyzing Data and Factor 9--Defining the Problem Space in Terms of Data Characteristics tap into the research skills needed for collecting, analyzing, and interpreting data. Factor 11--Communication of Results picks up on the importance of sharing and reviewing results. These factors map on to the research-process skills and strategies included in definitions of inquiry education in the literature, thus adding face-validity to the factor structure of the *Strategic Demands of Inquiry* questionnaire.

Table 17.

Strategic Demands of Inquiry Factors

Factor	Description
	Preparation Factors
Factor 1--Time and Task Organization	The teacher gives a flexible amount of time and models skills needed for inquiry. The student understands the instructions and key concepts, makes a plan, has backup plans, divides the task into steps, describes one's problem-solving strategies, organizes one's time and space, and sets aside preparation time.
Factor 2--Setting the Task in Context	The teacher encourages honest criticism of ideas and creative risk-taking. The student describes one's problem-solving strategies, connects old and new knowledge, and extends inquiry beyond the classroom.
Factor 3--Co-Construction	The teacher and student share construction of the curriculum and decision making, and have co-ownership of the question.
Factor 4--Planning to Solve the Problem	The teacher encourages honest criticism of ideas. The student makes a plan, has different plans in advance to accomplish the task, and has back-up plans at the end should the project stall.

Factor 5--Taking into Account Students' Interests and Needs	The teacher taps the students' as well as his or her own needs and interests. The teacher provides a mentor.
Factor 6--Linking Ideas Including View of the Future	The student divides the task into a coherent sequence of do-able steps, makes a concept map or web or cluster, and foresees possible outcomes of the activity.
	Enactment Factors
Factor 7--Students' Entering Knowledge and Affect	The student understands how preconceptions affect learning, applies previous knowledge to new concepts, separates relevant and irrelevant information, constructs new knowledge, and applies new knowledge to future experiences. The student interacts with or manipulates one's surroundings, assists others to make observations, communicates one's learning, and considers diverse means of communication. The student feels free to use imagination, makes suggestions, keeps an open mind to change, addresses doubts directly, shares emotions, feelings, ideas, and opinions, is aware of how the inquiry event affects one personally, and values personal judgment.
Factor 8--Skills for	The student identifies where to obtain data, records data,

Collecting Data and Analyzing Data	classifies data, finds patterns in data, understands hidden meanings in data, verifies data or information, and records methods, results, and conclusions. The student is aware of how the inquiry event affects one personally.
Factor 9--Defining the Problem Space in Terms of Data Characteristics	The student restates or reformats the problem, develops expectations of what will happen next, offers hypotheses about outcomes, makes careful observations, identifies where to obtain data, and recognizes hidden meanings in data.
Factor 10--Social Context of Solving the Problem	The student searches for resources beyond textbooks, seeks different viewpoints, tests ideas and hypotheses, compares and contrasts data with someone else's, anticipates and responds to arguments in opposition to one's view, uses vocabulary appropriate to the audience and topic, and accepts that more than on solution might be appropriate.
Factor 11--Communication of Results	The student organizes the presentation of the project, presents data in tables and graphs, considers diverse means of communication, uses vocabulary appropriate to the audience and topic, and communicates one's learning with others.
Factor 12--Expanding	The student searches for resources beyond textbooks, searches

the Data or Information Search	the Internet and World Wide Web, and separates relevant from irrelevant information.
Reflection Factors	
Factor 13--Explanation, Reflection, and Evaluation	The student explains the results, discusses what has been learned compared to what was known before, reflects upon and evaluates the inquiry experience.
Factor 14--Questioning the Results and Follow-up Questions	The student questions the findings and follows up the project with a new set of questions.

Chapter 5

Group Differences in Understanding of Inquiry Instruction

Multivariate Analyses

I carried out three one-way multivariate analyses of variance (MANOVAs) using SAS PROC GLM to evaluate the relationship between type of exposure to inquiry (i.e., group) and understanding of the strategic demands of inquiry in terms of preparation for an inquiry curriculum, enactment of an inquiry-oriented program, and reflection on the inquiry process and product. The null hypothesis being tested was that the groups' profiles of factor scores for each of the phases of inquiry (i.e., preparation, enactment, and reflection) were the same. For each of these MANOVAs, the independent variable, as described in the Chapter 2, was type of exposure to inquiry (i.e., group). This variable included five levels: (a) Year 1 Kindergarten and Elementary Education (n = 69), (b) Year 1 Secondary Education (n = 43), (c) Year 4 Kindergarten and Elementary Education (n = 54), (d) Continuing Education (n = 21), and (e) Psychology (n = 18).

The dependent variables in the Preparation MANOVA were participants' estimated factor scores on Factors 1 through 6. The dependent variables in the Enactment MANOVA were participants' estimated factor scores on Factors 7 through 12, and in the Reflection MANOVA, the dependent variables were participants' estimated factor scores on Factors 13 and 14.

As described in Chapter 2 (page 94), planned comparisons were carried out for each MANOVA including (a) Year 1 Secondary versus Year 1 Elementary, (b) Year 1 Elementary versus Year 4 Elementary, (c) Year 4 Elementary versus Continuing Education, and (d) Psychology versus Year 4 Elementary.

To follow up the multivariate analysis, discriminant analysis was performed using SAS DISCRIM to determine which factors contributed the most to the differences between groups.

Preparation analyses. Figure 2 illustrates the profile of Preparation factor scores for the different groups. The Year 4 Elementary Education group and the Continuing Education group gave higher ratings of importance to the Preparation factors compared to the other groups. Although the Psychology Honours group was higher on the first two factors, this group's profile looks more similar to those of the first-year groups in general.

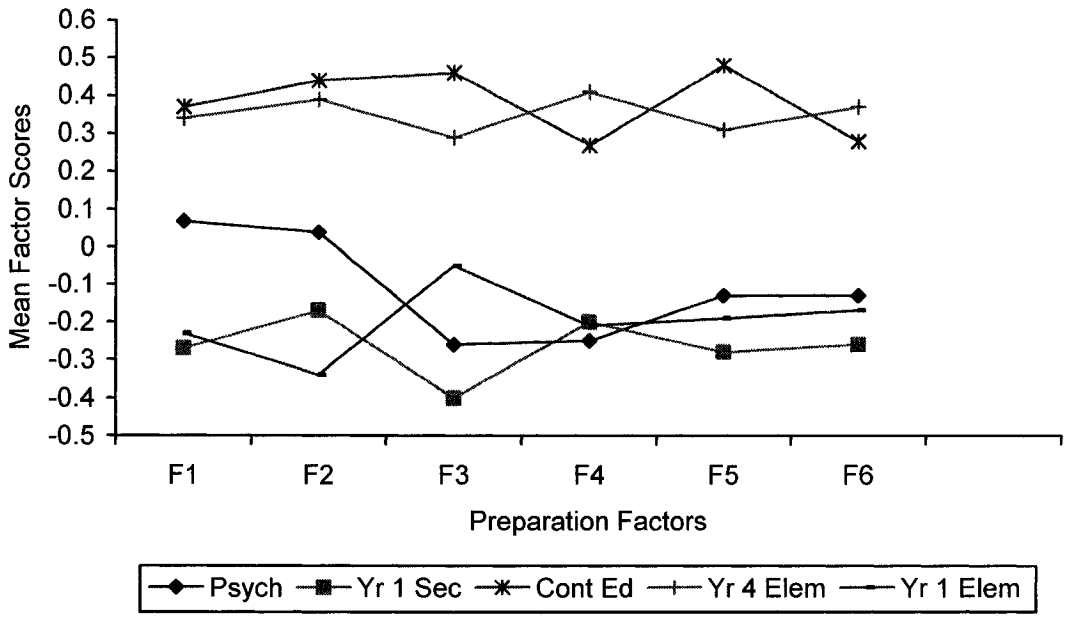

Figure 2. Groups' mean factor scores for the preparation factors.

In the Preparation-for-inquiry multivariate analysis, the planned-comparison tests yielded two significant differences among the groups. First, the Year 1 Elementary Education group's profile of Preparation factor scores was significantly different from that of the Year 1 Secondary Education group, Wilks' $\Lambda = .93$, $F(6, 195) = 2.36$, $p = .03$. The group factor had a weak effect, multivariate $\eta^2 = .07$. Second, the profile of

Preparation factor scores for the Year 1 Elementary Education group was significantly different from that of the Year 4 Elementary Education group, Wilks' $\Lambda = .89$, $F(6, 195) = 4.19$, $p < .01$. In this case, group accounted for a moderate amount of the variance, multivariate $\eta^2 = .11$. No significant differences were found between the Continuing Education group versus the Year 4 Elementary Education group, Wilks' $\Lambda = .98$, $F(6, 195) = .64$, $p = .7$, or the Psychology Honours group versus the Year 4 Elementary Education group, Wilks' $\Lambda = .95$, $F(6, 195) = 1.87$, $p = .09$, on the Preparation factors together. These statistical results are displayed in Table 18.

Table 18

MANOVA of Preparation Factor Scores

Effect	Wilks' Λ	df_1	df_2	Multivariate F	η^2
Year 1 Secondary vs. Year 1 Elementary	.93	6	195	2.36*	.07
Year 1 Elementary vs. Year 4 Elementary	.89	6	195	4.19**	.11
Continuing Education vs. Year 4 Elementary	.98	6	195	.64	.02
Psychology vs. Year 4 Elementary	.95	6	195	1.87	.05

* $p < .05$

** $p < .01$

To interpret these findings a discriminant analysis was conducted to determine which individual Preparation factors contributed the most to the discrimination between groups. Two-group discriminant analyses were performed separately with the Year 1 Elementary Education and Secondary Education data, and then the Year 1 and Year 4 Elementary Education data.

The first analysis included the Year 1 Elementary Education group and the Year 1 Secondary Education group. One discriminant function was calculated, however, it failed to reach significance, Wilks' $\Lambda = .89$, $F(6, 105) = 2.13$, $p = .06$. However, this failure to reach significance could reflect the low power of this test. For this reason, and because the results of the MANOVA indicated that the overall pattern of Preparation factors scores for the Year 1 Elementary Education group and the Year 1 Secondary Education group were significantly different, I chose to observe the trends in this analysis. The pooled within-class standardized canonical coefficients are presented in descending order reflecting the decreasing relative importance of each factor to the group difference in Table 19. The factor making the largest contribution to the difference between the first-year student teachers on the Preparation segment of the questionnaire was Factor 3--Co-Construction. The Year 1 Elementary group ($M = -0.05$, $SD = 0.90$) rated this factor much more important to the inquiry instructional process than the Year 1 Secondary group ($M = -0.40$, $SD = 1.01$). Factor 2--Setting the Task in Context also contributed substantially to the difference between the first year students. On this factor, the Year 1 Secondary group ($M = -0.17$, $SD = 0.83$) gave more affirmative ratings than the Year 1 Elementary group ($M = -0.34$, $SD = 1.18$). The factor making the least difference between student teachers entering the education programs was Factor 1--Time and Task

Organization. The Year 1 Secondary students (M = -0.27, SD = 1.10) gave similar importance to this factor as the Year 1 Elementary students (M = -0.23, SD = 1.04). Appendix K1 contains the means and standard deviations of the dependent variables (Factors 1 through 6) for all of the groups.

Table 19

Year 1 Secondary versus Year 1 Elementary Pooled Within-Class Standardized Canonical Coefficients for the Preparation Factors

Variable	Standardized Coefficient
	Year 1 Secondary vs. Elementary
Factor 3: Co-Construction	1.22
Factor 2: Setting the Task in Context	-1.18
Factor 6: Linking Ideas Including View of the Future	1.00
Factor 4: Planning to Solve the Problem	-0.60
Factor 5: Taking into Account Students' Interests and Needs	-0.59
Factor 1: Time and Task Organization	0.35

The second analysis included the Year 1 and Year 4 Elementary Education groups. The discriminant function was found to significantly separate first-year from fourth-year Elementary Education student teachers even with the less powerful test, Wilks' $\Lambda = .84$, $F(6, 116) = 3.73$, $p < .01$. The pooled within-class standardized canonical coefficients are presented in descending order reflecting the decreasing relative

importance of each factor to the group difference in Table 20. The factor contributing most to the difference between Year 1 and Year 4 Elementary Education student teachers was Factor 2--Setting the Task in Context. Year 4 Elementary Education students (M = 0.39, SD = 0.76) rated this factor as more important to inquiry teaching and learning than did the Year 1 Elementary group (M = -0.34, SD = 1.18). The factor making the second most important contribution to the group difference was Factor 5--Taking into Account Students' Interests and Needs. The Year 4 group (M = 0.31, SD = 0.81) also rated this factor more affirmatively compared to the Year 1 group (M = -0.19, SD = 1.01). Factor 4--Planning to Solve the Problem also contributed substantially to the difference between first-year students and fourth-year students, with the seniors (M = 0.41, SD = 0.78) giving more importance to this factor than the first-year students (M = -0.21, SD = 0.98). Interestingly, Factor 3--Co-Construction did not account for a substantial difference between groups, as reflected by its small value relative to the other factors' values. This means that first-year Elementary student teachers enter the program with a pre-existing appreciation for the collaborative nature inherent in inquiry instruction.

Table 20

Year 1 versus Year 4 Elementary Pooled Within-Class Standardized Canonical Coefficients for the Preparation Factors

Variable	Standardized Coefficient
	Year 1 vs. Year 4 Elementary
Factor 2: Setting the Task in Context	1.00
Factor 5: Taking into Account Students' Interests and Needs	-0.73
Factor 4: Planning to Solve the Problem	0.67
Factor 1: Time and Task Organization	0.20
Factor 3: Co-Construction	0.14
Factor 6: Linking Ideas Including View of the Future	-0.14

Enactment analyses. Figure 3 illustrates the profile of Enactment factor scores for the different groups. For the most part, the Year 4 Elementary Education and Continuing Education groups give the most affirmative ratings and thus have the highest factor scores, with the exception of Factors 11 and 12. The Psychology group also rated these two factors highly. The first-year Elementary Education group's factor scores are lower than the first-year Secondary Education group's scores, with the exception of Factor 8.

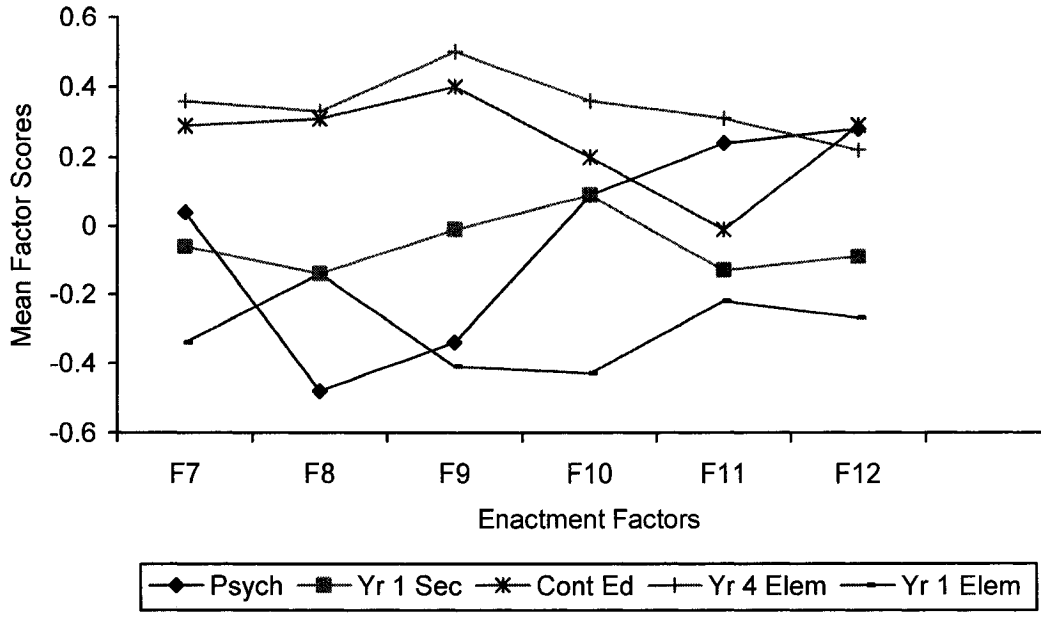

Figure 3. Groups' mean factor scores for the enactment factors.

In the Enactment-of-inquiry multivariate analysis, the planned-comparison tests yielded three significant differences among the groups. First, the Year 1 Elementary Education group's profile of Enactment factor scores was significantly different from that of the Year 1 Secondary Education group, Wilks' $\Lambda = .92$, $F(6, 195) = 2.74$, $p = .01$. The effect size for group was weak, multivariate $\eta^2 = .08$. Second, the Year 4 Elementary Education group's profile of Enactment factor scores was significantly different from that of the Year 1 Elementary Education group, Wilks' $\Lambda = .83$, $F(6, 195) = 6.63$, $p < .01$. The group factor had a moderate effect, multivariate $\eta^2 = .17$. Third, the profile of Enactment factor scores for the Year 4 Elementary Education group was significantly different from that of the Psychology Honours group, Wilks $\Lambda = .93$, $F(6, 195) = 2.54$, $p = .02$. The effect for group was weak, multivariate $\eta^2 = .07$. No significant differences were found between the Continuing Education group versus the Year 4 Elementary group, Wilks $\Lambda =$

.98, $F(6, 195) = .78$, $p = .59$, on the Enactment factors together. These statistical results are displayed in Table 21.

Table 21

MANOVA of Enactment Factor Scores

Effect	Wilks' Lambda	df_1	df_2	Multivariate F	η^2
Year 1 Secondary vs. Year 1 Elementary	.92	6	195	2.74*	.08
Year 1 Elementary vs. Year 4 Elementary	.83	6	195	6.63**	.17
Continuing Education vs. Year 4 Elementary	.98	6	195	.78	.02
Psychology vs. Year 4 Elementary	.93	6	195	2.54*	.07

* $p < .05$

** $p < .01$

To follow up, a discriminant analysis was performed to determine which individual Enactment factors contributed the most to the group differences. Two-group discriminant analyses were performed separately with the Year 1 Elementary Education and Year 1 Secondary Education data, the Year 1 and Year 4 Elementary Education data, and then the Psychology Honours and Year 4 Elementary data.

The first analysis included the Year 1 Elementary Education group and the Year 1 Secondary Education group. The extracted discriminant function reliably differentiated

first-year Elementary and Secondary student teachers, Wilks' $\Lambda = .89$, $F(6, 105) = 2.22$, $p = .05$; however, the effect was not highly significant. The pooled within-class standardized canonical coefficients, as seen in Table 22, suggested that the factors contributing most to the difference between the first-year Elementary and Secondary student teachers were Factor 10--Social Context of Solving the Problem and Factor 7--Students' Entering Knowledge and Affect. Year 1 Secondary Education students ($M = 0.09$, $SD = 0.89$) rated Factor 10--Social Context of Solving the Problem as more important to inquiry teaching and learning than did the Year 1 Elementary group ($M = -0.43$, $SD = 1.24$). The first-year Secondary students ($M = -0.06$, $SD = 0.10$) also rated Factor 7--Student's Entering Knowledge and Affect more favorably compared to the first-year Elementary students ($M = -0.34$, $SD = 1.29$). Factor 12--Expanding the Data or Information Search made the smallest contribution to the group difference, suggesting this factor does not help discriminate between first-year students entering different programs of the Education degree. Appendix K2 contains the means and standard deviations of the dependent variables (Factors 7 through 12) for all the groups.

Table 22

Year 1 Secondary versus Year 1 Elementary Pooled Within-Class Standardized Canonical Coefficients for the Enactment Factors

Variable	Standardized Coefficient
	Year 1 Secondary vs. Elementary
Factor 10: Social Context of Solving the Problem	1.42
Factor 7: Students' Entering Knowledge and Affect	-1.40
Factor 9: Defining the Problem Space in Terms of Data Characteristics	0.95
Factor 8: Skills for Collecting Data and Analyzing Data	-0.92
Factor 11: Communication of Results	0.46
Factor 12: Expanding the Data or Information Search	0.08

The second analysis included the Year 1 and Year 4 Elementary Education groups. The discriminant function significantly separated first-year from fourth-year Elementary Education student teachers, Wilks' $\Lambda = .74$, $F(6, 116) = 6.63$, $p < .01$. The pooled within-class standardized canonical coefficients (Table 23) indicated that the factors contributing most to the difference between Year 1 and Year 4 Elementary Education student teachers were Factor 9--Defining the Problem Space in Terms of Data Characteristics and Factor 7--Students' Entering Knowledge and Affect. The Year 4

group (M = 0.5, SD = 0.93) rated Factor 9--Defining the Problem Space in Terms of Data Characteristics higher than the Year 1 group (M = -0.41, SD = 1.14). The Year 4s (M = 0.36, SD = 0.75) also gave more favorable ratings to Factor 7--Students' Entering Knowledge and Affect relative to the Year 1s (M = -0.34, SD = 1.29). Factor 12--Expanding the Data or Information Search contributes insubstantially to difference between these two groups.

