Two Decades of Funded Research Goals and Achievements on Inquiry by the High Ability and Inquiry Research Group (HAIR) at McGill University

Maren Gube and Bruce M. Shore

Department of Educational and Counselling Psychology
Faculty of Education, McGill University
3700 McTavish, Room 614
Montreal, Quebec, Canada H3J 2C9
maren.gube@mail.mcgill.ca
bruce.m.shore@mcgill.ca

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Abstract

From the 1990s until 2017 the High Ability and Inquiry Research Group (HAIR) at McGill University in Montreal, received C$1.3M in research funds from Canadian, Quebec, and US agencies to support its research and graduate training in education and educational psychology. Their research encompassed two principal areas, Inquiry in Education and Gifted Education, from preschool to higher education. This report summarizes the goals of the funded research on Inquiry in Education, presents an overview of what was achieved relative to each of the goals

1. The Psychology of Learners' and Teachers' Understanding of and Engagement in Inquiry
2. Building and Sustaining Inquiry: Facilitating Inquiry in the Classroom
3. Creating a Toolbox for Research and Evaluation of Inquiry Learning and Instruction

and lists the 229 published books, chapters, conference proceedings, journal articles, dissertations, and theses, as of December 31, 2017, each with an annotation or abstract. Over 40 publications in preparation are also listed. This report is intended as an archival record of the work of the research group.

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This report thematically summarizes the research and research products undertaken by the HAIR group since approximately the year 2000 (some especially relevant earlier items that led to the later work are included), supported by the following six major grants:

Grant 1--2000-2003 Social Sciences and Humanities Research Council of Canada (SSHRC)
Grant 2--2003-2006 Social Sciences and Humanities Research Council of Canada (SSHRC)
Grant 3--2005-2008 American Psychological Foundation Esther Katz Rosen Fund (APF)
Grant 4--2007-2011 Fonds du Québec de Recherche en Société et Culture (FQRSC)
Grant 5--2008-2012 Social Sciences and Humanities Research Council of Canada (SSHRC) and
Grant 6--2011-2015 Fonds du Québec de Recherche en Société et Culture (FQRSC).
The total value of these six competitive research grants was $1,297,478 (Canadian).

The document is not a narrative summary or full synthesis. Rather it is a partially annotated bibliography of our collective work. A single synthesis of all this work is perhaps conceptually impossible. Our goal is simpler, namely, to leave at hand one document that at one point in time identifies the work we have done together, to be used as desired.

The three themes as stated below were extracted from the specific goals of this series of grants (the themes were not derived from open coding or any other analysis of the studies themselves). The studies were then listed within each section based on a judgment of best fit. The goal was to present an overall view of how we answered the main questions posed in the six grants listed above. The report highlights the major goals and findings across these main themes within inquiry research supported by these six major research grants, namely:

I. The Psychology of Learners' and Teachers' Understanding of and Engagement in Inquiry

II. Building and Sustaining Inquiry: Facilitating Inquiry in the Classroom

III. Creating a Toolbox for Research and Evaluation of Inquiry Learning and Instruction

Themes I and II are further divided into related Sections, and many of the sections include Clusters of studies. Each Cluster (or Section when there is only one Cluster) contains a narrative summary of the outcomes of our research productivity as well as specific citations that include books, chapters, articles, reports, and theses. These narrative summaries are not intended to be all-inclusive. They provide some highlights of the research program. A complete and annotated bibliography concludes this report, providing a more precise level of detail about the content of each publication.

The bibliography comprises 272 entries, including 229 completed items and 43 in varying states of preparation from raw data to submitted for review. Within the published items include 99 articles, 32 chapters and proceedings, 10 books, and seven major reports. Within the published items are details about 14 research tools, and five others await publication. There have been 40 completed doctoral dissertations (one other is submitted), 27 master's theses and major reports

(one other is nearly completed). Annotations are coded to facilitate the reader's task of determining the level of education to which they primarily pertain: Elementary School [E], Secondary School [S], and Higher Education [H], or a combination of these. In general, each item is cited only once except for the final section (preceding the bibliography itself) on research tools. Some of those items are unique to that section, but some are repetitions of entries that also addressed a theoretical or other question. Although assigned to one substantive category, it is of course possible that some items may also address a second theme. In respect of the last point, some narrative statements cite work listed in another section.

We have not included an almost equal number of conference presentations (unless they were published in proceedings) because most of these became subsequent publications or exist in the form of draft publications. In addition, we do not always have available complete texts for some kinds of presentations.

Although, due to retirements, the HAIR team is now an email list of past and continuing collaborators, many articles, theses, and books remain in preparation and will be completed in the months and years ahead, and some future items not yet formalized. We have included a tentative list of items to come, but this is of course a fluid catalog. It could be a future task, likely by someone else, to try to wrap up this list, but it stands on its own as is.

The above-noted six main grants all addressed inquiry-based teaching and learning. The team also received other research grants, for example, in gifted education. Only productivity directly related to inquiry is included in this summary; overlap with some of the research on giftedness and gifted education is expressed in some of the Clusters.

Principal Researchers in HAIR and Future Directions

During the time period covered by these grants and our summary of the team's productivity, the following researchers were part of the High Ability and Inquiry Research Group (HAIR) for the full period of time:

Mark W. Aulls (mark.aulls@mcgill.ca)
Marcia (Marcy) A. B. Delcourt (delcourtm@wcsu.edu)
Calvin S. Kalman (calvin.kalman@concordia.ca)
Bruce M. Shore (bruce.m.shore@mcgill.ca)

The following researchers were academic members of the team or research associates at different times during these years:

F. Gillian (Gill) Bramwell (formerly Rejskind) (g.reskind@mcgill.ca)
Juss (Jasvinder) Kaur Magon (juss.kaur.magon@mcgill.ca)
Frank LaBanca (franklabanca@gmail.com)
Judith (Judy) McBride (jmcbride@rsb.qc.ca)
Krista R. Muis (krista.muis@mcgill.ca)
Annie Savard (annie.savard@mcgill.ca)
Ronald (Ron) W. Stringer (ron.stringer@mcill.ca)
Diana Tabatabai (diana.tabatabai@mcgill.ca).

Student members are listed with their reports, theses, and dissertations within the various

sections of this report.

HAIR has undergone a “changing of the guard” as this report was compiled over 2014, 2015, and 2016, then updated to this, its final form in late 2017. Some senior members are now emeritus and phased out from active participation in new supervision and data collection. The future awaits the possibility of new leadership and direction to emerge, but the foundation for new undertakings is represented here. The “old” HAIR is now an email list of the most recent participants.

Theme I

The Psychology of Learners' and Teachers' Understanding of and Engagement in Inquiry

For learners and teachers, inquiry has both intellectual and emotional components that are closely intertwined (we arbitrarily separate these in the clusters). Both types of components are present at all points of engagement in inquiry, from considering involvement, to adapting to it, enacting inquiry, communicating within the process, and sharing the outcomes.

Our work on this theme is summarized in two sections addressing, in turn, learners' then teachers' preparedness to engage in inquiry. Each of those sections is further divided into three clusters of research outcomes. Paragraphs within clusters highlight key findings that share some common ground conceptually; citations immediately follow each paragraph. Theme I contains many and varied contributors with overlapping findings regarding student and teacher preparedness to learn and teach with inquiry.

I.1. Learner Preparedness to Engage in Inquiry

I.1.1. Cognitive Dimensions

I.1.2. Social-Emotional and Cultural Dimensions

I.1.3. Additional Insights for and from Gifted Learners

I.2. Teacher Preparedness to Engage in Inquiry

I.2.1. Teachers' Understanding of Inquiry

I.2.2. Self-Efficacy to Teach with Inquiry

I.2.3. Instructional and Content Dimensions (including Roles)

Section I-1. Learner preparedness to learn with inquiry

Cluster 1: Cognitive dimensions

Includes: expertise, creativity, enhanced disciplinary thinking, problem-finding, and problem-solving in inquiry (i.e., from a social-constructivist perspective as a defining characteristic of inquiry), as well as problem representation, self-regulation, metacognition, and tolerance or preference for ambiguity.

> Inquiry is a combined social-emotional and intellectual undertaking. Self-regulated learning and metacognition are important to performance in nontraditional learning settings. Possessing expert knowledge and being able to reliably display it through routine reproductive performance is not the same as having adaptive creative expertise. Inquiry is related to understanding the underlying common qualities of related constructs (as experts do), thereby allowing more adaptive knowledge construction: inquiry helps build connections within knowledge constructs through the learning process. Flexibility and preference for complexity, also common properties of creative thinking and adaptive expertise, are intimately related to inquiry. One application is that it helps people design hypermedia, which are also based on linkages among information. Another is that mathematical experts use fewer categories than novices to group problems by finding deep structural similarities between the problems. Young mathematics learners generate more original solutions and multiple answers; however, they can experience difficulty interpreting word problems into mathematical problems and develop misconceptions along the way unless they are well scaffolded. At the same time, they engage more when the presented problems are incoherent or ambiguous. Yet another is that library and information science students have more interconnected web search strategies, and they work with a higher number of simultaneously open tabs, when compared to education students. They search the web in a wider variety of ways, and their strategies can be compared to the interconnectivity of knowledge structures in the cognitive model of expertise. [E, S, H] (Barfurth, Ritchie, Irving, & Shore, 2009; Manuel, Freiman, & Bourque, 2012; Pelletier, Birlean, & Shore, in preparation; Pelletier & Shore, 2003; Polotskaia, Savard, Freiman, 2011, 2015, 2016; Ritchie, Lajoie, & Shore, advanced draft under revision; Savard & Polotskaia, 2017; Shore, 2000; Syer, Jad-Moussa, Pelletier, & Shore, 2003; Tabatabai, 2002; Tabatabai & Shore, 2005; Walker & Shore, 2012)

> Learners who are invested in problem-finding (vs. learners taking part in more standard laboratory-based science courses) are considerably more likely to engage in productive problem-solving heuristic strategies. Effective problem-finding (which also impacts the quality of science- and engineering-fair projects) results from using resources from previous specialized experiences in an idiosyncratic, nonlinear, and flexible manner as can be demonstrated by or learned from a community of practicing scientists. Appropriately representing, stating, or modeling a problem is important to designing effective solutions and is a part of inquiry. The greater academic challenges and ambiguity in problem-finding allow learners to initiate successful self-regulatory strategies to re-engage constructively with their work. [E, S, H] (Chichekian & Shore, 2016, 2017a; LaBanca, 2008; LaBanca, Delcourt, Yulo, & Dimock, under revision; LaBanca & Ritchie, 2011; Polotskaia, 2014; Polotskaia, Savard, Freiman, 2011, 2015, 2016; Redden, 2006; Ritchie, Shore, LaBanca, Fitzpatrick, & Bracewell, in preparation)

> Inquiry skills have common elements across disciplines, and many similarities (and some differences) exist among students talented in athletics, science, and visual arts. Significant correlations exist between learning styles and problem-solving styles. The ways learners think about psychomotor activities parallels what they do intellectually (planning, reflecting, etc.); metacognition is present in the same way. [E, S] (Delcourt, Treffinger, Woodel-Johnson, & Burke, 2015; Martini & Shore, 2008; Martini, Wall, & Shore, 2004)

