# Student Outcomes in Inquiry Instruction

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## Contributions of Authors

This thesis is based on two manuscripts in preparation. The first manuscript, *Student Outcomes in Inquiry Instruction: A Literature-Derived Checklist*, is based substantially on the literature review of a PhD dissertation by Katie Saunders-Stewart (2008). My role in the article was to draft a major reduction from the original thesis format, to update the literature review, and to prepare the new text in journal format. On this article, Katie Saunders-Stewart is first author because the original intellectual contributions came from her. I am the second author on this paper; I played the primary role in turning the dissertation into a manuscript for publication.

The second manuscript, *Teachers' Inquiry Experience Matters: Predicting Student Outcomes*, is based on a research idea I developed and on which I conducted an empirical study. I am first author on this paper and my roles included reviewing recent literature, developing the procedure, recruiting participants, administering the questionnaires, performing the analyses, and writing the manuscript.

My supervisor, Prof. Bruce M. Shore, is the final author on both manuscripts; his role included guidance on development of ideas, recruiting participants, and editing.

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Abstract

A literature review of student outcomes from inquiry instruction generated a list of 23 criterion-referenced student outcomes. These included more commonly addressed outcomes such as content knowledge and process skills, and less commonly addressed outcomes such as creativity, motivation, collaborative ability, and autonomy. This list was adapted into a questionnaire probing to what extent the various outcomes were perceived in classrooms by teachers working at varying self-rated levels of inquiry use (low, middle, high). Analyses were performed on a sample of 74. Teachers' self-ratings of inquiry use were significantly and positively related to the inquiry outcomes categorized as learning competencies and personal motivation. At moderate levels of inquiry use, teachers recognized that students adopted new learning roles. Teachers appeared to perceive changes in students' roles before their own but this result could be explained by recognition of the positive value of collaboration and, unexpectedly, memorization within high levels of inquiry.

Résumé

Un survol de la littérature des résultats d'élèves ayant suivi une démarche par investigation raisonnée nous a permis d'établir une liste de résultats d'étudiants avec 23 critères référentiels. Ceux-ci incluaient des résultats plus usuels, tels que la connaissance du contenu ou les habiletés procédurales, mais aussi des résultats moins souvent abordés, comme la créativité, la motivation, les habiletés à collaborer, et l'autonomie. Cette liste a été adaptée sous forme de questionnaire visant à déterminer jusqu'à quel point les divers résultats étaient perçus en classe par les enseignants dans leur auto-évaluation des divers niveaux d'utilisation (faible/moyen/élevé) de leur approche par investigation raisonnée. Des analyses ont été faites avec un échantillon de 74 individus. L'auto-analyse des enseignants de l'approche par investigation raisonnée était définitivement reliée de façon significative à la démarche par investigation de la catégorie des compétences d'apprentissage et de la motivation personnelle. Selon les enseignants, l'utilisation modérée de l'approche par investigation a permis aux élèves d'adopter de nouveaux rôles d'apprenants. Les enseignants ont semblé percevoir des changements dans le rôle des élèves avant de les constater dans leurs rangs, mais ce résultat pourrait s'expliquer par la reconnaissance de la valeur positive de la collaboration, et, de façon inattendue, de la mémorisation aux niveaux supérieurs de l'approche par investigation raisonnée.

# Chapter 1

## Introduction to the Manuscripts

This thesis is composed of two manuscripts on students' inquiry outcomes. The first manuscript, *Student Outcomes in Inquiry Instruction: A Literature-Derived Checklist*, is a literature review in which the principal goal was to catalog the diverse outcomes for students engaging in inquiry. The article presents definitions of inquiry and logically elaborates what outcomes are associated with it. The paper outlines theoretical as well as empirical sources for possible student outcomes. Science process skills and content knowledge are among student outcomes commonly researched in inquiry, but this review goes beyond these to include outcomes related to creativity, motivation, collaboration, and autonomy. No article to date has, as its primary goal, attempted to determine all the various potential student inquiry outcomes—thus, therein lies an original contribution. A criterion-referenced list of 23 categories of student outcomes was synthesized.

The second manuscript, *Teachers' Inquiry Experience Matters: Predicting Student Outcomes*, used the list of outcomes as a tool for assessing the degree to which the potential inquiry outcomes were found in actual classrooms, as judged by teachers. This paper describes an empirical study in which the literature-derived checklist was modified into a questionnaire administered to teachers, assessing to what extent various inquiry outcomes occurred in their classes, and compared this to their self-ratings as inquiry teachers. Several original contributions were made in this paper. There is little classroom instrumentation available regarding inquiry outcomes; this paper presents a questionnaire in which teachers rate inquiry features of their classes. The inquiry outcomes measured by this instrument related to teachers' inquiry level, providing initial evidence for the validity of the questionnaire. This study was also the first to look at an expanded set of inquiry outcomes through the eyes and experience of teachers.

# Chapter 2

## Student Outcomes in Inquiry Instruction: A Literature-Derived Checklist

Numerous contemporary curricular reform initiatives are built on or include elements of inquiry. These reforms focus on the teaching of specific subjects as well as across disciplines, on a provincial, state, national, or international level (International Baccalaureate Organization, 2005; International Reading Association, 2003; National Council for the Social Studies, 1994; National Council of Teachers of Mathematics, 2000; National Research Council, 1996; Québec, 2001, 2004). Because a change to inquiry-based instruction requires major effort, it is important to be able to understand what students gain from inquiry learning environments in general, as well as above and beyond traditional instruction.

Inquiry outcomes exist at the individual student or teacher level--seen in learning, attitudes, and behavior, in classrooms and schools--affecting the institutional culture and structure, and even a societal level--producing informed, interested citizens. Although outcomes of inquiry-based education have been addressed in specific contexts, no single document has, as its main objective, assembled a list of the many and varied student outcomes of inquiry engagement. We propose that such a list would be a helpful research and practical tool.

In this paper, therefore, from theoretical and empirical sources we have synthesized a consolidated list (see Table 1) of student-level inquiry outcomes. Illustrative examples are highlighted and elaborated in the overview of the literature that has generated the list of outcomes.

## Inquiry-Based Teaching and Learning

In the *National Science Education Standards* . . .

> Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations (National Research Council, 1996).

Inquiry-based education is a learner-centered form of teaching and learning that enables students to tailor their learning experiences to their own interests and curiosity. A role shift occurs between teachers and students. Power relationships become increasingly horizontal in terms of (a) communication in the classroom--encouraging dialog among teachers and students, and (b) curricular decisions--incorporating student interests and abilities into course content, pedagogy, and evaluation (Aulls & Shore, 2008). Inquiry is rooted in social-constructivist theory (Vygotsky, 1978); students learn best when they are given the opportunity to interact, ask questions and construct their own knowledge. Students are scaffolded by their teachers or by more knowledgeable peers, with whom they actively construct knowledge. Inquiry differs from traditional instruction in that the latter is more often lecture-based, teacher-directed, and highly structured (e.g., Chang & Mao, 1999; Hall & McCurdy, 1990).

Educational goals can be categorized with regard to concrete outcomes, the actual products created by students in addition to the acquisition of knowledge, understanding, and methodological skills (Tomlinson et al., 2002). Other outcomes are abstract, for example, frameworks of knowledge, ideas, problem-solving strategies, attitudes, beliefs and values, and personal and social development. Abstract educational outcomes are regarded as more enduring and transferable, whereas concrete products are not necessarily or always ends in themselves, but vehicles through which abstract outcomes can be developed and applied.

As with traditional teaching, students engaged in inquiry are expected to acquire new knowledge as a result of this experience. However, the goals of inquiry extend beyond content knowledge and other concrete outcomes to include objectives that are not always a priority in other types of instruction (Aulls & Shore, 2008). For example, students in inquiry-based learning environments are generally expected to learn how to generate questions and construct their own understanding of concepts or identify and evaluate evidence in support of an idea; these more abstract outcomes have not necessarily been traditionally promoted in the classroom.

## Student Inquiry Outcomes Derived from Theoretical Sources

The *National Science Education Standards* (NSES) identified two overarching goals or inquiry outcomes in the content standards through all grade levels: (a) abilities necessary to do scientific inquiry, and (b) understanding about scientific inquiry (National Research Council, 1996). The NSES emphasized the importance of students learning through and about inquiry as a process, requiring them to use reasoning and critical thinking as opposed to merely moving through the steps of the so-called scientific method. The skills and processes of inquiry themselves become important outcomes (e.g., Kuhn, 2005; Llewellyn, 2002; National Research Council, 2006). Through this experience, students are expected to create their own knowledge and form their own understandings of science. Ideally, students will come to closely resemble experts in some of the topics they study through inquiry, an experience which may be driven by or contribute to their interest in engaging in such tasks again in the future (Aulls & Shore, 2008). Some other common goals of inquiry are “discovery, being inquisitive, being a problem finder and problem solver, being a thinker, and doing what you can to create meaning on your own" (Aulls & Shore, 2008, p. 23).

Llewellyn (2002) offered a thorough definition and explanation of the inquiry-based science standards, and included theoretical support for many potential outcomes of inquiry in science: "As we communicate and share our explanations, inquiry helps us connect our prior understanding to new experiences, modify and accommodate our previously held beliefs and conceptual models, and construct new knowledge" (p. 16). Further,

> learning through inquiry empowers students with the skills and knowledge to become independent thinkers and lifelong learners. Teachers can encourage students to use communication, manipulation, and problem-solving skills to increase their awareness and interest in science and set them on their way to becoming scientifically literate citizens. (p. 16)

Several potential outcomes of inquiry are embedded in Llewellyn's definition, and are supported by others who have theorized about the goals of inquiry-based education (e.g., Kuhn, 2005). In contrast to the memorization of facts, learning through inquiry can help students learn about learning, and these metacognitive skills remain valuable long after students are finished school.

> The primary goal of an inquiry curriculum is to teach students to inquire and learn. If achieved, the outcome appears to be a powerful one, well worth the effort invested. Students become equipped to take charge of their own learning, choosing the questions they wish to investigate and seeking and finding answers to them. (p. 39)

Kuhn added that inquiry entails conceptual change on the part of students. She also emphasized that an important goal of engagement in inquiry should be that students understand the nature and value of inquiry itself. Only by personally recognizing the value of asking their own questions, constructing knowledge, and developing a deeper understanding, will students choose to continue to be inquirers throughout their lives.

Enhanced creative productivity in school and beyond is an important goal of inquiry that merits specific discussion. Students must be able to use their creativity in order to generate novel products and to produce knowledge as opposed to merely consuming information (Renzulli & Reis, 1985), also to pose novel questions and ways to investigate those questions, all integral components of inquiry-type education (Aulls & Shore, 2008; Llewellyn, 2002). An overarching goal is that students will be able to use classroom skills outside school as lifelong learners and active contributors to knowledge (Aulls & Shore, 2008; Kuhn, 2005; Llewellyn, 2002). This ability is important as students become adults and are expected to produce solutions to real problems in the real world, and it can be fostered through engagement in inquiry-type experiences.

Curriculum models such as the *Schoolwide Enrichment Model* (SEM) (Renzulli & Reis, 1985) provide students with the opportunity to assume the role of first-hand inquirer, and to create original products by acting like a professional. Type III enrichment activities within the SEM provide students the opportunity to pursue advanced content acquisition and process training in a self-selected area: "Investigative activities and artistic productions in which the learner assumes the role of a first hand inquirer; the student thinking, feeling and acting like a practicing professional" (p. 396). Student products should be authentic, and findings should be shared with an appropriate audience. Student interest and choice are also important components of products of Type III activities, as students engage in these activities on the basis of having demonstrated sincere interest in a particular area and a willingness to pursue the topic at an advanced level of involvement. Type III activities also aim to develop task commitment, self-confidence, and feelings of creative accomplishment. Other learning outcomes that result from programs such as the SEM may relate to the development of student interests, the acquisition of independence and self-directed learning, and a love of learning (Reis & Renzulli, 2003). The opportunity to engage in inquiry-type activities can foster the development of characteristics that help students to become better learners (Renzulli & Reis, 1985).