Table 23

Year 1 versus Year 4 Elementary Pooled Within-Class Standardized Canonical Coefficients for the Enactment Factors

Variable	Standardized Coefficient
	Year 1 vs. Year 4 Elementary
Factor 9: Defining the Problem Space in Terms of Data Characteristics	1.38
Factor 7: Students' Entering Knowledge and Affect	-1.03
Factor 11: Communication of Results	0.98
Factor 8: Skills for Collecting Data and Analyzing Data	-0.81
Factor 10: Social Context of Solving the Problem	0.62
Factor 12: Expanding the Data or Information Search	0.09

The third analysis included the upper year Psychology Honours and the Year 4 Elementary Education groups. The discriminant function reliably discriminated the

Psychology Honours group from the Year 4 Elementary Education group, Wilks' Λ = .79, $F(6, 65) = 2.88$, $p = .01$. As shown in Table 24, the largest pooled within-class standardized canonical coefficient was for Factor 8--Skills for Collecting Data and Analyzing Data, suggesting this was the factor that contributes most to the group difference. The Year 4 Elementary Education group ($M = 0.33$, $SD = 0.85$) rated this factor as more important to inquiry teaching and learning than the Psychology Honours group ($M = -0.48$, $SD = 1.32$).

Table 24

Psychology Honours versus Year 4 Elementary Pooled Within-Class Standardized Canonical Coefficients for the Enactment Factors

Variable	Standardized Coefficient
	Psychology vs. Year 4 Elementary
Factor 8: Skills for Collecting Data and Analyzing Data	1.08
Factor 10: Social Context of Solving the Problem	-0.61
Factor 9: Defining the Problem Space in Terms of Data Characteristics	0.48
Factor 11: Communication of Results	-0.43
Factor 12: Expanding the Data or Information Search	-0.25
Factor 7: Students' Entering Knowledge and Affect	0.20

Reflection analyses. Figure 4 depicts the Reflection factor scores for each of the groups. The Year 4 Elementary Education and Continuing Education groups gave almost identically high ratings of importance to the two Reflection factors. The Psychology Honours and Year 1 Secondary Education groups' factor scores were in the mid-range. The Year 1 Elementary Education group had the lowest factor scores for this segment of the questionnaire.

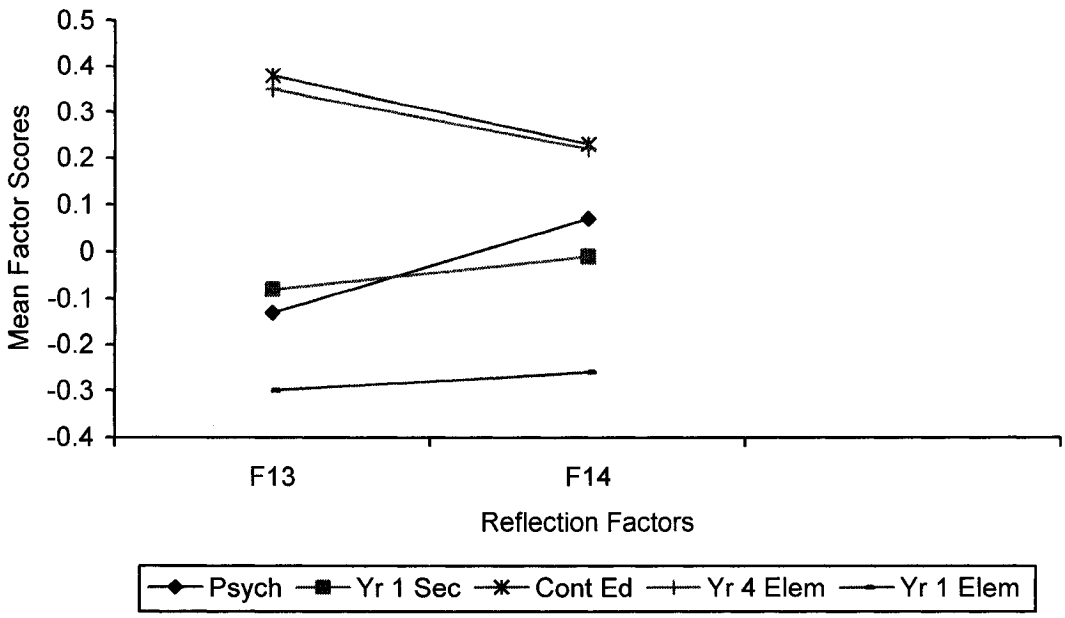

Figure 4. Groups' mean factor scores for the reflection factors.

In the Reflection-on-inquiry multivariate analysis, the planned-comparison tests indicated two significant differences among the groups. First, the profile of Reflection factor scores for the Year 1 Elementary Education group was significantly different from that of the Year 4 Elementary Education group, Wilks' $\Lambda = .93$, $F(2, 199) = 7.95$, $p < .01$. The effect size for group was moderate, multivariate $\eta^2 = .07$. Second, the Year 4 Elementary Education group's profile of Reflection factor scores was significantly different from that of the Psychology Honours group, Wilks $\Lambda = .96$, $F(2, 199) = 3.92$, p

= .02. The group factor had a weak effect, multivariate η^2 = .04. No significant differences were found between the Continuing Education group versus the Year 4 Elementary Education group, Wilks Λ = 1.0, $F(2, 199) = .03$, $p = .97$, or between the Year 1 Secondary Education group versus the Year 1 Elementary Education group, Wilks $\Lambda = .99$, $F(2, 199) = .94$, $p = .39$, on the Reflection factors together. These statistical results are displayed in Table 25.

Table 25

MANOVA of Reflection Factor Scores.

Effect	Wilks' Lambda	df_1	df_2	Multivariate F	η^2
Year 1 Secondary vs. Year 1 Elementary	.99	2	199	.94	0
Year 1 Elementary vs. Year 4 Elementary	.93	2	199	7.95**	.07
Continuing Education vs. Year 4 Elementary	1.0	2	199	.03	0
Psychology vs. Year 4 Elementary	.96	2	199	3.92*	.04

* $p < .05$

** $p < .01$

Discriminant analysis was performed as a follow-up to the MANOVA to determine which individual Reflection factors contributed the most to the group differences. Two-group discriminant analyses were performed separately with the Year 1

and Year 4 Elementary Education data, and then the Psychology Honours and Year 4 Elementary Education data.

The first analysis included the Year 1 and Year 4 Elementary Education groups. The discriminant function significantly separated first-year from fourth-year Elementary Education student teachers, Wilks' $\Lambda = .89$, $F(2, 120) = 7.04$, $p < .01$. The pooled within-class standardized canonical coefficients (Table 26) suggested that Factor 13--Explanation, Reflection, and Evaluation contributes most to the difference between Year 1 and Year 4 Elementary Education student teachers. The Year 4 group ($M = 0.35$, $SD = 0.62$) valued this factor more than the Year 1 group ($M = -0.26$, $SD = 1.18$). Factor 14--Questioning the Results and Follow-up Questions contributes substantially less. Appendix K3 contains the means and standard deviations on the dependent variables (Factors 13 and 14) for all of the groups.

The second analysis included the Psychology Honours and the Year 4 Elementary Education groups. The discriminant function reliably discriminated the Psychology group from the Year 4 Elementary group, Wilks' $\Lambda = .85$, $F(2, 69) = 6.34$, $p < .01$. Examination of the pooled within-class standardized canonical coefficients, as shown in Table 26, indicated that Factor 13--Explanation, Reflection, and Evaluation makes the larger contribution to the group difference, followed by Factor 14--Questioning the Results and Follow-up Questions. The Year 4 Elementary group ($M = 0.35$, $SD = 0.62$) gave more favorable ratings to Factor 13 compared to the Psychology group ($M = -0.13$, $SD = 1.12$). Similarly, the Year 4 group ($M = 0.22$, $SD = 0.68$) valued Factor 14 more highly than the Psychology students ($M = 0.07$, $SD = 0.86$).

Table 26

Pooled Within-Class Standardized Canonical Coefficients for the Reflection Factors

Variable	Standardized Coefficient	
	Year 1 vs. Year 4 Elementary	Psych vs. Year 4 Elementary
Factor 13: Explanation, Reflection, and Evaluation	1.42	-2.16
Factor 14: Questioning the Results and Follow-up Questions	-0.52	1.71

Qualitative Analyses

I carried out a qualitative analysis of individuals' personal definitions of the pedagogical approach known as inquiry, as described in Chapter 2 (pages 95 to 98). To explore how the groups of student teachers might conceptualize inquiry teaching and learning differently, I examined the frequency distribution of the 25 categories of definitions across groups. More specifically, I looked at categories with the highest frequency of participants overall and in each group, the range of categories in each group, and the shifts in categories between groups. This analysis included a large amount of data (five groups, $N = 205$; 25 categories), thus analysis at a descriptive level was most appropriate. The detailed explanation of the 25 categories of definitions can be found in Appendix G; however, the main idea of each category is described briefly in Table 27.

Table 27

Definition Categories of Inquiry Education

Category	Main Idea
0. Missing	The participant did not write anything as a response.
1. Critical Thinking and Reflection	A (self) questioning or critical thinking or reflective approach or process.
2. Student Teacher Interaction	Bi-directional or interactive learning or questioning or discussion.
3. Teacher Research and Reflection	The teacher reflects on her work or researches and experiments with evidence-based teaching strategies.
4. Teacher Facilitates Student Learning	The teacher facilitates the students' learning by creating opportunities to construct new knowledge. The student is actively engaged in the learning process, which includes doing some form of research.
5. Student Responsible for Student Learning	The students' role is to construct new knowledge by being active participants in the learning process, which includes doing some form of research.
6. Teacher Asks Questions which Leads to Learning	Learning is based on being asked questions.
7. Students Ask Questions which Leads to Learning	Learning results from asking questions.
8. Questioning and Research	The process of asking questions and doing research.
9. Information Search and Research	The process of gathering information and doing research.
10. Curiosity-Driven Learning	Interest and curiosity drive the learning process, which includes doing some form of research.
11. Student-Centered Learning	The learning process is student-centered.
12. Student-Centered Teaching	Instruction is student-centered.

13. Teacher Gathers Information About Students	The teacher asks about or finds out information about students.
14. Teacher Assess Students' Prior Knowledge	The teacher assesses students' prior knowledge to guide instruction.
15. Teacher Asks Questions to Assess Student Learning	The teacher asks students questions to assess their understanding or learning.
16. Teacher Asks Questions and Students Solve	The teacher asks questions or presents problems for the students to solve.
17. Teacher Gives Information	Teaching involves giving students information and skills.
18. Investigation	A label with the root "investigate."
19. Problem Solving	A label with the root "problem solve."
20. Research	A label with the root "research."
21. Being Curious	To be curious.
22. Learning	Inquiry is learning or students learn through inquiry.
23. Teaching	Inquiry is a teaching method.
24. Don't Know	"I don't know."
25. Miscellaneous	These definitions do not fit into a category because they are too vague or unrelated to inquiry education.

Frequency. I began this analysis by examining the frequency distribution of the 25 categories collapsed across the five groups, which is shown in Table 28. The total number of definitions (i.e., participants) was 205. The definition category with the greatest number of participants was quite clearly #8--Questioning and Research (n = 22, 11%). For example, "inquiry is learning based on asking questions, researching, interviewing, using many resources to find possible answers and stimulate more

questions" (Participant EDEM4050013). Tied for second place were #7--Students Ask Questions which Leads to Learning and #9--Information Search and Research (n = 15, 7%). Examples of definitions in these respective categories are, "inquiry is basically asking questions to gain knowledge/information" (Participant EDPE3000320), and "to go out and research, investigate about someone, something, and use that to come to a conclusion if information is valid" (Participant EDPE3000151). The definition categories with the third largest number of participants were #4--Teacher Facilitates Student Learning, #10--Curiosity-Driven Learning, and #12--Student-Centered Learning (n = 12, 6%). A representative example of a definition in category #4 is,

> I believe inquiry learning is a way of teaching children, where a child's own questions lead them to research in a special area. By getting children curious about a subject/topic, they are prompted to find the answers to their questions on their own. The teacher doesn't teach the answer to a question, rather s/he allows the students to find the answer on their own. (Participant EDPI3410116)

The following is an example of category #10--Curiosity-Driven Learning, "inquiry is learning through testing, analyzing and researching a motivating question. Students are curious about a topic or idea and try to find out more about it" (Participant EDPI3410122). An example of a definition in category #11--Student Centered Learning is, "inquiry is learning by doing. It is finding something that interests you and learning while you find the answer. It is student-based and student-driven" (Participant EDPI5260017). The category with the fourth greatest frequency of participants was #1--Critical Thinking and Reflection (n = 11, 5%). An example of a definition in this category is, "inquiry is to not 'take everything at face value and question it' along with

conducting an in-depth study to further understand a specific subject and contribute to its understanding" (Participant EDPE3000121).

To elaborate, the categories with the greatest frequencies of participants included inquiry processes such as asking questions, doing research, gathering information, and reflection. The majority of individuals also described the inquiry context as being student-centered and interest-driven. In other words, the categories with the highest number of participants involved elements of students learning actively by asking questions of interest to them, and finding answers through research and problem solving. These categories involve a high degree of elaboration or richness. This means that most of the participants in this study held meaningful conceptualizations of the inquiry method. Moreover, these categories are reminiscent of the items with the highest overall means on the *Strategic Demands of Inquiry* questionnaire. Recall that everyone agreed that asking questions, student motivation, knowledge construction, and a supportive environment are central to an inquiry-oriented classroom. Together these data provide triangulation, lending support to the construct validity of the questionnaire.

The categories with the fewest number of participants were #24--Don't Know, #0--Missing, and #20--Research, (n = 2, 1%). This means that only four participants did not or were unable to define inquiry teaching and learning. Two individuals described inquiry simply as "research" without any elaboration. Therefore, participants, on a whole, did have some understanding of the pedagogical approach known as inquiry, which means their replies on the Likert-style items of the questionnaire were meaningful to them, if not to experts, and to this extent a valid reflection of students in preservice programs like this one at research universities in Canada and perhaps elsewhere.

Table 28

Frequency Distribution of Definition Categories

Definition Category	Total $N = 205$	Psych $n = 18$	Yr1 Sec $n = 43$	Yr1 Elem $n = 69$	Yr4 Elem $n = 54$	Cont Ed $n = 21$
#0	2	2	0	0	0	0
#1	11	1	4	6	0	0
#2	7	1	3	3	0	0
#3	10	0	2	5	2	1
#4	12	4	1	1	3	3
#5	9	1	0	2	4	2
#6	5	0	1	1	3	0
#7	15	1	4	6	4	0
#8	22	4	3	5	7	3
#9	15	2	2	7	3	1
#10	12	2	2	1	5	2
#11	12	0	1	0	7	4
#12	3	0	2	0	1	0
#13	4	0	1	0	3	0
#14	8	0	3	2	3	0
#15	6	0	1	5	0	0
#16	8	0	1	2	4	1
#17	5	0	0	4	0	1
#18	4	0	3	1	0	0

#19	6	0	3	1	1	1
#20	2	0	0	0	2	0
#21	5	0	1	3	1	0
#22	6	0	1	3	1	1
#23	5	0	0	5	0	0
#24	2	0	1	1	0	0
#25	9	0	3	5	0	1

At the second level of this analysis, I systematically examined the three categories with the greatest number of participants per group. These results are presented as percents in Table 29. I also examined the categories with a complete absence of individuals for each group.

The categories with highest number of Psychology Honours students centered around the idea of students actively learning by asking questions and doing research driven by their own interests. The student was seen as responsible for constructing his or her own knowledge. For example,

> Inquiry is a learning approach that encourages seeking information out of one's own interest and as directed by the teacher. Students should be encouraged to seek different sources and evaluate them critically." (Participant PSYCH0007)

Although the Psychology Honours students described student-centered processes and none of them described inquiry as teacher-directed, no one specifically referred to inquiry as a "student-centered" approach. The absence of Psychology Honours students in the categories that refer to this language may reflect this groups' lack of experience

with instruction and educational vocabulary and practices. None of the Psychology Honours students defined inquiry using vague labels, indicating they hold more elaborate conceptualizations. These results imply that Psychology Honours students have a complex understanding of the inquiry approach insofar as what is important for students to learn through participation in inquiry instruction in elementary and secondary schools. This would suggest that engaging in inquiry through doing a thesis and studying psychological research, without learning explicitly about the approach or how to teach using this approach, is sufficient for individuals to form a meaningful conceptualization of inquiry.

The Year 1 Secondary Education group, on the other hand, did not, as a group, appear to have formed complex conceptualizations of the inquiry approach. For example, several participants provided simple, albeit relevant, labels such as "investigation" or "problem solving." In addition no one in this group defined inquiry using category #5, which explicitly and elaborately describes inquiry learning as the student responsible for constructing knowledge. Nonetheless, the categories with the greatest number of Year 1 Secondary Education students suggested that preservice teachers who are entering the Secondary Education program come with established beliefs about inquiry involving asking questions and doing research, engaging in critical thinking and reflection, a shared conversation between the teacher and student, and the learning being student-directed. Moreover, no one in this group referred to inquiry as the teacher giving learners information. This result is somewhat unanticipated given Richardson's (1996) finding that student teachers typically enter teacher-preparation programs with traditional and transmission-oriented views of teaching and learning. It suggests that almost a decade

later many of the Secondary Education student teachers have had previous schooling experience with more contemporary methods of instruction.

Similarly, the Year 1 Elementary Education students entered the program with pre-established notions of inquiry involving asking questions, doing research, engaging in critical thinking, and reflection. An example of a first-year Elementary student teacher's definition is,

> Inquiry is looking into an issue. It's not simply accepting what something is but actually looking into it and why something is that way. It's researching, it's asking questions, and looking for possible answers." (Participant EDPE3000326)

Some students appeared to have biases involving the teacher's role being directive. For example, "this method involves asking students lots of questions about what they understand" (Participant EDPE3000243). Perhaps these students' views are rooted in their school-based experiences as pupils that were more transmission-oriented or authority-oriented views of teaching. Other first-year Elementary student teachers provided vague definitions which made it difficult to ascertain their level of understanding. For example, "a certain way in which teachers teach their students" (Participant EDPE3000252). Thus, the Year 1 Elementary group did understand the inquiry processes involved in this instructional approach, but some held incomplete or less developed conceptualizations of this method. Moreover, nobody in this group defined inquiry using categories #11 or #12, which use the language, "student-centered." This suggests that first-year Elementary student teachers do not have experience with this terminology. The Year 1 Elementary group gave the lowest ratings of importance to the various factors involved in carrying out or enacting an inquiry curriculum. This implies

that having a simple or less elaborate understanding of the inquiry approach did not allow this group to fully appreciate the intellectual tasks involved in this type of instruction.

In contrast, the Year 4 Elementary student teachers emphasized the student's role in actively constructing his or her own knowledge by asking questions and doing research on topics in which they are interested. An example of a fourth year Elementary Education student teacher's definition is,

> Inquiry teaching follows a constructivist model by which students devise a question, hypothesis, and approach to solving their problem. Then they follow this approach and evaluate the solutions it generated. (Participant EDPI3410209)

Interestingly, no one defined inquiry as critical thinking or as student-teacher interaction. Perhaps these categories were replaced by more elaborate categories that included these processes, such as those just described.