> Working primarily in the area of physics learning in higher education, we have identified multiple and varied instructional opportunities that allow students to actively reflect on and discuss concepts in a way that facilitates the understanding of systematic relations among ideas, rather than simply collecting unrelated laws and facts. These include, for example, reflective writing, argumentative essays, and various forms of classroom dialog. For physics students, laboratory experiences are salient. Learners thus become more expert-like in their thinking. (Chichekian & Shore, 2013; Huang, 2012; Huang & Kalman, 2012, 2013; Ibrahim, Kalman, & Milner-Bolotin, 2013; Kalman, 1998, 2001a, 2001b, 2002, 2003, 2007, 2008, 2009a, 2009b, 2010a, 2010b, 2011a, 2011b; Kalman & Aulls, 2003; Kalman, Aulls, Rohar, & Godley, 2008; Kalman & Kalman, 1996; Kalman, Milner-Bolotin, & Antimirova, 2010; Kalman, Milner-Bolotin, Aulls, Charles, Coban, Shore, Antimirova, Kaur Magon, Xiang, Ibrahim, Wang, Lee, Coelho, Tan, & Fu, 2014; Kalman, Morris, Cotton, & Gordon, 1999; Kalman & Rohar, 2010; Kalman, Rohar, & Wells, 2003, 2004; Kalman, Shore, Aulls, Antimirova, Kaur Magon, Lee,

Coelho, Unal Coban, Huang, Ibrahim, Wang, Minh Tan, Fu, & Khanam, 2017; Khanam, 2014; Lee, Schulz, Kalman, & Coelho, 2013; Mitchell, 2001; Wang & Kalman 2014). This has also been demonstrated in secondary-school physics (El Helou, 2016; El Helou & Kalman, in preparation) and elementary school mathematics (Freiman, Polotskaia, & Savard, 2017). [E, S, H]

> Undergraduates have a somewhat constrained conception of inquiry, and it is entirely on the cognitive side: inquiry as a means of gaining information is the most prevalent single conception. In addition to learning to do it, attention should be given to understanding what it is. (Getahun, 2014; Getahun, Aulls, & Saroyan, 2014) [H]

Cluster 2: Social-Emotional and Cultural Dimensions

Includes: Elements of self-efficacy, relative valuing of different inquiry strategies and tactics, cultural differences.

> Inquiry is not merely a cognitive activity, and the path to effective collaborative problem solving is not necessarily smooth. The resolution of cognitive conflicts is frequently preceded by social moves to broaden the inclusion of individuals and ideas, and socio-emotional aspects also play a role in the divergent thinking processes that are a key component of creativity and inquiry approaches to teaching and learning. [E, S] (Barfurth, 1994; Barfurth & Shore, 2008; Ritchie, Shore, LaBanca, & Newman, 2011).

> Social perspective-taking is necessary for inquiry success, and is a skill which can be learned The nature of classroom activities, instructional choices, problem-solving training, group dynamics, and personality differences all influence the extent to which an understanding of self and others develops in inquiry. Learners active in choosing their work partners and who were assigned a task that required consideration of the audience's understanding adopted a more emotionally-based social perspective. [E, S] (Main, 2014; Main, Delcourt, & Treffinger, 2017; Walker, 2013; Walker, Shore, & Tabatabai, 2013)

> Learners start out with enthusiasm for inquiry but some lose confidence as they discover the complexities involved. Students feel least efficacious planning inquiry and most efficacious with (perhaps more familiar) tasks and components that are not exclusive to inquiry. Having only a

little bit of inquiry experience can be a barrier because students may accurately assess the difficulty, complexity, and metacognitive or self-regulatory demands of inquiry learning, but not (yet) have had enough practice to feel efficacious. Multiple, sustained inquiry efforts are often necessary to allow students to improve their perceived self-efficacy, and teachers with more inquiry experience identify more inquiry-based student outcomes. [E, S, H] (Aulls, 2008; Chichekian, 2014; Chichekian & Shore, 2016, 2017a, in preparation; Chichekian, Shore, & Tabatabai, 2016; Gyles, 2011; Gyles & Shore, advanced draft under final editing--b; Leung, MA thesis awaiting submission; Leung, Shore, & Williams, in preparation; Longo, 2012; Savard & Freiman, 2016, under review)

> Despite the positive cognitive contributions of being invested in the problem-finding stage, students so involved are also more likely to experience negative emotions through the process. The greater academic challenges and ambiguity have the potential to cause frustration and fatigue. By understanding and developing their own creative-productive behavior, students are better prepared to think of new ideas for scientific investigations. [E, S, H] (Aulls & Lemay, 2013; LaBanca, Delcourt, Yulo, & Dimock, under revision; LaBanca & Ritchie, 2011; Ritchie, Shore, LaBanca, Fitzpatrick, & Bracewell, in preparation; Woodel-Johnson, Delcourt, & Treffinger, 2012)

> Chinese international students experience a rich and intense emotional life highlighted by combinations of stress, joy, and anxiety. Self-regulated sources (e.g., meta-emotion) influence both the nature of emotions that students have and their readiness for epistemic change. Self-regulation and metacognition may play an important role in the change process. [H] (Hou, 2009; Wang, 2014; Wang, Saroyan, & Aulls, 2016)

> In inquiry-driven learning, there is a diversification, exchange, or interchange of roles between learners and teachers *[as discussed in more detail in Theme II, Section 3]*. New roles are added. Cultural expectations relating to roles can be a source of anxiety for international students who are surprised at the amount of responsibility learners have for determining their own learning goals and strategies. In addition, the terminology used for inquiry learning varies in different languages, which has a direct impact on the nuances of what is understood by inquiry across cultures. [E, S, H] (Aulls & Ibrahim, 2012; Aulls & Shore, 2008--see chapter 1; Chichekian, Savard, & Shore, 2011, 2012; Hou, 2009; Walker, 2013; Kalman, 2010b; Lemay, 2010; Savard

& Polotskaia, 2014; Walker & Shore, 2015b; Walker, Shore, & Tabatabai, 2013; Walker, Shore, & Tabatabai, advanced draft; Wang, 2014)

> Students value face-to-face interaction more highly than asynchronous verbal interaction online (as in MyCourses, previously WebCT), despite their positive ratings of most aspects of the online learning environment. On-line dialog can support the learning of thinking skills. It can allow the group to co-construct knowledge, promote metalearning skills, and enable the group to deal with social stigma, but it cannot replicate all benefits of face-to-face interaction. [S, H] (Aulls, Ibrahim, Peláez, Wang, & Orjuela-Laverde, 2009; Kaur Magon & Shore, advanced draft under revision) *[For more discussion on dialog in inquiry, please refer to Theme II, Section 3.]*

Cluster 3: Additional insights for and from gifted learners

> Inquiry-based and gifted education programming share several pedagogical priorities. Inquiry learning fits well within the larger theory of social-constructivist learning which supports the high comfort zone of bright learners with social-constructivist learning processes. Pedagogy in gifted education has had a headstart over general education in incorporating inquiry-based instruction, but not everywhere and not consistently, frequently due to poor alignment with identification (e.g., limited emphases on IQ or school grades). Gifted learners appear to have mindsets conducive to inquiry, which can honor students' many abilities in a school environment through seeking opportunities for children to thrive; providing opportunities for children's voices to be heard; and pairing students with experts who have similar interests and strengths. [E, S] (Aulls & Shore, 2008--see the chapter on giftedness and inquiry; Chichekian & Shore, 2014; Clark & Shore, 2004; Delcourt, 2001; Gyles, 2016; Gyles & Shore, advanced draft under final editing--a; Shore & Delcourt, 1996; Shore & Gube, 2018; Robinson, Shore, & Enersen, 2006--see the chapter on inquiry and giftedness)

> Gifted learners display higher levels of metacognition, strategy flexibility, tolerance for ambiguity, social-perspective coordination (perspective taking), and preference for complexity. These characteristics are hallmarks of inquiry, making this pedagogy highly suitable for bright learners. Flexible instructional settings enable gifted students to be highly creative problem

solvers as they draw on their interrelated knowledge constructs, in the same fluid and flexible way an adaptive domain expert would. Rigid settings, on the other hand, thwart the use of their metacognitive abilities and strengths. Able learners, like experts, use fewer categories to group problems by finding commonalities between the problems. Gifted learners are thus also able to further reduce initial categories and group problems based on deep structural similarities. [E, S] (Aulls, 2008; Barfurth, Ritchie, Irving, & Shore, 2009; Delcourt, Treffinger, Woodel-Johnson, & Burke, 2015; Masden, 2004; Masden, Leung, Shore, Schneider, & Udvari, 2015; Pelletier, Birlean, & Shore, in preparation; Pelletier & Shore, 2003; Robinson, Shore, & Enersen, 2006; Shore, 2000)

> Giftedness resembles the development of expertise, for example, in the use of self-regulatory strategies including metacognition, pattern recognition, forward-chaining, and the understanding of the interrelatedness of individual constructs. These are inquiry processes and strategies that are used by experts to solve problems, and bright learners flourish in inquiry environments because of their metacognitive ability to metaplan and see ahead. Inquiry settings allow high ability learners to adapt their solution strategies throughout the process, rather than waiting for a wrong answer to signal a need to correct the course. [E, S] (Barfurth, Ritchie, Irving, & Shore, 2009; hannah & Shore, 2008; Irving, Oppong, & Shore, 2016; Martini & Shore, 2008; Martini, Wall, & Shore, 2004; Oppong, 2015; Oppong, Shore, & Muis, under review; Shore, 2000)

> Twice-exceptional students (who have high intellectual ability coupled with a learning challenge or developmental disability) benefit particularly from inquiry learning opportunities, and approach the inherent inconsistencies and ambiguities from a high ability rather than a disability angle. Inquiry-based instruction within an authentic community of practice can play an integral role in talent development for gifted students with ADHD. Students with learning challenges benefit from inquiry when sufficient structure is given for strategies and content to be taught at the same time. Inquiry is thus appropriate for a wide range of abilities and learning disabilities. [E, S, H] (Bellande, 2001; Chevalier, Deacon, Parilla, & Ritchie, under revision; hannah & Shore, 2008; Hua, Shore, & Makarova, 2014; Mitchell, 2001; Tabatabai, Shore, Delcourt, & Aulls, in early stage of preparation)

> A persistent myth suggests that gifted children prefer to work alone. We found that this only holds true in high-stakes situations, and only if the gifted learners have little or no input in the

selection of their partner. Parents often disagree with teachers about the importance of sharing results and working collaboratively because of concerns about the fair distribution of workload. Gifted learners thrive on smaller numbers of close friendships. Social-perspective coordination (an indicator of psychosocial maturity), perceptions (self-concept) of ability to make and keep friends, academic ability, sex, and grade predicted perceptions of the overall quality of friendships. In addition, it is not essential for successful collaborative groups--a signature of inquiry learning--to always be happy and in full agreement; respectful argument and the clash of ideas is welcomed by highly able students compared to others and this can complicate the process of creating working groups in the classroom. Gifted learners do appear wary of the "free-rider" effect. The literature is becoming clearer about their learning preferences, but there has not been research specifically addressing what they expect to happen in group work--this expectation, for example, that they will be carrying a disproportionate share of the workload, if true, could in turn influence their preferences. [E, S] (Barfuth, 1994; Barfurth & Shore, 2008; Cera Guy, Williams, & Shore, in preparation; Chichekian & Shore, 2017b; French, 2007; French & Shore, 2009; French, Walker, & Shore, 2011; Masden, 2004; Masden, Leung, Shore, Schneider, & Udvari, 2015; Saunders, 2004; Saunders-Stewart, Walker, & Shore, 2013; Walker, 2010; Shore, Chichekian, Gyles, & Walker (accepted for publication); Walker & Shore, 2015a; Walker, Shore, & French, 2011; Williams, Cera Guy, & Shore, advanced draft)