Another objective of Type III activities in the SEM is the development of self-directed learning skills such as planning and organization, which are similar to skills described by Costa and Kallick (2000) as habits of mind, “dispositions displayed by intelligent people in response to problems, dilemmas, and enigmas, the resolutions of which are not immediately apparent” (p. xvii). These dispositions or behaviors become second nature through experiences such as the creation of authentic products and the opportunity to act as professionals in a given field. It is not only important to acquire knowledge or information through educational experiences, but also to be able to put that knowledge to use (Aulls & Shore, 2008; Costa & Kallick, 2000).

*The Parallel Curriculum* (Tomlinson et al., 2002) also provided a curriculum model for carrying out inquiry-type learning experiences with students of all abilities, while promoting the development of high potential. These experiences, especially those embedded in its Curriculum of Practice, promote students’ abilities to understand the application of the discipline to the real world, to produce their own knowledge, and to act as professionals in the field. As with Type III activities, students are given the opportunity to engage in the creation of authentic products using the methods that professionals in a given discipline would use to investigate their own questions.

Despite the predominant focus on science education, there are also potential outcomes of inquiry involvement that apply primarily to other content areas. For example, students engaged in inquiry-based instruction in social studies may develop an increased motivation to be informed citizens, or an increased social awareness (Aulls & Shore, 2008). The ability to share ideas and work collaboratively, and the recognition of the importance of the social nature of learning, is also an important goal of this type of teaching and learning (Aulls & Shore, 2008). In addition, others have argued that broad coverage should be replaced with more depth (Newmann, 1988), a change which inquiry can promote. Educational goals evolve from memorization of large amounts of information to understanding concepts and the use of new knowledge to answer a variety of questions and ask new ones. Through inquiry, students' understanding of concepts is considered an important goal (Aulls & Shore, 2008; National Research Council, 1996).

Anecdotal reports of students' improved development in an inquiry-based learning environment also point to interesting and potentially important outcomes. Martino-Brewster (1999) provided a personal account of her experience as a sixth-grade teacher, in which she encouraged students to write about their own lives and connect school to their own experiences. Students were thus given a voice, and she observed dramatic improvements in their attitudes toward school, and their confidence that they could succeed. Such a student-centered approach contains many aspects of inquiry-based education, and provides valuable information about the importance of these practices.

## Student Inquiry Outcomes Derived from Empirical Sources

Relatively few research studies have investigated the effects of inquiry-type learning experiences, and this appears to be related to the unique goals of this form of teaching and learning (Reis & Renzulli, 2003). Nonetheless, some formal research studies have investigated the effects of inquiry-based teaching and learning on a variety of outcomes, and evidence exists for the importance of some of the curricular and theoretical outcomes presented above.

Anderson (2002) identified and summarized research on inquiry in science-education reform, including several meta-analyses and empirical studies conducted in the 1980s and early 1990s. Bredderman (1983) conducted a meta-analysis to synthesize research on the effectiveness of three major activity-based elementary science programs: (a) The *Elementary Science Study* (ESS), (b) *Science--A Process Approach* (SAPA), and (c) *The Science Curriculum Improvement Study* (SCIS). These programs contained many elements of inquiry-based teaching and learning. For example, these programs were activity-based, using experience and experimentation rather than textbooks as sources of information, and they were process-oriented. Each program was unique in terms of the emphasis on science-process and content objectives, the degree of structure, and the advocated instructional approach. ESS was the least structured, lacking predetermined objectives or detailed instructional methods. Open-ended exploration and class discussion were used to approach problems. SAPA was highly structured and focused on teaching specific science processes. Finally, SCIS aimed to develop scientific literacy through free exploration of material, introduction of new concepts, and application of the new concepts.

Bredderman's (1983) meta-analysis demonstrated that the activity-based programs were able to reach traditional curricular goals such as the acquisition of content knowledge, while also producing the value-added of other outcomes that are more unique to these nontraditional forms of science education. The overall effects of the activity-based programs on all outcome areas combined were positive, with a mean effect size of .35. When considered separately, the activity-based science programs promoted student achievement in the majority of outcome areas studied. The most positively influenced outcomes were science process, intelligence, and creativity. Other outcome areas that were positively influenced were affective outcomes, perception, language, science content, and mathematics. Students in activity-based science programs consistently outperformed their counterparts in nonactivity-based programs in all of the above outcome areas; however, the positive effects of the activity-based programs appeared to be lost when these students were subsequently enrolled in traditional programs.

A second set of meta-analyses compared the new science curricula of the 1960s with traditional curricula (Shymansky, Hedges, & Woodworth, 1990; Shymansky, Kyle, & Alport, 1983). New science curricula were classified as instruction that emphasized the nature, structure, and processes of science, integrated laboratory activities, and emphasized higher cognitive skills. Traditional curricula emphasized knowledge of scientific facts, laws, theories, and applications. Overall, new science curricula positively affected students' performance in comparison with traditional textbook-based curricula. Effects were also significantly positive in achievement, process skills, problem solving, and attitude. Therefore, acquisition of content knowledge need not be compromised in order to obtain gains in process skills or attitude.

Although the new science curricula were favored in most outcome areas, when analyzed by subject the pattern of results was somewhat unclear. Although new biology and physics curricula were effective overall, and particularly in achievement and process skills, chemistry curricula showed no positive effects. Also, biology and chemistry curricula had negative impacts on student performance in areas such as reading, mathematical computation, and writing. Shymansky and colleagues provided some possible explanations for these puzzling results, including that the new chemistry curricula may not be very different from the traditional curricula, or that teachers were not prepared to implement the new curricula. The importance of teacher in-service was highlighted, because student performance was significantly enhanced when curriculum implementation was accompanied by special teacher in-service. This point has been made by several authors (e.g., also Anderson, 2002; Barrow, 2006), and is important in terms of understanding the practical concerns of implementing a complex form of instruction such as inquiry. Teachers require support in applying inquiry-based teaching and learning (Flick, 1995), and they also must be given the opportunity to engage in inquiry activities themselves before using them with their students (Barrow, 2006).

Overall, the Shymansky et al. (1990) meta-analysis provided further support for the use of inquiry-based types of instruction for promoting students' achievement in many outcome areas. An interesting finding raised by both meta-analyses was that the nontraditional forms of instruction provided the greatest positive impact for under-privileged students. This is important in terms of providing support for the use of these instructional practices in rural and inner-city school settings.

The content area most frequently studied in empirical studies in relation to inquiry outcomes is science, not unexpectedly given that the core qualities of inquiry resemble those of scientific thinking and practice. In addition to the meta-analyses described above, studies have examined the effect of inquiry instruction on particular student outcomes.

Basaga, Gebain, and Tekkaya (1994) emphasized process skills as a major goal of science instruction in their study of the effects of inquiry teaching on biochemistry and science process-skill achievements with university science-education students. Participants were randomly assigned to an experimental group (inquiry approach in the laboratory plus classroom activities) and a control group (traditional approach in the laboratory plus classroom activities). The inquiry laboratory required students to design an experiment that would provide a solution to a presented problem. They were given the opportunity to practice problem-solving skills such as defining problems, forming hypotheses, and interpreting data. In the traditional laboratory, students were asked to follow a written procedure to verify predetermined results. Students' prior biochemistry achievement and science process skills were not significantly different between the two groups at the beginning of the study. However, following the intervention, students who had engaged in inquiry laboratories performed better on a biochemistry content achievement test and on a process-skill test than students who engaged in traditional laboratories.

Other research also supported claims that student achievement is improved through inquiry. Hall and McCurdy (1990) randomly placed university students studying introductory general biology in two treatment groups. The experimental treatment consisted of an inquiry-oriented *Biological Sciences Curriculum Study* (BSCS)-style laboratory approach that emphasized basic and integrated science processes, concept development through extensive questioning, and increased student discretion. The control group engaged in a traditional approach that was highly structured, more prescriptive, and contained teacher-oriented activities. Following the intervention, students using the BSCS-style laboratory scored significantly higher than students in the traditional laboratory on a test of biology content achievement. In addition to outcomes that are related to knowledge or skill, inquiry also provides an opportunity for students to develop affectively. For example, students' self-esteem, confidence, and sense of accomplishment can be improved through engagement in inquiry (Bredderman, 1983; Renzulli & Reis, 1985).

Actual students' and teachers' behavior during inquiry have also been evaluated. Cianciolo, Bory, and Atwell (2006) reported that inquiry-process behaviors such as solving problems, reflecting on work, and drawing conclusions occurred more frequently during inquiry-based activities than during traditional teaching methods at the university level. Other investigations into the effectiveness of inquiry-based activities have focused on even more specific outcomes such as particular skills or conceptual understanding of a certain topic. For example, problem-solving performance on both qualitative (synthesis) and quantitative (analysis) problems was superior for university students engaged in an inquiry-based physics course versus a traditional physics course (Thacker, Kim, & Trefz, 1994). The inquiry approach used in that study, *Physics by Inquiry*, it emphasized conceptual understanding rather than quantitative problem solving. Inquiry-based instruction was superior to traditional instruction; inquiry students, who coincidentally started with less prior knowledge of physics than the other groups, outperformed the others on both quantitative and qualitative problems. In another study, grade 4 students who engaged in inquiry-oriented activities along with the use of Microcomputer-Based Laboratories had significantly better graphing skill, interpretation, and conceptual understanding than students who had engaged in traditional laboratory methods or Microcomputer-Based Laboratories without inquiry (Nicolaou, Nicolaidou, Zacharia, & Constantinou, 2007). Although the study focused on the use of Microcomputer-Based Laboratories in enhancing students' ability to interpret graphical representations, students benefited most when these laboratories were used in conjunction with inquiry-based methods.

Other research has identified discovery learning as more effective than direct instruction in terms of promoting fourth-grade students' specific *control of variables* strategy over an extended period of time (Dean & Kuhn, 2006). Although *discovery* in that study was primarily viewed as practicing problems over time, it did provide evidence for the role of one aspect of inquiry instruction in developing a particular skill, namely control of variables.

Another important potential outcome that has been considered empirically is students' attitudes toward the subject matter or toward learning in general. Elementary students' attitudes toward science were greatly enhanced in inquiry-oriented, process-approach, science classes in comparison to students in textbook-oriented science (Kyle, Bonnstetter, & Gadsden, 1988). Students responded to questions addressing topics such as whether they wished they had more time for science in school and whether the science they learned was useful in their daily lives. In addition, students in the treatment group were equally able to respond correctly to eight common scientific terms, an indication that they were not disadvantaged in terms of specific science achievement. Others also found that students who were part of the *Science Curriculum Improvement Study* (SCIS) also more greatly enjoyed science than did their non-SCIS counterparts (Lowery, Bowyer, & Padilla, 1980). Studies of science classes have found a similar positive relationship between inquiry and positive attitude towards the subject matter. These studies have included aspects of inquiry such as high levels of cooperation and collaboration (Chang & Mao, 1999), high levels of experimentation (Ornstein, 2006), as well as incorporation of students' life experiences and increased responsibility in learning for students (Ebenezer & Zoller, 1993). This change in attitude may persist over time (Ebenezer & Zoller, 1993). Despite the large amount of support for inquiry's positive influence on student attitudes, other studies found no significant differences between groups in attitude toward biology (Hall & McCurdy, 1990).