Some of these senior students described inquiry as the teacher presenting problems to the students to be solved. These students appear to have been most influenced by the approach taken in mathematics toward using an inquiry-oriented approach to instruction. For example,

> The inquiry approach is one where the students are presented with a question or a problem and are then presented with opportunities to ask questions and do "research" to find the answer to their problem. (Participant EDPI3410117)

For the most part, Year 4 Elementary Education participants provided elaborate and meaningful or complex conceptualizations of inquiry teaching and learning. They did not define inquiry as the teacher asking questions to assess student learning or as the teacher giving information. Very few students used vague labels as definitions. For

example, no one defined inquiry as "an investigation" or as "teaching." These results triangulate with the high value they placed on the various strategic demands of inquiry, as measured on the Likert-type scale.

The Continuing Education group also focused heavily on the student's role and interests. For example,

> Inquiry is a creative, student-centered way of delivering curricular content by engaging and creating opportunities for learners to generate and construct their own learning. It can be project-based, portfolio-based, or even summative, but the learners must be *actively* engaged in research at one or more points of their learning cycle. (Participant EDPI5260018)

There were several categories in which this group was completely absent, and which describe strategies or processes that seem to be encompassed in the more elaborate categories used by the Continuing Education group. For example, no one in this group defined inquiry as asking questions, critical thinking, student-teacher interaction, or assessing learners' prior knowledge; however, these strategies are part of more complex definitions such as student-based learning or the student responsible for student learning, which are categories with a high frequency of Continuing Education students. This group's complex understanding of the inquiry approach seems to be reflected in their appreciation for the strategic demands involved in carrying out an inquiry curriculum.

Table 29

Definition Categories with the Highest Frequency Ratios per Group.

Group	Definition Categories	Ratio (% of group)
Psychology	#4: Teacher Facilitates Student Learning	22
	#8: Questioning and Research	22
	#0: Missing	11
	#9: Information Search and Research	11
	#10: Curiosity-Driven Learning	11
	#1: Critical Thinking and Reflection	5
	#2: Student Teacher Interaction	5
	#5: Student Responsible for Student Learning	5
	#7: Students Ask Questions which Leads to Learning	5
Year 1 Secondary	#1: Critical Thinking and Reflection	9
	#7: Students Ask Questions which Leads to Learning	9
	#2: Student Teacher Interaction	7
	#8: Questioning and Research	7
	#14: Teacher Assesses Students' Prior Knowledge	7
	#18: Investigation	7
	#19: Problem Solving	7
	#25: Miscellaneous	7
	#3: Teacher Research and Reflection	5

	#9: Information Search and Research	5
	#10: Curiosity-Driven Learning	5
	#12: Student-Centered Teaching	5
Year 1	#9: Information Search and Research	10
Elementary	#1: Critical Thinking and Reflection	9
	#7: Students Ask Questions which Leads to Learning	9
	#3: Teacher Research and Reflection	7
	#8: Questioning and Research	7
	#15: Teacher Asks Questions to Assess Student Learning	7
	#23: Teaching	7
	#25: Miscellaneous	7
Year 4	#8: Questioning and Research	13
Elementary	#11: Student-Centered Learning	13
	#10: Curiosity-Driven Learning	9
	#5: Student Responsible for Student Learning	7
	#7: Students Ask Questions which Leads to Learning	7
	#16: Teacher Asks Questions and Students Solve	7
Continuing	#11: Student-Centered Learning	19
Education	#4: Teacher Facilitates Student Learning	14
	#8: Questioning and Research	14
	#5: Student Responsible for Student Learning	10
	#10: Curiosity-Driven Learning	10

Range. After examining the categories with the highest frequency ratios for each group, I looked at the range of categories (i.e., conceptualizations) held by each group. Interestingly, the Psychology Honours group overlapped only nine categories. They solely gave elaborate and complex definitions of the inquiry approach. In contrast, the Year 1 Secondary Education and Elementary Education groups were distributed across 21 of the categories, indicating a higher degree of variability in the conceptualizations they held compared to the Psychology Honours group. The Year 4 Elementary Education group was also distributed across a larger number (i.e., 17) of the categories, indicating some variability in conceptions held by the group; however, the variability is smaller than the first-year groups. The Continuing Education group, not unlike the Psychology Honours group, was covered by 12 categories. The groups with the largest number of participants were also the groups holding the most variable conceptualizations of inquiry education. The variability in definitions of the inquiry approach echoes what is happening in the inquiry literature insofar as the research on inquiry education is also based on different definitions of inquiry teaching and learning.

Shifts. I next examined shifts in conceptualizations (or differences) held between various groups. Following the pattern of the quantitative findings, I looked at the similarities and differences in the most commonly held conceptualizations (see Table 20) between (a) first-year and fourth-year Kindergarten and Elementary Education students, (b) first-year Kindergarten and Elementary Education and Secondary Education students, and (c) Psychology Honours and fourth-year Kindergarten and Elementary Education students. In addition, I examined the complete presence (i.e., frequency count ≥ 1) or

absence (frequency count = 0) of a group across definitional categories (see Table 19). This analysis allowed me to more closely examine how the (a) unique and (b) weighted conceptualizations of inquiry held by the different groups might explain the difference in value they placed on various factors on the *Strategic Demands of Inquiry* questionnaire.

The most striking and consistent difference between groups that I found in the quantitative analyses was between the Year 1 and Year 4 Kindergarten and Elementary Education students, therefore, I was particularly interested in how their conceptualizations of inquiry education might compare. The notion that inquiry involves asking questions and doing research was held by many students entering and exiting the Kindergarten and Elementary Education program, thus this seems to be a core pre-established idea that remains set in student teachers' minds as they progress through the program. From a constructivist point of view, the belief that inquiry involves asking and answering questions likely serves as a filter that affects how and what student teachers learn in their education program. A common theme that arose in the interview data about the Elementary Education program was about professors emphasizing the importance of teachers encouraging their pupils to ask questions. Thus, this pre-established belief with which preservice teachers enter the program is supported and perhaps strengthened throughout their program.

In contrast, a belief with which several student teachers enter the program that needs to be addressed if we want to develop inquiry-oriented teachers, has to do with the role of the teacher as a transmitter of knowledge. Several first-year students' definitions focused on the teacher's role of asking questions to assess students' understanding or of giving learners information to learn. Although none of the Year 4 students defined

inquiry exactly that way, the emphasis on teacher's role was also present in the conceptualizations held by some Year 4 Elementary student teachers who defined inquiry as the teacher providing problems for students to solve. In addition, no first-year students, but three fourth-year students defined inquiry as the teacher gathering information on her pupils. For example, "inquiry is trying to find out as much as possible about your students" (Participant EDPI3410101). The senior students who conceptualized inquiry in this way did not place the learner at the center of the learning process, compared to other senior students who defined inquiry as the student coming up with their own problems to solve. Although these data are cross-sectional and not longitudinal in nature, the teacher-belief literature would support the view that there could be some student teachers who enter the preparation program holding traditional, didactic views of instruction and whose beliefs remain stable and resistant to change. At the very least, it seems reasonable to consider that there are a handful of student teachers entering the education program with more authority-oriented views of inquiry that will likely frame or shape what information they learn in their preparation program about inquiry. There might be a subgroup of student teachers who hold beliefs about inquiry teaching that reflect a more traditional view of education who are less receptive to more contemporary views presented in the program

For the most part, however, incomplete or simple definitions held by first-year student teachers seemed to be replaced by richer and more sophisticated conceptions in the fourth-year group. A major shift that occurred between first-year and fourth-year Elementary Education students was the element of critical thinking and reflection. Definitions of inquiry based on critical thinking and reflection were present in Year 1 and

absent in Year 4. Student teachers entering the teacher-preparation program may have come with pre-existing ideas about critical thinking and reflection that may have been espoused in their high school, but which novice student teachers may not be very knowledgeable about in terms of what these terms entail. By fourth year, student teachers may have gained experience and knowledge about the specific strategies and processes involved, and then incorporated them into more complete definitions of inquiry education.

A few of the first-year Elementary Education students also defined inquiry as involving interactive learning or discussion. For example,

> Inquiry refers to a teaching approach where the teacher spends more time interacting with his/her classroom instead of simply lecturing. In this approach, I believe that students' opinions and ideas would be more considered than in most of the approaches used today. (Participant EDPE3000307)

None of the senior students defined inquiry in this way. This conceptualization of inquiry may have been replaced by more definitions using the term "student-centered," in the fourth-year group. Indeed, not one first-year Elementary student teacher defined inquiry as a student-centered approach, however, this was a common conceptualization held amongst fourth-year Elementary student teachers. Based on the student interview data, Elementary preservie teachers seem to acquire this language during their program. Whereas in first year, student teachers can describe an approach or strategy, by fourth year student teachers have the terminology and language to call that approach by name. In other words, they have learned more sophisticated ways of conceptualizing inquiry pedagogy.

Some first-year Elementary Education students also held vague, almost meaningless definitions of inquiry, such as "investigation" or "teaching," which seem to have been replaced by more sophisticated understandings of inquiry education in Year 4, such as curiosity-driven learning or student-centered instruction. However, this was not always the case, as one fourth-year student (2%) did define inquiry simply as "research." Nonetheless, more fourth-year students defined inquiry as learners being responsible for constructing their own knowledge through the research process. For example,

> Inquiry is a student-centered approach that involves students being responsible for their own learning. I believe it involves collecting data, testing out hypotheses, and drawing conclusions in order to answer a question. (Participant EDPI3410107)

Moreover, more first-year Elementary student teachers defined inquiry as a strategy involving information gathering. For example, "inquiry is finding out information from various sources and then analyzing it" (Participant EDPE3000231). This idea also seems to have been replaced by a more complete and elaborate definition outlining a process or context in which learners are responsible for constructing their knowledge and in which learners' interest and curiosity are key, as it was not a common definition described by senior Elementary student teachers. The program experiences reported by Year 4 Elementary Education students support their developing richer, elaborate, more complex conceptualizations of inquiry engagement. For example, as explained in Chapter 2, student teachers are expected to participate as learners in inquiry-oriented courses beginning the second year of their teacher-preparation program. In addition, they are shown how to incorporate the inquiry approach into their own

classrooms throughout their pedagogy and practicum courses. In short, the qualitative data suggest that greater experience with inquiry instruction fosters the development of more sophisticated conceptualizations of the approach.

Another group in this study that received a substantial amount of experience with the inquiry approach was the Continuing Education group. Because I was following patterns found in the quantitative data and no such differences emerged between the Year 4 Elementary Education group and the Continuing Education group, I did not compare their conceptualizations in any detail. However, at first glance, there was a lot of overlap in the most commonly held conceptualizations between the two groups. This indicates that the Continuing Education group, who received intensive explicit and implicit inquiry-oriented instruction, and who may or may not have had inquiry experience prior to their Continuing Education course, held sophisticated conceptualizations of the inquiry approach similar to the fourth-year Elementary Education students.

A third group in this study that engaged in inquiry-related activities was the Psychology Honours group. There were differences found in the quantitative analysis between Psychology Honours students and Year 4 Elementary Education students. Examination of the conceptualizations held by each group showed that both groups actually held sophisticated understandings of the inquiry approach. For example, members in both groups emphasized the elements of asking questions and doing research. Furthermore, participants in both groups held complex conceptualizations in which the learner is responsible for constructing knowledge and the teacher facilitates this process. Senior Psychology and Education students also focused on the learners' interest and curiosity in this type of instruction.

The groups differed in that some Psychology Honours students defined inquiry as critical thinking and reflection, whereas this was not a focus in the Year 4 Elementary Education group. Moreover, conceptualizations held by some of the Psychology Honours group involved student-teacher interaction, which was replaced by more student-centered categories in the Year 4 Elementary Education group. None of the Psychology Honours students defined inquiry as a student-centered instructional approach.

Another group difference found in the quantitative analysis was between Year 1 Elementary and Year 1 Secondary students. In terms of conceptualizations, both groups shared the notion that inquiry involves critical thinking and reflection. They also agreed that inquiry entails asking questions, gathering information, and doing research. There were first-year students in both programs who held rudimentary conceptualizations of inquiry and defined it using a label such as "problem solving" or "investigation." Only the Elementary Education group additionally used the label "teaching."

I examined the differences in ratios for each definition category between groups. Although these revealed slight differences, the actual frequency counts between groups were not all that different. However, this was a qualitative analysis, thus I understood the differences to be potentially meaningful. With that caveat in mind, I found that first-year Secondary students differed slightly from first-year Elementary students in that a greater proportion of the Secondary preservice teachers were of the opinion that learner interest is vital to inquiry instruction. Some Secondary students also conceptualized inquiry as including the element of assessing learners' prior knowledge. For example, "inquiry is to find out what the students/learners already know in order to build upon it" (Participant EDPE3000120). This strategy was not common in the Elementary Education group's

definitions. Furthermore, some Secondary students focused on the element of a shared conversation between learners and teachers, whereas some Elementary students emphasized the teacher's role as asking questions to assess student understanding. Only students in the Elementary Education group defined inquiry explicitly and completely as occurring when the student is responsible for constructing new knowledge by actively participating in the learning process and by doing research. The small differences between the first-year Elementary Education and Secondary Education groups in terms of the conceptualizations they hold are commensurate with the inconsistent differences found between the groups in their factor scores on the questionnaire. Differences in conceptualizations and factor scores suggest dissimilar educational backgrounds in which these beliefs are rooted.

Integration of Findings

Together, the quantitative data and qualitative data indicate that student teachers who receive different types of exposure to the inquiry approach do have different understandings of inquiry instruction. The quantitative analyses indicated group differences on the *Strategic Demands of Inquiry* factor scores. Theorizing from a social-constructivist perspective and based on the teacher-belief literature, conceptualizations that students hold about inquiry pedagogy can influence the importance they place on the various tasks involved in carrying out an inquiry curriculum. Therefore, the group differences found on the factors of the *Strategic Demands of Inquiry* questionnaire might be, in part, be explained by the conceptualizations of inquiry education held by the different groups. As part of the mixed-methods design in this study, I used the conceptualizations data (qualitative data) to elaborate upon and help interpret or explain

the quantitative findings. I also tried to understand the findings within the context of the teacher-preparation program as experienced by the student teachers.

Year 1 versus Year 4 Elementary Education. The most salient and reliable difference was between the Year 1 Kindergarten and Elementary Education group and the Year 4 Kindergarten and Elementary Education group on all the Preparation, Enactment, and Reflection factors together. This means that Elementary preservice teachers exit the program holding different values about the strategic demands of inquiry than those Elementary student teachers entering the program. However, in each of the multivariate analyses, the effect for group was weak to moderate, suggesting that some other factor beyond group accounts for much of the difference in factor scores.

The Preparation factors that contributed most to this group difference included Factor 2--Setting the Task in Context. This difference in factor scores matches well with the most frequently held conceptualizations held by the two groups. The Year 4 group emphasized the students' responsibility in learning, which is also a theme of Factor 2. The Year 1 group did not place an emphasis on the students' role in this way. Moreover, fourth-year student teachers reported in their interviews ways in which professors set the stage for them in inquiry-oriented classrooms. For example, in the Teaching Science course,

> It was more the first few steps was he wasn't teaching a concept or a new concept, he got you right into discovery of your own, at your own table within your groups. I remember that clearly because he made the point of stressing, "you don't go up in front of the class and start teaching the concept' or whatever, 'but you have them discover why electricity flows and you get them to think, and then

> after they realize whether or not it worked or not, they know, and then that's when you teach the concept." (EDPI3410108)

Another Preparation factor that discriminated the first-year and fourth-year Elementary Education groups was Factor 5--Taking into Account Students' Interests and Needs, which also fits with the different conceptualizations most frequently held by the two groups. Fourth-year Elementary students frequently focused on the learners' interest and curiosity as key, whereas this element was virtually absent from the first-year groups' most frequent definitions, with the exception of some students who defined inquiry as the student asking questions. Fourth-year student teachers have also had lots of exposure in their program to the notion that learners' interests and needs are central, which helps to explain this group difference. For example,

> In the professional seminars it was more that we talked about that type of learning environment and creating a learning environment that's conducive to children's interest and really captivating their motivation or whatever you want to call it. So it was more of a theoretical, "you need to create this kind of atmosphere by doing these kinds of things," which would I lead to, I guess, sort of inquiry-based learning. Whereas, I think with the Mathematics course with Professor [name deleted], he created that kind of setting and had us learn that way so that we could see the benefits of it in the mathematics lab. (EDPI3410117)

The Enactment factors that contributed most to the difference between these two groups were Factor 9--Defining the Problem Space in Terms of Data Characteristics and Factor 7--Students' Entering Knowledge and Affect. The fourth-year groups' more favorable ratings of these factors reflect their more complex conceptualizations of inquiry

education which place the responsibility of learning on the student. For example, the fourth-year group placed a large emphasis on the learners' role as actively producing knowledge, which is reflected in Factor 7 insofar as it includes the element of the learner constructing new knowledge and applying previous knowledge to new concepts. The Year 4 group also had more practice with these types of activities. For example, they participated in discovery-based labs and centers, and presented inquiry-oriented lesson plans in their Science Teaching and Teaching Mathematics courses. In addition, senior Elementary student teachers reported learning about and learning in constructivist-oriented classrooms during their teacher-preparation program which would expose them to some of these concepts.

Factor 13--Explanation, Reflection, and Evaluation is the factor most responsible for the separation between groups in terms of the Reflection segment of the questionnaire. Year 4s' greater appreciation for this stage in inquiry instruction seems to be a result of holding sophisticated and elaborate conceptualizations of inquiry, which are not as well developed in the Year 1 group. They also reported having experience with these types of activities in the education program in some of their courses.

The higher frequency of richer, expanded definitions of inquiry seen in the Year 4 Elementary Education group suggests that they have thought about the elements involved in inquiry instruction and are knowledgeable about what preparation, enactment, and reflection entail in the inquiry process. This group placed the learner at the center of the inquiry process, which suggests that they have greater command of the process. The Year 4 group understands that the student always has some responsibility for learning how to inquire, which means the student needs to be a good planner and problem solver, and the

teacher needs to be astute to managing the classroom and creating opportunities for knowledge construction in enacting plans for inquiry teaching.

The exposure to the inquiry approach offered through the Bachelor of Education program in Kindergarten and Elementary Education at McGill University supports the fourth-year preservice teachers' more sophisticated understanding of inquiry instruction compared to the first-year student teachers. Interview data indicate that student teachers are exposed to the inquiry approach through modeling in their preparation program. For example, a fourth-year student teacher recalled two professors that

> Actually use it in their own method of education . . . actually modeling it for us, by using it, like since they were applying it to their own teaching methods in their, by teaching it. Like using it to teach the concept itself, as well as the rest of the class. It's just direct modeling, so that was the major one. (EDPI34100306)

In addition, when student teachers take the Teaching Mathematics and Science Teaching courses they become inquirers and learn the course material through different levels of the inquiry method. For example,

> Teaching Mathematics was arranged in that sort of situation, where we had labs and we were presented with, "okay, we're going to learn about this topic. Here's a whole bunch of stuff, play with it, explore it, and see what you can learn about this topic. (EDPI3410117)

Simultaneously, fourth-year student teachers are shown how to use this method in their own classrooms with their own pupils. For example, a fourth-year student teacher reported "we had to do presentations, projects, where we had to use the basis of inquiry as our lesson plan" (EDPI3410116).

These types of exposure to the inquiry approach allow the fourth-year student teachers to appreciate more fully what the inquiry phases of preparation, enactment, and reflection entail. The fourth-year student teachers reported that these types of experiences are not offered until second year of the Kindergarten and Elementary Education program. For example, "when you start second year, third year you get into more of the subject-related areas, like teaching mathematics, teaching science. And that's where they bring out a lot of those concepts" (EDPI3410116). In short, the qualitative data (conceptualizations of the inquiry approach as well as descriptions of inquiry occurrences throughout the preparation program) help explain the quantitative differences found on the factor scores between first-year and fourth-year student teachers. These results point to the crucial role the Bachelor of Education program plays in helping student teachers understand inquiry instruction.

Year 1 Secondary versus Year 1 Elementary Education. The Year 1 Secondary Education group was significantly different from the Year 1 Kindergarten and Elementary Education group on all Preparation and Enactment factors together, but not Reflection factors combined. Where group differences were found, the effect size for group was minimal. In other words, for the most part, Elementary and Secondary preservice teachers enter the teacher-education program with generally different perceptions of the strategic demands of inquiry, however, these differences are not consistent and not consistently large.