I-2. Teacher preparedness to teach with inquiry

Cluster 1– Teachers' Understanding of Inquiry

> Inquiry is not a script with stage directions. It is becoming an empirically-supported goal that new teachers should have had some inquiry or research experience if they are going to adopt an inquiry approach. It is possible to gain inquiry experience in different ways, whether by "doing" inquiry or "learning about" inquiry. Teachers' exposure to, and training in, inquiry impacts attitudes as well as knowledge and skills. "Doing" inquiry and "learning about" inquiry as pedagogy lead to similar valuing of the specific tasks in inquiry, but differences in the ability to

teach others to use inquiry to learn (favoring the latter). Research experiences enhance abstract thinking about inquiry, but merely having "done" inquiry is insufficient to support teachers' ability to teach with inquiry, even if there is awareness of the teaching-research nexus and its importance for students. Teaching student-teachers about inquiry instruction probably benefits more from connections to familiar instructional experiences than to theoretical inquiry constructs, and student-teachers are better able to articulate inquiry outcomes when asked about inquiry experiences rather than inquiry definitions. Teachers learn to teach with inquiry not only by experiencing but specifically by extensively practicing teaching with inquiry, which increases both teachers' and students' knowledge about inquiry. There are qualities of the learner (especially the preservice teacher) that facilitate inquiry engagement but whose enhancement is also a product or outcome of inquiry participation, in a reciprocally supported, bidirectional process. Inquiry teaching accommodates personal styles and differences, and inquiry teachers are willing to grow and change in general, but so far there is little evidence that they grow or change as a specific result of their action research. Nonetheless, teachers of gifted students are more likely to be inquirers themselves. Preservice teachers' prior experience doing a thesis or research is especially related to the quality of their definitions of inquiry, and having taken a research-methods course was especially related to the quality of their descriptions of an actual inquiry event, perhaps because it was recent and provided process-relevant vocabulary. [E, S, H] (Aulls, Tabatabai, & Shore, 2016; Carkner, 1996; Delcourt & Carkner, under revision in preparation for resubmission; Hua, Yang, & Shore, data collected; McBride, 2005; Syer, 2007; Syer, Chichekian, Shore, & Aulls, 2013; Xenos-Whiston, 1989)

> Practice-based teaching allows preservice teachers to engage in innovative approaches. An authentic learning environment (such as a situated learning framework) increases the likelihood of successfully transferring learned skills to teaching. Repeated, sustained practice that is not just procedural knowledge but is also connected to understanding inquiry supports student teachers in learning to teach with inquiry. A close correspondence existed between inquiry-based instructors' conceptions of inquiry instruction and the place they accorded inquiry instruction in their courses. [H] (Aulls, Kaur Magon, & Shore, 2015; Chichekian, Shore, & Tabatabai, 2016; Din, 2014; Kaur Magon, Aulls, & Shore, in early preparation--data collected).

> Cultural sensitivity and perspective-taking are not only important for students but also between teachers and university-based researchers who might act as consultants in professional development. For example, an implicit research contract between an Inuit teacher and "southern" investigator stumbled when mutual expectations about roles and contributions were breached, not necessarily intentionally. [S, H] (Savard, Lin, & Manuel, D., under review)

Cluster 2 –Self-efficacy to Teach with Inquiry

> Teaching from an inquiry approach is difficult and challenging to implement. It requires considerable managerial skills and a high level of reflection on the part of the teacher, and even experienced teachers occasionally struggle and need scaffolding to enact inquiry. In order to succeed at teaching inquiry (or with inquiry), teachers must be able to simultaneously teach both content and strategy, and sometimes across disciplines. For example, preservice teachers (in mathematics) struggle to shed their perspective held while they were student-teachers when they often learned about inquiry as a series of classroom procedures rather than as a more general set of principles as they move from theory to practice, which ultimately affects their development of knowledge for teaching. [H] (Bellande, 2001; Lamb, 2010; Savard. 2014b; Savard, Lin, & Lamb, 2017; Savard & Manuel, 2016; McBride, 2005; Mitchell, 2002; Sagel & Shore, 2004; Shore, 2017; Slapcoff, Dobler, Tovar, Chromik, Cossette, Ellis, Fallon, Fitzgibbons, Harris, Hébert, Laver, McCourt, Radziszewski, Ragsdale, & Savard, 2011; Shore, 2017)

> In the first year, new teachers' self-efficacy declines in parallel with their conceptualizations of inquiry, but the number of inquiry events enacted in their classes nonetheless increases over the year. High self-efficacy to teach with inquiry requires sustained mastery and vicarious experiences. Being taught specific research skills alone is related to lower self-efficacy to teach with inquiry; abstract and practical aspects need to be linked--yet student teachers appear to have learned about inquiry more as a series of classroom procedures than conceptually. Self-efficacy differences between elementary and secondary preservice teachers were more evident on tasks related to engaging students in problem finding rather than tasks involving linking knowledge [H] (Chichekian, 2014; Chichekian & Shore, 2016, 2017a, in preparation; Chichekian, Shore, & Tabatabai, 2016)

> Inquiry teaching is complex but ultimately rewarding. University instructors' reflection on

their teaching can lead to charting a new teaching path that takes into account different learning types and roles. Both internal beliefs and external influences can act as catalysts and barriers to teacher use of inquiry in the classroom. Teachers with more inquiry experience identify more inquiry-based student outcomes, and inquiry-trained teachers provide more time and opportunities for students to ask advanced questions and create project-oriented science environments. Teachers use individual problem-solving styles to enhance their teaching in the classroom. Engagement in inquiry and a transformational leadership style are related. [E, S, H] (Delcourt, Aslanian, & Duncanson, 2007; Guertin, 2014; Gyles & Shore, advanced draft under final editing; Issa, 2014; Savard, 2014c; Shore, Aulls, & Delcourt, 2008)

Cluster 3 – Instructional and Content Dimensions (including Roles)

Much but not all of our research on this topic was done in higher education.

> Teachers with both pedagogical and content knowledge (PCK) are better able to plan and evaluate inquiry-based learning. Inquiry teachers are more likely to plan ahead (either for the whole course or on a weekly basis in light of reflections of the previous class), rather than relying on a textbook for content. Subject-matter experts are better able to evaluate the content of science-fair projects, but teachers are better able to articulate how to elicit projects from learners. Expertise in the subject-matter is an important variable underlying teachers' openness and disposition to implementing inquiry instruction in their own classes, and personal inquiry experiences of student teachers predict the subjects they choose to teach (except in mathematics). Strong subject-matter knowledge, even if not essential to the initial development of pedagogical-content knowledge, increases instructional effectiveness. Instructors can employ a range of student activities to evaluate learning. [E, S, H] (Aulls, 2002; Aulls, Kaur Magon, & Shore, advanced draft); Birlean, 2003, 2011; Birlean & Shore, under revision--a, b; Birlean, LaBanca, & Shore, in preparation; Kalman, 1997; Savard, 2014a; Tabatabai, Shore, & Aulls, advanced draft)

> Effective inquiry instructors are perceived to undertake more roles than just-effective instructors, and help students be more active in a variety of different ways, for example, offering wider curricular choices. Effective inquiry teachers must overcome the fear of not covering the prescribed course of study and allow students to make evaluations and set standards, thus taking on specific roles that just-effective teachers do not demonstrate. Role diversification in inquiry

is a good fit to social-constructivist theory, which can also be widely adopted and applied in undergraduate classes. Students who attributed responsibility for learning to both the professor and students themselves understood and applied course content more than those who attributed responsibility to either solely the professor or student on measures of understanding and application. Effective inquiry teachers also have a much stronger understanding of inquiry concepts than good traditional teachers, especially about the construct of process in inquiry *[please refer to Theme II, Section 4 for more discussion on the Aulls-Shore model and the four inquiry constructs of process, content, strategy, and context]*. Professors' perceptions about the role and use of computers were found to be in line with their conceptions of effective teaching. Professors whose conception of effective teaching focused on developing learning independence (as in inquiry) used computers as tools in active learning environments; those with a "transmitting knowledge" conception considered computers as a means of accessing or presenting information. Teachers who received professional development with Virtual Communities of Practice--and thus experienced an inquiry-instruction social-constructivist dialog--demonstrated the highest level of technology integration. [E, S, H] (Aulls & Ibrahim, 2012; Baratta, 2012; Gebre, Saroyan, & Aulls, 2015; Kaur Magon & Shore, advanced draft; Manconi, 2004; Peetush, 1998; Redden, 2006; Shore & Chichekian, 2011; Redden, Simon, & Aulls, 2007; Walker & Shore, 2015b; Wolfe, 2005)

> Instructors who implement multiple and varied instructional pedagogies allow students to actively reflect on and discuss physics (and likely mathematics or other subject) concepts in an expert-like, deeply conceptual way, facilitating the understanding of systematic relations among ideas, rather than unrelated laws and facts (in contrast to the chemistry professors in the paragraph below). [H] (Chichekian & Shore, 2013; Huang, 2012; Huang & Kalman, 2012, 2013; Kalman, 1998, 2001, 2001b, 2002, 2003, 2007, 2008, 2009a, 2010a, 2010b, 2011a, 2011b; Kalman & Aulls, 2003; Kalman, Aulls, Rohar, & Godley, 2008; Kalman, & Kalman, 1996; Kalman, Milner-Bolotin, & Antimirova, 2010; Kalman, Milner-Bolotin, Aulls, Charles, Coban, Shore, Antimirova, Kaur Magon, Xiang, Ibrahim, Wang, Lee, Coelho, Tan, & Fu, 2014; Kalman, Morris, Cotton, & Gordon, 1999; Kalman & Rohar, 2010; Kalman, Rohar, & Wells, 2003, 2004; Kalman, Shore, Aulls, Antimirova, Kaur Magon, Lee, Coelho, Unal Coban, Huang, Ibrahim, Wang, Minh Tan, Fu, & Khanam, 2017; Khanam, 2014; Lee, Schulz, Kalman, & Coelho, 2013; Manuel, in progress; Mitchell, 2001; Wang & Kalman 2014)

> Two-thirds of interviewed chemistry professors regarded students as passive receivers of information. (A similar result was observed for seven science professors from different universities.) Acquiring the basic facts of a discipline was seen as necessary before engaging in research experiences, but the excessive emphasis on core content knowledge excludes early engagement in the process of inquiry and does not teach students to think like chemistry researchers. Professors claimed research engagement (a) enhances student interest, (b) promotes subject-matter currency, (c) generates research examples, (d) models ways of thinking in the discipline, (e) provides contextualization guidance for instruction, and (f) helps them explain difficult concepts. They appear to have increasingly reflected on this link and, when asked about what they actually do to promote it in their teaching, they do relate a range of pedagogical strategies. [H] (Aulls, Kaur Magon, & Shore, advanced draft; Chichekian, Hua, & Shore, in press; Hua, 2009; Hua & Shore, 2013; Ibrahim, 2014)

Theme II:
Building and Sustaining Inquiry:
Facilitating Inquiry in the Classroom

Our work on this theme is summarized in four sections essentially addressing what happens as inquiry in classrooms and schools from descriptive and model-building perspectives. Section 2 is further divided into two clusters separating theory and practice.