The effects of inquiry-oriented approaches to science learning have also been studied in relation to special-education classrooms. Scruggs, Mastropieri, Bakken, and Brigham (1993) used a counterbalanced design in which 26 junior high school students with learning disabilities received both textbook-based and inquiry-oriented science instruction. Students scored higher on both immediate and one-week delayed recall tests after having been taught with activity- and inquiry-oriented instruction. In addition, students overwhelmingly preferred the inquiry-oriented condition: They enjoyed it more, it prompted them to try harder, helped them to learn more, and they would prefer to do it again more so than the textbook-based condition. Learning-disabled students may benefit from inquiry-based teaching and learning in ways similar to their normally or high achieving peers.

Research has not always focused on open inquiry in which students generate their own problems to investigate. For example, Pine and Aschbacher (2006) reported no significant difference in ability to successfully carry out investigations between fifth graders in either hands-on or textbook-based science classes. The authors speculated that the extent or quality of hands-on instruction, which may not have gone beyond a recipe-like approach, could have brought about both groups' relatively poor performance in carrying out these tasks. They recommended that teachers need more preparation in order to effectively implement hands-on science curricula that will develop students' inquiry skills. The type of instruction investigated did not involve the component of inquiry in which students define their own problem or question to answer. Thus, although the literature on inquiry in science is the source of a great deal of information about outcomes, the form of inquiry that includes the important step of problem-generation requires further investigation. The outcomes of open inquiry might be expected to be somewhat different from its more guided forms. Unfortunately, a great deal of hands-on science instruction may stop at the point of following a cook-book procedure, and this results in a lack of research regarding forms of inquiry that more closely match the goals of the NSES and other recommendations for how this type of instruction can be most beneficial. Although teachers are in need of concrete information about how to successfully use inquiry with their students, literature on the higher-order cognitive goals of the process of inquiry is essential.

**Curriculum Other than Science**

Inquiry outcomes have been investigated, although to a lesser degree, in subjects other than science. For example, the study of critical thinking as an important outcome of inquiry-based education has also been studied within art (Lampert, 2006) and nursing education (Magnussen, Ishida, & Itano, 2000). Lampert (2006) reported that university-level fine-arts students scored significantly higher than non-arts students on truth-seeking, critical thinking maturity, and open-mindedness. Although Magnussen, Ishida, and Itano (2000) were not able to demonstrate clearly whether students who have experienced inquiry-based learning in nursing curriculum demonstrate growth in critical-thinking ability overall, they were able to conclude that students who initially had the lowest critical-thinking scores showed significant improvement after engaging in inquiry-based curriculum. Another study provided evidence that nursing students who engaged in problem-based learning had significantly higher overall critical-thinking disposition scores when compared to students who attended lectures (Tiwari, Lai, So, & Yuen, 2006). Problem-based learning (PBL) is a particular form of inquiry-based instruction in which students learn through solving complex problems (Hmelo-Silver, 2004). The general goals of PBL include helping students "1) construct an extensive and flexible knowledge base, 2) develop effective problem-solving skills, 3) develop self-directed, lifelong learning skills, 4) become effective collaborators, and 5) become intrinsically motivated to learn" (p. 240). Empirical support exists for the effectiveness of PBL in helping students reach these goals, although most research has occurred in the domains of medicine and gifted education. For example, when compared to graduates of a conventional medical school, graduates from a problem-based learning school ranked themselves significantly higher on 14 of 18 professional competencies in the interpersonal, cognitive, and work-related skills domains (Schmidt, Vermeulen, & van der Molen, 2006).

**Creativity**

The development of creativity is another important goal of inquiry-based education. In a study that examined the effects of the *Revolving Door Identification Model* (RDIM), seventh and eighth grade students who carried out Type III projects were more likely to generate creative products outside of school (Starko, 1988). They also felt that this experience helped them to improve their research skills and had an effect on their career goals. Students who took part in this study had participated in RDIM programs for four years or longer, and were compared with matched students who had been identified for a gifted program but who had not yet received services. Gifted high-school students also reported that the opportunity to develop creative projects helped them improve the quality of their investigations, explore potential careers, and enhance their personal characteristics (Delcourt, 1993). Students who feel they make significant contributions through their creative work were also more likely to continue engaging in these types of activities in the future (Delcourt, 1993). Although the research of Starko and Delcourt focused on gifted or highly-able students, similar instructional activities with students with a wide range of ability levels could conceivably produce comparable results.

## Barriers to Positive Outcomes of Inquiry Participation

Although there is only a small amount of empirical research to support specific benefits or outcomes of inquiry-based teaching and learning methods, especially outside of science education, there is virtually no evidence that such methods are detrimental to students in any way. One concern about the use of inquiry has been that the acquisition of content knowledge will be neglected in favor of developing process skills or enhanced attitudes. The research summarized above indicates that, not only is content knowledge not hindered, but it may actually be enhanced through engagement in inquiry along with a number of other outcomes (e.g., Bredderman, 1983; Kyle et al., 1988; Shymansky et al., 1990; Shymansky et al., 1983). A potential drawback of one particular form of inquiry, discovery learning, is that without sufficient teacher guidance, students may learn factual information inaccurately (Aulls & Shore, 2008) because in discovery students ask and answer their questions with the highest level of autonomy (Keegan, 1993). This is less likely to be the case with other types of inquiry instruction in which teachers begin by providing students with important information, such as directed discovery or guided inquiry, likely optimal levels of autonomy (Aulls & Shore, 2008). Flick (1995) suggested that some direct instruction is needed in addition to inquiry-based strategies. This may be especially true with younger children or those who struggle academically. Students' lack of prior knowledge may be conceived as a barrier to the implementation of inquiry, although the use of inquiry-oriented methods does not negate the teaching of background information.

Other barriers exist which make inquiry-based teaching and learning a challenge for teachers and learners in some circumstances. Teachers may experience anxiety due to the open-ended nature of the task, especially if they have not experienced inquiry themselves as a student. Open-ended tasks may also be anxiety-provoking for students, and they may avoid risks by remaining off-task (Starko, 2008). These and other barriers, in different contexts, are discussed in more detail by Shore, Aulls, and Delcourt (2008).

Another concern about the use of inquiry-based teaching and learning practices has been that, while they are associated overall with higher science achievement, this instructional approach (as with others) does not affect all students equally or in the same ways (VonSecker, 2002). Of particular concern was that "these practices are as likely to exacerbate achievement gaps among some groups of students as they are to narrow them among others" (p. 159). Meta-analyses (Bredderman, 1983; Shymansky et al., 1990) provide evidence, however, that disadvantaged students may benefit at least as much as other students from inquiry-type science instruction. Germann (1989) also concluded that an inquiry-based approach, *Directed-Inquiry Approach to Learning Science Process Skills and Scientific Problem Solving* (DIAL(SPS)2), was more effective with students with lower cognitive development than with higher cognitive development. However, the results of that comparison should be interpreted with caution because students with average aptitude were assigned to the treatment group, whereas those who made up the comparison group had above-average aptitude. Students with both average and above-average aptitude were not present in both types of treatment.

## Conclusion

From the theorizing and research presented, the proposed outcomes for students who engage in inquiry are extensive--reaching well beyond acquisition of content knowledge. Table 1 summarizes the findings from the literature review including theoretical sources and overarching goals of inquiry as well as empirical studies of inquiry assessing measurable outcomes. Each outcome criterion is matched to sources from the literature. The left column lists the inquiry-outcomes categories, and the right column provides a reference or references for each. All references, primary and secondary, from the text and table are listed together in the reference list.

Table 1

*Literature-Referenced List of Student Inquiry-Participation Outcomes*

| | Inquiry Outcome Categories | References |
|---|---|---|
| *1* | Acquisition of facts or knowledge | Anderson & Burns (1989) cited by Aulls & Shore (2008) p. 9<br>Aulls & Shore (2008), pp. 15, 143, 148, 176, 284<br>Basaga, Gebain, & Tekkaya (1994)<br>Bredderman (1983)<br>DeBoer (1991) cited by Aulls & Shore (2008) p. 215<br>National Research Council (1996)<br>Newmann (1988)<br>Schön (1992) cited by Aulls & Shore (2008) p. 4<br>Zachos, Hick, Doane, & Sargent (2000) |
| *2* | Learn process, the “how-to” | Anderson & Burns (1989) cited by Aulls & Shore (2008) p. 9<br>Aulls & Shore (2008) pp. 195, 208, 236<br>Bredderman (1983)<br>Llewellyn (2002) p. 16<br>National Research Council (1996) pp. 105, 121<br>Schön (1992) cited by Aulls & Shore (2008) p. 4<br>Shymansky, Hedges, & Woodworth (1998)<br>Shymansky, Kyle, & Alport (1983) |

| | | |
|---|---|---|
| *3* | Understanding about the nature of the content area (e.g., scientific literacy) | DeBoer (1991) cited by Aulls & Shore (2008) p. 215<br>Llewellyn (2002) p. 10<br>National Research Council (1996) p. 105<br>Zachos, Hick, Doane, & Sargent (2000) |
| *4* | Understanding of the nature and value of inquiry | Kuhn (2005) pp. 59, 77<br>National Research Council (1996) p. 121 |
| *5* | Positive attitude toward subject or learning | Aulls & Shore (2008), p. 207<br>Chang & Mao (1999)<br>Ebenezer & Zoller (1993)<br>Kyle, Bonnstetter, & Gadsen (1988)<br>Lowery, Bowyer & Padilla (1980)<br>Martino-Brewster (1999)<br>Massialas (1969) cited by Aulls & Shore (2008) p. 4<br>Ornstein (2006)<br>Shymansky, Hedges, & Woodworth (1990)<br>Shymansky, Kyle, & Alport (1983)<br>Sunal, Sunal, Whitaker, Odell, & MacKinnon (2003) cited by Aulls & Shore (2008), p. 230 |
| *6* | Learn how to learn or lifelong learning | Aulls & Shore (2008) pp. 2, 284<br>Brown (1990) cited by Aulls & Shore (2008) p. 233<br>Kuhn (2005) p. 39<br>Llewellyn (2002) p. 16<br>Traugh (1974) cited by Aulls & Shore (2008) p. 148 |
| *7* | Understanding concepts (vs. memorizing facts) | Aulls & Shore (2008) pp. 15, 147, 194<br>National Research Council (1996) p. 105<br>Wade (1995) cited by Aulls & Shore (2008) p. 149 |

| | | |
|---|---|---|
| *8* | Development of intellectual or thinking skills | Anderson & Burns (1989) cited by Aulls & Shore (2008) p. 9 |
| | | Aulls & Shore (2008) pp. 15, 155, 206, 207, 215, 236, 249 |
| | | Bredderman (1983) |
| | | Brown (1990) cited by Aulls & Shore (2008) p. 233 |
| | | Hall & McCurdy (1990) |
| | | Kuhn (2005) p. 39 |
| | | Lampert (2006) |
| | | Llewellyn (2002) p. 16 |
| | | Magnussen, Ishida, & Itano (2000) |
| | | Massialas & Cox (1966) cited by Aulls & Shore (2008) p. 158 |
| | | Tiwari, Lai, So, & Yuen (2006) |
| *9* | Improved achievement | Chang & Mao (1999) |
| | | Scruggs, Mastropieri, Bakken, & Brigham (1993) |
| | | Shymansky, Hedges, & Woodworth (1990) |
| | | Shymansky, Kyle, & Alport (1983) |
| | | VonSecker (2002) |
| | | Wise & Okey (1983) |
| *10* | Enhanced creativity | Bredderman (1983) |
| | | Shymansky, Kyle, & Alport (1983) |
| *11* | Problem-solving skills | Anderson & Burns (1989) cited by Aulls & Shore (2008) p. 9 |
| | | Aulls & Shore (2008) p. 23 |
| | | Delcourt (1993) |
| | | Shymansky, Hedges, & Woodworth (1990) |
| | | Starko (1988) |
| | | Thacker, Kim, & Trefz (1994) |