The factors that most greatly differentiated the first-year student teachers on the Preparation factors were Factor 3--Co-Construction and Factor 2--Setting the Task in Context. First-year Elementary Education students enter the program with pre-established

beliefs about the importance of the teacher and students co-constructing the curriculum and the inquiry question, which suggests something in their prior experience as pupils as the source of this belief. The difference on Factor 2 could be related to the first-year Secondary student teachers' emphasis on the importance of the role of prior knowledge in the inquiry approach, which is part of setting the current inquiry task in context. In terms of Enactment factors, Factor 10--Social Context of Solving the Problem contributed most to the difference between these groups. This difference could reflect the different expectations that Secondary and Elementary student teachers have for their high-school and elementary-school pupils respectively. For example, elementary-age pupils may not be expected to anticipate and respond to arguments in opposition to one's view or to use vocabulary appropriate to the audience. Factor 7--Students' Entering Knowledge and Affect made the second largest contribution to the difference between Elementary and Secondary first-year students. This could be explained by the Secondary Education group's emphasis on the importance of prior knowledge in learning, and the learner's active role in learning, which are tasks involved in Factor 7.

It is not surprising that the Elementary and Secondary preservice teachers entered their education programs holding different perceptions of inquiry from each other. The teacher-belief literature has suggested that these groups have had dissimilar previous schooling experiences as pupils; however, exploration into this realm is beyond the evidence gathered in this thesis.

Psychology versus Year 4 Elementary Education. The Psychology Honours group was significantly different from the Year 4 Kindergarten and Elementary Education group on the Enactment and Reflection factors, but they were similar in terms of the

Planning factors. Group accounted for a small amount of the variance in these analyses. Therefore, in many ways the Psychology Honours group has a different understanding of the strategic demands of inquiry, but these differences are not pervasive.

The three factors making the most substantial contribution to the separation between these groups included Factor 8--Skills for Collecting and Analyzing Data, Factor 10--Social Context of Solving the Problem, and Factor 13--Explanation, Reflection, and Evaluation. That Psychology students would not fully appreciate the importance of these elements of inquiry instruction is at first puzzling given that they likely engage in the activities summarized by these factors in their own research. It appears as though the Psychology Honours group is not generalizing what they are doing in their own work to an instructional situation. In other words, engaging in inquiry (implicitly) allowed the Psychology Honours students to form sophisticated conceptions about the inquiry approach, in general. However, this experience was insufficient in helping individuals translate this knowledge about inquiry into how to carry out an inquiry curriculum in the classroom. Year 4 Elementary Education students have engaged in some levels of inquiry learning (e.g., discovery learning) in their pedagogical courses, but they have also been more likely to have learned explicitly about the approach and how to teach it. This type of experience with inquiry education appears to be critical to understanding and appreciating the intellectual tasks involved in inquiry instruction.

Continuing Education versus Year 4 Elementary Education. There were no significant differences found between the Continuing Education group and the Year 4 Kindergarten and Elementary Education group on the Preparation, Enactment, or Reflection factors combined. This means that preservice teachers exiting the

Kindergarten and Elementary Education program have a similar understanding of the strategic demands of inquiry as students exiting a semester-long inquiry-oriented course. It is difficult to draw any further conclusions given the heterogeneous nature of the Continuing Education group. It is unknown whether the Continuing Education group's sophisticated conceptualizations of inquiry pedagogy and full appreciation of the tasks involved in carrying out an inquiry curriculum can be attributed to the course itself or self-selection on the part of the individuals enrolled in the course. That is, it is unknown whether individuals already had good understandings of inquiry teaching and learning before they began the course. Cleary, it appears they have as good an understanding as undergraduate students in the fourth year of their teaching-certification program.

Summary. Groups of student teachers who have had different types of exposure to inquiry have different understandings of inquiry instruction. Student teachers entering the Elementary Education program do not appreciate the intellectual tasks involved in carrying out an inquiry curriculum as much as student teachers exiting the Elementary Education program. The group factor only accounts for a moderate amount of the variance, however, which suggests that there are other variables beyond year in the education program that explain this difference. The difference in values between groups seems to be related to the conceptualizations of inquiry education that each group holds. That is, the rich, elaborate, and complex conceptualizations held by the senior students allows them to more fully appreciate the various tasks involved in carrying out an inquiry curriculum compared to the first-year student teachers. The difference between these groups also suggests that something is happening in the Bachelor of Education program to advance Elementary Education students' understanding of inquiry teaching and

learning. An in-depth look at this program, as described by student teachers themselves, supports this claim.

Student teachers entering the Elementary Education program also have different perceptions of the inquiry approach compared to fellow first-year student teachers entering the Secondary Education program. This finding points to the importance of prior experience as pupils in the understanding of inquiry instruction. This group difference, however, is not strong or consistent.

Preservice teachers exiting the Elementary Education program have a similar understanding of the strategic demands of inquiry as students completing a semester-long inquiry-oriented course. It is difficult to draw comparisons between these groups given the heterogeneity of the Continuing Education participants and because it is not known whether the Continuing Education group's sophisticated understanding of inquiry is the result of the inquiry-oriented course or student self-selection.

A comparison group of Psychology Honours students hold sophisticated conceptualizations of inquiry education, not so unlike those held by fourth-year Elementary Education students. This suggests that having engaged in inquiry implicitly (by doing research) can enable individuals to develop complex conceptions of inquiry education espoused by experts in the inquiry education literature. However, this experience is not sufficient to allow these individuals to fully appreciate all that is involved in carrying out an inquiry curriculum. Psychology Honours students were not able to generalize their knowledge of inquiry pedagogy to how to teach using an inquiry approach. This group difference also implicates the Kindergarten and Elementary Education program in advancing the understanding of inquiry instruction.

Chapter 6

Discussion and Conclusions

Most of the research on teacher education which is based on an inquiry model of instruction has focused on intervention strategies--courses that promote inquiry-driven learning--and the impact these have on preservice teachers' understanding of the subject matter or on their views of teaching and learning in general. Virtually none of this research has described the views of inquiry that preservice teachers have acquired through formal schooling and other personal experiences, nor the relationship of their views to their knowledge of how to plan, enact and evaluate inquiry instruction. Specifically, do groups of student teachers who receive different types of exposure to the inquiry approach differ in their understanding of inquiry instruction?

The results of this study offer valuable insights into how students at different phases of preservice training conceptualize inquiry as a pedagogical approach and the significant differences between preservice teachers in different phases of teacher preparation in terms of their perceptions of components of effective inquiry instruction. In addition, the results shed light on whether formal opportunities to engage in research, without training in inquiry instruction, are sufficient to construct knowledge similar to formally trained preservice teachers and experienced teachers in the design, enactment, and evaluation of inquiry instruction in the elementary and secondary grades. This study describes what preservice teachers say they experience as inquiry instruction at different phases of their teacher-certification program through their course work and practice teaching internships. These descriptive results offer a clearer picture of the ways in which teacher preparation programs might have an influence on preservice teachers' views of

what is important to the effective planning, enactment, and evaluation of inquiry instruction.

Indeed, the results of this study show that preservice Secondary and Elementary preservice teachers do significantly differ in their views of what is important to effective inquiry instruction. In addition, undergraduates majoring in Honours Psychology, while having a more in-depth grounding in how to do scholarly research, do not use this knowledge as extensively as fourth-year preservice teachers to identify important aspects of inquiry instruction. Further, experienced teachers are not significantly different from fourth-year preservice teachers in identifying important dimensions of effective inquiry instruction after the completion of a semester-long course on how to plan and enact inquiry instruction. Finally, first-year preservice teachers when compared directly to fourth-year students are significantly less knowledgeable. Thus while knowledge of the nature of inquiry as a process may be necessary for excellence in implementing inquiry instruction, it is not sufficient to enable undergraduates who do not specialize in education to identify important aspects of planning, enacting, and evaluating inquiry instruction which corresponds to the views of experts who have developed the knowledge base for inquiry instruction. Although these results are correlational rather than causal, the quantitative and qualitative data triangulate, thus strengthening these knowledge claims.

Validity and Reliability of the Strategic Demands of Inquiry Measure

Due to a lack of existing instruments, considerable effort was given in the first phase of this mixed-model study to establish the reliability and validity of a measure of importance assigned to aspects of planning, enactment, and evaluation of inquiry

instruction. In the present study, I establish the grounds for claiming validity and reliability for the *Strategic Demands of Inquiry* questionnaire developed by Shore and our research lab (Boisvert & Roumain, 2000) in terms of its three segments and the questionnaire as a whole. In this regard, my specific research questions were (a) What is the internal structure of the *Strategic Demands of Inquiry* questionnaire?, and (b) Are all the items on the questionnaire measuring the same overarching construct called inquiry instruction. Finally, the results of this investigation also provided evidence of test validity in terms of group differences.

Evidence based on internal structure. An examination into the internal structure of the three segments (i.e., Preparation, Enactment, and Reflection) of the *Strategic Demands of Inquiry* questionnaire revealed a total of 14 factors underlying the 79-item questionnaire. Six factors accounted for the Preparation segment of the instrument, six factors underlined the Enactment segment, and two factors accounted for the Reflection segment. These factors, which were explained in Table 17 (page 147), were congruent with the research-process skills and strategies included in definitions of inquiry instruction in the literature (e.g., Martinello, 1998; NRC, 1996). The underlying dimensions corresponded well to what the instrument was intended to measure, namely understanding of inquiry instruction.

Qualitative analysis of the respondents' conceptualizations of the pedagogical approach known as inquiry showed that the definitional categories with the highest number of participants involved elements of students learning actively by asking questions of interest to them, and finding answers through research and problem solving. The most commonly held conceptualizations of inquiry instruction were similar to the

rating-scale items on the questionnaire with the highest rankings, such as asking questions, self-motivation, knowledge construction, and a supportive environment. Hence the qualitative results triangulated with the quantitative results, thereby strengthening the claim for construct validity.

Interestingly, the three phases of inquiry instruction as reflected in the *Strategic Demands of Inquiry* questionnaire (i.e., Preparation, Enactment, and Reflection) are mirrored in current models of Self-Regulated Learning (SRL). Puustinen and Pulkkinen (2001) evaluated contemporary models of SRL concerned with "describing the ways in which individuals regulate their own cognitive processes within an educational setting" (p. 269). Common to each of the five models compared in this review, was the assumption that SRL is a cyclical process that proceeds from a preparatory phase, through the actual task performance phase, to an appraisal phase. These phases map onto the design of the *Strategic Demands of Inquiry* questionnaire that includes preparation, enactment, and reflection segments. Generally, the preparatory phase in the SRL models consists of activities such as task analysis, planning, and goal-setting, and is based on beliefs and metacognitive knowledge about the self, the task, and the environment (Puustinen & Pulkkinen, 2001). These ideas are also present in the factors underlying the Preparation segment of the questionnaire including time and task organization, setting the task in context, planning to solve the problem, and linking ideas including a view of the future. Puustinen and Pulkkinen reported that the performance phase in the SRL models includes strategy use and self-regulatory and monitoring activities (e.g., comprehension monitoring and resource allocation). The *Strategic Demands of Inquiry* Enactment factors are also concerned with skills and strategies (e.g., collecting data) as well as self-

monitoring (e.g., applying previous knowledge to new concepts, being aware of how preconceptions affect learning). The appraisal phase in the SRL models comprises evaluation of outcomes. This component is reflected in one of the Reflection factors. It is understandable that similarities exist between the phases and components of SRL and inquiry instruction given that inquiry learning requires students to be active, self-motivated, and the constructors of their own knowledge. The inquiry learning process promotes self-regulated learning.

Evidence based on internal consistency. The high internal-consistency estimates for the *Strategic Demands of Inquiry* instrument as a whole, and for the Preparation, Enactment, and Reflection segments individually, indicate that this is a highly homogeneous measure with all its items measuring a single over-arching construct, namely understanding of inquiry instruction. This means that individuals consistently responded in the same way to similar items on the questionnaire, which suggests that the *Strategic Demands of Inquiry* questionnaire has strong reliability, which is a necessary condition for validity.

Evidence based on group differences. The group differences found on the factor scores and in the responses to the open-ended question, especially between first-year and fourth-year Elementary preservice teachers, were in the direction we would expect. This suggests that the *Strategic Demands of Inquiry* questionnaire behaves as would be expected of a valid measure of understanding of inquiry instruction. Moreover, the conceptualization results triangulated with the quantitative results, which strengthens this claim.

Importance of findings. Given the intentional and criterion-referenced design of the *Strategic Demands of Inquiry* questionnaire to measure the different elements that make up inquiry instruction, it is not surprising, but very satisfying, to discover that the underlying factor structure corresponds to the strategies and processes outlined in the inquiry literature, and that the instrument, which is intended to be used as a whole, consistently measures a unifying construct. These findings suggest that one can have confidence that *Strategic Demands of Inquiry* questionnaire is a valid measure of understanding inquiry instruction. This is an important outcome because we now have an instrument that includes an open-ended question as well as a rating scale that yields factor scores, which researchers can use to measure understanding of inquiry instruction that has evidence supporting its construct validity.

Student Teachers' Understanding of Inquiry Instruction

The second aim, and the major focus, of this study was to explore if student teachers who differ in the types of inquiry experiences they have been exposed to also differ in the conceptualizations they hold of inquiry instruction and the value they place on various intellectual elements involved in carrying out an inquiry-oriented curriculum. I used a mixed-methods design to explore this question, whereby the primary emphasis was on the quantitative approach, and the qualitative approach was used to complement (i.e., help interpret) the quantitative findings.

First-year and fourth-year Elementary preservice teachers. The most striking and consistent group difference in ratings of the importance of inquiry instruction is between the first-year and fourth-year preservice teachers in the Kindergarten and Elementary Education program. Quantitative data analyses show that fourth-year Elementary

preservice teachers have a much greater appreciation for the intellectual tasks that the learner and teacher must do in the preparation, enactment, and reflection phases of an inquiry curriculum. The two groups differ most on factors that emphasize the learners' active role and responsibility in knowledge construction, meeting the learners' interest and needs, and the opportunity to reflect on the inquiry process. These findings suggest that fourth-year preservice teachers are more likely to put the learner at the center of the inquiry process than are first-year preservice teachers.

The fourth-year Elementary Education group also holds more sophisticated, complex, and rich conceptualizations of the inquiry approach compared to the first-year Elementary Education group who holds more naïve conceptualizations. Moreover, fourth-year student teachers frequently emphasize the learner's role in actively constructing knowledge by asking questions and doing research on topics in which they are interested, which is consistent with the content of the specific factors that contribute most to the overall group differences. Having more sophisticated conceptualizations of the inquiry approach seems to allow the fourth-year student teachers to more fully appreciate what preparation, enactment, and reflection entails in inquiry instruction. The emphasis the fourth-year group frequently places on the learners' responsibility for knowledge construction and on curiosity-driven learning in their conceptualizations helps explain the differences on specific factor scores between the groups.

McGill University's Bachelor of Education program in Kindergarten and Elementary Education is not an inquiry-oriented program; however, there are some professors who present it as an approach to teaching and some who use it as their own teaching method. Student teachers appear to acquire the most exposure to inquiry-driven

teaching and learning in their mathematics and science courses, and perhaps also their social-sciences course, all of which are pedagogy courses taken after first year. It is not unexpected that this is where students report getting the most exposure to the inquiry approach, as this has been found in other studies specifically examining program influences on teacher thinking (e.g., Lazarowitz et al., 1978; Reinke & Mosely, 2002; Smagorinsky et al., 2003). Student teachers report learning about inquiry instruction in these courses predominantly by engaging in inquiry learning and through activities such as discussion and group work, which allow them to see how inquiry can be used as an instructional approach in their classrooms. These types of experiences with the inquiry approach help to explain how the students exiting the program are able to have such a rich and sophisticated understanding of inquiry instruction compared to first-year students.

It makes sense that student teachers who are exiting a teacher-preparation program have a better understanding of inquiry instruction than student teachers who are entering the program, given that they have more experience. Before now, however, we did not know whether this was the case. Previous research has shown that student teachers leaving elementary education programs that are typically two-years in length (as opposed to four years in the present study) exit holding different attitudes towards research and integration than students entering the program (Gitlin et al., 1999; Reinke & Mosely, 2002) and we know that in-service teachers hold more positive views about the inquiry process and inquiry teaching than secondary pre-service teachers (Damnjanovic, 1999), but the research stopped short of investigating preservice teachers' understanding of inquiry instruction. Moreover, the research on learning how to teach suggests that

preservice teachers' beliefs are quite stable and resistant to change (e.g., Block & Hazelip, 1995; Bullough, 1997a, 1997b; Clark, 1988; Kagan, 1992a, 1992b; Kane, 1992; Richardson, 1996).

Although I did not examine change in the same individuals' perceptions across the four years, I did find salient and stable differences between first-year and fourth-year preservice teachers. This discovery is important because it suggests that experience in the teacher-preparation program advances knowledge of inquiry instruction, which is essential given that recent curriculum reform encourages inquiry-driven teaching and learning.

Given that the experiences the preservice teachers have had with the inquiry approach in their teacher-preparation program seem to play a role in advancing their understanding of inquiry instruction, it is puzzling why all of the senior preservice teachers do not hold the most sophisticated and complex conceptualizations of inquiry engagement. Nine percent of fourth-year student teachers defined the inquiry approach in a somewhat vague, almost meaningless way (e.g., problem-solving, research, being curious, or learning), without much elaboration. One reason why this variability might exist has to do with the overall preservice teacher-training program. Even though all student teachers are required to take the pedagogy courses where they are exposed to the inquiry approach, the program is not an inquiry-oriented program. As the qualitative analysis of the interview data shows, student teachers are exposed to the inquiry approach in some courses and with some professors. This type of exposure ranges from reading about the concept to being an inquirer. Moreover, ideas about social constructivism and teacher reflection may be incorporated in the methodology, pedagogy, and professional-

seminar courses (C. Riches, personal communication, April 19, 2005). Still, an inquiry-stance does not seem to be a sustained and consistent focus throughout the program. Perhaps the absence of a pervasive focus and teaching philosophy throughout the entire program makes it difficult for all student teachers to develop sophisticated understandings of the inquiry approach (e.g., Smagorinsky et al., 2003). A second reason why some senior student teachers do not hold sophisticated conceptualizations of inquiry instruction likely arises from their epistemological beliefs. The learning-to-teach and teacher-belief literature suggests that student teachers enter their preparation programs with pre-existing epistemological beliefs that filter what they learn in the program and that are resistant to change (e.g., Kane et al., 2002). It could be that this small percentage of preservice teachers that are graduating from the program also entered it holding beliefs about teaching and learning that are not congruent with the social-constructivist view, generally, and the inquiry approach, specifically, that are presented in the program. This subset of students may have had more difficulty developing complex conceptualizations of the inquiry approach.

Another question that arose from the data has to do with the moderate effect size (Kiess, 1996) for the group factor in the quantitative analyses. The effect sizes for the Preparation, Enactment, and Reflection analyses were 0.11, 0.17, and 0.07, respectively. This finding begs the question, what other factors, beyond group, might contribute to the difference between first-year and fourth-year student teachers? The literature on learning to teach and on teacher beliefs suggests that beliefs serve as filters that affect how and what student teachers learn (Nespor, 1987; Richardson, 1996). This suggests in turn that the particular conceptualization a student teacher holds about the inquiry approach to

instruction is likely to influence the value that they place on the specific intellectual tasks involved in carrying out an inquiry curriculum. In other words, group differences on the rating scale might also be explained, in part, by the conceptualizations preservice teachers hold. Indeed this appears to be the case.

The difference in degree of sophistication of conceptualizations held by the Elementary and Secondary preservice teacher groups is mirrored in the rankings of importance they give to the various tasks involved in the rating scale. That is, several fourth-year student teachers emphasized the student's active role in inquiry instruction in their conceptualizations. For example,

> Motivation and curiosity causes one to generate certain questions. Once these questions are posed, one must generate a hypothesis (a possible solution to problem, or answer to initial question). In order to support their hypotheses, the individual must then go on to gathering information in a real-life situation context. Testing their information will then lead them to a certain conclusion. This conclusion or solution can then be discussed with peers and adapted. (EDPI3410105)

The meanings in this type of sophisticated definition are reflected in the high rankings fourth-year student teachers gave to factors such as, Factor 9--Defining the Problem Space in Terms of Data Characteristics, which emphasizes the students' active role in the inquiry learning process. In contrast, the first-year student teachers' definitions were less elaborate. For example, "inquiry is basically asking questions to gain knowledge/information" (EDPE3000320). Having a less complete conceptualization of

the inquiry approach does not seem to allow the first-year student teachers to fully appreciate all that is entailed in carrying out an inquiry curriculum.