II.1. Language of Inquiry

II.2. Instruction and Design of Learning Strategies

II.2.1. Theory

II.2.2. Pedagogical Practices and Changes

II.3. Outcomes of Inquiry

II.4. Model/Framework

II.1. Language of Inquiry

> Inquiry is described by slightly different terminology reflecting underlying conceptual differences in different languages and even different countries using the same language. International conversations need to take these variations into account. The strong influence of science inquiry on the language and concepts is not an accident; several prominent physicists in France and the USA in particular, played a leading role in connecting scholarly and educational inquiry. Inquiry literacy in science education is growing, and diverse content domains offer different opportunities for developing inquiry literacy within learners' experiences. At the same time, science educators have moved away from the term inquiry in favor of practices of science, but these practices stop short of teaching learners to do independent research. [E, S] (Aulls, Kaur Magon, & Shore, under review; Chichekian, Savard, & Shore, 2011, 2012; Hua, 2018--submitted; Shore, Birlean, Walker, Ritchie, LaBanca, & Aulls, 2009).

II.2. Instruction and Design of Learning Strategies

Cluster 1: Theory

> Social constructivism can be widely adopted in an undergraduate class, with chapter questions and exercises moving in the direction of inquiry-based learning. A research base supports many of the practices to be used in undergraduate teaching, especially the need to provide repeated, sustained practice that is not just procedural knowledge but is also connected to understanding inquiry. In the example closest to our experiences, teaching educational psychology to first year-preservice teachers, such a course could not ensure that student-teachers (especially in their first

year) had a high level of content knowledge (and understanding of inquiry) in the areas in which they intended to teach. [H] (Aulls, Kaur Magon, & Shore, 2015; Aulls, Kaur Magon, & Shore, under review; Kaur Magon, Aulls, & Shore, in early preparation--data collected; Chichekian & Shore, 2016, 2017a; Ormrod, Saklofske, Schwean, Andrews, & Shore, 2010)

> Community is an important aspect of social constructivism and also supports professional development. An online community can be a support and resource for dialogs in which inquiry-related thinking skills are taught, applied, and learned. Community- and ability-based characteristics enable groups to deal with social stigma, co-construct knowledge, and promote metalearning skills, and also highlight barriers faced by both members and tutors. For gifted students with ADHD, inquiry-based instruction within an authentic community of practice can play an integral role in talent development. Among teachers, those who received professional development with Virtual Communities of Practice demonstrated the highest level of technology integration. [S, H] (Barratta, 2012; Hua, Shore, & Makarova, 2014; Kaur Magon & Shore, advanced draft; LaBanca, 2008, 2016)

> Learners with growth mindsets tend to adopt mastery goals and believe their abilities can be learned and developed, employing effortful learning and persisting in the face of challenge. Student-centered, interest-driven, collaborative, project-based learning, in which students have opportunities to pursue in-depth investigations of questions of interest with scaffolded core principles of inquiry-based teaching and learning practices, are well aligned in classroom structures that promote mastery mindsets. [E, S] (Gyles & Shore, 2016, advanced draft; Gyles, Shore, & Hoover, completed draft).

> Csikszentmihalyi's notion of Flow is a good motivational model for supporting inquiry. Flow is optimal when the task is well scaffolded and taps student interest, and when the difficulty level is perceived as challenging but not overpowering (as in Vygotsky's "Zone of Proximal Development). Inquiry theory could usefully include this to support teacher planning. [E, S] (Borovay, 2008; Borovay, Shore, Caccese, Yang, & Hua, advanced draft under revision pending resubmission).

Cluster 2: Pedagogical Practices and Changes

> Classroom practices have started to move from direct teaching to inquiry, supported by theory. Inquiry teaching is complex and requires attention to detail, but it is worth the effort. Facilitators and barriers abound, but three characteristics that seem to be common to all conceptualizations or implementations of inquiry in education are (a) it is based on student interest and curiosity, (b) student-student dialog is central to learning, and (c) and the exchange (better described as diversification) of roles among learners and teachers is central to inquiry in the classroom. [E, S, H] (Aulls, 2008; Aulls & Shore, 2008; Freiman & Manuel, 2015; Savard & Corbin, 2012; Shore, 2009; Shore, Aulls, & Delcourt, 2008; Walker, Shore, & Tabatabai, advanced draft).

> Inquiry instruction is complex and demanding, and needs support at different levels (curriculum, pedagogy, etc.). Even a curriculum leading to superior PISA outcomes still lacks some key qualities of inquiry and suitability for gifted students. In the IB program, inquiry is strongly stated as core pedagogy, but it appears to be more rhetorical than enacted in practice due to increasing emphasis on content-based examinations across the three IB levels from primary years to matriculation. [S] (Chichekian, 2014; Chichekian & Shore, 2014; Freiman & Manuel, 2015; Oppong, 2015; Irving, Oppong, & Shore, 2016; Reid, Simmt, Savard, Suurtaam, Manuel, Lin, Quigley, & Knipping, 2015)

> Building inquiry within a school involves identifying key stakeholders, using community resources, and planning the process. School leadership is critical, as well as making time for inquiry and professional development. This also applies to national efforts to enhance instruction (Chichekian, Shore, & Tabatabai, 2016; Cyr, Savard, & Braham, 2016; Issa, 2014; LaBanca, 2016). We have data yet to be analyzed and written up on how three collaborating Montreal schools built and sustained their inquiry foci, even during stresses such as school mergers, change of leadership, and loss of nearly half the original teaching staff. The three schools also had IB programs. [E, S]

> Inquiry projects need to be scaffolded in time, resources, and help (e.g., by teaching effective oral presentation skills), as well as carefully monitored for progress jointly by teachers and students. Fundamental skills are important to inquiry success. For elementary-school teachers, there is a need to blend theory and real-life examples as they try to build inquiry experiences for their pupils. Students seek help from parents; a key concern is that help is not available to the

extent desired in class. As many as 25% of students cheat in science fairs, and they do so for the same reasons as "real" scientists cheat: limited resources including time, and the pressure for recognition (whether grades or publications). [E, S, H] (Chevalier, Deacon, Parilla, & Ritchie, under revision; Chichekian, Hua, & Shore, 2013; Gervais, Polotskaia, & Savard, 2013; LaBanca, 2011; Schapiro, 1998; Shore, Aulls, Tabatabai, & Kaur Magon, in preparation; Shore, Delcourt, Syer, & Schapiro, 2008; Syer, 2002; Syer & Shore, 2001)

> Creative teachers engage students in inquiry-relevant activities, and there are strong links between inquiry and creativity. Inquiry is also a pedagogical link between expertise and giftedness; both can be learned and taught to some degree. For example, inquiry processes can be understood and taught in search strategies. Further, inquiry engagement enhances motivation and problem solving. Problem finding is a creative and open-ended problem-solving task, and there are strategies for teachers and for students to successfully engage in the problem-finding stage of the inquiry process. Building higher-order questioning skills in students also facilitates critical thinking, and students need opportunities to develop increasingly sophisticated methods of reasoning through practicing their critical thinking. [E, S, H] (Delcourt & McKinnon, 2011; Delcourt & Renzulli 2013; Hua, thesis submitted; Lilly, 2002; Longo, 2012; LaBanca & Ritchie, 2011; McKinnon, 2012; Savard & DeBlois, 2013; Shore & Irving, 2005; Syer, Jad-Moussa; Pelletier, & Shore, 2003; Tabatabai, 2002; Walker & Shore, 2012)

> Inquiry-based practices are possible but not yet widespread in undergraduate programs and teaching. The Boyer Report provided several ideas for implementing inquiry-based learning experiences, but they have proven challenging to implement. Disciplines vary in the extent to which core teaching practices bring learners into contact with core inquiry practices in scholarly work. Inquiry in higher education is a collaborative effort and therefore the interpersonal interactions between instructors and learners are an important part of the success of helping students become inquirers. [E, H] (Aulls, Kaur Magon, & Shore, 2015; Aulls, Kaur Magon & Shore, under review; Hua, 2009; Hua & Shore, 2014; Sagel & Shore, 2004; Shore, 2014; Shore, Pinker, & Bates, 1990).

> Integrating research into coursework is an effective means of communicating to students the value of attending a research-intensive university while improving student engagement and learning. Accordingly, identifying instructors who already integrate research into their teaching

and sharing their examples is an important to support institutional learning. The means by which an understanding of research can be promoted within undergraduate coursework are various and will be influenced by factors such as discipline, academic level, class size, and students' background knowledge. Determining how to integrate research into coursework is a complex process and thus requires that instructors have the time and support necessary for designing or redesigning their courses in ways that promote meaningful student learning. To be most effective, it must include opportunities for reflection and cross-disciplinary dialog and be reflected in policies and practices at the departmental, faculty or college, and institutional levels. [S] (Savard & Manuel, 2016; Shore, 2017; Slapcoff, Dobler, Tovar, Chromik, Cossette, Ellis, Fallon, Fitzgibbons, Harris, Hébert, Laver, McCourt, Radziszewski, Ragsdale, & Savard, 2011)

> Concept maps reveal areas of strong and weak connections between content and pedagogy in instruction. They are especially relevant to inquiry because inquiry is claimed to enhance the integration of new and old knowledge. Maps created by domain experts and high-performing students contain more and better-explained links among the concepts, reflecting the integration of concepts. Inquiry is both cognitive and social-emotional, and learners can be taught to work with all kinds of input. Teaching learners to simultaneously purposefully attend to different kinds of input in a learning situation, for example social, emotional, situational, and cognitive, is an example of creating multiple links among concepts--not all the links in a concept map need be directly related to the two linked constructs alone but could also reflect a common situational context, or from whom and with whose help they were connected. Just as the social intervention of a fellow learner can support a learner in making a contribution can help the latter, so can attending to different kinds of input generally help overcome social barriers to cognitive actions. [H] (Austin, 1993; Austin & Shore, 1998, 1995, 1994, 1993; Barfurth & Shore, 2008; Chichekian & Shore, 2013; Lasry, 2006).