| | | |
|---|---|---|
| *12* | Motivation to be informed citizens, increased social awareness and action | Aulls & Shore (2008) p. 190, 195, 206, 207<br>Brown (1990) cited by Aulls & Shore (2008) p. 233<br>Janzen (1995) cited by Aulls & Shore (2008) p. 190<br>Massialas & Cox (1966) cited by Aulls & Shore (2008) p. 158<br>Newmann (1988)<br>Osborne & Seymour (1988) |
| *13* | Change in teacher and student roles, increased student ownership | Aulls & Shore (2008) pp. 14, 106, 234<br>Crawford (2000) cited by Aulls & Shore (2008) p. 243<br>Kuhn (2005) p. 39 |
| *14* | Ability to see concepts as related | Aulls & Shore (2008) pp. 129, 176, 205, 206, 284<br>Llewellyn (2002) p. 16 |
| *15* | Generation of questions, curiosity | Aulls & Shore (2008) pp. 15, 23, 153, 158<br>Kuhn (2005) p. 57<br>Llewellyn (2002) p. 16 |
| *16* | Self-esteem, self-confidence | Aulls & Shore (2008) p. 15<br>Bredderman (1983)<br>Martino-Brewster (1999)<br>Renzulli & Reis (1985)<br>-ch. Reis & Renz too? |
| *17* | Social nature of learning | Aulls & Shore (2008) pp. 15, 175, 176, 182, 205, 208 |
| *18* | Construction of knowledge | Aulls & Shore (2008) p. 23<br>Kuhn (2005) p. 39<br>Llewellyn (2002) p. 16 |
| *19* | Development of personal skills (e.g., planning and organization), habits of mind | Bredderman (1983)<br>Costa & Kallick (2000)<br>Renzulli & Reis (1985) |
| *20* | Application of knowledge or Information | Aulls & Shore (2008) pp. 176, 284 |

| | | |
|---|---|---|
| *21* | Emulate professionals, create authentic products | Bruner (1960/1963) p. 14<br>Kuhn (2005) p. 39<br>Renzulli & Reis (1985)<br>Tomlinson, Kaplan, Renzulli, Purcell, Leppien, & Burns, (2002) |
| *22* | Motivation, task commitment | Renzulli & Reis (1985) |
| *23* | Development of expertise | Aulls & Shore (2008) p. 173 |

*Note: Page numbers are given for sources that address multiple topics.*

# Chapter 3

## Linking Text

The literature-derived checklist (Table 1) was developed and initially used in a dissertation study assessing students' perceptions of inquiry outcomes (Saunders-Stewart, 2008). The categories on the checklist were converted to a student-administered questionnaire. The findings of this study are briefly outlined in Chapter 4.

The following manuscript, *Teachers' Inquiry Experience Matters: Predicting Student Outcomes*, details a study assessing teachers' perceptions of student inquiry outcomes as a follow-up to the original study with students. This study used a different population to address the same question—are the theorized student inquiry outcomes present in actual classrooms? In addition, this study asked two other research questions: (a) Are similar outcomes perceived by teachers and students? (b) Are there observable patterns of differences in the relations between the reported student outcomes and teachers' level of inquiry? Examining the pattern of differences provides insight into a potential trajectory of development as an inquiry classroom—which features or outcomes develop first and which ones take longer to achieve.

This study used a teacher population to describe their experiences with inquiry and the classroom dynamics. The questionnaire from the original study with students was adapted to be completed by teachers about their classrooms. Seven additional items were added to the teacher questionnaire based on unpublished data from an ongoing study in which conversations were held with teachers about their understandings of inquiry.

# Chapter 4

## Teachers' Inquiry Experience Matters: Predicting Student Outcomes

Inquiry-based educational approaches are being widely implemented across North America (e.g., Québec Education Program, 2001, 2004) and internationally (e.g., International Baccalaureate Organization, 2005). In inquiry, students play an active role in learning and teachers shift their role to act as facilitators (Aulls & Shore, 2008). Inquiry is a learner-centered approach aimed at creating more authentic learning environments, engaging students in the process of seeking meaningful questions, and then guiding them through the process of solving the problems and communicating their results. Inquiry is based on social-constructivism, thus dialog and collaboration are incorporated into the learning environment (Vygotsky, 1978).

## Learner Outcomes in Inquiry

Numerous benefits are claimed for students in inquiry learning (Saunders-Stewart, Gyles, & Shore, 2010), although not all of these benefits have been supported empirically. Good, Farley, and Fenton (1969) empirically supported several inquiry outcomes in a three-year longitudinal study of 190 grade eight students. Students were selectively admitted to the study based on teacher recommendations and IQ scores, then randomly assigned to either an inquiry-based social-studies curriculum or a control curriculum. The inquiry curriculum was focused on developing students' abilities to recognize problems from data, formulate hypotheses and analytical questions, gather and analyze data, and modify hypotheses, if necessary. The control curriculum was the standard social-studies curriculum for the city. After three years of participating in the study, students exposed to the inquiry curriculum scored higher in inquiry skills than those in the control group. These student-inquiry outcomes were related to critical thinking and learning how to learn, and included making generalizations that would logically follow from a hypothesis, recognizing sources likely to find relevant information, and filtering through information to recognize data relevant to the hypothesis.

Wheeler and Ryan (1973) looked at interpersonal and motivational outcomes in addition to learning skills in relation to social-constructivist features of inquiry. Eighty-five fifth- and sixth-grade students were randomly grouped into a cooperation condition (using group work with an inquiry-based social-studies unit), a competition condition (doing independent work with an inquiry-based social-studies unit), and a control condition (working with a noninquiry social-studies unit). Students in both inquiry groups had outcomes related to inquiry-based learning competencies such as finding a problem, developing hypotheses, finding and evaluating evidence, testing the hypothesis, and developing a conclusion. In addition to these inquiry skills, students in the cooperation condition were also found to prefer working in groups and to enjoy social studies significantly more than students in the competitive condition.

In addition to empirical study, educational philosophers and psychologists have attested to many potential benefits of inquiry for students. Newmann (1988) argued the benefit of inquiry for in-depth coverage of concepts, as opposed to a surface-level coverage of a broad range of information. Deep understanding facilitates long-term retention and ease in transfer of knowledge. Students are able to use this knowledge to answer questions and ask new ones, applying it to new situations or new domains. Aulls and Shore (2008) described how, through effective inquiry instruction as opposed to exclusive use of repetition (e.g., worksheets with many similar problems), students achieve a deeper understanding of the material and how units of the curriculum are related to one another through content and skills.

There is a distinction between observed and perceived learner outcomes. Certain hypothesized and studied inquiry outcomes lend themselves to direct observation. For example, learned content knowledge or skills may be measured through tests or observation. On the other hand, several hypothesized student outcomes of inquiry are difficult to observe, such as attitudes or motivation, and are more easily measured through perceived experience.

Saunders-Stewart, Gyles, and Shore (2010), explored the potential outcomes of students engaging in inquiry. A number of student outcomes were identified in the literature with either theoretical or empirical bases. These outcomes were grouped into 23 categories and compiled into a criterion-referenced list of student outcomes of engaging in inquiry and are listed below.

- Acquisition of facts or knowledge (Aulls & Shore, 2008; Bredderman, 1983; National Research Council, 1996)
- Learn the process; the "how to" (Anderson & Burns, 1989; Llewellyn, 2002; Shymansky, Kyle, & Alport, 1983)
- Understanding about the nature of the content area, e.g., scientific literacy (DeBoer, 1991; National Research Council, 1996)
- Understanding the nature and value of inquiry (Kuhn, 2005; National Research Council, 1996)
- Positive attitude toward subject or learning (Ebenezer & Zoller, 1993; Martino-Brewster, 1999)
- Learn how to learn or lifelong learning (Aulls & Shore, 2008; Kuhn, 2005; Llewellyn, 2002)
- Understanding concepts vs. memorization of facts (Aulls & Shore, 2008; National Research Council, 1996; Newmann, 1988)
- Development of intellectual or thinking skills (Aulls & Shore, 2008; Bredderman, 1983; Magnussen, Ishida, & Itano, 2000)
- Improved achievement (Scruggs, Mastropieri, Bakken, & Brigham, 1993; Shymansky, Kyle, & Alport, 1983; Wise & Okey, 1983)
- Enhanced creativity (Bredderman, 1983; Shymansky, Kyle, & Alport, 1983)

- Problem solving skills (Thacker, Kim, & Trefz, 1994)
- Motivation to be informed citizens, increased social awareness and action (Aulls & Shore, 2008; Janzen, 1995)
- Change in teacher and student roles, increased student ownership (Aulls & Shore, 2008; Crawford, 2000)
- Ability to see concepts as related (Aulls & Shore, 2008; Llewellyn, 2002)
- Generation of questions, curiosity (Aulls & Shore, 2008; Kuhn, 2005; Llewellyn, 2002)
- Self-esteem, self-confidence (Martino-Brewster, 1999; Renzulli & Reis, 1985)
- Social nature of learning (Aulls & Shore, 2008; Wheeler & Ryan, 1973)
- Construction of knowledge (Aulls & Shore, 2008; Kuhn, 2005; Llewellyn, 2002)
- Development of personal skills (e.g., planning and organization), habits of mind (Bredderman, 1983; Costa & Kallick, 2000; Renzulli & Reis, 1985)
- Application of knowledge or information (Aulls & Shore, 2008)
- Emulate professionals, create authentic products (Bruner, 1960, 1963; Renzulli & Reis, 1985; Tomlinson, Kaplan, Renzulli, Purcell, Lepien, & Burns, 2002)
- Motivation, task-commitment (Renzulli & Reis, 1985)
- Development of expertise (Aulls & Shore, 2008)

Saunders-Stewart (2008) studied the extent to which these diverse potential outcomes occurred in actual classrooms, as perceived by students. The criterion-referenced list of student inquiry outcomes was adapted into a student-administered questionnaire and given to a sample of 181 students from grades 8 to 10, in which students ranked how true each statement was of their classes. Three groups (least, middle, and most) were compared, varying in level of inquiry as derived from teacher interviews based on criteria for inquiry instruction by Llewellyn (2002). The outcomes were grouped into four components with a Principal Components Analysis: (a) learning competencies—cognitive and affective learning competencies and predispositions, (b) personal motivation—student motivation and creativity, (c) student role—students' involvement and responsibility in the learning process, and (d) teacher role—traditional, noninquiry, teacher roles (e.g., emphasizing memorization of facts). Although teacher role may be considered a teacher outcome as opposed to a student outcome, this category also signals the role shift that takes place in inquiry, in which teachers and students have shared responsibility in learning and shared agendas. Certain items were excluded from the components due to low loadings or multiple loadings. Students in the groups higher in inquiry responded significantly higher on the three inquiry components (learning competencies, personal motivation, and student role), and lower on the noninquiry component (teacher role). Inquiry-based classes were associated with the theorized student-inquiry outcomes, as perceived by students. Specifically, in the learning-competencies component, students in the most-inquiry group responded significantly higher than the middle- and least-inquiry groups. In the personal motivation component, the most-inquiry group responded higher than the middle-inquiry group. For the student-role component, students responded significantly higher in the most-inquiry group than in the middle- and least-inquiry groups. Finally, for the teacher-role component, students in the least- and middle-inquiry groups responded significantly higher than those in the most-inquiry group.