Another factor that might contribute to the difference between first-year and fourth-year groups has to do with experience. According to the research on teacher beliefs and on learning how to teach, understanding of inquiry instruction develops through different categories of experience, including personal experiences, research experiences, school-based experiences, and university-based experiences (Pajares, 1992; Richardson, 1996). Not all of these types of experiences were explored in the present study; nonetheless a key type of experience that likely accounts for some of the variance between the two groups has to do with the teacher-preparation program. Fourth-year student teachers report being exposed to the inquiry approach in ways that the first-year students have not yet experienced in the program. For example, one fourth-year student teacher reported, "I've definitely done inquiry in one of the science courses, it was based mainly on that, we were constantly discovering and then him not telling the information" (EDPI3410108). The fourth-year preservice teachers perceived being exposed to the inquiry approach in two ways. In the first way, student teachers were exposed to professors who teach subjects that emphasize forms of inquiry in the learning of the subject matter (e.g., science). In the second way, student teachers were exposed to professors who likely hold social-constructivist theories of learning, and in turn set up conditions for inquiry-oriented learning in the courses they teach (e.g. social sciences or professional seminars). The teacher-preparation program offers student teachers multiple lenses for experiencing inquiry as instruction.

Psychology Honours students and fourth-year Elementary preservice teachers. The second important difference among groups is between senior Psychology students completing their Honours research and fourth-year Elementary student teachers. Senior Elementary preservice teachers have a much greater appreciation than senior Psychology students for the strategic demands required of students and teachers in the enactment and reflection phases of inquiry-oriented instruction. Their perceptions of what is involved at the preparation phase are similar. The factors that contribute most to the differences between these groups represent skills and strategies that we would expect the Psychology students to have experienced as part of their research (e.g., collecting data, analyzing data, and explaining the results), thus it is surprising that the Psychology students do not appreciate more the importance of these tasks as part of the inquiry instructional process. On the other hand, they may not hold a meta knowledge of the strategies they actually use to engage in inquiry learning.

Equally unanticipated was the finding that the Psychology Honours students, who have no formal training in pedagogy, hold just as sophisticated conceptualizations of the inquiry approach as the senior preservice teachers. This discovery is important because it suggests that engaging in the inquiry research process allows individuals to form sophisticated conceptualizations about the inquiry approach; however, this experience is inadequate in helping individuals generalize this knowledge about implementing an inquiry curriculum in the classroom. These findings point to the essential role the teacher-preparation program plays in advancing knowledge about inquiry instruction.

The findings also shed some light on what other factors might be contributing to the group difference found on the rating scale. Group had a weak effect (Kiess, 1996),

suggesting that other factors are contributing to the difference. It seems reasonable to expect experience (e.g., with research, with instruction, and general program experiences) contributes to this difference. As described in the previous section, we might also expect other types of experience, such as personal history and previous school-based experience to play a role. In other words, group differences can also be explained by the varied background experiences in which beliefs are rooted. The different experiences of these two groups might also be thought of as reflecting different domain expertise. The Psychology Honours students learned about the inquiry approach in a different domain (i.e., within the context of their psychological research) than the Elementary preservice teachers who learned about inquiry within the educational and pedagogical domain. This raises the question of whether understanding of inquiry instruction is domain specific.

The differences between the Psychology Honours students and the student teachers is an interesting discovery because previous research has shown that experience with authentic inquiry research contributes to understanding of inquiry (e.g., Crawford, 1999; Gitlin et al., 1999; Windschitl, 2000, 2002, 2003). Thus it might not have been surprising if the Psychology Honours students who engaged in inquiry research had similar perceptions about inquiry instruction as the fourth-year Elementary student teachers.

The finding that the fourth-year preservice teachers have a better understanding of inquiry instruction is important because it points to the critical role that the teacher-preparation program in a research-oriented university plays in developing preservice teachers' understanding of inquiry instruction. In other words, this group difference suggests that there is something unique happening in the Bachelor of Education program

that is not happening in other Bachelor programs. Moreover, experience with research is not sufficient to allow undergraduates of the same age, but in a different discipline where research activity and interpretation of published research is emphasized, to fully appreciate the intellectual tasks involved in the inquiry instructional process.

First-year Elementary and Secondary preservice teachers. A third group difference is between student teachers entering the Elementary versus the Secondary preparation programs. Student teachers entering the Elementary Education program have different perceptions than student teachers entering the Secondary Education program of what is entailed in the enactment phase of inquiry instruction. They likely also differ in how they perceive the elements involved in the preparation phase. However these differences failed to reach significance in this study likely due to insufficient power. The two groups are similar in how they perceive the elements involved in the reflection phase of inquiry instruction.

Previous research suggests that there are inherent differences between Elementary and Secondary preservice teachers when they enter their teacher-preparation programs (e.g., Book & Freeman, 1986; Reinke & Mosely, 2002). This finding of course implicates the role of prior school-based experiences in the development of conceptualizations of inquiry instruction. The results of this study show that first-year Elementary and Secondary preservice teachers hold mostly naïve conceptualizations of inquiry instruction. There were small differences between the first-year Elementary and Secondary groups in terms of the conceptualizations they held. The differences between these groups were not striking or consistently large, and need to be explored further in future research.

Continuing Education students and fourth-year Elementary preservice teachers. Elementary preservice teachers exiting the Bachelor of Education program have a similar understanding of all that is entailed in carrying out an inquiry curriculum at all three phases compared to a group who completed a semester-long inquiry-oriented course on gifted education. Moreover, both groups hold rich, elaborate, complex definitions of the inquiry approach. The group who was exposed intensively (explicitly and implicitly) to the inquiry approach was heterogeneous in its makeup. For example, just more than half of the participants were licensed teachers, and just less than one half of the participants came from various undergraduate programs. This diversity makes it difficult to draw conclusions about the similarities between the two groups. That said, the findings tell us that after being in a four-year teacher-preparation program, individuals have similar perceptions about inquiry instruction as individuals who have had an intensive exposure to the inquiry approach. This is important because it suggests that the two different types of exposure to inquiry (i.e., general teacher-preparation program and intensive inquiry-oriented course) might play a role in developing similar understandings of inquiry instruction.

Conclusions. The quantitative results clearly showed differences between some of the groups in knowledge of inquiry instruction and the qualitative data, including the analysis of student teachers' conceptualizations and of the teacher-preparation program, enabled the triangulation and validation of these quantitative results. The combined qualitative and quantitative results do not conflict with each other and often agree in their support of a particular claim. Moreover, the qualitative data allowed richer and more detailed interpretations of the quantitative results. For example, analysis of student

teachers' conceptualizations of inquiry helped to explain their replies on the rating scale and helped to address the issue concerning different factors that might account for group differences on the rating scale. The examination of the teacher-preparation program as experienced by student teachers themselves provided rich data in the form of the student teachers' own voices. These voices enabled me to contextualize the findings within the larger learning-to-teach environment. In addition, results from the questionnaire and conceptualizations data implicated the teacher-preparation program in advancing understanding of inquiry instruction. By carrying out an examination of the program as described in documents and combining the patterns found with the themes arising from analysis of the interviews, I was able to explore this possibility in more depth. In short, the use of quantitative and qualitative data in this mixed-methods design allowed me to fully pursue my major and secondary research questions.

The complete picture is that student teachers enter their preparation program at McGill University holding somewhat naïve or incomplete conceptualizations of the inquiry approach. For the most part, they understand that the inquiry instructional process entails learners asking questions, gathering information, and doing research. There are some differences between those students entering the Kindergarten and Elementary Education program and those entering the Secondary Education program, but these differences are blurry in the present picture.

If we put a microscope on the two Elementary Education groups, we see how remarkably different the first-year student teachers are when they enter the program from those student teachers exiting the program in year four. The fourth-year student teachers seem to have replaced or built upon the naïve conceptualizations of the inquiry approach

with rich, elaborate, complex conceptualizations of inquiry teaching and learning. This sophisticated understanding allows them to more fully appreciate the intellectual tasks entailed in the preparation, enactment, and reflection phases of carrying out an inquiry curriculum. The fourth-year student teachers place the learner at the center of the inquiry process and understand the importance of the learner's interests and needs as well as the learner's responsibility for constructing knowledge as part of inquiry instruction.

In the broader educational environment in which the Elementary preservice teachers are learning to teach, we see that they are exposed to the inquiry approach in some of their courses and with some of their professors. They start to hear or read about it in their first year Educational Psychology course but it begins in second year that they actually engage in inquiry learning in their Teaching Mathematics and Science Teaching courses. They will also be exposed to inquiry instruction further in the Teaching Social Sciences course, but in a less extreme way. In these methods courses, student teachers become inquirers themselves and practice being inquiry teachers for their peers. In third and fourth year, student teachers also see how inquiry instruction can be used in their classrooms as they discuss this in their professional seminars that accompany their field placements. By the time they are about to exit the preparation program, student teachers at McGill University have had opportunities to engage in inquiry learning and teaching that appear to promote a sophisticated understanding of the approach

This exposure to the inquiry approach seems to be quite crucial. Let us look at another group at McGill University who are Psychology Honours students working on their Honour's thesis. Compared to the senior Elementary Education students, the senior Psychology students hold similarly sophisticated conceptualizations of inquiry. However,

they do not fully appreciate the importance of what is entailed in the inquiry instructional process. It appears as though experience with doing research and engaging in the inquiry process has enabled them to hold complex conceptualizations of inquiry instruction. Nonetheless, this type of exposure is insufficient to help them translate this knowledge about inquiry into how to carry out an inquiry curriculum in the classroom. The senior Education students, on the other hand, engaged in inquiry learning (e.g., in their methods courses), learned explicitly about the approach and how to teach it in their pedagogical courses. This type of experience with inquiry appears to be critical to understanding and appreciating the intellectual tasks involved in inquiry-based teaching and learning.

If we look at another part of the broad picture of the community of educators making up this study, one can see a group of Continuing Education students who have taken a semester-long course in which they are engaged explicitly and implicitly in the inquiry approach. They have received an intensive 13-week exposure to inquiry instruction. Compared to senior Elementary Education students, Continuing Education students hold similarly complex conceptualizations of the inquiry approach and they also perceive the importance of the various elements involved at each of the phases of the inquiry instructional process in a similar way. It appears as though both types of exposure to the inquiry approach (the general education program and an intensive dose of self-selected instruction) could be related to similar, sophisticated understandings of inquiry instruction.

This rich and detailed overall picture suggests that groups of student teachers who receive different types of exposure to the inquiry approach have different understandings of inquiry instruction. The picture suggests how important the teacher-preparation

program is in helping student teachers develop sophisticated conceptualizations of the inquiry approach to instruction and fully appreciate the importance of the different tasks that learners and teachers must perform as part of the inquiry instructional process. While research experience is important, student teachers also need the experiences provided to them in their pedagogy courses, to learn about the inquiry approach implicitly and explicitly, to most fully understand all that is entailed in carrying out an inquiry-oriented curriculum.

Original Contributions to Knowledge

One original contribution the present study has made to knowledge is to provide validation data for Shore's *Strategic Demands of Inquiry* questionnaire (Boisvert & Roumain, 2000). Before now researchers have been evaluating perceptions and conceptualizations of inquiry engagement using Likert scales, journal reflections, metaphors, essays, surveys, interviews, and other qualitative techniques. Some have combined quantitative and qualitative methods. The problem with these methods is that many of them involve a high degree of inference on the researchers' part. Moreover, the diversity in assessment techniques makes comparisons between studies difficult. The *Strategic Demands of Inquiry* questionnaire includes an open-ended question that taps into respondents' conceptualizations of the nature of inquiry as a process and is analyzed qualitatively. The questionnaire includes a 79-item Likert-type rating scale that assesses the value respondents place on the intellectual tasks identified in the expert literature on inquiry instruction to be involved in planning, enacting, and evaluating an inquiry-oriented curriculum. This segment of the questionnaire was analyzed quantitatively using factor scores.

In the present study, I demonstrated the underlying factor structure and the high internal consistency of the *Strategic Demands of Inquiry* questionnaire, thus providing evidence of internal validity for the comparison of preservice teacher-training groups and construct measurement validity. Moreover, I further validated the questionnaire by showing group differences in terms of the factor scores and categories of definitions between groups of preservice teachers who differed in their type of exposure to the inquiry approach. As an outcome, researchers now have available to them a reliable and valid instrument for measuring understanding of inquiry engagement qualitatively and quantitatively.

The second and most important original contribution to knowledge of the present study is the provision of rich, detailed information about student teachers' understanding of inquiry as a process and its relation to what they view as important aspects of inquiry instruction. Previous research has described student teachers' perceptions of inquiry as a community, misconceptions about the inquiry approach, theories about the nature of the scientific inquiry process, beliefs about who can participate in an inquiry curriculum, and ability to distinguish inquiry from other methods of instruction (e.g., Aulls 2005a; Aulls & Peetush, 2005; Farr Darling, 2001, Reiff, 2002; Windschitl, 2000, 2002, 2003). The present study has added to this knowledge base by demonstrating first-year and fourth-year preservice teachers' understanding of the strategic demands involved in the preparation, enactment, and reflection phases of an inquiry-oriented curriculum.

This is also the first time that preservice teachers' understanding of inquiry instruction has been examined within the context of a complete Bachelor of Education program across four years. Previous research has focused on the change in student

teachers' beliefs or attitudes about inquiry-related topics over the span of a semester or course (e.g., Atwood & Rogers, 1974; Lazarowitz et al., 1978; Windschitl, 200, 2002, 2003) or programs which were between one and two years in length (e.g., Gitlin et al., 1999; Reiff, 2002; Reinke & Mosely, 2002). The present study was cross-sectional in design and demonstrated that fourth-year Elementary Education student teachers have a better understanding of inquiry instruction than first-year Elementary Education student teachers who have just entered the program. A comparison group of Psychology Honours students who were engaged in inquiry research, but who were not learning about the inquiry process as a curriculum to be enacted, and a group of Continuing Education students (including in-service teachers) who were engaged in inquiry instruction provided evidence strengthening these findings. Moreover, using a qualitative approach, this study contextualized the findings by describing the teacher-preparation program as perceived by preservice teachers. This knowledge about preservice teachers' understanding of inquiry as an instructional process is especially important in light of the recommendations put forth by the Quebec Ministry of Education, Leisure, and Sports (MELS) which mandate inquiry-driven learning and teaching.

The third contribution the present study has made to knowledge is to expand on the way preservice teachers' thinking is examined. Previous research has used qualitative or quantitative methods; however, this is the first study to use a mixed-model research design (Creswell, 2003) in the investigation of preservice teachers' understanding of inquiry instruction. I used an instrument which I found to possess factorial validity and high internal consistency. This study showed the importance of using qualitative methods in contextualizing, enhancing, and elaborating upon the quantitative data. In short, the

results of this study show how a mixed-methods design addresses the assertion of researchers (e.g., Kagan, 1990; Pajares, 1992; Richardson and Anders, 1994; Wideen et al., 1998) that multiple methods must be used in assessing preservice teacher's knowledge and beliefs.

Limitations of the Present Study

Sample size and power. In the planning of the present study, power analysis indicated that groups of 50 would be necessary to adequately detect moderate effect sizes and groups of 20 would be necessary to adequately detect large effect sizes in the examination of group differences (Runyon, Coleman, & Pittenger, 2000). I defined "adequately" as power being above .90 (Cohen, 1988, p. 224-226). Due to problems gaining access to participants, as described in Chapter 2 and Appendix C, I was unable to achieve these sample sizes. Consequently, a posthoc power analysis indicated that I had low power. This suggests that group differences might exist that I was unable to pick up. The most evident from the data analysis is the first-year preservice groups. The differences I found between these groups were not consistent, even though I had 43 Secondary student teachers and 69 Elementary student teachers. This may also have been the reason for a nonsignificant group difference between Psychology students and fourth-year students on the individual Preparation factors. It does not look like this was the case for the similarities found between senior preservice teachers and the Continuing Education group. Visually, the pattern of factor scores for these two groups were remarkably similar, especially compared to the pattern for other groups. Moreover, the nature of their definitions was equivalent. Given these two similarities, it is unlikely I

failed to pick up quantitative differences between the two groups, despite one of the groups being relatively small in size.

As described in Appendix C, the original aim of the study was to compare groups of student teachers across different years of the Elementary and Secondary Education programs. Due to the insufficient sample sizes in the majority of these years, I was limited to comparing first-year and fourth-year Elementary preservice teachers and comparing first-year Elementary and Secondary preservice teachers. An important group missing in the present study is the fourth-year Secondary student teachers. Data from this group would have provided information about the Secondary Education program at a Canadian research-oriented university. As is the present case, I can only make claims about the Elementary Education program. This gap is important because the Secondary Education program is different from the Elementary Education program insofar as the courses the students in each program take (i.e., the Secondary preservice teachers take more courses in their subject specialization and the Elementary preservice teachers take more pedagogical courses).

Other groups missing in the present study include second- and third-year students in the two programs. Data from these groups would have provided more in-depth information about what exactly is happening in the methods classes at this time. For example, it would be interesting to see the pattern of factor scores across the different years in each program to observe the potential magnitude of existing differences at various points in time.

Sampling design. The present study is cross-sectional in nature which allows me to talk about group differences but makes it difficult to draw conclusions about changes

over time. The group difference found between first-year and fourth-year student teachers is based on a difference in type of exposure to the inquiry approach. The triangulation of multiple types of data (quantitative and qualitative) in the present study strongly indicates a difference in understanding of inquiry instruction between first-year and fourth-year student teachers. A longitudinal design would have allowed me to say with more confidence that student teachers' understanding of inquiry changes over the duration of their teacher-preparation program. A longitudinal study was not possible given that the present study is a doctoral thesis and not a career research program. In order to collect longitudinal data I would have needed to follow first-year students for the duration of their four-year program. Given the time constraints inherent in doing a doctoral dissertation, data collection for this length of time was not feasible.

Within-group heterogeneity. Given the heterogeneity of individuals in the Continuing Education group in terms of background, specialty, and teacher status, drawing conclusions about the differences between this group and the fourth-year elementary education group was constrained. An ideal comparison group would have been a distinct group of senior preservice teachers who had been exposed to an intensive inquiry-oriented course, but who had not been exposed to inquiry elsewhere. This type of group was not available to me. In addition, I examined the Continuing Education groups' factor scores and definitions of inquiry at the end of the course. A comparison between their scores and definitions at the beginning of the course and the end of the course would have given me more information about the impact of the course on this groups' understanding of inquiry. I chose not to do this repeated-measure analysis as part of the

present study because examination of the impact of an inquiry-oriented course was not central to my original research questions.

Relationship between program experiences and understanding of inquiry. As part of the mixed-methods design of this study, I used the qualitative data to complement the quantitative data. This was not a study that included distinct quantitative and qualitative subsets. Given this design, I provided a description of the Bachelor of Education program based on student teachers' voices in order to contextualize the results. I stopped short of doing a complete and systematic qualitative analysis of that interview data and integrating it wholly with the quantitative findings. This additional analysis could have provided richer and stronger data about specific program experiences that are related to or influence specific parts of preservice teachers' knowledge of inquiry instruction.

Practical Implications

For inquiry curriculum to gain a solid foot hold in education, we need to prepare teachers to be inquirers and how to teach inquiry in their classrooms. The first step in this direction is to know the extent of preservice teachers' understanding of inquiry instruction. We also need to know what type of educational experiences can effectively develop inquiry-oriented teachers (Martinello, 1998). The experiences reported by student teachers about how they learned about the inquiry approach to instruction are consistent with a social-constructivist view of learning, which views knowledge as socially constructed. For example, class discussion and group work promote processes that involve language and social discourse between peers and a professor, which are important in acquiring knowledge (Driver et al., 1994). Further, "learning by doing" and engaging in inquiry learning provide the preservice teacher with authentic, meaningful

experiences, which are important to internalizing meaning (Driver et al., 1994). Theorizing from this perspective, program experiences that might be helpful in promoting greater understanding of inquiry as an instructional process include engaging in inquiry learning and having opportunities to become inquirers, as well as having opportunities (e.g., discussion, modeling, inquiry teaching) to see how inquiry can be an effective instructional method in the classroom.