> Promoting opportunities for dialog and reflection in undergraduate classrooms enhances expert-like thinking about concepts. Reflective writing exercises help students advance their epistemic beliefs, thereby supporting learning. [H] (Bernard, Savard, & Beaucher, 2014; El Helou, 2016; El Helou & Kalman, in preparation; Ha, Lee, & Kalman, 2013; Huang, 2012; Huang & Kalman, 2012; Kalman & Aulls, 2003; Kalman & Kalman, 1996; Kalman & Rohar, 2010; Kalman, 1998, 2001, 2001b, 2002, 2003, 2007, 2008, 2009a, 2009b, 2010a, 2010b, 2011a,

2011b, 2017a, 2017b, 2017c; Kalman, Milner-Bolotin, & Antimirova, 2010; Kalman, Milner-Bolotin, Aulls, Charles, Coban, Shore, Antimirova, Kaur Magon, Xiang, Ibrahim, Wang, Lee, Coelho, Tan, & Fu, 2014; Kalman, Morris, Cottin, & Gordon, 1999; Kalman, Rohar, & Wells, 2003, 2004; Lee, Schulz, Kalman, & Coelho, 2013; Kalman, Shore, Aulls, Antimirova, Kaur Magon, Lee, Coelho, Unal Coban, Huang, Ibrahim, Wang, Minh Tan, Fu, & Khanam, 2017; Kalman, Sobhanzadeh, Thompson, Ibrahim, & Wang, 2015; Wang & Kalman, 2014; Khanam & Kalman, 2017; Wang & Kalman, 2014).

II.3. Outcomes of Inquiry

This section refers mostly to student outcomes because we have so far done few studies about teacher outcomes (apart from what we have in the preparedness to teach with inquiry, mostly in terms of self-efficacy). What teachers do may usefully be regarded as part of the input and student outcomes as the output of the process. However, there is the reward from struggling through learning to teach with inquiry, being scaffolded, reflecting, and then seeing it work, plus the growth of competence, but we have not done studies on that other than those we have described above. Career outcomes (satisfaction, burn-out, etc.) were not part of our initial mandate, but later studies started to focus on professional development (see Annie Savard's research).

> Dialog is a powerful inquiry tool, and students' experiences directly impact what they learn. By directing learner attention to critical content and skills (including communication), instructors act as "guides" and orient developing discourse through the use of linguistic and other devices. Patterns of co-occurring forms of discourse and activities across sequences of lesson events provide a useful window into interactions between learning and instruction, and indicate that teachers teach both content and learning strategies. [S, H] (Aulls, 1998; Aulls, 2002; Aulls, Kaur Magon, & Shore, 2015; Ha, Lee, & Kalman, 2013; Lemay, 2017)

> Student experiences in an inquiry setting are different from those in a noninquiry classroom. Instructors agree that student motivation is the most important science-instructional quality, and learning was rarely expressed as a goal. Inquiry instructors noted student responsibility for their own learning, and provided notable opportunities for dialog and discourse. [H] (Aulls, Kaur Magon, & Shore, under review)

> How collaborative learning groups are formed (e.g., by teachers or students) affects their successful functioning and the types and numbers of roles that members adopt. In successful inquiry, learners and teachers add multiple roles to their repertoires. Classroom context, teacher personalities and teaching styles, individual student personalities, and group-work dynamics affect the nature and numbers of roles undertaken by students and teachers when engaged in complex inquiry. Role diversification can be a nonacademic indicator of inquiry success for students. [E] (Walker, 2013; Walker, Shore, & Tabatabai, advanced draft)

> The frequency of speech turns is a better predictor of learning than the patterning of turn-taking. Ensuring all learners have ample opportunity to express themselves in topically organized discourse is critical for inquiry success. In certain settings, students themselves take on the role of ensuring that other students get a chance to make their points (role diversification). [S, H] (Barfurth, 1994; Barfurth & Shore, 2008; Lemay, 2010)

> All interpersonal interactions occur in context, and the extent to which high-performing students prefer their friends and themselves to hold firm in the face of a disagreement varies in different program contexts, for example, IB, enriched French, and Sports Excellence. [S, H] (Chichekian & Shore, 2017b)

> Inquiry provides optimal conditions for students to achieve outcomes less likely to be found in a more traditional classroom, for example, learning competencies, personal motivation, and increased responsibility for their own learning, and to engage less in such outcomes as memorization out of a larger context. A newly generated list (below) of 23 criterion-referenced student inquiry outcomes (MISIO-S, -T, and -P; also the modified MISIO-Sm) 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. 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 still existing within high levels of inquiry (possibly as a part of pursuing a more complex goal). [E, S] (Aulls, Tabatabai, & Shore, 2016--modified list; Gyles, 2011; Saunders-Stewart, 2008;

Saunders-Stewart, Gyles, & Shore, 2012--the original list; Saunders-Stewart, Gyles, Shore, & Bracewell, 2015)

The 23 criterion-referenced, literature-derived inquiry outcomes were, in alphabetical order:
Ability to see concepts as related
Acquisition of facts or knowledge
Application of knowledge or Information
Change in teacher and student roles, increased student ownership
Construction of knowledge
Development of expertise
Development of intellectual or thinking skills
Development of personal skills (e.g., planning and organization), habits of mind
Emulate professionals, create authentic products
Enhanced creativity
Generation of questions, curiosity
Improved achievement
Learn how to learn or lifelong learning
Learn process, the "how-to"
Motivation to be informed citizens, increased social awareness and action
Motivation, task commitment
Positive attitude toward subject or learning
Problem-solving skills
Self-esteem, self-confidence
Social nature of learning
Understanding about the nature of the content area (e.g., scientific literacy)
Understanding concepts (vs. memorizing facts)
Understanding of the nature and value of inquiry

> IB [inquiry]-trained students have more sophisticated epistemic beliefs, moderate surface motives associated with their approach to learning, and higher ratings of aspects of inquiry learning that represent self-regulation of the inquiry process. They also have higher ratings of importance assigned to the reflective and self-regulatory dimensions of inquiry learning than non-IB students. [S, H] (Aulls & Lemay, 2013)

> Creative problem solving, scholarly rigor, and literary analysis were enhanced when (a) teachers created and administered a multiple choice exam that asked conceptual questions; (b) students participated in a Socratic test debate in which they were required to support their answers using specific textual references; and (c) students wrote a metacognitive reflection of the evolution of their thought process including an initial interpretation of the question, the points gleaned during the debate, and their final interpretation of the course concept or theme addressed in the question. These findings reinforce the roles of dialog and reflection in inquiry. [S] (Kowgios, 2008; Kowgios, Burke, Cyganovich, Delcourt, & Shore, under revision).

> Inquiry based on student interest does not directly impact specific inquiry skills--teacher guidance does--but it does impact attitudes. Students in a teacher-directed inquiry group had significantly higher scores on mental focus and learning orientation. Students' civic responsibility was also predicted by group assignment, and by motivation to use creative problem solving and critical thinking skills. Failure to provide inquiry-based instructional context can cause able students to go to other programs, like those who left French immersion programs due to reported dissatisfaction with the highly formalized teaching and content. [E, S] (Bell, 2012; Karovitch, 1994; Karovitch, Shore, & Delcourt, 1996)

> Inquiry settings contribute to enhanced causal attributions among low-achieving students, and students in a thematic [inquiry] social-studies program had significantly more positive attitudes toward social studies compared to peers in the nonthematic-based program. Inquiry settings in science instruction also uniquely support students' development of expert-like thinking and understanding. Sometimes inquiry outcomes can be achieved in traditional classes, but not as consistently or frequently as in inquiry-committed classrooms. [E, S, H] (Cloutier, 2013; multiple publications by Kalman and with co-authors; Mitchell, 2001; Salon, 2008)

> The accomplishment of inquiry tasks and foundational reading, writing, and study and search skills are necessary to successfully accomplish common university academic tasks in most disciplines. However, first year [university] students experienced research primarily through reading it, writing about it, and occasionally discussing it but never through actually doing it as part of their coursework or even outside the classroom. [S, H] (Aulls & Peláez, 2013)

II.4. Model or Framework

> Four postulated constructs of inquiry, namely process, content, strategy, and context [these are the first dimension of the Aulls-Shore model described in the next paragraph], were found in the literature and in experienced inquiry teachers' detailed conceptualizations of inquiry as shown in their definitions, interviews, and concept maps. Inquiry teachers were distinguished from noninquiry teachers by the relative difference in the frequency of their use of the four constructs.

The inquiry teachers each had one predominant construct that they emphasized more in their teaching, and their identity could be expressed in terms of a profile of their pedagogical use of these four constructs. The noninquiry teachers made fewer inquiry statements when compared to the literature and as proportion of all their statements. Effective inquiry teachers also have a much stronger understanding of inquiry concepts than good traditional teachers, especially about process. [E, S, H] (Manconi, 2004; Manconi, Aulls, & Shore, 2008)

> The Aulls-Shore four-element conceptual model usefully categorizes inquiry objectives and reflects teachers' self-perceptions as inquiry instructors in terms of process, content, strategy, and context. Preliminary analyses of school visits and teacher interviews revealed that (a) the four elements each have two sides--inquiry as understood in and of itself and subject matter as taught through inquiry; (b) an inquirer has specific knowledge, skills, and dispositions that explicitly include beliefs (e.g., as studied by Krista Muis); (c) the specific tasks of doing inquiry were initially regarded as forming three engagement stages based on Schön's (1983) *The Reflective Practitioner*--planning, execution, and reflection --Ibrahim identified a fourth engagement stage before planning--inquiry deliberation--thinking about an inquiry question or problem and imagining outcomes, asking questions or defining the problem, and formulating hypotheses or proposing solutions; and (d) there are four phases--committing to, initiating, building, and sustaining inquiry as a learner, teacher, or school. The actors (students, teachers--including their past inquiry experience, etc.), discipline, and school level are important contextual variables. The phases are relevant to beginning inquiry in a school. [E, S, H] Aulls & Shore, in early stages of preparation; Ibrahim, 2014; Ibrahim, Aulls, & Shore, in preparation--a, b, c, d; Shore, Birlean, Walker, Ritchie, LaBanca, & Aulls, 2009; Shore, Chichekian, Syer, Aulls, & Frederiksen, 2012)

Theme III
Creating a Toolbox for Research and Evaluation of Inquiry Learning and Instruction

Citations are typically duplicates of those cited in Themes I and II because most of our tools were created as parts other studies rather than specifically in instrument-development papers. Theme III does not contain separate Sections or Clusters. Rather, it lists the tools we have created in two lists that will ultimately come together: Those already described in theses and published reports, and those in progress of being written up. Most tools are instruments that can be directly used for the indicated purposes, but some are checklists, etc., that require adaptation to current needs. Each entry contains the abbreviation or acronym plus the full name of the tool, the primary published (or to-be-published) source, other relevant products in our portfolio, and a brief description or annotation. The HAIR team agreed in the early 2000s that the names of tools developed by HAIR at McGill would begin with the word "McGill." Tools with other names were created elsewhere (e.g., in Connecticut) or in the context of other projects (e.g., Interprofessional Practice in Medicine).