Teachers may add an additional perspective beyond that of students in examining classroom outcomes. Teachers are more aware of the goals of the class and, thus, may be more aware of the outcomes. Ultimately, there is a need for direct observation, but classroom observation without self-report risks finding a limited set of outcomes that are situation-specific. There are constraints in observing behaviors that take place infrequently or over a long period of time. Moreover, there are issues in using behavioral indicators to approximate the unobservable, such as attitudes and dispositions—these do not always directly impact behavior (Bagozzi, 1992). Teacher reports can bypass some of the problems associated with observational approaches. Various factors influence accuracy and reliability of direct observation (e.g., frequent vs. infrequent behaviors, number of categories in a rating system, inter-rater reliability) (Mash & McElwee, 1974; Mitchell, 1979; Reid, 1970). Saunders-Stewart (2008) assessed the many broad and diverse possible student outcomes of inquiry as identified by students. The current study assessed student-inquiry outcomes as perceived by teachers.

The research questions of this study are as follows:

- To what extent do various student outcomes of inquiry exist in classrooms, as perceived by teachers working at differing levels of inquiry?
    - Are similar outcomes perceived by teachers and students?
- Are there observable patterns of differences in the relations between the reported student outcomes and teachers' level of inquiry?

## Methodology

### Participants

Ninety-eight participants were recruited through schools in the Montreal area and through workshops given in the Faculty of Education at McGill University. Participants consisted of teachers currently teaching at primary or secondary schools, and students, at the graduate or undergraduate level, with teaching experience at all levels.

Teachers currently teaching in schools were recruited on the basis of inquiry use. Two groups of teachers were recruited through part of a larger study on inquiry, in which member of a research team regularly meet with teachers from two schools, engaging in conversations on barriers to implementing inquiry. The two schools are at differing levels of inquiry: (a) a self-described noninquiry secondary school, and (b) a primary school in the process of becoming an inquiry school—currently undergoing the requirements of becoming an International

Baccalaureate (IB) school. Another group of teachers was recruited through an inquiry-based educational summer program with children aged 4 to 18, designed to incorporate student interests and take a hands-on approach.

Teachers from the education workshops were recruited through guest sessions on inquiry given in graduate and undergraduate courses. Students in the education workshops were asked to indicate subject and level taught and their data were excluded from the study if they expressed that they had no teaching experience.

**Instruments**

**McGill Outcomes of Inquiry Instruction Questionnaire: Teachers' Perspectives.** This questionnaire was adapted from the study addressing inquiry outcomes from students' perspectives (Saunders-Stewart, 2008). The 24 items (with 19 subitems, total 43) of the original questionnaire were reworded to take a teacher's perspective of various behaviors and attitudes for the students in their classroom. Questions that addressed the students as "you" were changed to address teachers and "the students," as well "in your judgment" was added as a preface to each question (e.g., In your judgment, to what extent are the students expected to be problem-finders in this class?). The questionnaire contains questions in a seven-point Likert scale format (1—not at all, 2—a little bit, . . . 7—completely), as well as open response format questions. The questionnaire begins with an open response section requesting a personal definition of inquiry. The items from the original student version of the questionnaire were created based on a criterion-referenced list of 23 student outcomes of inquiry engagement, in turn derived from a literature review of theoretical and empirically based student inquiry outcomes (Saunders-Stewart, Gyles, & Shore, 2010). Seven additional items were added to the teacher questionnaire, based on unpublished data from an ongoing study being conducted in the High Ability and Inquiry Research Group. These qualitative data were obtained from conversations with teachers at schools, either well established in inquiry use or in the process of adopting an inquiry approach, discussing possible student benefits from inquiry. An additional item was added to the teacher questionnaire assessing, in the teachers' judgment, the extent to which they used inquiry instruction in their classrooms. This item was used to group the teachers by level of inquiry.

**Procedure**

Questionnaires were administered in groups to the participating teachers working at the two schools in the larger study. Questionnaires were completed independently then used as a tool for discussion of various aspects of inquiry occurring in classes. In the education workshops, questionnaires were given out at the beginning of the workshop. Students were told they could complete the questionnaires for the exercise and they could fill out a consent form for their data to be used in the study, if they chose to. Basic demographic information was obtained from participants on the consent forms to determine if their data were eligible to use in the study (namely, if he or she had past teaching experience). Students were given time to complete the questionnaires independently and then the questionnaire was used as a tool to invoke discussion about inquiry. The final group of participants from the educational summer program was given the questionnaires at their school and completed the questionnaires independently. There was no compensation for participation in this study.

**Analysis**

Of the 98 initial participants, 18 were excluded from the Education workshop sample because they had no teaching experience. Five were excluded because the self-rating of inquiry item was not completed. Two more were excluded because of excess missing data in which entire, apparently random, pages of the questionnaire were left unfilled. The missing data in these cases appeared to meet the Missing Completely At Random (MCAR) criterion, in which case it is appropriate to use case deletion (Scheffer, 2002). Series mean imputation was used as a conservative estimate to fill in univariate outliers and the remaining missing data, which were less than 5% per variable (Tabachnick & Fidell, 2007). Self-rating of inquiry use was ranked on a seven-point Likert scale. Groups were created by portioning the sample according to high, middle, and low self-ratings of inquiry use. The analyses were completed with a total sample size of $N = 74$, $n_{\text{Low}} = 30$, $n_{\text{Middle}} = 18$, and $n_{\text{High}} = 26$.

A Multivariate Analysis of Variance (MANOVA) was performed on four dependent variables--learning competencies, personal motivation, student role, and teacher role, with teachers' self-rating of inquiry as the independent variable. Tukey HSD *post hoc* tests were performed as conservative estimated (Tabacknick & Fidell, 2007) of the specific relationships between group membership in self-rating of inquiry use and ranking of the inquiry outcomes. Forty-three one-way Analyses of Variance (ANOVAs) were performed with Tukey HSD post hoc tests, with self-rating of inquiry as the independent variables and each questionnaire item as a dependent variable. The MANOVA controls for inflated Type I error with multiple dependent variables. Although running multiple ANOVAs increases the risk of Type I error, this was performed to enable an item-by-item analysis of which questionnaire items were more or less strongly related to self-rating of inquiry use, thereby providing additional information to the results of the MANOVA. Additionally, this allowed us to look at questionnaire items, outside the four components, that were added in the present study.

## Results

Table 2 contains descriptive information for the sample.

Table 2

*Descriptive Information about the Teacher Participants*

| Level of Instruction | *n* | Subject | *n* | Teaching Experience | *n* |
|---|---|---|---|---|---|
| Elementary | 40 | French/English/Language Arts | 26 | Classroom Teacher | 42 |
| Secondary | 22 | Math/Science | 22 | Resource or one-on-one tutor | 13 |
| University | 3 | Both French/English and Math/Science | 7 | Field placement/Substitute | 5 |
| Unknown | 9 | Other/Unknown | 19 | Unknown | 14 |
| Total *N* | 74 | Total *N* | 74 | Total *N* | 74 |

A MANOVA with teachers' self-rating of inquiry use as the independent variable (IV) and the four components of student-inquiry outcomes as the dependent variables (DVs) was performed. Normality, homogeneity of variance-covariance matrices, linearity, and multicollinearity were confirmed. The omnibus multivariate *F* test was significant with Wilks's Lambda (Λ) criterion ($\Lambda = .444$, $F(8, 136) = 28.526$, $p < .001$, $\eta_{partial}^2 = .334$), indicating that the combined inquiry outcome DVs were significantly related to self-rating of inquiry use. Reporting of partial eta-squared values should not be done with qualitative descriptors as is done with classic effect-size estimates (Cohen, 1988), although effect sizes in educational research are often on a smaller scale compared to other fields (Valentine & Cooper, 2003). The univariate *F* tests were significant for all four DVs: learning competencies ($F = 34.028$, $p < .001$, $\eta_{partial}^2 = .489$), personal motivation ($F = 20.011$, $p < .001$, $\eta_{partial}^2 = .360$), student role ($F = 12.930$, $p <$

.001, $\eta_{partial}^2$ = .267), and teacher role ($F$ = 5.267, $p$ = .007, $\eta_{partial}^2$ = .129). Graphs of DVs, including means, are displayed in Figures 1 to 4.

Tukey HSD *post hoc* test results are presented in Table 3. For both the learning-competencies and personal-motivation components, the high self-rating-of-inquiry group mean was significantly higher than for the middle and low groups, and the mean of the middle group was significantly higher than that of the low group. For the student-role component, the high and middle self-rating-of-inquiry groups scored significantly higher than the low group. The middle and high groups did not differ significantly. For teacher role, the high inquiry group scored higher than the middle and low groups. The middle and low groups did not differ significantly.

Figure 1

*Graph of Self-Rating of Inquiry by Learning Competencies*

Figure 2

*Graph of Self-Rating of Inquiry by Personal Motivation*

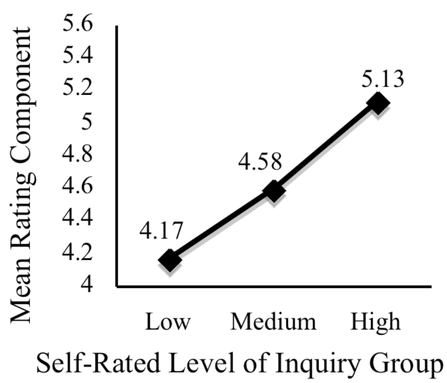


Figure 3

*Graph of Self-Rating of Inquiry by Student Role*

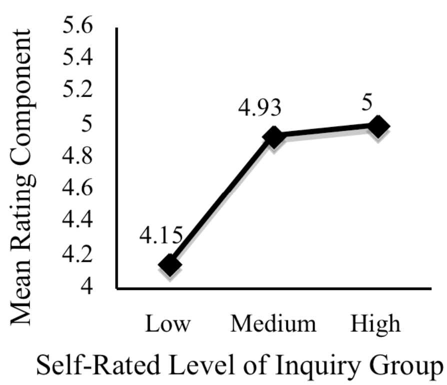

Figure 4

*Graph of Self-Rating of Inquiry by Teacher Role*

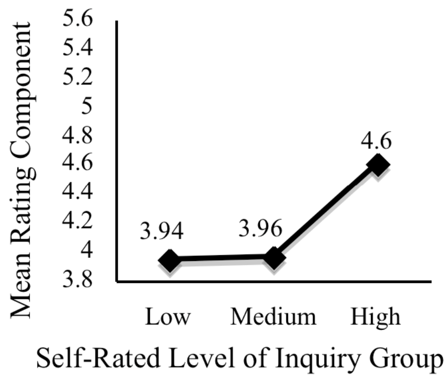

Table 3

*Tukey HSD post hoc Tests*

| Dependent Variable | Self-rating of Inquiry Group | Self-rating of Inquiry Group | *p* |
|---|---|---|---|
| Learning Competencies | High | Middle | .003 * |
| | High | Low | < .001 * |
| | Middle | Low | .001 * |
| Personal Motivation | High | Middle | .006 * |
| | High | Low | < .001 * |
| | Middle | Low | .046 * |
| Student Role | High | Middle | .950 |
| | High | Low | < .001 * |
| | Middle | Low | .001 * |
| Teacher Role | High | Middle | .036 * |
| | High | Low | .011 * |
| | Middle | Low | .997 |

* Significant at the .05 level

The one-way ANOVA and Tukey HSD *post hoc* test results are presented in Table 4. This table includes ANOVA results for all items including those loading onto the four components analyzed in the MANOVA, items that did not load onto the components, and additional items that were added for this study.