The data in the present study also offer ideas about what content needs to be included in the preparation program. The data suggest that the majority of student teachers enter the Kindergarten and Elementary Education program with pre-established beliefs about inquiry involving asking questions, gathering information, and critical thinking or reflection. Moreover, in terms of preparing for an inquiry curriculum, they enter understanding the importance of the learner linking ideas and foreseeing possible outcomes of an inquiry activity, as well as the importance of the learner and teacher co-constructing the curriculum. In terms of the enactment of an inquiry curriculum, first-year student teachers come with the knowledge that it is important for the learner to search for resources beyond textbooks, such as the Internet. With regard to the reflection phase of carrying out an inquiry curriculum, first-year Elementary preservice teachers enter with a pre-existing appreciation for the value of the learner questioning the findings and following up a project with a new set of questions. These findings suggest that these concepts do not need to be the focus of curriculum content in the teacher-preparation program since most students already have internalized them.

The types of knowledge that entering Elementary student teachers seem to be lacking most, and thus should be the focus of curriculum content include: (a) the

knowledge that inquiry-driven instruction is learner-centered and curiosity-driven; and (b) the knowledge that the learner is responsible for the knowledge-construction process. In addition, attention should be paid to showing student teachers the value of teachers setting the task in context for learners during the preparation phase of an inquiry-oriented curriculum (e.g., the teacher's role to encourage honest criticism of ideas and creative risk taking, and the learner's role to problem solve, connect old and new knowledge, and to extend inquiry beyond the classroom). Student teachers' questionnaire responses show they need opportunities to see how important it is during the enactment phase of inquiry instruction for the learner to develop problems and solve them using data, and for the learner to construct one's own knowledge. Student teachers would also benefit from opportunities to learn about the value of the learner reflecting on the inquiry process. Preservice teachers may also need to redefine the purpose of asking learners questions and to be taught how to pose questions to learners that do not test for mastery of teacher-directed content. Fourth-year student teachers in this study report having had opportunities in their preparation program to be exposed to these ideas, especially in their pedagogy courses for teaching mathematics and science.

The data also point to preconceptions with which student teachers enter the Elementary Education program that might interfere with their receptiveness to inquiry-driven teaching and learning. Approximately six percent of student teachers entering the preparation program come with pre-conceptualizations about inquiry involving primarily the teacher giving learners information. This suggests that these student teachers perceive the teacher's role as transmitting knowledge, and perhaps, in turn, the learner's role as

passively receiving knowledge. Views of inquiry instruction as a teacher-directed approach need to be publicly questioned and revised.

These implications are consistent with the ideas espoused in the Boyer Report (1998), which aims to promote inquiry-driven instruction for undergraduates enrolled in research-oriented universities. As part of this policy learners are expected to be given opportunities to engage in inquiry learning rather than rely upon teacher-directed methods.

Theoretical Implications

The learning-to-teach and teacher-belief literature is split in terms of the effectiveness of teacher-preparation programs to influence perceptions. The data in the present study suggest that the teacher-preparation program plays a vital role in advancing preservice teachers' understanding of inquiry instruction. It appears likely that student teachers do internalize meanings of inquiry instruction when they are given opportunities to engage in inquiry-driven teaching and learning and to see how this approach can be used in their classrooms through activities such as discussion and group work. They are provided with these opportunities in their pedagogy courses. Fourth-year preservice teachers have a better understanding and fuller appreciation of the elements involved in carrying out an inquiry curriculum compared to first-year preservice teachers, who have not yet experienced these opportunities, and compared to Psychology Honours students, who have engaged in inquiry research but who have not had the education courses unique to the teacher-preparation program.

Inquiry instruction is a complex process. As such, it would behoove university professors and researchers to develop frameworks to guide how to think about and

investigate this construct. The data in the present study suggest that inquiry instruction can be thought of as comprising three phases, including preparation, enactment, and reflection. I have demonstrated in this study that underlying the preparation and enactment phases are six dimensions each, and underlying the reflection phase are two dimensions. Moreover, these dimensions are effective in differentiating groups of preservice teachers with different types of exposure to the inquiry approach. This type of framework allows one to put a microscope on the different dimensions underlying inquiry instruction and provides a richness that is more difficult to capture by considering the process in only its entirety. This dimensionality is sensitive to the complexity inherent in the inquiry instructional process.

Future Directions

The present study represents an early step in the development of the construct validity for the *Strategic Demands of Inquiry* questionnaire. Future research should examine other forms of validity and reliability, including test-retest reliability. Moreover, more studies are needed to further validate the instrument with different populations, which could include in-service teachers, parents, and students.

The *Strategic Demands of Inquiry* questionnaire is intended to be used in its entirety; however, a shortened version that could be used as a screener or in repeated-measures research, would be useful. Thus, the next step could be to create a short version of the questionnaire that includes factors that most effectively differentiate groups and items that most highly load on factors.

In terms of investigating student teachers' understanding of inquiry instruction, the focus in the present study was on the Kindergarten and Elementary Education

program at McGill University. The next step is to replicate this study with student teachers in the Secondary Education program. It would be interesting to know if at the end of the education program, Elementary and Secondary preservice teachers have different understandings of the inquiry approach. In addition, within the Secondary program, do student teachers in different areas of specialization (e.g., science and mathematics versus English) understand inquiry instruction differently? These findings would shed light on whether understanding of inquiry is related to specific content areas or domains of expertise.

The present study was an exploratory investigation into student teachers' conceptualizations of inquiry instruction and views of the importance of aspects of the planning, enactment and reflection. Future studies need to examine more rigorously the program experiences that are related to or that influence differential understandings of the specific phases of an inquiry instructional approach. A mixed-modal design that includes classroom observations, examination of course syllabi, as well as professor and student interviews would be appropriate.

Moreover, future research should investigate whether and how preservice teachers' understanding of inquiry instruction translates into practice once they leave the program and have their own classrooms. For example, do Elementary and Secondary preservice teachers use the inquiry approach as a general pedagogical approach or is their use of it related to specific content areas? This information would shed light on the relationship between understanding of inquiry and future practice. It would also provide information about how inquiry teaching is related to general pedagogical knowledge or Shulman's (1988) pedagogical content knowledge and beliefs (as cited in Borko &

Putnam, 1996). Given the focus on inquiry-driven curriculum in educational reform, it would be important to know if, when, and how preservice teachers generalize their knowledge about inquiry instruction to their own inquiry instruction in the classroom.

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Appendix B

Participant Letters of Informed Consent and Consent Form

Bachelor of Education Students' Letter of Informed Consent

September, 2003

Dear participant,

We have obtained permission from your instructor to approach your class in the hopes you will agree to participate in our study. We are members of the High Ability and Inquiry Research Team at McGill University, Montreal. The general focus of our research is inquiry in education.

We are conducting a study of individuals' understanding of inquiry in education. The purpose of this research project is to investigate participants' perceptions and expectations of the strategic demands of participation in inquiry-based learning and teaching, and how these change with experience.

We have developed a questionnaire that probes understanding of inquiry-based learning. The questionnaire should take about 30 minutes to complete. There are no personal questions; however, we shall keep data about very broad group issues, such as, how much inquiry experience the respondent has with inquiry-based education. We would like to invite you, entirely at your discretion, to fill out the questionnaire, and to return it to the researcher. We plan to compare your replies in the beginning of the semester to your responses at the end of the course. As well, we will compare your replies to those of other Bachelor of Education students, to replies of students who are enrolled in courses that are organized around the inquiry approach, and to replies of psychology students who have completed a research project but have not learned about inquiry instruction.

We would also like to interview select students to obtain further information about their experience with inquiry and their understanding of the intellectual demands of engaging in this approach.

Questionnaires and interviews will be identified using a code. The replies on the questionnaire will be tallied up with the replies of other students in the class and will only be reported in aggregated totals or averages. Descriptive information will be reported about the interviews; however, no identifying information will be provided. Data from this study will be kept in a secure file at McGill University to which only the researchers have access. Therefore, your replies will be kept confidential and will be reported in such a way that no individual will be able to be identified.

Your participation in this study is voluntary and you will not be pressured to complete the survey. Refusal to participate will not involve a penalty or loss of benefits, or in any way influence your mark in the course. Your instructor will not be made aware of who agreed or did not agree to participate. You are free to quit at any time and to not answer any questions with which you are uncomfortable. In addition, you may choose to complete the questionnaire but later deny giving an interview.

continued on the reverse side

Participants who complete the questionnaire once at the beginning of the semester and again at the end of the semester will have their name entered in a draw to win tickets to the movies. Participants who give an interview will have their names entered into a second draw to win movie tickets. Winners will be notified by e-mail or telephone and asked to pick up their tickets(s) in Education B105 at an agreed upon time.

Please sign the consent form if you are interested in participating in this study. Your signature indicates that you have read the consent form and have agreed to complete this survey; you provide informed consent for your participation, for the researchers' use of the information for the study, and for the publishing of the research. Please retain a copy of this consent form for your personal files. If you have any questions about this study, please feel free to contact us.

Sincerely,

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McGill University, Department of Educational and Counselling Psychology
Consent Form for Conceptualizations of Inquiry Engagement Study

I have read and understood the letter concerning the research project on individuals' understanding of the strategic demands of participation in inquiry-based learning conducted by Dr. Bruce Shore and Cassidy Syer of McGill University. I understand that all information gathered for this project will be used for research purposes only and will be treated with the utmost confidentiality. I understand that I may withdraw permission to participate at any time.

Name (please print): _____
Gender: _____Male _____Female
Name of instructor: _____ Course: _____
Please check one of the following:
(a) ___Yes, I agree to participate in the research project
(b) ___ No, I will not participate in the research project
Signature _____ Date: _____
Home Mailing Address: _____ City: _____Postal Code: _____
Email Address: _____ Phone Number: (____)_____
Please check one of the following:
(a) ___Yes, you may contact me for an interview
(b) ___No, you may not contact me for an interview
Please check one of the following:
(a) ___Yes, I would like to be emailed a summary of the results of this study
(b) ___No, I would not like to be emailed a summary of the results

Participant Consent Form

McGill University, Department of Educational and Counselling Psychology

Consent Form for Conceptualizations of Inquiry Engagement Study

I have read and understood the letter concerning the research project on practitioners' understanding of the strategic demands of participation in inquiry-based learning conducted by Dr. Bruce Shore and Cassidy Syer of McGill University. I understand that all information gathered for this project will be used for research purposes only and will be treated with the utmost confidentiality. I understand that I may withdraw permission to participate at any time.

Name (please print): _____

Gender: _____ Male _____ Female

Name of instructor: _____ Course: _____

Please check one of the following:

(a) _____ Yes, I agree to participate in the research project

(b) _____ No, I will not participate in the research project

Signature _____ Date: _____

Home Mailing Address: _____
City: _____ Postal Code: _____
Email Address: _____Phone Number: (____)_____

Please check one of the following:
(a) _____ Yes, you may contact me for an interview
(b) _____ No, you may not contact me for an interview

Please check one of the following:
(a) _____ Yes, I would like to be emailed a summary of the results of this study
(b) _____ No, I would not like to be emailed a summary of the results

****

Please return this form to the researcher along with your completed questionnaire.
Thank you.

Appendix C

Original Sample and Procedure

To observe how understanding of inquiry instruction develops through student teachers' education, the original aim of the study was to have samples of BEd Kindergarten and Elementary Education and Secondary Education students in each of the four years of the program. Additionally, I aimed to test participants at two points in time to have repeated-measures data. However, as I will discuss further, it was difficult to gain access to participants, to recruit participants, and the attrition rate was high. Thus, the sample sizes for each intermittent year were too small to achieve these goals. The sample at Time 1 (September, 2003) included 69 first-year Kindergarten and Elementary Education students, 43 first-year Secondary Education students, eight second-year Kindergarten and Elementary Education students, three second-year Secondary Education students, six third-year Kindergarten and Elementary Education students, 12 third-year Secondary Education students, 54 fourth-year Kindergarten and Elementary Education students, and four fourth-year Secondary Education students.

The sample sizes at Time 2 (January, 2004) were, unfortunately, even smaller. The high attrition rate was likely due to my limited ability to have contact with participants. The attrition rate was much lower for groups who were given class time to participate in the study at Time 1 and Time 2. The other groups of participants were contacted repeatedly by email and asked to complete the Time 2 questionnaire either by email, coming to one of the questionnaire sessions, or to make a personal arrangement with me. Those groups that were asked to participate at Time 2 on their own time had a high attrition rate. Time 2 sample sizes included 33 first-year Kindergarten and

Elementary Education students, 33 first-year Secondary Education students, four second-year Kindergarten and Elementary Education students, one second-year Secondary Education student, one third-year Kindergarten and Elementary Education student, three third-year Secondary Education students, five fourth-year Kindergarten and Elementary Education students, and one fourth-year Secondary Education student.

Time 2 data were collected in much the same way as Time 1 data, with one modification. First, I re-administered the questionnaire to participants in the three sections of the first-year Educational Psychology course during class time. For all other participants, I emailed them a letter asking them to complete the Time 2 questionnaire. They could do this in one of three ways. First, I offered participants a list of dates and times when they could come and complete the questionnaire. Second, I emailed an on-line version to participants that they could complete on their computer and then email back to me the completed questionnaire. Third, participants could set up a time with me to complete the questionnaire at their convenience. I emailed participants throughout the months of December 2003 and January 2004 with reminders and requests. I telephoned participants whose email addresses did not work anymore.

Although the fourth-year Secondary Education group was not included in quantitative analyses of the present study due to its small sample size, I chose to conduct interviews with this group because they provided an interesting comparison for the Kindergarten and Elementary Education group. I did not include these data in the present study because I chose to focus on the Kindergarten and Elementary Education program in light of the striking differences I found between first-year and fourth-year student teachers in this program.

Appendix D

Kindergarten and Elementary Education Program Overview

	Year 1		Year 2		Year 3		Year 4	
Fall	1st Year Professional Seminar	1	Elementary School Mathematics	3	Integrating the Curriculum	2	Policy Issues in Quebec Education	3
	1st Year Field Experience	2	Elementary School Science	3	Classroom Practices	2	Instruction in Inclusive Schools	3
	Philosophical Foundations or Philosophy of Catholic Education	3	Science Teaching	2	Classroom-Based Evaluation	3	Methods I*	3
	Educational Psychology	3	Academics	6	3rd Year Field Experience	7	Electives	6
	Communication in Education	3						
	Intercultural Education	3						
	Total Credits	15	Total Credits	14	Total Credits	14	Total Credits	15
Winter	Academics	12	Language Arts	3	Media, Technology, & Education	3	MRE in the K/Elem Curriculum or Catholic Religious Education	2
	Geography, History, & Citizenship Education**	3	Kindergarten Class	2	Academics	12	4th Year Professional Seminar	3
			Teach Social Sciences	2			4th Year Field Experience	7
			Exceptional Students	3			Methods II*	3
			Teaching Mathematics I	3				
	Total Credits	15	Total Credits	13	Total Credits	15	Total Credits	15
Spring			2nd Year Field Experience	4				
			Total Credits	4				

*Methods I and Methods II courses to be chosen from Art, Music, Drama, Physical Education, TESL, TFSL

** Students may opt to do this course in the Winter of Year 1 or the Fall of Year 2.

Appendix E

Strategic Demands of Inquiry Questionnaire

STUDENT TEACHERS' CONCEPTUALIZATIONS OF INQUIRY ENGAGEMENT

PART I
Defining Inquiry Teaching and Learning

The pedagogical approach known as *inquiry* has many possible meanings.

Please write down your own definition of inquiry and explain its importance. If you do not have a personal definition of inquiry, please write down as precisely as possible what you think it might be.

The statements below are based on past research with pre-service teachers. Please read each of the 23 statements about inquiry listed below. Rank which 2 statements come closest to your definition of inquiry by indicating (a) and (b) beside the item number in parentheses ( ). Then, please rank which two definitions are furthest from your own definition of inquiry by indicating (y) and (z) beside the item number in parentheses.

1. ( ) To seek new sources of information beyond material covered in the class textbook.
2. ( ) To replace textbooks with other sources of information.
3. ( ) To replace textbooks with problems designed by the teacher to go beyond information in a class textbook to pursue personal subject matter interests.
4. ( ) To ask questions in order to find answers to them.
5. ( ) Knowledge is acquired in the process of forming, answering, and testing teacher questions.
6. ( ) Question asking is motivated by personal interest.
7. ( ) Actively searching for information from many sources, and then analyzing that information.
8. ( ) Interest and curiosity drives the search for answers to self questions resulting in deeper content understanding.
9. ( ) To first think and ponder over interesting information, ask critical questions, and give reasons for answers.
10. ( ) Thoughtfulness – a disposition not to accept everything at face value and to question and search for deeper meaning.
11. ( ) To attempt to solve problems presented by the teacher.
12. ( ) To attempt to solve problems encountered in real situations that demand action.
13. ( ) Being given a problem and then gathering information through research that leads toward a solution.
14. ( ) Designing a problem and then gathering information through research that leads toward a solution.
15. ( ) Searching for relevant and important information using an organized plan.
16. ( ) Finding, collecting, and organizing information in order to come up with a conclusion.
17. ( ) Data collection and analysis on a personally generated thesis.
18. ( ) To discover by ourselves through solely our own efforts.
19. ( ) To respond to a situation.
20. ( ) The freedom to generate a question, consult any type of resource until I feel I have made a discovery or learned enough for my interests, needs or purposes.
21. ( ) Doing an experiment and interpreting its results.
22. ( ) An opportunity to do in depth study with enough time to reflect on a certain issue or problem which then leads me to feel there is room to make a contribution to subject matter by making it more complete.
23. ( ) Doing a research project with a group using available classroom and school library resources.
24. ( ) I am not confident I am able to define inquiry.

Please take a moment to imagine a classroom scenario in which the teacher and students are engaged in good teaching and learning. Please describe what this scenario looks like (e.g., layout of the room, who is interacting with whom, what activities are they engaged in, what materials are present, and any other thought that you might envisage – do not feel confined to this list of examples).

STUDENT TEACHERS' CONCEPTUALIZATIONS OF INQUIRY ENGAGEMENT

PART II
Strategic Demands of Engaging in An Inquiry Task

Engaging in an inquiry task has several possible elements. We would like to know how you rate the importance of the following 79 items. Each item is prefaced by the question,

"how important is it in inquiry based learning and teaching. . . ?"

Please rate the importance of the following questions from 0 (low or "not at all") to 10 (high or "very much so") by placing an X on the corresponding number.

1- for the student and teacher to have co-ownership of the question

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

2- for the student and teacher to share construction of the curriculum

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

3- for the student and teacher to share decision-making

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

4- for the teacher to listen as much as he or she speaks

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

5- for the student to work in a nurturing and creative environment

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

6- for the student to extend inquiry beyond the classroom

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

7- for the teacher to tap into the student's and his or her own interests

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

8- for the teacher to explore his or her interest

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

9- for the teacher to address his or her needs and student's needs

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

"how important is it in inquiry based learning and teaching. . . ?"

10- for the teacher to provide a mentor
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

11- for the teacher to model skills needed for the inquiry
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

12- for the teacher to give the amount of time needed, be flexible with time
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

13- for the student to organize time and space
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

14- for the student to understand the goal of the task
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

15- for the student to divide the task into a coherent sequence of do-able steps
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

16- for the student to make a concept map or web or cluster
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

17- for the student to foresee possible outcomes of the activity
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

18- for the student to understand key concepts
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

19- for the student to understand instructions
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

20- for the student to describe his or her own problem-solving strategies
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

21- for the student to have previous experience with similar activities
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

22- for the teacher to encourage honest criticism of ideas
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

"how important is it in inquiry based learning and teaching. . . ?"