Published Tools

ECIS-STM-HSS, *Educational and Career Interest Scale in Science, Technology, and Mathematics for High School Students*. (Oh, Jia, Lorentson, & LaBanca, 2013). http://eric.ed.gov/?id=EJ1038529 A self-report instrument measuring high school students' educational and career interest in STEM. The measure assesses self-efficacy, indirectly related to inquiry based on what students understand to be the nature knowledge and acquiring knowledge in STEM domains. A sample item is "I believe that I can get into college after high school to study science, technology, engineering, or math (STEM) if I want." (p. 99)

MAVIES, *McGill Attainment Value for Inquiry Engagement Survey*. Ibrahim, Aulls, & Shore (2016b). "Expectancy value theory posits that attainment values are important

components of task values that, in turn, directly influence students' achievement-related choices and performance. The current paper developed and validated the McGill Attainment Value for Inquiry Engagement Survey (MAVIES) with undergraduate students in STEM disciplines. The MAVIES is a 67-item, learner-focused survey that addresses four components that are theoretically important for engaging in scientific inquiry: (a) teachers' roles, (b) students' personalities, (c) inquiry learning outcomes, and (d) practices of science and engineering. Evidence for internal consistency and construct, content, and criterion validity was obtained from 85 undergraduates who had experience with scientific inquiry in diverse STEM fields. Confirmatory factor analyses generated factors that were aligned with role theory, Big Five personality traits, Bloom's learning outcomes, and the Next Generation Science Standards. The MAVIES instrument was a reliable and valid instrument for measuring undergraduate students' attainment values for scientific inquiry in STEM disciplines."

MCLIC, *McGill Classroom Level of Inquiry Checklist*. Oppong-Nuako, Shore, Saunders-Stewart, & Gyles (2015). New literature searches of inquiry-indicative statements, goals, outcomes, advantages, and benefits generated a criterion-referenced checklist--an expanded, updated MISIO--of 25 inquiry-outcome categories that can be use together with the MITSI, MTALIR, or any interview protocol or open-ended questionnaire response. Most-Inquiry classroom teachers mentioned 21 or 25 of the 25 criterion-referenced inquiry items in Table 2 (respectively 84% and 100% of the properties). Middle-Inquiry teachers noted 17 or 18 items each (68% and 72%). In the Least-Inquiry classrooms, 6 and 9 items were mentioned (25% and 36%). The wide range of tallies (from 6 to 25) with natural breaks was a welcome result, and offered considerably more potential to plot progress than High versus Low (even with the addition of Middle), or the use of 11 or 12. Nonetheless, a ceiling effect was found in that for one science and two English classes the teachers mentioned all 25 (100%) inquiry categories.

McSELFIE, *McGill Self-Efficacy of Learners' Inquiry Engagement Instrument*. Ibrahim, Aulls, & Shore (2016a); also see Ibrahim (2014); Ibrahim, Aulls, & Shore (advanced draft); Ibrahim, Aulls, & Shore (in preparation--a, b, c). Inquiry Self-Efficacy for university-level learners, but likely useful at other levels of education. Based on an MSDIQ subset covering all three planning, enactment, and reflection phases, with an initial validation

samples in science, using self-efficacy perspective. The new factor analysis revealed a fourth phase, Deliberation, that precedes the framework used in the MSDIQ and from which was sampled for the MEIQ-SET (enactment only). (Compare with MCSESILT and MEIT-SET.)

MEIQ-SET, *McGill Enactment of Inquiry Questionnaire–Self-Efficacy for Teachers*. Chichekian & Shore (2016, 2017a, in preparation); Chichekian, Shore, & Tabatabai, 2016; also see Chichekian (2014). The MEIQ-SET is based solely on the 41 MSDIQ enactment items (#30 to #73, two items of which are distractors) about inquiry tasks that teachers enabled students to perform in the classroom across disciplines (not planning or reflection--from Schön's 1983 three phases of reflection, and asks participants to rate their sense of self-efficacy from zero ("absolutely cannot") to 10 ("absolutely can"). Exploratory Factor Analysis using Principal Axis Factoring followed by Promax oblique rotation yielded a four-factor Self-efficacy for enactment of inquiry model: (a) Collecting and Analyzing Data, (b) Linking Knowledge, (c) Communicating Findings, and Engagement and Problem Finding. Student-teachers were most exposed to inquiry as an instructional approach in their methods courses through activities such as rehearsals of core practices in teaching and learning, but these were not sufficient for them to learn how to teach skills needed for inquiry learning as shown in the lower self-efficacy ratings and a lack of keywords describing Collecting and Analyzing Data. In focus-group interviews, the lack of undergraduate research opportunities was often referred to as a limitation in the teacher-education program. (Also compare to MCSESILT and McSELFIE.)

MGWIQ, *McGill Group Work in Inquiry Questionnaire.* Saunders-Stewart, Walker, & Shore (2013); also see Saunders (2004). Eleven questions plus optional follow-ups for parents and teachers focusing on preferences for their children to work alone or in groups. Could be adapted for students.

MISIO, *McGill Inventory of Student Inquiry Outcomes* derivatives, Saunders-Stewart, Gyles, and Shore (2012); also see Gyles (2011); Gyles & Shore (advanced draft under final editing--b), Saunders-Stewart (2008); Saunders-Stewart, Gyles, & Shore (2012)--the original list of 23 items; Saunders-Stewart, Gyles, Shore, & Bracewell (2015). The study developed our first inventory of inquiry outcomes for students. The MISIO-S Long inquiry

questionnaire included 23 criterion-referenced categories of student inquiry outcomes and partially overlapped the Llewellyn-based rubric, but added outcomes to the inputs and observable practices. MISIO remained a set of elements to be developed into measurement tools: MISIO-S, MISIO-T, MCLIC, MISIO-Sm, and was superseded by these three tools.

MISIO-S, *McGill Inventory of Student Inquiry Outcomes-Student Questionnaire*. Saunders-Stewart, Gyles, Shore, & Bracewell (2015); also see Aulls, Tabatabai, & Shore (2016). The MISIO was developed into a student inquiry-outcomes questionnaire with 23 basic items plus prompts and subquestions yielding 31 items. Principal-components analysis generated four factors from their responses: Learning Competencies (e.g., content knowledge, learning-process skills), Personal Motivation (e.g., creativity, enjoyment, motivation), Student Role (e.g., autonomy, sense of responsibility) and Teacher Role (loading negatively--e.g., encouraging factual recall).

MISIO-Sm, *McGill Inventory of Student Inquiry Outcomes-Student Questionnaire (modified)* Aulls, Tabatabai, & Shore (2016). [S, H] This is slight modification of the MISIO-S. It was used to code university students' definitions of inquiry and descriptions of their best-experienced inquiry experience. Coding their replies in terms of numbers (and types) of inquiry outcomes mentioned therein proved to be an effective way to quantify the differences among replies. This is therefore more of a secondary tool than a direct survery. It was not used by the participants themselves, but it could be worded to do so as a derivative of the MISIO suite of tools.

MITSI, *McGill Inquiry Teacher Short Interview*. Saunders-Stewart, Gyles, Shore, & Bracewell (2015); also see Oppong-Nuako, (2013), Oppong-Nuako, Shore, Saunders-Stewart, & Gyles (2015), Saunders-Stewart (2008). [S] A short (three-question) teacher interview containing just three core teacher-inquiry questions plus prompts that can be used to effectively assess the extent of inquiry (or inquiry level) of a classroom (based on the teacher's descriptions). However, MITSI needs a scoring rubric or protocol-analysis procedure such as MCLIC or MISIO versions, but can use open coding:

1. What methods of teaching and learning are used most often in your classroom?

- Please describe these methods in more detail (e.g., What does it mean when you say you

use inquiry-based teaching strategies? What does this involve?).

2. Please describe what your classroom looks like on a typical day.

3. What are the most important outcomes that you hope your students will achieve in your class?

- What sorts of things should students learn about or learn how to do in your class?

- What do you consider to be the important outcomes of inquiry-based teaching and learning?

MPWAQI; *McGill Preferences for Working Alone Questionnaire and Interview*. Walker & Shore (2015b); also see Walker (2010). 26-item survey for students plus a follow-up interview. Can be used to compare different learning environments.

MSDIQ, *McGill Strategic Demands of Inquiry Questionnaire*. Shore, Chichekian, Syer, Aulls, & Frederiksen (2012); also see Boisvert & Roumain (2000)--student version; Saunders (2004)--teacher and parent versions; Syer (2007); Syer, Chichekian, Shore, & Aulls, (2013). An 11-point Likert-type scale with 79- criterion-referenced questionnaire items (2 of which are distractors) grouped according to Schön's three inquiry phases and generating three subscores--planning, enactment, and reflection--at a relatively fine level of granularity of specific tasks that students and teachers undertake when engaged in inquiry, but across disciplines. Each questions asks how important each task is to learning or teaching through inquiry. Chichekian (2011); Chichekian & Shore (2014, 2016, 2017a, in preparation); Chichekian, Shore, & Tabatabai, 2016); D. Leung (in progress); Getahun (2014); Ibrahim (2014); Ibrahim, Aulls, & Shore (2016b, under review--c), and Leung, Shore, & Williams (in preparation). Adaptations include MAVIES, McSELFIE, MCSESILT, and MEIT-SET in these lists.

MTALIR, *McGill Three-level Adapted Llewellyn Inquiry Rubric*. Saunders-Stewart, Gyles, Shore, & Bracewell (2015); also see Oppong-Nuako, Shore, Saunders-Stewart, & Gyles (2015); Saunders-Stewart (2008). [S] Adapted Llewellyn's 12-point scale, *Rubric for Becoming an Inquiry-Based Teacher* (Llewellyn, 2004) to an 11-point observational scale and that identifies three inquiry levels. Llewellyn Abbreviated Checklist--Shortened, reduced Llewellyn's rubric to 11 items and described a middle level of classroom inquiry for each. MTALIR can be used with teacher or student interviews in a protocol analysis

or simple tally, or in classroom observations.

STEM-CGES-HSS, *STEM College-Going Expectancy Scale for High School Students.* Oh, Jia, Sibuma, Lorentson, & LaBanca, (2013). "The study modified the CGSES (Gibbons, 2005) to measure college-going expectancy in STEM learning and work in college" (p. 100). "The STEM CGES is a self-report instrument measuring college-going expectancy, specifically for science, technology, engineering, and mathematics (STEM) domains. In Study 1, 95 students in an urban high school completed an 11-item online questionnaire to measure college-going expectancy in STEM domains. Exploratory factor analysis (EFA) retained 6 out of the 11 items for inclusion. In Study 2, Confirmatory Factor Analysis (CFA) used data collected from 658 students in 31 urban, suburban, and rural high schools. The results provide strong evidence that the STEM CGES is a valid and reliable instrument for measuring college-going expectancy for STEM domains" (p. 93). The measure is one of self-efficacy, indirectly related to inquiry based on what students understand to be the nature knowledge and acquiring knowledge in STEM domains. A sample item is "I believe that I can get into college after high school to study science, technology, engineering, or math (STEM) if I want." (p. 99) (available on-line from Yueming Jia_reprint 3.pdf)

Tools Awaiting Publication

MBoFS, *McGill Benefits of Friendship Survey*. Walker, Gyles, Hou, Shore, Muis, & Schneider (article in preparation); also see Chichekian & Shore (2017); Shore, B. M., Chichekian, T., Gyles, P. D. T., & Walker, C. L. (chapter accepted for publication); [Originally prepared for Shore, Walker, & Gyles (2009, November). *"How do I love thee? Let me count the ways." New insights into gifted friendships.* Paper presented at the annual meeting of the National Association for Gifted Children, St. Louis, MO. Conference reports are not included in this report and bibliography.] Questionnaire with 10 questions for secondary students and 14 for post-secondary students (who are also asked to reflect on their teenage years): How many good friends do you have? In general, suppose you were to have a disagreement with any friend; to what extent would you think it is important and appropriate that your friend sticks firmly to his or her position (0-to-7 scale)? . . . that your friend appreciates YOU sticking firmly to your position? . . . would

you be willing to modify your position in the disagreement to bring about a resolution? Six questions asked for a definition of a "good friend," how many friends the student would ideally want, benefits received from each identified good friendship, how they meet new friends, desired qualities of a new friend, and what might challenge the quality of a friendship. Potentially useful in examining how students express preferences for with whom they collaborate in inquiry learning.