Table 4

*One-Way ANOVAs and Tukey HSD post hoc Tests for Self-Rating of Inquiry Use by Item Scores*

| Item | $F(2, 73)$ | $p$ | Partial $\eta^2$ | Component Loading | Tukey *post hoc* significant results |
|---|---|---|---|---|---|
| 1. In your judgment, to what extent have your students learned facts or gained new knowledge in this class? | 3.075 | .052 | .080 | Learning Competencies | |
| 2. In your judgment, to what extent has this class helped your students learn how to plan and carry out their own investigations? | 10.523 | < .001 * | .229 | Learning Competencies | High > Low $p < .001$ |
| 3. In your judgment, to what extent do most of the good ideas in this class come from you rather than from the students? | .746 | .478 | .021 | None | |
| 4. In your judgment, to what extent has this class helped the students understand the way (SUBJECT) works in the real world? | 11.279 | < .001 * | .241 | Learning Competencies | High > Low $p < .001$ Middle > Low $p = .005$ |

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| 5. In some classes, students are given the opportunity to come up with their own questions, search for information, analyze the evidence, and report their findings.<br>a. In your judgment, to what extent have the students learned to do these things in this class? | 16.593 | < .001 * | .319 | None | High > Middle<br>$p = .021$<br>High > Low<br>$p < .001$ |
| 5. In some classes, students are given the opportunity to come up with their own questions, search for information, analyze the evidence, and report their findings.<br>b. In your judgment, to what extent are these skills valuable to them? | 4.988 | .009 * | .123 | Learning Competencies | High > Low<br>$p = .010$ |
| 6. In your judgment, to what extent do your students enjoy (SUBJECT)? | 6.745 | .002 * | .160 | Learning Competencies | High > Low<br>$p = .001$ |

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| 7. To what extent do the students work on a large number of similar examples as they learn new types of problems or information? | 3.132 | .050* | .081 | None | High > Low<br>$p = .042$ |
| 8. In your judgment, to what extent has this class helped the students to become more successful learners, or to be better at learning new things? (This does not necessarily refer to getting higher grades) | 13.586 | < .001* | .277 | Learning Competencies | High > Middle<br>$p = .005$<br>High > Low<br>$p < .001$ |
| 9. a. In your judgment, to what extent do you expect the students to memorize information covered in this class? | 1.614 | .206 | .043 | Teacher Role | |
| 9. b. In your judgment, to what extent do you expect the students to have a good understanding of the concepts covered in this class? | 1.380 | .258 | .037 | None | |

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| 10. In your judgment, to what extent has this class taught the students to think in new or systematic ways? | 4.739 | .012 * | .118 | Learning Competencies | High > Low $p$ =.009 |
| 11. In your judgment, to what extent are the students successful in meeting the objectives or goals in this class? | 11.113 | < .001 * | .283 | Learning Competencies | High > Low $p < .001$ Middle > Low $p = .009$ |
| 12. a. In your judgment, to what extent do the students enjoy being creative? | 8.809 | < .001 * | .199 | Personal Motivation | High > Low $p < .001$ Middle > Low $p = .040$ |
| 12. b. In your judgment, to what extent are the students allowed to be creative in the assignments in this class? | 11.359 | < .001 * | .242 | Learning Competencies | High > Low $p < .001$ |
| 13. a. In your judgment, to what extent are the students expected to be problem-finders in this class? | 11.120 | < .001 * | .239 | Student Role | High > Low $p < .001$ Middle > Low $p = .041$ |

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| 13. b. In your judgment, to what extent are they expected to be problem-solvers in this class? | 10.732 | < .001 * | .232 | Student Role | High > Low $p < .001$ Middle > Low $p = .001$ |
| 14. In your judgment, to what extent do your students enjoy learning about politics, or about current issues? | 3.947 | .024 * | .100 | None | High > Low $p = .032$ |
| 15. a. When a student is working on an assignment in this class, in your judgment, to what extent is he or she expected to be the most important or responsible person for his or her learning? | .614 | .544 | .017 | Personal Motivation | |
| 15. b. When students are working on an assignment in this class, in your judgment, to what extent are you the most important or responsible person for their learning? | 1.511 | .228 | .041 | Student Role (Negative loading) | |

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| 16. In your judgment, how likely are the students in this class to relate new information or experiences to something they knew before? | 7.690 | .001 * | .178 | Learning Competencies | High > Low $p = .001$ Middle > Low $p = .023$ |
| 17. a. In your judgment, how often do students ask questions in this class? | 2.931 | .060 | .076 | Student Role | |
| 17. c. To what extent do you encourage students to ask questions in this class? | 3.312 | .042 * | .085 | Learning Competencies | High > Low $p = .032$ |
| 18. In your judgment, to what extent does the students' work in this class make them feel good about themselves? | 6.799 | .002 * | .161 | Learning Competencies | High > Low $p = .001$ |
| 19. a. To what extent do you emphasize the importance of teamwork and cooperation in this class? | 9.604 | < .001 * | .213 | Teacher Role | High > Low $p < .001$ |
| 19. b. In your judgment, to what extent do the students value teamwork and cooperation? | 14.965 | < .001 * | .297 | Teacher Role | High > Low $p < .001$ Middle > Low $p = .010$ |

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| 19. c. To what extent do you emphasize the importance of independent work? | 1.030 | .362 | .028 | Personal Motivation | |
| 19. d. In your judgment, to what extent do the students value independent work? | 5.590 | .006 * | .136 | Personal Motivation | High > Low $p = .004$ |
| 20. a. To what extent do you provide answers for students to memorize? | 3.184 | .047 * | .082 | Teacher Role | |
| 20. b. To what extent are students in this class responsible for coming up with answers on their own? | 3.252 | .045 * | .084 | Student Role | High > Low $p = .035$ |
| 21. In your judgment, to what extent are your students successful at skills such as organizing and planning? | 7.318 | .001 * | .171 | Personal Motivation | High > Low $p = .002$ Middle > Low $p = .029$ |
| 22. a. In your judgment, to what extent do the activities students do in this class relate to the real world? | 10.565 | < .001 * | .229 | None | High > Low $p < .001$ Middle > Low $p = .007$ |

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| 22. b. In this class, to what extent are students ever asked to imagine themselves in a professional or expert role in the real world? | 8.427 | .001* | .192 | None | High > Low $p < .001$ |
| 23. a. In your judgment, to what extent do the students get excited about their work in this class? | 15.442 | < .001* | .303 | Personal Motivation | High > Middle $p = .035$ High > Low $p < .001$ |
| 23. b. In your judgment, to what extent do your students get excited about their work in other classes? | 2.669 | .076 | .070 | Personal Motivation | |
| 24. a. In your judgment, to what extent have the students become experts about any particular topic? | 13.066 | < .001* | .269 | None | High > Low $p < .001$ Middle > Low $p = .003$ |
| 25. In your judgment, to what extent do students in your class use other sources of information to either supplement or go beyond material provided in textbooks? | 6.310 | .003* | .151 | None | High > Low $p = .019$ Middle > Low $p = .006$ |

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| 26. In your judgment, to what extent do students ask questions arising from their personal interests in addition to or in contrast to requests for clarification of material presented? | 4.963 | .010 * | .123 | None | High > Low $p = .013$ |
| 27. In your judgment, to what extent do you feel the students in your class are able to adapt to a variety of learning situations? | 6.031 | .004 * | .145 | None | High > Low $p = .007$ Middle > Low $p = .025$ |
| 28. In your judgment, to what extent do the students in your class participate in creating the curriculum (e.g., deciding the format or topics for assignments)? | 7.876 | .001 * | .182 | None | High > Low $p = .001$ |
| 29. In your judgment, to what extent do your students understand why they are studying what they are studying? | 9.744 | < .001 * | .215 | None | High > Low $p < .001$ |

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| 30. In your class, to what extent are students evaluated by their peers or self-evaluation? | 4.895 | .010 * | .121 | None | High > Low *p* = .009 |
| 31. In your judgment, to what extent do students engage in dialog in class? | 13.400 | < .001 * | .274 | None | High > Low *p* < .001 Middle > Low *p* = .042 |

* Signficant at the .05 level

## Discussion and Conclusions

**To what extent do various student outcomes of inquiry exist in classrooms, as perceived by teachers working at differing levels of inquiry?**

The sample of 74 teachers working at varying levels of inquiry significantly differed in their perceived classroom outcomes. The four primary outcomes examined were learning competencies—including learning content and process, personal motivation—including student enjoyment, creativity, and responsibility in learning, student role—assessing students' sense of responsibility in the learning process, and traditional teacher role—including items assessing emphasis on memorization and cooperation and teamwork in the class.

Teachers with higher self-reported levels of inquiry rated student-inquiry outcomes related to learning competencies, personal motivation, and student role as present to a greater degree in their classes than did teachers with lower self-reported levels of inquiry. However, teachers with higher inquiry levels also rated outcomes related to a noninquiry, traditional teacher role higher than teachers with lower inquiry levels. The partial effect size for teacher role ($\eta_{partial}^2 = .129$) was substantially smaller than for the other outcome variables ($\eta_{partial}^2 = .489$, $\eta_{partial}^2 = .360$, and $\eta_{partial}^2 = .267$, respectively), showing that the strength of the relationship with inquiry level was weaker for the traditional teacher role than for the other inquiry outcomes.

Although the small, positive relationship between traditional teacher roles and inquiry is counter-intuitive, some of the items loading onto the teacher role component are examples of traditional instruction as well as inquiry-based instruction. For instance, the teacher role component includes items related to group work. Although inquiry involves a greater degree of autonomy and will often include independent projects, its basis in social constructivism also necessitates collaborating with others to construct knowledge. The teacher-role outcome consisted of four items from the questionnaire—two relating to group work and collaboration, and two relating to memorization. From the item-by-item analysis, the items related to group work were significant with effect size estimates at .213 and .297, indicating that, at higher levels of inquiry, teachers reported having higher levels of group work and collaboration in their class. Of the two items relating to memorization, one item was also significant overall with a smaller effect size estimate of .082, demonstrating that at higher levels of inquiry, teachers also reported higher levels of memorization in their class, but to a lesser degree than with the collaboration items, although the *post hoc* comparisons for memorization were not significant.

The seven items that were added to the questionnaire based on conversations with teachers on inquiry (items 25 to 31) all significantly predicted group differences. The items addressed research skills and using multiple resources, asking questions based on personal interest, student adaptability to new learning situations, student and teacher co-construction of curriculum, understanding why students are learning what they are learning, sources of evaluation other than the teacher (e.g., peers or self), and engaging in class dialog. These outcomes were not included in the criterion-referenced list of student outcomes (Saunders-

Stewart, Gyles, & Shore, 2010) or the study assessing students' perceptions of outcomes (Saunders-Stewart, 2008) and, thus, could usefully be included in the instrument while it is subjected to further study.

**Are similar outcomes perceived by teachers and students?** For the inquiry outcomes learning competencies, personal motivation, and student role, higher levels of inquiry instruction were related to higher ratings of these outcomes, as judged by teachers and students. However the specific patterns of the relationships differed. For the traditional teacher-role component, students in higher inquiry classes rated this component as occurring to a lesser degree, whereas teachers in higher inquiry classes rated it to a larger extent.

**Are there observable patterns of differences in the relations between the reported student outcomes and teachers' level of inquiry?**

The pattern of the relations between teachers' self-ratings of inquiry and the learning competencies and personal motivation outcomes appears to increase linearly, as was shown by Figures 1 and 2. The high-inquiry teachers rated student learning competencies and personal motivation outcomes significantly higher than the middle-inquiry group, and the middle group rated these outcomes significantly higher than the low-inquiry group. As teachers use increasing levels of inquiry, they report more student outcomes related to knowledge gain, inquiry skills, and motivation to learn in their classes.