23- for the teacher to encourage creative risk-taking

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

24- for the student to connect old and new knowledge

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

25- for the student to set aside preparation time

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

26- for the student to brainstorm his or her ideas

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

27- for the student to make a plan

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

28- for the student to have different plans in advance to accomplish the task

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

29- for the student to have back up plans at the end should the project stall

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

30- for the student to feel free to use imagination

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

31- for the student to keep motivated

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

32- for the student to have self-motivation

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

33- for the student to get a high grade

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

34- for the student to win a prize

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

"how important is it in inquiry based learning and teaching. . . ?"

35- for the teacher to give sensitive feedback, positive reinforcement, praise for persistence

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

36- for the student to ask questions

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

37- for the student to restate or reformat the problem

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

38- for the student to make suggestions

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

39- for the student to share emotions, feelings, ideas, and opinions

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

40- for the student to develop expectations of what will happen next

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

41- for the student to offer hypotheses about outcomes

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

42- for the student to make careful observations

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

43- for the student to identify where to obtain data

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

44- for the student to recognize hidden meanings in data

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

45- for the student to record data

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

46- for the student to classify data

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

"how important is it in inquiry based learning and teaching. . . ?"

47- for the student to search for resources beyond textbooks

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

48- for the student to search the Internet and World Wide Web

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

49- for the student to separate relevant and irrelevant information

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

50- for the student to apply previous knowledge to new concepts

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

51- for the student to understand how preconceptions affect learning

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

52- for the student to be aware of how the inquiry event affects him or her personally

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

53- for the student to keep an open mind to change

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

54- for the student to address doubts directly

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

55- for the student to assist others to make observations

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

56- for the student to find patterns in data

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

57- for the student to value personal judgment

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

58- for the student to verify data or information

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

59- for the student to compare and contrast data with someone else's

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

"how important is it in inquiry based learning and teaching. . . ?"

60- for the student to anticipate and respond to arguments in opposition to one's view
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

61- for the student to seek different viewpoints
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

62- for the student to test ideas and hypotheses
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

63- for the student to have a mental representation of the task
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

64- for the student to construct new knowledge
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

65- for the student to interact with or manipulate his or her surroundings
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

66- for the student to communicate one's learning with others
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

67- for the student to consider diverse means of communication
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

68- for the student to organize the presentation of the project
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

69- for the student to present data in tables and graphs
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

70- for the student to use vocabulary appropriate to the audience and topic
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

71- for the student to accept that more than one solution might be appropriate
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

72- for the student to apply new knowledge to future experiences
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

"how important is it in inquiry based learning and teaching. . . ?"

73- for the student to record methods, results, and conclusions
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

74- for the student to explain the results
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

75- for the student to question the findings
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

76- for the student to reflect upon his or her inquiry experience
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

77- for the student to discuss what has been learned compared to what was known before
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

78- for the student to evaluate the inquiry experience
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

79- for the student to follow-up the project with a new set of questions
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

Additional Questions:
1- Indicate how much experience you have with inquiry-based education, from 0 ("none at all") to 10 ("an extensive amount").
⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

2- Indicate your present level of education.
U0 U1 U2 U3 U4 MA/MEd 1 MA/MEd 2 Other: _____

PLEASE TURN PAGE OVER FOR REMAINING QUESTIONS

3a- If you are a Bachelor of Education student, which program are you in?

B. Ed. Kindergarten & Elementary _____
B. Ed. General Secondary _____
B. Ed. Teaching English as a Second Language _____
B. Ed. Teaching French as a Second Language _____
Concurrent B. Ed / B. Music _____
B. Ed. Physical & Health Education _____
B. Ed. Kinesiology _____

3b- If you are in the *old* Secondary Education track, what are your two teaching subjects?

_____ and _____

3c- If you are in the *new* Secondary Education track, what profile are you following?

English _____
Mathematics _____
Social Sciences _____
Science & Technology _____

3d- If you are not a B. Ed. student, indicate your program and your specific major or specialty or track.

Program/Degree: _____ Major/Specialty: _____

4- If you are currently a licensed teacher, indicate the following:

Year you obtained your teaching certificate/license: _____
Total years of teaching experience: _____
Grades and subjects you have taught:

_____
_____
_____
_____

5- Are you taking (Have you taken) a research methods course?

Yes _____ No _____
Indicate if course was a CEGEP, undergraduate, or graduate course: _____

6- Are you writing (Have you written) an undergraduate research project or thesis?

Yes _____ No _____
Indicate major: _____

7- Are you writing (Have you written) a Master's research project or thesis?

Yes _____ No _____
Indicate major: _____

Appendix F

Semi-Structured Interview Schedule

STUDENT TEACHERS' CONCEPTUALIZATIONS OF INQUIRY ENGAGEMENT

PART III
Structured Interview of Inquiry Teaching and Learning Experience

Show participant's definition. Do you recognize it? How did you come up with this definition or idea?

Probe: Do you hold some other definition?

If you could use some other language to refer to inquiry, would you please tell me, say whatever comes to mind.

Probe: Free associate, I'll write down and the right words will come.

Show Means graph.

We found a large statistical difference in terms of what you and the other U4 elementary student-teachers know about inquiry compared to other years.

Based on you experiences in the Education program, people you know in the program, does anything come to mind that might explain this difference?

Example: U4's gave higher ratings to "extend inquiry beyond the classroom," "compare and contrast with someone," "co-construct the curriculum".

Probe: Does anything come to mind at all? Take a few moments to think about it.

Probe: What was it that brought you to this understanding?

Where in the Education program have you been exposed, in any shape or form, to the inquiry approach?

Names of courses: _____

How was inquiry-oriented instruction taught to you? Describe ways briefly_____

How long was spent on inquiry teaching in this course?

Have you ever completed a research project? Yes _____ No _____

Maybe you have. Let me give you some examples: library research, a research paper, an experiment.

Have you completed a student-teaching placement? Yes _____ No _____

Where have you completed your student-teaching placements?

What instructional strategies did you use (were you exposed to) during your student-teaching placements?

What instructional strategies would you like to have used (or been exposed to) during your student-teaching placements?

Where have you learned about inquiry teaching and learning (besides BEd program at McGill)?

During elementary school, did any teachers involve you in inquiry instruction/learning?

Yes _____ No _____

Names of subjects: _____

Describe ways briefly: _____

Did you enjoy learning this way?

Yes _____ No _____

Do you think you would have learned more or less through a more direct teaching approach?

_____

During secondary school, did any teachers involve you in inquiry instruction/learning?

Yes _____ No _____

Names of subjects: _____

Describe ways briefly: _____

Did you enjoy learning this way?

Yes _____ No _____

Do you think you would have learned more or less through a more direct teaching approach?

_____

During CEGEP, did any teachers involve you in inquiry instruction/learning?

Yes _____ No _____

Names of subjects: _____

Describe ways briefly: _____

Did you enjoy learning this way?

Yes _____ No _____

Do you think you would have learned more or less through a more direct teaching approach?

_____

Appendix G

Inductive Categories of Definitions of the Inquiry Approach

1. Critical Thinking and Reflection

(a) A (self) questioning or critical thinking or reflective approach or process. Reflection can be described as thinking, or questioning or assessing the validity of research or material.
The approach or process can also be described as the teacher asking questions or giving information to encourage critical thinking and reflection.

2. Student Teacher Interaction

(a) Bi-directional or interactive learning or questioning or discussion.
Can additionally refer to the student and teacher interacting or discovering or questioning each other or exchanging ideas.

3. Teacher Research and Reflection

(a) The teacher questions or reflects on her work or knowledge, or researches or gathers information, or inquires into teaching strategies or learning behaviors.
(b) The teacher applies or implements or experiments with evidence-based teaching strategies.

Criteria (a) or (b) must be met.

4. Teacher Facilitates Student Learning

(a) The teacher facilitates the students' learning. The teacher is the "doer" in this category. The emphasis is on the teacher's role.
Facilitates can be described as getting students curious, or as encouraging or creating or providing or allowing students the opportunity to raise questions or construct their own knowledge or learn actively or engage in research.
(b) The student is actively engaged in the learning process.
The learning process can be described as students discovering or investigating or exploring areas of interest, or doing projects, or finding answers to problems or questions, or as doing research.

Criteria (a) and (b) must be met.

5. Student Responsible for Student Learning

(a) Students learn constructively. The student is the "doer" in this category. The emphasis is on the students' role to construct their own knowledge.
Constructing knowledge can also be described as students as asking questions about what they know and would like to know (KWL method), or as students leading the process, or the constructivist approach, or students being active participants in their learning.
The learning process can be described as students discovering or investigating or exploring areas of interest, or doing projects, or finding answers to their own problems or questions.

Criterion (a) must be met. Note that Criterion (a) includes the two components of constructing knowledge and the learning process.

6. Teacher Asks Questions which Leads to Learning

(a) Learning is based on being asked questions.
The teacher asks the students questions with the goal of guiding them to the right answer, or giving them knowledge, or directing their understanding of a subject.

7. Students Ask Questions which Leads to Learning

(a) Learning is based on asking questions or asking questions leads to knowledge.
The learner asks questions with the goal to learn, or to get answers, or to gain knowledge or information, or to understand the subject. The process here is asking questions and the goal is learning or obtaining knowledge.

8. Questioning and Research

(a) Questioning and researching or research initiated by a question.
Research is the action and can be described as forming hypotheses, or as seeking or searching or collecting or gathering information or data, or as looking for evidence, or as learning more about the question or topic, or as conducting an in-depth study, or as finding answers. The process is emphasized this category

Note that Criterion (a) includes the two components of questioning and researching.

9. Information Search and Research

(a) Refers to engaging in research.
Research is the action and can be described as finding out or researching or searching for information or ideas or opinions, or as searching for knowledge, or as exploring or investigating a topic.

Note that Criterion (a) is a process.

10. Curiosity-Driven Learning

(a) Interest and curiosity drive the generation of questions, the search for knowledge, the research process, or problem solving.

Note that Criterion (a) includes the two components of curiosity and a process.

11. Student-Centered Learning

(a) The learning process is student or learner-centered or –directed or -based.
The learning process can be described as students responsible for their own learning, or constructing their own knowledge through discovery or research or answering their own questions or problem solving, or as the search for knowledge. Note that the learning process does not necessarily need to be elaborated upon (as in SRSL for example), it must be mentioned though.

Note that Criterion (a) includes the two components of reference to a learning process and reference to student-centered.

12. Student-Centered Teaching

(a) Students' questions, ideas, interests, and needs guide instruction or teaching.

13. Teacher Gathers Information About Students

(a) The teacher asks about, researches, or finds out about her students. Can additionally refer to a goal (e.g., to get to know or to better teach students).

14. Teacher Assess Students' Prior Knowledge

(a) The teacher finds out or takes into account students' knowledge about a subject to guide instruction.

15. Teacher Asks Questions to Assess Student Learning

(a) The teacher asks students questions to assess or verify their understanding or learning of a topic.

16. Teacher Asks Questions and Students Solve

(a) The teacher asks questions or presents problems for students to find answers to or to guide students to their own conclusions.

17. Teacher Gives Information

(a) Teaching involves giving the students information, or using sources of information beyond textbooks, or using real-life situations.

(b) Teaching involves teaching students skills, such as asking questions.

Criterion (a) or (b) must be met.

18. Investigation

(a) A single idea (i.e., term) about an investigation into a problem, an investigative approach, or to investigate.

19. Problem Solving

(a) A single or primary idea (i.e., term) about problem solving, or the problem-solving process.

20. Research

(a) A single idea (i.e., term) about research, learning through research, or the research method.

21. Being Curious

(a) To be curious or to have curiosity or questions.

22. Learning

(a) A single or primary idea about learning, a learning process, or to learn. Idea that inquiry is learning or students learn through inquiry.

23. Teaching

(a) A single idea (i.e., term) about teaching or teacher's method / approach / strategy.

24. Don't Know

(a) The respondent writes that s/he doesn't know the definition.

25. Miscellaneous

(a) The definition does not fit into a category. It may be too vague or un-related to inquiry.

Appendix H

Descriptive Statistics for the Strategic Demands of Inquiry Questionnaire $N = 205$

Questionnaire Item Prefaced by the Question "How important is it in inquiry-based learning and teaching . . . ?"	Mean	Standard Deviation
1 for the student and teacher to have co-ownership of the question	7.25	2.32
2 for the student and teacher to share construction of the curriculum	6.75	2.49
3 for the student and teacher to share decision-making	7.16	2.23
4 for the teacher to listen as much as he or she speaks	8.48	1.95
5 for the student to work in a nurturing and creative environment	9.37	1.14
6 for the student to extend inquiry beyond the classroom	8.93	1.49
7 for the teacher to tap into the student's and his or her own interests	8.57	1.74
8 for the teacher to explore his or her interest	6.40	2.66
9 for the teacher to address his or her needs and student's needs	8.04	2.03
10 for the teacher to provide a mentor	7.19	2.13
11 for the teacher to model skills needed for the inquiry	8.54	1.55
12 for the teacher to give the amount of time needed, be flexible with time	8.60	1.45
13 for the student to organize time and space	7.85	2.08
14 for the student to understand the goal of the task	9.05	1.60
15 for the student to divide the task into a coherent sequence of do-able steps	8.19	1.80
16 for the student to make a concept map or web or cluster	6.84	2.16

17 for the student to foresee possible outcomes of the activity	7.76	2.00
18 for the student to understand key concepts	8.77	1.42
19 for the student to understand instructions	8.89	1.52
20 for the student to describe his or her own problem-solving strategies	8.38	1.62
21 for the student to have previous experience with similar activities	5.11	2.92
22 for the teacher to encourage honest criticism of ideas	8.09	1.91
23 for the teacher to encourage creative risk-taking	8.37	1.73
24 for the student to connect old and new knowledge	8.80	1.59
25 for the student to set aside preparation time	7.77	1.97
26 for the student to brainstorm his or her ideas	8.37	1.61
27 for the student to make a plan	7.88	1.89
28 for the student to have different plans in advance to accomplish the task	6.84	2.31
29 for the student to have back up plans at the end should the project stall	7.05	2.33
30 for the student to feel free to use imagination	9.09	1.39
31 for the student to keep motivated	9.33	1.26
32 for the student to have self-motivation	9.15	1.32
33 for the student to get a high grade	5.31	2.66
34 for the student to win a prize	3.19	2.63
35 for the teacher to give sensitive feedback, positive reinforcement, praise for persistence	9.17	1.32
36 for the student to ask questions	9.32	1.20

37 for the student to restate or reformat the problem	7.83	1.77
38 for the student to make suggestions	8.37	1.61
39 for the student to share emotions, feelings, ideas, and opinions	8.84	1.47
40 for the student to develop expectations of what will happen next	7.66	1.91
41 for the student to offer hypotheses about outcomes	8.03	1.68
42 for the student to make careful observations	8.40	1.37
43 for the student to identify where to obtain data	8.04	1.75
44 for the student to recognize hidden meanings in data	7.58	2.05
45 for the student to record data	7.46	2.14
46 for the student to classify data	7.32	2.11
47 for the student to search for resources beyond textbooks	8.57	1.63
48 for the student to search the Internet and World Wide Web	7.94	1.9
49 for the student to separate relevant and irrelevant information	8.61	1.53
50 for the student to apply previous knowledge to new concepts	8.90	1.45
51 for the student to understand how preconceptions affect learning	8.11	1.66
52 for the student to be aware of how the inquiry event affects him or her personally	7.60	2.13
53 for the student to keep an open mind to change	8.77	1.43
54 for the student to address doubts directly	8.24	1.69
55 for the student to assist others to make observations	7.99	1.87
56 for the student to find patterns in data	7.63	1.99
57 for the student to value personal judgment	8.31	1.65

58 for the student to verify data or information	7.94	1.84
59 for the student to compare and contrast data with someone else's	7.44	2.09
60 for the student to anticipate and respond to arguments in opposition to one's view	7.93	1.70
61 for the student to seek different viewpoints	8.57	1.46
62 for the student to test ideas and hypotheses	8.43	1.52
63 for the student to have a mental representation of the task	7.75	1.83
64 for the student to construct new knowledge	8.90	1.23
65 for the student to interact with or manipulate his or her surroundings	8.14	1.81
66 for the student to communicate one's learning with others	8.54	1.69
67 for the student to consider diverse means of communication	8.20	1.84
68 for the student to organize the presentation of the project	7.77	2.04
69 for the student to present data in tables and graphs	6.20	2.45
70 for the student to use vocabulary appropriate to the audience and topic	7.86	2.02
71 for the student to accept that more than one solution might be appropriate	8.71	1.45
72 for the student to apply new knowledge to future experiences	8.84	1.39
73 for the student to record methods, results, and conclusions	7.85	1.89
74 for the student to explain the results	8.39	1.64
75 for the student to question the findings	8.53	1.54
76 for the student to reflect upon his or her inquiry experience	8.53	1.71
77 for the student to discuss what has been learned compared to what was known before	8.77	1.41

78 for the student to evaluate the inquiry experience	7.99	2.06
79 for the student to follow-up the project with a new set of questions	8.09	1.86

Appendix I1

Preparation Partial Correlation Matrix

	item1	item2	item3	item4	item6	item7	item9	item10	item11	item12	item13	item14	item15
item1	1	-	-	-	-	-	-	-	-	-	-	-	-
item2	.47	1	-	-	-	-	-	-	-	-	-	-	-
item3	.46	.65	1	-	-	-	-	-	-	-	-	-	-
item4	.35	.27	.27	1	-	-	-	-	-	-	-	-	-
item6	.29	.33	.23	.34	1	-	-	-	-	-	-	-	-
item7	.27	.32	.33	.26	.27	1	-	-	-	-	-	-	-
item9	.29	.21	.19	.30	.24	.39	1	-	-	-	-	-	-
item10	.43	.33	.31	.31	.36	.31	.45	1	-	-	-	-	-
item11	.34	.27	.19	.40	.46	.32	.43	.45	1	-	-	-	-
item12	.25	.32	.33	.29	.28	.35	.34	.31	.45	1	-	-	-
item13	.22	.26	.28	.29	.18	.21	.36	.41	.41	.44	1	-	-
item14	.24	.20	.22	.25	.32	.28	.37	.33	.48	.44	.57	1	-
item15	.31	.26	.37	.28	.34	.24	.36	.42	.47	.29	.55	.60	1
item16	.32	.21	.16	.32	.31	.21	.43	.42	.34	.20	.40	.51	.52
item17	.23	.19	.17	.16	.31	.16	.38	.33	.29	.18	.23	.31	.43
item18	.16	.13	.08	.25	.29	.13	.33	.37	.43	.32	.44	.56	.51
item19	.15	.15	.11	.12	.28	.27	.32	.35	.38	.29	.42	.57	.47
item20	.20	.32	.18	.29	.47	.23	.25	.31	.43	.34	.35	.52	.43
item22	.41	.29	.31	.28	.38	.17	.27	.37	.37	.35	.38	.47	.38
item23	.34	.33	.2	.34	.54	.32	.31	.47	.38	.39	.22	.37	.25
item24	.23	.16	.12	.27	.27	.22	.34	.34	.39	.20	.21	.27	.31
item25	.18	.20	.25	.2	.25	.21	.26	.35	.30	.32	.48	.43	.43
item26	.25	.23	.24	.28	.33	.34	.37	.45	.40	.32	.35	.45	.34
item27	.14	.15	.21	.19	.24	.12	.35	.36	.32	.29	.48	.58	.56
item28	.17	.21	.25	.01	.22	.14	.34	.37	.26	.23	.40	.43	.43
item29	.13	.18	.23	.18	.21	.08	.30	.35	.33	.25	.46	.48	.47

	item16	item17	item18	item19	item20	item21	item23	item24	item25	item26	item27	item28	item29
item16	1	-	-	-	-	-	-	-	-	-	-	-	-
item17	.51	1	-	-	-	-	-	-	-	-	-	-	-
item18	.38	.35	1	-	-	-	-	-	-	-	-	-	-
item19	.36	.12	.65	1	-	-	-	-	-	-	-	-	-
item20	.44	.34	.42	.39	1	-	-	-	-	-	-	-	-
item22	.33	.33	.41	.27	.45	1	-	-	-	-	-	-	-
item23	.37	.35	.32	.29	.47	.49	1	-	-	-	-	-	-
item24	.33	.26	.34	.24	.44	.33	.40	1	-	-	-	-	-
item25	.43	.26	.42	.45	.38	.30	.28	.38	1	-	-	-	-
item26	.46	.35	.42	.44	.43	.41	.50	.42	.44	1	-	-	-
item27	.40	.34	.53	.47	.40	.45	.30	.29	.48	.58	1	-	-
item28	.42	.45	.41	.33	.38	.53	.31	.34	.42	.39	.62	1	-
item29	.50	.33	.49	.39	.42	.42	.18	.29	.44	.42	.64	.68	1