MCSESILT, *McGill Checklist of Student Self-Efficacy on Specific Inquiry Learning Tasks*. D. Leung & Shore (preliminary draft); also see D. Leung (MA in progress). [E, S] Inquiry self-efficacy measure for pupils based on 70 of the MSDIQ specific inquiry tasks (those that were about students rather than teachers, and not the two distractor elements). The initial study tallied the inquiry tasks on which pupils expressed the most and least efficacy. (Compare to MEIQ-SET and MSELFIE.)

McSPARTN, *McGill Survey of Professors' Articulation of the Research-Teaching Nexus.* Chichekian, Hua, & Shore (in press--uses a subset of the questions); Hua 2008 (this thesis contains the full questionnaire on pp. 51-53); Hua & Shore (2014--uses a subset of the questions); Hua, Yang, & Shore (data collected--full questionnaire will be in this article); Shore, Pinker, & Bates (1990--includes the prototype questionnaire on which McSPARTN is based). Based on principles of inquiry instruction, this questionnaire probes professors' articulation of research methods, teaching methods, student roles in learning, and the relations among these. Parts of McSPARTAN have been shown to be sensitive to differences in professors' descriptions about how research impacts their teaching and the degree of passivity or activity in undergraduate student roles; the original 1990 version elicited clear misalignment between clearly differentiated research approaches in different disciplines but nearly total use of lecturing in undergraduate instruction (with one notable exception). The 1990 study sampled 18 different disciplines then replicated the first study with nearly every member of the English and Chemistry departments at a major research university. The latest studies focused on the same Chemistry department more than three decades later. Data for most of the questions are still being analyzed. The 1990 and current questionnaires are closely parallel but not identical, however they are similar enough to make a 30-year comparison

in support of the validation of the instrument and describing how the research-teaching nexus has (or has not) changed in one department that has over this extended time period regarded both teaching and research as important. The question of interest is how well they are linked in the professors' articulations of the two processes.

MIBST, *McGill Inquiry Background Survey for Teachers*. This unpublished, 20-page background questionnaire contains three main sections. Section A, "Background Information," contained 19 items, including, sex, age, degree, and program. Earliest level of inquiry exposure can be derived from the data given by participants on their grade, subject, and examples of inquiry at all schooling levels. MIBST can be used in protocol analysis of interviews, definitions, and descriptions regarding inquiry. In Section B, "Inquiry From the Point of View of a Student," participants are first asked to define inquiry in their own words: "Please explain what 'inquiry' means to you from a student's point of view." Second, they are asked to describe in detail all occasions of inquiry they could recall in their elementary, secondary, community college, and university education on separate pages. They are provided enough space to name the grade level and subject, and briefly describe what happened during every instance of inquiry they could remember. Later they are asked to "Go back (to the inquiry experiences listed) and place an [asterisk] (*) in front of the example you consider the best inquiry experience you had as a student and to explain why" they selected this one experience and what was special about it. They are instructed to select only one example as their best inquiry example and explain why that one, especially what was particularly memorable about it. Section C, called "Inquiry From the Point of View of a Teacher," asked for information about teaching. MIBST was designed as a research tool to explore presage or background information about prior inquiry-related experiences by student teachers and teachers. Data from portions of the instrument have been used in the following publications: Aulls, Tabatabai, & Shore (2016); Tabatabai, Shore, & Aulls (Student teachers' specialization and best-recalled prior inquiry--advanced draft); Tabatabai, Shore, Delcourt, & Aulls (Inquiry and differing levels of students' abilities, in early stage of preparation).

MIRQ, *McGill Interprofessional Reciprocity Questionnaire. An assessment tool for*

collaborative practice and education. Birlean, Ritchie, Shore, & Margison (2006); Shore, Birlean, Ritchie, Margison, & The McGill Interprofessional Practice and Education Project (in preparation). Unpublished document, The McGill Educational Initiative on Interprofessional Collaboration: Partnerships for Patient and Family-Centred Practice, Faculty of Medicine, McGill University, Montreal, QC. [An article is in preparation based on this instrument, to be submitted to *Medical Education*.] [H] This Likert-type scale was developed first to evaluate how different health professionals value the input and roles of other health professionals. The idea and form of the instrument can generally be adapted to education because it is also an interprofessional occupation (classroom teachers, consultants, specialists, different levels and subjects, counsellors, psychologists, administrators, etc.). MIRQ could also be a basis for looking at how collaborating students view each other in inquiry work.

MISIO-T, *McGill Inventory of Student Inquiry Outcomes-Teacher Questionnaire*. Gyles & Shore (advanced draft under final editing--b); also see Gyles (2011), Oppong-Nuako, Shore, Saunders-Stewart, & Gyles (2015). A 33-item questionnaire for teachers about student outcomes in inquiry learning. Reworded the MISIO-S (31 items) and added two items on the extent of inquiry use and inviting comments. "You" became "the students" and most questions were prefaced with "In your judgment."

Annotated Bibliography of HAIR Products

SUPERVISION

(Dissertations, Thesis, Special Activities, etc.)

PhD, EdD

Austin, Lydia Bronwen (1993). *Individual differences in knowledge representation and problem-solving performance in physics*. —PhD in Educational Psychology (Major in Instructional Psychology), McGill University. (Supervised by Bruce M. Shore.) [H] High performing students in college-level gateway physics courses improved their performance, notably on multistep problems, after receiving instruction in concept mapping. Their maps more closely resembled those of experts, especially in the number and quality of links among the concepts. Concept maps can be used effectively as instructional and evaluation tools.

Barfurth, Marion Anne. (1994). *The collaborative process as seen through children's disagreements while learning science.* PhD in Educational Psychology (Major in Applied Cognitive Science), McGill University. (Supervised by B. M. Shore.) [E] Resolution of cognitive conflicts is frequently preceded by social moves to broaden the inclusion of individuals and ideas. The path to effective collaborative problem solving is not necessarily smooth.

Barratta, D. G. (2012). *The effects on online professional development in technology with virtual communities of practice on teachers' attitudes and content integration.* EdD in Instructional Leadership, Department of Education and Educational Psychology, Western Connecticut State University. Danbury, CT. (Supervised by K. Burke and F. LaBanca.) [E, S] Teachers who received professional development with Virtual Communities of Practice (VCoP) demonstrated the highest level of technology integration. Professional development is effective.

Bell, Stephanie. (2012). *The effects of project-based learning on creativity, motivation, and inquiry*. EdD in Instructional Leadership, Western Connecticut State University.

(Supervised by M. A. B. Delcourt.) [S] Inquiry based on student interest does not directly impact specific inquiry skills--teacher guidance does--but it does impact attitudes. Participation in a Student-Directed Inquiry group utilizing problem-based service learning (PBSL) versus a Teacher-Directed Inquiry group was compared to motivation to apply creative problem solving and critical thinking, and as a measure of its impact on students' sense of civic responsibility. The Teacher-Directed Inquiry group had significantly higher scores on Mental Focus and Learning Orientation. Group assignment, and motivation to use creative problem solving and critical thinking skills, predicted students' civic responsibility.

Birlean, Camelia. (2011). *The role of teachers' pedagogical and subject-matter knowledge in planning and enacting science-inquiry instruction, and in assessing students' science-inquiry learning.* PhD in Educational Psychology (Instructional Psychology Stream), McGill University. (Supervised by B. M. Shore.) [E, S] Teachers with both pedagogical and content expertise were better able to plan and evaluate inquiry-based learning.

Borovay, Lindsay Anne. (2008). *Inquiry education as a context for the experience of Flow*. PhD in School/Applied Child Psychology, McGill University. (Supervised by B. M. Shore.) [S] Csikszentmihalyi's notion of Flow is a good motivational model for supporting inquiry. Flow is optimal when the task is well scaffolded and taps student interest, and when the difficulty level is perceived as challenging but not overpowering (as in Vygotsky's "Zone of Proximal Development). Inquiry theory could usefully include this to support teacher planning.

Chichekian, Tanya. (2014). *Self-efficacy for inquiry-based instruction: Surviving the leap from student teacher to an inquiry-oriented novice teacher.* PhD in Educational Psychology (Learning Sciences Concentration), McGill University. (Canadian Association for Teacher Education Award for Research on Teacher Education, 2014; McGill University K. B. Jenkes Convocation Prize for the outstanding dissertation in the Social Sciences and Humanities, 2015) (Supervised by B. M. Shore.) [H] Student teachers appear to have learned about inquiry more as a series of classroom procedures than conceptually. In their first year teaching, self-efficacy declined in parallel with their conceptualizations of inquiry, but the number of inquiry events enacted in their classes nonetheless increased

over the year.

Cloutier, Andrew. (2013). *The effect of a digital collaboration and thematic social studies program on students' historical reasoning, perceptions of social studies instruction, and inquiry skills*. EdD in Instructional Leadership, Western Connecticut State University. (Supervised by M. A. B. Delcourt.) [E, S] Thematic instruction refers to a curriculum delivery that is based on themes in history, such as wealth, discovery, and conflict. Students in the thematic-based social-studies program had significantly more positive attitudes toward social studies compared to peers in the nonthematic-based program. There were no significant differences between groups on historical reasoning skills.

French, Lisa Rebecca. (2007). *Do gifted students prefer to work alone? A social-constructivist re-examination of the longstanding claim.* PhD in School/Applied Child Psychology, McGill University. (Supervised by B. M. Shore.) [E, S] Gifted students do not necessarily prefer to work alone. Gifted students who feel adequately supported by those in their environment will be less likely to indicate a preference for working alone, compared to those who do not feel supported.

Getahun, Dawit. (2014). *Education and science undergraduate students' conceptions of inquiry: relationship to perceptions of strategic demands of inquiry learning and instruction, and epistemic beliefs.* PhD in Educational Psychology (Learning Sciences Stream), McGill University. (Supervised by M. W. Aulls.) [H] Inquiry conceptions could be grouped into three superordinate categories: inquiry as a learning process (three subcategories), inquiry as an instructional process (five subcategories), and inquiry as a research/scientific process (five subcategories). Inquiry as a learning process was the most prevalent and inquiry as a research/scientific process was the least prevalent. Participants with sophisticated epistemic beliefs have well informed and multidimensional conceptions of inquiry compared to those with naive epistemic beliefs. More indistinct definitions (vague, did not explicitly indicate a goal or process of inquiry, and/or 'I don't know' responses) were found more often in the naïve epistemic belief group's definitions.