The pattern of the relation between teachers' self-ratings of inquiry use and student-role outcomes demonstrated a leveling off of perceived student-role outcomes from middle to high levels of inquiry instruction (Figure 3), preceded from low to middle levels of teacher inquiry by an early recognition of an increase in students' new roles as active, responsible learners. As classroom dynamics shift and teachers share the responsibility of learning more with their students, students may readily adopt their new roles and teachers recognize this change even at moderate levels of inquiry use.

For outcomes related to a traditional teacher role, the middle group did not differ from the low group (Figure 4). Only high-inquiry teachers experienced heightened levels of outcomes related to the traditional teacher-role component. One interpretation of this contrast is that, as teachers progress along a continuum of inquiry instruction, they became aware of changes in students' roles before they perceive changes in their own. A second and more complex interpretation can complement the first. The teacher role comprised two distinct elements with slightly different outcomes. In this study group work was initially treated as a traditional quality because of the autonomous work associated with inquiry. However, group or collaborative work can also be a part of inquiry due to its social-constructivist roots. Group work is a frequently recognized source of difference between traditional and inquiry teaching (Collis, 1998). The items on memorization, however, tap a variable not extensively present as a feature of inquiry learning; more often it has been portrayed as a quality of traditional teaching from which the teacher should move away. The result relating to memorization indicates that, at the highest levels of inquiry, memorization may play a renewed role. At high levels of inquiry, teachers support the students through increasingly autonomous learning in which students must have a more fluent knowledge the basics of the subject matter, as well as some advanced content, and have them ready to manipulate and apply. Complex, ill-formed, multi-step problems require a solid knowledge base. Consequently, teachers working at high levels of inquiry may encourage and recognize memorization by their students.

**Limitations**

Participants recruited from the two schools had either low or moderate levels of experience with inquiry, and participants recruited through education workshops had more widely varied experience. No sample group was explicitly recruited for high levels of inquiry use. A group known to be high in inquiry may have provided more power to the design. Classroom observation could mitigate this limitation—the level of classroom inquiry could be determined by the researcher through observational criteria, such as Llewellyn's (2002).

The teacher-role component, derived from a Principal Components Analysis (PCA) from the study addressing students, included items relating to traditional as well as inquiry-based instruction. Although, with a student sample (Saunders-Stewart, 2008), the items loaded onto the same component, this might not have the same relationship with teacher participants. In a follow-up study with a larger teacher sample, the questionnaire items could be statistically reduced through a PCA to examine this relationship in a teacher population. Conceptually, it would be useful to further address the roles of group work and memorization as parts of traditional and inquiry instruction, and to explore the possibility that teachers might recognize a role shift in students before seeing it in their own performance.

**Implications**

This study broadened the scope of research into instructional style and potential benefits for students. A wider range of student outcomes can be further examined in research and acknowledged in classrooms. Awareness of a broader range of student outcomes, beyond that of content knowledge and related skills, may allow teachers to chart their progress in effective inquiry-based instruction or their students' progress in becoming autonomous inquirers. Professional development tools or assessment tools may as a result incorporate more diverse student outcomes.

# Chapter 5

## Overall Conclusions

Learners in inquiry experience a host of diverse outcomes or benefits from their learning environments. This goes beyond the standards of content knowledge or related skills to include enhanced creativity, curiosity, motivation, collaborative ability, and autonomy in learning. These are among the student outcomes reported by teachers practicing higher levels of inquiry instruction in their classes, along with the expected outcomes of content knowledge and process skills. Outcomes related to learning competencies and students' motivation increased with higher levels of teachers' self-rated levels of inquiry. Somewhat unexpectedly, outcomes associated with a traditional teacher role were reported by teachers working at high levels of inquiry. They reported encouraging student collaboration—which traditionally could be considered a noninquiry outcome, because of student independence, or an inquiry outcome, because of ties to social constructivism. Teachers working at high levels of inquiry also reported encouraging memorization. For outcomes related to autonomous learners, teachers noticed students' role shift before noticing their own.

The findings of this study are relevant for psychological professionals working in schools; awareness of diverse outcomes related to instructional style may guide recommendations for struggling students. School psychology is still closely anchored to mastery of content- or academic skill-based learning and standardized tests. Adopting more curriculum-based assessment tools for a wider variety learning outcomes is imperative.

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## Appendix A

### Recruitment Email for Summer Program Participants

Hello,

I am a master's student in the School/Applied Child Psychology program at McGill University and I am conducting a study on Teachers' Perceptions of Important Student Outcomes of Inquiry Learning with my advisor, Professor Bruce Shore. In this study, we are interested in understanding the unique outcomes and evaluation requirements of inquiry-based instruction. As part of the study, we have asked teachers from different schools to share their experiences and expertise regarding what happens in classrooms. The findings from this study, I plan to use for my master's thesis and present at the World Conference for Gifted and Talented Children this August.

I am currently contacting teachers from the Explorations summer program to participate in this study. Participating would involve completing one questionnaire. This would take about 20 to 30 minutes. I would be very grateful if you would be willing to help me with this study. If you are willing to participate or would like more information on the study, please reply to this email address with your best telephone number and times when I can try to contact you.

Thank you!
Petra Gyles
petra.gyles@mail.mcgill.ca
514-518-8618

## Appendix B

## Consent Form for Participants of Two Schools of Larger Inquiry Study

McGill

**Department of Educational and Counselling Psychology** **Département de psychopédagogie et du counseling**

Faculty of Education
McGill University
3700 McTavish Street
Montreal, Quebec, Canada
H3A 1Y2

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Université McGill
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Fax/Télécopieur: +1-514-398-6968

**Month XX, 2009**

### One-Time Letter of Consent for Teacher Participation

Dear XXX School Faculty Members,

Several of your teaching and administration colleagues are actively collaborating with us in a project over approximately three years. Two elementary schools and one high school are participating. We engage in approximately bi-monthly conversations about outcomes and evaluation of inquiry instruction, and reflect on the fit between the two. We share ideas, experiences, and expertise (from practices in the classroom and research on inquiry and inquiry evaluation) regarding what would make a valuable and meaningful set of evaluation tools for teachers, schools, and school boards, as well as for broader program evaluation and research purposes.

We have so far formulated a small set of broad questions that can help to initiate pedagogical and evaluation conversations. These do not address personal or private matters and we anticipate that articulating responses to these questions will be of equal interest to us and the school personnel who daily face the task of implementing the QEP (and, in the case of our three collaborating schools, developing elements of the IB). Some of these general questions are as follows:

- What is considered to be included in the concept of inquiry instruction and learning or cross-curricular studies in your classroom and school?
- What are some of the successes, large or small, that have been achieved thus far in the context of inquiry instruction and learning in this school?
- What do members of the staff, administrators, and students consider to be unique or different about learning in an inquiry-oriented instructional setting compared to a non-inquiry-oriented instructional setting?
- What kinds of support could we as university-based partners offer to help better assess valued and frequent goals for inquiry learning and instruction?

We would like to work with our collaborators to develop and try out different approaches to assessing and reporting inquiry-learning outcomes, addressing questions such as: Which tools are relatively unobtrusive? Which reflect change when change is otherwise not observable? Which evaluation results are trusted by teachers, administrators, parents, and students to convey important and usable information?

We have used the attached draft questionnaire with the group of your colleagues with whom we meet regularly. The purpose is to try to identify some student outcomes of doing inquiry. The questions in this draft instrument are based on a review of the literature about what students do as inquiry in schools. From your replies, we would like to understand what you, in this school, consider to be valid outcomes of engagement in inquiry. We will be pleased to send back a summary of the replies.

On this occasion your participation would involve completing this **one questionnaire**. This takes about 15 to 20 minutes. We ask for your name, grade, and subject so that we can categorize the data, and to be able to contact you if we need help with any of your replies, but we shall then remove all identifying information.

All data will be maintained in a manner that respects your anonymity and confidentiality. Pseudonyms will replace real names in any example of data provided. Raw data will be kept in a secure lab office at McGill and will be accessible only to the researchers.

If you have any questions or concerns, please contact us at the numbers above or the McGill Research Ethics Board Office at 514-398-6831. If you are willing to help us with this project, please sign the next page. If you would rather not, please simply return the material blank, but feel free to look it over.

Thank you very much for your consideration,


| | | |
|---|---|---|
| Mark W. Aulls | and | Bruce M. Shore |
| Professor and Co-Lead Investigator | | Professor and Co-Lead Investigator |
| 514-398-4241 | *Phone (W) & Messages* | 514-398-7685 |
| 514-398-6968 | *Fax (W)* | 514-398-6968 |
| mark.aulls@mcgill.ca | *E-Mail* | bruce.m.shore@mcgill.ca |
| 3700 McTavish, Room 535 or 614<br>Montreal, QC H3A 1Y2 | *Post* | 3700 McTavish, Room 532 or 614<br>Montreal, QC H3A 1Y2 |


also on behalf of Ron Stringer, Calvin S. Kalman, and Marcy Delcourt (our co-researchers)

To indicate your agreement to participate, please sign the next page and leave it attached to the questionnaire. Then tear off these first two pages and keep them for your information. One of the McGill team will be present to directly collect the questionnaires.

One-Time Consent form

I agree to participate as a Teacher at **XXX** School in the project titled "Collaborative Development of an Inquiry-Evaluation Toolbox" (as described on Pages 1 and 2) with the team from McGill University and note in particular that I may withdraw my participation at any time. This permission is for the use of data from one questionnaire on teachers' perceptions of student outcomes of inquiry.

__________________________ ________________________ __________2009
Printed Name Signature Date

*Please leave this form attached to the questionnaire. We will separate it and the next page from the replies as soon as we code the grade and subject. They will not be re-attached to your replies.*

*Teacher Consent Form - One-Time*

## Appendix C

## Consent Form for Summer Program Participants

## One-Time Letter of Consent for Teacher Participation

Month XX, 2009

Dear Explorations Teacher,

We are a research team from McGill University currently conducting a study on Teachers' Perceptions of Important Student Outcomes of Inquiry Learning. The study we are conducting is interested in assessing outcomes and evaluation of inquiry instruction. As part of the study, we have teachers from different schools share their experiences and expertise regarding what happens in classrooms.

The purpose is to try to identify some student outcomes of doing inquiry. The questions in the attached questionnaire are based on a review of the literature about what students do as inquiry in schools. From your replies, we would like to understand what you, as a teacher in Explorations, consider to be valid outcomes of engagement in inquiry. Participating would involve completing this **one questionnaire**. This task takes about 15 to 20 minutes.

We ask for your name, grade, and subject so that we can categorize the data, and to be able to contact you if we need help with any of your replies, but we shall then remove all identifying information. I or a research assistant will remove or hide your name after we extract and tally the data. We shall keep all data in a locked office at McGill University. We shall only use grouped data with no personal names, although we may wish to quote from some of your replies without the use of names. We hope to use the data in research publications, conference presentations, and theses.

We hope you will agree to participate so that we can learn more about teacher responses to different approaches to learning in different disciplines. If you agree to participate, please sign the consent form on the following page and then complete the questionnaire and return it to the researcher. If you would rather not, please simply return the material blank, but feel free to look it over.

If you have any questions or concerns, please contact us at the numbers above or the McGill University Research Ethics Board Office at 514-398-6831.

Thank you very much for your consideration of our request. Please continue to the next page.