Appendix I2

Enactment Partial Correlation Matrix

	item30	item37	item38	item39	item40	item41	item42	item43	item44	item45	item46	item47	item48
item30	1	-	-	-	-	-	-	-	-	-	-	-	-
item37	.33	1	-	-	-	-	-	-	-	-	-	-	-
item38	.53	.54	1	-	-	-	-	-	-	-	-	-	-
item39	.54	.35	.64	1	-	-	-	-	-	-	-	-	-
item40	.30	.38	.40	.49	1	-	-	-	-	-	-	-	-
item41	.32	.36	.55	.48	.52	1	-	-	-	-	-	-	-
item42	.30	.39	.45	.37	.42	.66	1	-	-	-	-	-	-
item43	.31	.34	.42	.39	.38	.52	.55	1	-	-	-	-	-
item44	.26	.36	.37	.33	.39	.53	.60	.75	1	-	-	-	-
item45	.18	.29	.27	.20	.32	.29	.39	.60	.59	1	-	-	-
item46	.29	.36	.37	.27	.32	.34	.44	.63	.61	.86	1	-	-
item47	.45	.28	.39	.44	.31	.38	.39	.47	.42	.36	.42	1	-
item48	.33	.18	.29	.36	.25	.33	.21	.40	.29	.34	.36	.54	1
item49	.47	.38	.45	.42	.30	.41	.45	.48	.38	.36	.41	.53	.48
item50	.42	.25	.40	.50	.47	.44	.37	.39	.28	.28	.32	.38	.35
item51	.44	.45	.49	.48	.37	.50	.50	.54	.53	.37	.47	.33	.28
item52	.39	.28	.34	.37	.28	.33	.38	.37	.40	.38	.47	.40	.29
item53	.58	.21	.54	.54	.23	.44	.41	.44	.39	.37	.46	.41	.36
item54	.38	.35	.58	.53	.31	.48	.47	.43	.34	.31	.38	.40	.32

	item30	item37	item38	item39	item40	item41	item42	item43	item44	item45	item46	item47	item48
item55	.40	.29	.55	.54	.35	.46	.45	.44	.36	.35	.38	.42	.33
item56	.30	.27	.34	.29	.30	.35	.45	.58	.50	.62	.69	.42	.36
item57	.45	.30	.49	.53	.34	.35	.44	.44	.34	.30	.41	.42	.33
item58	.36	.31	.42	.32	.32	.40	.44	.65	.50	.61	.69	.46	.43
item59	.35	.25	.45	.36	.39	.34	.27	.49	.33	.41	.50	.43	.47
item60	.42	.33	.33	.43	.35	.39	.35	.42	.41	.38	.44	.47	.37
item61	.52	.33	.48	.53	.32	.44	.34	.37	.35	.21	.34	.55	.37
item62	.39	.34	.48	.46	.41	.52	.44	.48	.42	.35	.44	.45	.32
item63	.47	.36	.38	.38	.38	.42	.42	.59	.54	.47	.54	.42	.34
item64	.38	.25	.50	.46	.31	.34	.41	.36	.29	.25	.39	.39	.32
item65	.45	.30	.44	.44	.37	.35	.37	.43	.33	.26	.39	.36	.30
item66	.52	.21	.42	.50	.28	.32	.26	.37	.27	.33	.45	.44	.49
item67	.40	.25	.37	.40	.39	.35	.36	.45	.36	.44	.52	.38	.49
item68	.26	.14	.19	.26	.26	.11	.22	.40	.28	.48	.50	.21	.34
item69	.17	.09	.07	.15	.23	.12	.20	.34	.36	.44	.47	.18	.30
item70	.37	.24	.24	.34	.28	.22	.21	.30	.21	.35	.41	.31	.32
item71	.44	.38	.41	.47	.32	.31	.42	.44	.40	.33	.39	.52	.30
item72	.48	.22	.38	.39	.36	.30	.35	.31	.31	.24	.34	.38	.28
item73	.28	.27	.33	.28	.33	.34	.41	.51	.48	.61	.66	.36	.26

	item49	item50	item51	item52	item53	item54	item55	item56	item57	item58	item59	item60	item61
item49	1	-	-	-	-	-	-	-	-	-	-	-	-
item50	.61	1	-	-	-	-	-	-	-	-	-	-	-
item51	.47	.45	1	-	-	-	-	-	-	-	-	-	-
item52	.40	.30	.57	1	-	-	-	-	-	-	-	-	-
item53	.51	.48	.54	.56	1	-	-	-	-	-	-	-	-
item54	.50	.43	.48	.50	.64	1	-	-	-	-	-	-	-
item55	.39	.40	.41	.49	.59	.61	1	-	-	-	-	-	-
item56	.47	.39	.45	.44	.48	.41	.50	1	-	-	-	-	-
item57	.47	.45	.45	.34	.47	.54	.48	.47	1	-	-	-	-
item58	.50	.41	.51	.47	.56	.44	.50	.76	.5	1	-	-	-
item59	.35	.34	.33	.35	.40	.39	.47	.55	.43	.64	1	-	-
item60	.45	.36	.45	.37	.47	.46	.48	.45	.49	.48	.50	1	-
item61	.43	.37	.44	.32	.46	.52	.44	.33	.49	.38	.48	.63	1
item62	.44	.35	.49	.41	.44	.55	.51	.51	.52	.53	.48	.57	.68
item63	.43	.39	.57	.47	.56	.48	.46	.56	.35	.56	.46	.49	.46
item64	.45	.41	.43	.38	.52	.54	.53	.41	.50	.42	.38	.34	.43
item65	.48	.45	.43	.41	.51	.46	.52	.44	.52	.43	.34	.45	.41
item66	.39	.35	.30	.31	.51	.36	.51	.44	.39	.40	.44	.41	.44
item67	.35	.39	.41	.39	.51	.44	.51	.48	.37	.49	.44	.44	.38
item68	.28	.26	.26	.26	.31	.24	.47	.49	.27	.48	.39	.40	.21
item69	.09	.10	.18	.22	.23	.11	.35	.43	.18	.39	.39	.30	.13
item70	.29	.29	.26	.20	.38	.33	.31	.38	.37	.37	.40	.45	.38
item71	.45	.35	.43	.38	.49	.50	.47	.48	.57	.45	.49	.56	.61
item72	.46	.51	.47	.36	.59	.42	.51	.42	.37	.45	.29	.41	.36
item73	.29	.28	.41	.44	.46	.45	.41	.62	.40	.69	.47	.40	.35

Appendix I3

Reflection Partial Correlation Matrix

	item74	item75	item76	item77	item78	item79
item74	1	-	-	-	-	-
item75	.62	1	-	-	-	-
item76	.63	.68	1	-	-	-
item77	.61	.66	.76	1	-	-
item78	.56	.52	.71	.60	1	-
item79	.39	.69	.53	.51	.45	1

Appendix J1

Preparation EFA Variable Loadings on Factors

Questionnaire Item Prefaced by the Question "How important is it in inquiry-based learning and teaching … ?"	F1[a]	F2[b]	F3[c]	F4[d]	F5[e]	F6[f]	Com-munality Estimate	Root Mean Square Residual
1- for the student and teacher to have co-ownership of the question	-0.10	0.18	0.43*	-0.07	0.15	0.20	0.42	0.04
2- for the student and teacher to share construction of the curriculum	-0.07	0.18	0.68*	0.03	0.02	-0.04	0.56	0.02
3- for the student and teacher to share decision-making	0.00	-0.11	0.93*	0.11	0.00	-0.06	0.82	0.01
4- for the teacher to listen as much as she speaks	0.12	0.24	0.17	-0.27	0.15	0.19	0.33	0.04
6- for the student to extend inquiry beyond the classroom	0.05	0.63*	0.09	-0.10	-0.09	0.12	0.47	0.03
7- for the teacher to tap into the student's and his or her own interests	0.06	0.08	0.23	-0.10	0.46*	-0.08	0.37	0.03
9- for the teacher to address his or her needs and student's needs	0.05	-0.12	-0.04	0.09	0.68*	0.23	0.59	0.02

10 for the teacher to provide a mentor	0.06	0.16	0.13	0.11	0.35*	0.14	0.46	0.03
11- for the teacher to model skills needed for the inquiry	0.35*	0.25	0.01	-0.14	0.22	0.13	0.48	0.04
12- for the teacher to give the amount of time needed, be flexible with time	0.33*	0.18	0.21	-0.03	0.22	-0.20	0.38	0.04
13- for the student to organize time and space	0.60*	-0.14	0.13	0.07	0.11	0.04	0.50	0.03
14- for the student to understand the goal of the task	0.72*	0.11	-0.01	0.02	-0.03	0.06	0.64	0.03
15- for the student to divide the task into a coherent sequence of do-able steps	0.58*	-0.10	0.18	-0.01	-0.8	0.40*	0.69	0.02
16- for the student to make a concept map or web or cluster	0.17	0.11	-0.08	0.10	0.12	0.52*	0.56	0.04
17- for the student to foresee possible outcomes of the activity	-0.17	0.17	-0.03	0.25	0.09	0.56*	0.50	0.03
18- for the student to understand key concepts	0.68*	0.13	-0.17	0.07	0.01	0.02	0.57	0.03
19- for the student to understand instructions	0.80*	0.04	-0.11	-0.02	0.10	-0.18	0.58	0.04
20- for the student to describe his or her own problem-solving strategies	0.32*	0.52*	-0.00	0.07	-0.18	0.09	0.52	0.03

22- for the teacher to encourage honest criticism of ideas	0.11	0.43*	0.16	0.33*	-0.10	0.01	0.50	0.04
23- for the teacher to encourage creative risk-taking	-0.10	0.81*	0.00	0.07	0.10	-0.03	0.69	0.02
24- for the student to connect old and new knowledge	0.04	0.33*	-0.08	0.15	0.17	0.10	0.31	0.04
25- for the student to set aside preparation time	0.45*	0.04	0.07	0.18	0.05	-0.01	0.38	0.04
26- for the student to brainstorm ideas	0.23	0.31	-0.02	0.21	0.23	-0.05	0.49	0.04
27- for the student to make a plan	0.51*	0.01	-0.03	0.43*	-0.00	0.01	0.64	0.03
28- for the student to have different plans in advance to accomplish the task	0.05	0.03	0.04	0.81*	0.03	0.08	0.79	0.02
29- for the student to have back up plans at the end should the project stall	0.37*	0.09	0.03	0.54*	-0.05	0.13	0.64	0.03

* loadings above .32 that were interpreted
F1[a] Time and Task Organization
F2[b] Setting the Task in Context
F3[c] Co-Construction
F4[d] Planning to Solve the Problem
F5[e] Taking into Account Students' Interests and Needs
F6[f] Linking Ideas Including the View of the Future

Appendix J2

Enactment EFA Variable Loadings on Factors

Questionnaire Item Prefaced by the Question "How important is it in inquiry-based learning and teaching … ?"	F7[a]	F8[b]	F9[c]	F10[d]	F11[e]	F12[f]	Com-munality Estimate	Root Mean Square Residual
30- for the student to feel free to use imagination	0.51*	-0.13	-0.02	0.17	0.05	0.22	0.49	0.04
37- for the student to restate or reformat the problem	0.06	0.10	0.35*	0.15	-0.07	0.04	0.29	0.05
38- for the student to make suggestions	0.49*	-0.04	0.29	0.09	-0.12	0.08	0.55	0.05
39- for the student to share emotions, feelings, ideas, and opinions	0.43*	-0.26	0.29	0.16	0.08	0.17	0.58	0.04
40- for the student to develop expectations of what will happen next	0.01	-0.10	0.59*	0.02	0.25	0.05	0.44	0.04
41- for the student to offer hypotheses about outcomes	0.13	-0.04	0.72*	0.07	-0.05	0.00	0.65	0.03
42- for the student to make careful observations	0.19	0.18	0.62*	-0.03	-0.04	-0.12	0.60	0.03
43- for the student to identify where to	-0.02	0.48*	0.42*	-0.01	0.04	0.13	0.67	0.03

obtain data								
44- for the student to recognize hidden meanings in data	-0.13	0.48*	0.55*	0.01	-0.01	0.01	0.67	0.04
45- for the student to record data	-0.13	0.88*	0.05	-0.11	0.10	0.13	0.80	0.02
46- for the student to classify data	0.00	0.85*	0.00	-0.03	0.09	0.12	0.84	0.02
47- for the student to search for resources beyond textbooks	0.06	0.16	0.02	0.36*	-0.10	0.43*	0.55	0.03
48- for the student to search the Internet and World Wide Web	0.04	0.11	-0.01	0.06	0.14	0.58*	0.52	0.03
49- for the student to separate relevant and irrelevant information	0.45*	0.18	0.04	0.02	-0.17	0.36*	0.56	0.04
50- for the student to apply previous knowledge to new concepts	0.51*	-0.02	0.18	-0.13	0.02	0.24	0.47	0.05
51- for the student to understand how preconceptions affect learning	0.43*	0.20	0.30	0.04	-0.09	-0.08	0.54	0.04
52- for the student to be aware of how the inquiry event affects him or her personally	0.53*	0.33*	-0.02	0.00	-0.11	-0.06	0.44	0.04
53- for the student to keep an open mind to change	0.82*	0.16	-0.09	-0.02	-0.03	-0.00	0.68	0.04
54- for the student to address doubts	0.61*	0.07	0.08	0.21	-0.12	-0.08	0.59	0.04

directly								
55- for the student to assist others to make observations	0.55*	-0.01	0.15	0.03	0.21	-0.05	0.56	0.04
56- for the student to find patterns in data	0.22	0.61*	-0.06	0.06	0.11	0.02	0.65	0.03
57- for the student to value personal judgment	0.37*	0.09	0.02	0.30	-0.05	0.08	0.48	0.04
58- for the student to verify data or information	0.26	0.61*	-0.05	0.08	0.04	0.06	0.68	0.04
59- for the student to compare and contrast data with someone else's	0.22	0.26	-0.04	0.34*	0.16	0.20	0.48	0.04
60- for the student to anticipate and respond to arguments in opposition to one's view	0.05	0.09	0.04	0.50*	0.14	0.13	0.54	0.03
61- for the student to seek different viewpoints	0.04	-0.11	0.04	0.80*	-0.07	0.18	0.74	0.02
62- for the student to test ideas and hypotheses	0.10	0.09	0.16	0.64*	0.02	-0.09	0.68	0.02
63- for the student to have a mental representation of the task	0.27	0.24	0.15	0.16	0.21	-0.07	0.57	0.04
64- for the student to construct new knowledge	0.63*	0.02	-0.00	0.07	0.03	-0.00	0.49	0.04

65- for the student to interact with or manipulate his or her surroundings	0.58*	0.02	0.05	-0.01	0.07	0.08	0.47	0.03
66- for the student to communicate one's learning with others	0.32*	-0.02	-0.07	0.12	0.36*	0.26	0.56	0.04
67- for the student to consider diverse means of communication	0.34*	0.09	0.06	-0.05	0.44*	0.13	0.59	0.04
68- for the student to organize the presentation of the project	0.12	0.19	-0.03	-0.15	0.70*	0.04	0.66	0.03
69- for the student to present data in tables and graphs	-0.21	0.28	0.07	0.01	0.61*	-0.05	0.51	0.03
70- for the student to use vocabulary appropriate to the audience and topic	0.00	-0.02	-0.05	0.32*	0.60*	0.02	0.58	0.04
71- for the student to accept that more than one solution might be appropriate	0.18	0.02	-0.01	0.59*	0.17	-0.04	0.63	0.04
72- for the student to apply new knowledge to future experiences	0.69*	-0.07	-0.00	-0.06	0.27	-0.05	0.55	0.04
73- for the student to record methods, results, and conclusions	0.08	0.55*	-0.01	0.25	0.21	-0.22	0.67	0.03

* loadings above .32 that were interpreted
F7[a] Students' Entering Knowledge and Affect

F8[b] Skills for Collecting and Analyzing Data
F9[c] Defining the Problem Space In Terms of Data Characteristics
F10[d] Social Context of Solving the Problem
F11[e] Communication of the Results
F12[f] Expanding the Data or Information Search

Appendix J3

Reflection EFA Variable Loadings on Factors

Questionnaire Item Prefaced by the Question "How important is it in inquiry-based learning and teaching … ?"	F13[a]	F14[b]	Com-munality Estimate	Root Mean Square Residual
74- for the student to explain the results	0.62*	0.14	0.53	0.03
75- for the student to question the findings	0.22	0.68*	0.74	0.04
76- for the student to reflect upon his or her inquiry experience	0.78*	0.13	0.78	0.03
77- for the student to discuss what has been learned compared to what was known before	0.64*	0.22	0.67	0.02
78- for the student to evaluate the inquiry experience	0.74*	0.02	0.57	0.03
79- for the student to follow-up the project with a new set of questions	0.03	0.71*	0.54	0.04

* loadings above .32 that were interpreted
F13[a] Explanation., Reflection, and Evaluation
F14[b] Questioning the Results and Follow-Up Q's.

Appendix K1

Preparation Factor Score Means and Standard Deviations

	Factor 1: Time and Task Organization		Factor 2: Setting the Task in Context		Factor 3: Co-Construction		Factor 4: Planning to Solve the Problem		Factor 5: Taking into Account Students' Interests and Needs		Factor 6: Linking Ideas Including View of the Future	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Psychology Honours	0.07	0.85	0.04	0.81	-0.26	0.93	-0.25	1.16	-0.13	0.80	-0.13	0.95
Year 1 Secondary Education	-0.27	1.10	-0.17	0.83	-0.40	1.01	-0.20	1.03	-0.28	1.06	-0.26	0.98
Year 1 Elementary Education	-0.23	1.04	-0.34	1.18	-0.05	0.90	-0.21	0.98	-0.19	1.01	-0.17	1.01
Year 4 Elementary Education	0.34	0.79	0.39	0.76	0.29	0.88	0.41	0.78	0.31	0.81	0.37	0.82
Continuing Education	0.37	0.66	0.44	0.69	0.46	1.13	0.27	0.81	0.48	0.64	0.28	0.74

Appendix K2

Enactment Factor Score Means and Standard Deviations

	Factor 7: Students' Entering Knowledge and Affect		Factor 8: Skills for Collecting Data and Analyzing Data		Factor 9: Defining the Problem Space in Terms of Data Characteristics		Factor 10: Social Context of Solving the Problem		Factor 11: Communication of Results		Factor 12: Expanding the Data or Information Search	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Psychology Honours	0.04	1.02	-0.48	1.32	-0.34	1.13	0.09	1.09	0.24	0.93	0.28	1.20
Year 1 Secondary Education	-0.06	0.10	-0.14	1.34	-0.01	0.85	0.09	0.89	-0.13	1.30	-0.09	1.50
Year 1 Elementary Education	-0.34	1.29	-0.14	1.14	-0.41	1.14	-0.43	1.24	-0.22	1.08	-0.27	1.32
Year 4 Elementary Education	0.36	0.75	0.33	0.85	0.50	0.93	0.36	0.78	0.31	0.86	0.22	0.84
Continuing Education	0.29	0.71	0.31	0.80	0.40	0.75	0.20	0.82	-0.01	1.20	0.29	1.07

Appendix K3

Reflection Factor Score Means and Standard Deviations

	Factor 13: Explanation, Reflection, and Evaluation		Factor 14: Questioning the Results and Follow-up Questions	
Group	*M*	*SD*	*M*	*SD*
Psychology Honours	-0.13	1.12	0.07	0.86
Year 1 Secondary Education	-0.08	0.84	-0.01	0.98
Year 1 Elementary Education	-0.30	1.19	-0.26	1.18
Year 4 Elementary Education	0.35	0.62	0.22	0.68
Continuing Education	0.38	0.51	0.23	0.66