Sincerely yours,

Petra D. T. Gyles


| | | |
|---|---|---|
| Bruce M. Shore | and | Mark W. Aulls |
| Professor and Co-Lead Investigator | | Professor and Co-Lead Investigator |
| 514-398-7685 | *Phone (W), Messages* | 514-398-4241 |
| 514-398-6968 | *Fax (W)* | 514-398-6968 |
| bruce.m.shore@mcgill.ca | *E-Mail* | mark.aulls@mcgill.ca |
| 3700 McTavish, Room 532 or 614<br>Montreal, QC H3A 1Y2 | *Post* | 3700 McTavish, Room 535 or 614<br>Montreal, QC H3A 1Y2 |

Please keep the first page for your personal records.

To indicate your agreement to participate, please complete and sign this page. We need your actual signature to include the data you grant us in the study, so please, if you agree, sign and date the indicated lines below and submit this sheet with the questionnaire.

I agree to participate in the project on **Teachers' Perceptions of Important Student Outcomes of Inquiry** with the team from McGill University, and note in particular that I may withdraw my participation at any time. This consent is limited to the provision of my completed copy of the questionnaire on teachers' perceptions of student outcomes of participation in inquiry.

_________________________ _________________________ _____________________

Printed Name Signature Date

Degree and program of study: ____________________________________________
(e.g., B.Ed. in Elementary Education, OR B.Sc. OR B.S. and Major Subjects OR MEd, MA, etc.)

I am in Year (circle 1) 0 or Prep 1 2 3 4 5 of my program.

sex (please check one): ☐ Female ☐ Male

*my best e-mail address: ________________________________________________

*home telephone number with area code: ___________________________________

*other telephone number (optional): _______________________________________

*in case we need to contact you to understand one of your replies:

☐ I am interested in knowing the outcomes of this research. Please e-mail me abstracts of the main published or reported studies that arise from this research. (Note: These are expected to be available between 2010 and 2012, but some preliminary conference reports may appear earlier.)

*Teacher Consent Form - One-Time*

## Appendix D

## Consent Form for Education Workshop Participants

### Letter of Consent for Student Participation

Month XX, 2009

Dear Student,

We are a team of six researchers from three universities who have received funding from the Social Sciences and Humanities Research Council of Canada for a study of university students' perceptions of inquiry, learning, teaching, and scientific thinking. This project involves students at our three universities (McGill and Concordia Universities in Montreal, Quebec, and Western Connecticut State University in Danbury, CT). In each university we are asking undergraduate students in Education and Science to help us collect data. Your instructor in this course has invited one of us (Bruce M. Shore) to present a workshop on inquiry in your class and I would like to do so, in part by giving you a chance to work with one of our data-collection tools, and then discussing what it is trying to measure as an introduction to inquiry. We would like to take this opportunity to share our interest in inquiry with you and, if you agree, to benefit from your replies to this questionnaire. The questions are about your interpretation of inquiry and your expectations regarding student outcomes in classroom teaching and learning.

Please note that your instructor *will not be told* if you personally have agreed or refused to provide us with data in this study. I or a research assistant will remove or hide your name after we extract and tally the data. The list that connects codes and real names will be destroyed. Taking part in this study will in no way affect any grades. We shall keep all data in a locked lab.

We shall only use grouped data with no personal names, although we may wish to quote from some of your replies without the use of names. We hope to use the data in research publications, conference presentations, and theses.

We hope you will agree to participate so that we can learn more about student responses to different approaches to learning in different disciplines.

If you agree to participate, we shall ask you to do just one thing:

Please complete the questionnaire being distributed in class and submit it along with the attached consent form to the workshop animator when we are finished discussing it. If you do not wish to participate, please do the questionnaire as part of the workshop, but do not submit it or the consent form (please tear them up or shred them and recycle the remnants).

If you have any questions or concerns, please contact us at the numbers above or the McGill University Research Ethics Board Office at 514-398-6831.

Thank you very much for your consideration of our request. Please continue to the next page and look at the actual consent form.

Sincerely yours,


| | | |
|---|---|---|
| Bruce M. Shore | and | Mark W. Aulls |
| Professor and Co-Lead Investigator | | Professor and Co-Lead Investigator |
| 514-398-7685 | *Phone (W), Messages* | 514-398-4241 |
| 514-398-6968 | *Fax (W)* | 514-398-6968 |
| bruce.m.shore@mcgill.ca | *E-Mail* | mark.aulls@mcgill.ca |
| 3700 McTavish, Room 532 or 614 Montreal, QC H3A 1Y2 | *Post* | 3700 McTavish, Room 535 or 614 Montreal, QC H3A 1Y2 |

**McGill-Concordia-WCSU Study on**
**University Students' Perceptions of**
**Inquiry, Learning, Teaching, and Scientific Thinking**

Please keep the first two pages for your personal records.

To indicate your agreement to participate, please complete and sign this page. We need your actual signature to include the data you grant us in the study, so please, if you agree, sign and date the indicated lines below and submit this sheet with the questionnaire.

I agree to participate in the project on **University Students' Perceptions of Inquiry, Learning, Teaching, and Scientific Thinking** with the team from McGill University, Concordia University, and Western Connecticut State University, and note in particular that I may withdraw my participation at any time. This consent is limited to the provision of my completed copy of the questionnaire on teachers' perceptions of student outcomes of participation in inquiry completed during today's workshop or class.

____________________ ____________________ ____________________

Printed Name Signature Date

Degree and program of study: ____________________________________
(e.g., B.Ed. in Elementary Education, OR B.Sc. OR B.S. and Major Subjects OR MEd, MA, etc.)

I am in Year (circle 1) 0 or Prep 1 2 3 4 5 of my program.

sex (please check one): ☐ Female ☐ Male

*my best e-mail address: ________________________________________

*home telephone number with area code: ____________________________

*other telephone number (optional): ________________________________

*in case we need to contact you to understand one of your replies:

☐ I am interested in knowing the outcomes of this research. Please e-mail me abstracts of the main published or reported studies that arise from this research. (Note: These are expected to be available between 2010 and 2012, but some preliminary conference reports may appear earlier.)

*Student Consent Form - Workshop Version for One Instrument*

**Appendix E**

**McGill Outcomes of Inquiry Instruction Questionnaire: Teachers' Perspectives**

**Name:**_______________________________________________________

**Grade (if multiple, choose one):**____________________________________

**Subject (if multiple, choose one):**___________________________________

In your own words, and whatever experience you have had to date, please write your current definition of inquiry teaching and learning:

.

**Please answer the following questions while thinking about one level and one subject or content area that you CURRENTLY teach. For example, in an elementary school, think of one subject and one group of students for all the questions. Perhaps use a class and subject that you especially enjoy. Use your best judgment to answer each question.**

**Please circle the number that fits best for each question. We expect that you will circle some high numbers, and some low numbers. If a question does not make a lot of sense to you, please try to answer it anyway and add a comment in the margin if you wish. Some questions also ask for you to provide a brief explanation or an example. You can also write additional comments in the space at the end of the questionnaire.**

**1. In your judgment, to what extent have your students learned facts or gained new knowledge in this class?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**2. In your judgment, to what extent has this class helped your students learn how to plan and carry out their own investigations?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**3. In your judgment, to what extent do most of the good ideas in this class come from you rather than from the students?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**4. In your judgment, to what extent has this class helped the students understand the way (SUBJECT) works in the real world?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**5. In some classes, students are given the opportunity to come up with their own questions, search for information, analyze the evidence, and report their findings.**

**a. In your judgment, to what extent have the students learned to do these things in this class?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**b. In your judgment, to what extent are these skills valuable to them?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**c. Please briefly explain why you answered questions 5 a. & b. the way you did, or give an example:**

______________________________________________

______________________________________________

**6. In your judgment, to what extent do your students enjoy (SUBJECT)?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**7. To what extent do the students work on a large number of similar examples as they learn new types of problems or information?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**8. In your judgment, to what extent has this class helped the students to become more successful learners, or to be better at learning new things? (This does not necessarily refer to getting higher grades)**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**9. a. In your judgment, to what extent do you expect the students to memorize information covered in this class?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**b. In your judgment, to what extent do you expect the students to have a good understanding of the concepts covered in this class?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**10. In your judgment, to what extent has this class taught the students to think in new or systematic ways?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**11. In your judgment, to what extent are the students successful in meeting the objectives or goals in this class?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**12. a. In your judgment, to what extent do the students enjoy being creative?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**b. In your judgment, to what extent are the students allowed to be creative in the assignments in this class?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**13. a. In your judgment, to what extent are the students expected to be problem-finders in this class?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**b. In your judgment, to what extent are they expected to be problem-solvers in this class?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**14. In your judgment, to what extent do your students enjoy learning about politics, or about current issues?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**15. a. When a student is working on an assignment in this class, in your judgment, to what extent is he or she expected to be the most important or responsible person for his or her learning?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**b. When students are working on an assignment in this class, in your judgment, to what extent are you the most important or responsible person for their learning?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**c. Please briefly explain why you answered questions 15 a. & b. the way you did, or give an example:**

______________________________________________

______________________________________________

**16. In your judgment, how likely are the students in this class to relate new information or experiences to something they knew before?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**17. a. In your judgment, how often do students ask questions in this class?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**b. Please give an example of a question a student asked recently:**

______________________________________________

______________________________________________

**c. To what extent do you encourage students to ask questions in this class?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**18 . In your judgment, to what extent does the students' work in this class make them feel good about themselves?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**19. a. To what extent do you emphasize the importance of teamwork and cooperation in this class?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**b. In your judgment, to what extent do the students value teamwork and cooperation?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**c. To what extent do you emphasize the importance of independent work?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**d. In your judgment, to what extent do the students value independent work?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**20. a. To what extent do you provide answers for students to memorize?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**b. To what extent are students in this class responsible for coming up with answers on their own?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**21. In your judgment, to what extent are your students successful at skills such as organizing and planning?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**22. a. In your judgment, to what extent do the activities students do in this class relate to the real world?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**b. In this class, to what extent are students ever asked to imagine themselves in a professional or expert role in the real world?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**c. When students finish a project or assignment in this class, who will see their findings/results/final products? (e.g., other students, you, friends, parents, etc.)**

__________________________________________

__________________________________________

**23. a. In your judgment, to what extent do the students get excited about their work in this class?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**b. In your judgment, to what extent do your students get excited about their work in other classes?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**c. In your judgment, what especially motivates students to do their best work?**

__________________________________________

__________________________________________

**24. a. In your judgment, to what extent have the students become experts about any particular topic?**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**b. In your judgment, in what areas are the students more or less experts (if any)?**

______________________________

______________________________

**c. How do you decide that the students are experts in these areas?**

______________________________

______________________________

**25. In your judgment, to what extent do students in your class use other sources of information to either supplement or go beyond material provided in textbooks?**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**26. In your judgment, to what extent do students ask questions arising from their personal interests in addition to or in contrast to requests for clarification of material presented?**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**27. In your judgment, to what extent do you feel the students in your class are able to adapt to a variety of learning situations?**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**28. In your judgment, to what extent do the students in your class participate in creating the curriculum (e.g., deciding the format or topics for assignments)?**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**29. In your judgment, to what extent do your students understand why they are studying what they are studying?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**30. In your class, to what extent are students evaluated by their peers or self-evaluation?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**31. In your judgment, to what extent do students engage in dialog in class?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**32. In your judgment, to what extent do you use inquiry instruction in your classroom?**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all | A little bit | Some, but not a lot | Moderately | Quite a bit | A lot | Completely |

**33. Please write any additional comments here:**

______________________________

______________________________

______________________________

______________________________

______________________________

______________________________

______________________________

# Thank You!

Teacher Questionnaire--Student Inquiry Outcomes

# Appendix F

## McGill Research Ethics Board Approval

## McGill Research Ethics Board Amendment Approval

(following)