Guertin, Susan. (2014). *An investigation of teachers' perceptions of inquiry learning; Why some use it and some don't.* EdD in Instructional Leadership, Western Connecticut State

University. (Supervised by J. Mitchell, M. A. B. Delcourt, and F. LaBanca.) [E] Internal influences--beliefs about educational change, direct instruction practices, student engagement, teacher emotions, teacher knowledge of instructional practices, teacher knowledge of inquiry practices, teacher pedagogical beliefs, teacher problem-solving style, and types of questions posed, and external influences--age and years of teaching experience, collaboration, mandated educational change, mandated testing, parent feedback, peer pressure, professional development, program support, state standards, teacher experience with inquiry as students, and time constraints can each act as a catalysts and barriers to teacher use of inquiry in the classroom. Teachers use individual problem-solving styles to enhance their teaching in the classroom.

Gyles, Petra Dawn Tapper. (2016). *Mindsets, mastery, and inquiry: Classroom impact on students' achievement goals*. PhD in School/Applied Child Psychology, McGill University. (Supervised by B. M. Shore.) [S] "Implicit theories, also known as mindsets, and achievement goals are motivational constructs that describe the reasons that we engage in or disengage from learning scenarios. These theories provide accounts of how likely we are to approach or avoid tasks, the extent to which we persist in the face of challenge, the cognitive strategies we apply, how well we perform, and the emotional reactions and underlying beliefs about ourselves. . . . This study investigated the impact of guided-inquiry-classrooms versus comparison teacher-structured classrooms as contexts to promote mastery goals in a sample of 81 grade-12 English students from seven classes. Binomial logistic regression analyses revealed that students in inquiry-based classes (regardless of implicit theory) and students with incremental theories of ability (in either instructional setting) each predicted the likelihood of reporting mastery goals in response to questions about student motivation in class. These students reported a desire to learn for the sake of learning, wanting to build and develop a skillset or knowledge base, and later application to life outside of academic contexts. Students in more teacher-structured classes and those holding entity theories of ability were more likely to report performance goals (e.g., grade emphasis, planning for university admission, outperforming peers) as their motivation. There was an additive effect of guided inquiry and incremental theories on students' learning goals. . . . This study further demonstrated that students in inquiry-based classes reported mastery goals over

and above the level predicted by students' mindset or implicit theory alone."

Hou, Dadong (Charles). (2009). *Students' conceptions of learning and their correspondence to learning in western universities: A study of Chinese graduate students*. PhD in Educational Psychology (Cognition and Instruction Stream), McGill University. (Supervised by M. W. Aulls.) [H] A major surprise for Chinese graduate students in Canada and the UK was how much responsibility they needed to assume for guiding their own learning.

Hua, Olivia (Liv). (2018--submitted). *How professors educate students to formulate quality research questions*. Thesis submitted for examination on 2017 December 2. PhD in Educational Psychology (Learning Sciences Concentration), McGill University. (Supervised by B. M. Shore.) [H] The literature mostly addresses how to ask questions of clarification or that promote learning, not how to advance the boundaries of knowledge. Using a convenience sample drawn from the sciences, a minority of professors intentionally taught their undergraduate students to pose researchable questions, even though in their upper years students had research requirements. The majority regarded the students' task as filling gaps in the knowledge base rather than as a cognitive process. Some purposeful strategies were nonetheless documented.

Huang, Xiang. (2012). *Changing the way students learn in physics gateway courses.* PhD in Physics (Physics Education), Concordia University. (Supervised by C. S. Kalman.) [H] Reflective writing exercises help students think in the manner of a hermeneutical circle (an iterative self-dialog between the text as understood by the student and as intended by the author).

Ibrahim, Ahmed Mohammed. (2014). *Self-efficacy and attainment value for enacting inquiry.* PhD in Educational Psychology (Learning Sciences Concentration), McGill University. (Supervised by M. W. Aulls.) [H] Added an additional inquiry phase to the first three by Shore, Syer, etc.: "self-efficacy for inquiry deliberation, self-efficacy for inquiry planning, self-efficacy for inquiry enactment, and self-efficacy for inquiry reflection. Self-efficacy for inquiry deliberation is composed of thinking about an inquiry question or problem and imagining outcomes, asking questions or defining the problem, and

formulating hypotheses or proposing solutions."

Issa, Reine. (2014). *Educators' perceptions of instructional leadership characteristics and the relationships of these perceptions to their problem solving styles*. EdD in Instructional Leadership, Western Connecticut State University. (Supervised by M. A. B. Delcourt.) [E, S] Teachers as well as others are instructional leaders. Highest degree earned, educators' preference for Orientation to Change: Explorer-Developer problem-solving style, sex, and type of certificate were significant predictors of the variance in the mean scores of transformational leadership. Engagement in inquiry and a transformational leadership style were therefore related.

Kowgios, Nick. (2008). *Effects of conceptual assessments using test debate and test analysis on critical thinking skills and literary analysis*. EdD in Instructional Leadership, Western Connecticut State University. (Cosupervised by M. A. B. Delcourt and K. Burke.) [S] Creative problem solving, scholarly rigor, and literary analysis were enhanced when (a) teachers created and administered a multiple choice exam that asked conceptual questions; (b) students participated in a Socratic test debate in which they were required to support their answers using specific textual references; and (c) students wrote a metacognitive reflection of the evolution of their thought process including an initial interpretation of the question, the points gleaned during the debate, and their final interpretation of the course concept or theme addressed in the question. Reinforces the roles of dialog and reflection in inquiry.

LaBanca, Frank. (2008). *Impact of problem finding on the quality of authentic open inquiry science research projects.* EdD in Instructional Leadership, Western Connecticut State University. (Supervised by M. A. B. Delcourt.) [S] Teachers who received professional development with Virtual Communities of Practice demonstrated the highest level of technology integration.

Lasry, Nathaniel. (2006). *Understanding authentic learning: A quasi-experimental test of learning paradigms.* PhD in Educational Psychology (Major in Applied Cognitive Science, Minor in Instructional Psychology), McGill University. (Supervised by M. W. Aulls.) [H] The characteristically cognitive feature posited is "n-coding," the encoding of multimodal input (verbal, visual, kinesthetic, social . . .). The instructional literature

identified Collaborative Group Problem Solving (Heller et al., 1992) as an appropriate candidate for authentic instruction in physics. High and medium n-coding groups were significantly more effective than the situated low n-coding group ($p = 0.003$) showing the effectiveness of increasing n-coding and refuting the claim that social approaches must subsume cognitive ones. No significant difference was found between high and medium n-coding groups ($p = 0.74$) whereas all treatment groups differed from the control ($p = 0.0497$), replicating findings on the effectiveness of nontraditional instruction (Hake, 1998). Competing cognitive and social perspectives (Schoenfeld, 1999) may be better replaced by cross-paradigm symbioses such as importing authentic learning from situated approach into cognition.

Lemay, David. (2017). *Negotiating meaning: Discourse in the graduate research seminar.* PhD in Educational Psychology (Learning Sciences Stream), McGill University. (Supervised by M. W. Aulls.) [H] How a discourse of qualitative research is constructed by participant-apprentices "learning to be qualitative researchers" through a 13-week course about qualitative research methods, through the use of specific linguistic devices, namely, the use of deictic reference, i.e., demonstrative pronouns such as this/that, here/there, now/then. Preliminary results demonstrate rather neatly that the instructor (acting as "guide") orients the developing discourse through the use of these linguistic devices. The vast majority of instances of deictic reference is performed by the instructor and not the students. Illustrates the importance of the role of the teacher in creating the learning environment.

Lilly, Frank. (2002). *Teaching outside of the box: Studying a creative teacher*. PhD in Educational Psychology (Major in Applied Developmental Psychology), McGill University. (Supervised by F. G. Rejskind.) [H] Creative teachers engage students in inquiry-relevant activities. Link between inquiry and creativity.

Longo, Christopher. (2012). *The effects of an inquiry-based science program on motivation and problem-solving of middle school students*. EdD in Instructional Leadership, Western Connecticut State University. (Supervised by M. A. B. Delcourt.) [E, S] Inquiry engagement enhances motivation and problem solving.

Main, Laura. (2014). *Effect of style training on Future Problem Solving performance.* EdD in Instructional Leadership, Western Connecticut State University. (Supervised by M. A. B. Delcourt.) [S] Future Problem Solving Program (FPSPI) high school participants who also received problem-solving styles training along with FPSPI (treatment) were compared to FPSPI curriculum-only on Qualifying Problem scores. After controlling for pretest scores, the treatment group outperformed the comparison group and more often qualified for state competition and training in problem-solving styles. Program type significantly predicted QP scores; Torrance test creativity scores did not significantly predict QP. Treatment-group participants made more statements related to an understanding of self and others; FPSPI-only participants made more statements about the technical aspects of FPSPI.

Manconi, Lynn. (2004). *Teachers' understanding of inquiry*. PhD in Educational Psychology (Major in Special Populations of Learners, Minor in Adult Education), McGill University. (Cosupervised by B. M. Shore and M. W. Aulls.) [E, S, H] "Four postulated constructs of inquiry, process, content, strategy, and context [these comprise the first dimension of the Aulls-Shore model], were found in the literature and in experienced inquiry teachers' detailed conceptualizations of inquiry as shown in their definitions, interviews, and concept maps. Inquiry teachers were distinguished from the non-inquiry teachers by the relative difference in the frequency of their use of the four constructs. The inquiry teachers each had one predominant construct that they emphasized more in their teaching, and their identity could be expressed in terms of their pedagogical use of these four constructs. The non-inquiry teachers made fewer inquiry statements when compared to the literature and when compared to their own personal statements" about their approach to instruction. Effective inquiry teachers also have a much stronger understanding of inquiry concepts than good traditional teachers, especially about process.

Manuel, Dominic. (in progress). *Observing teacher practices with inquiry-based learning (IBL) instruction in mathematics in regions of Canada.* PhD in Educational Studies, McGill University. (Cosupervised by A. Savard--Integrated Studies in Education and D. Reid--Acadia University.) [E, S] "Do Canadian teachers use effective practices with IBL

instruction that fosters students' deep conceptual learning in mathematics? How can teacher practices impact student achievement in mathematics?"

Masden, Catherine Ann. (2004). *Social perspective coordination in gifted young adolescent friendships*. PhD in School/Applied Child Psychology. PhD dissertation, McGill University. (Supervised by B. M. Shore.) [S] "Overall psychosocial maturity (or social-perspective coordination) was measured and related to academic ability and adolescents' perceptions of friendship quality and self-concept. Gifted status, sex, and grade significantly predicted overall psychosocial maturity in multiple regression analyses. Conversely, as a group, overall social-perspective coordination, perceptions of one's ability to make and keep friends (close friendship self-concept), academic ability, sex, and grade level predicted the overall quality of adolescents' friendships. Being a female, seventh grader, or adolescent not identified as gifted, significantly predicted friendship quality. In addition, higher developmental levels of psychosocial maturity and close friendship self-concept predicted higher levels of friendship quality. . . . Higher levels of psychosocial competence were associated with higher levels of help, closeness, and lower levels of social comparison in friendship experiences."

McBride, Judith. (2005). *How do I, a teacher-researcher, contribute to knowledge of teacher learning and practice in teacher-education as I explore my values through self-study?* PhD in Educational Psychology (Major in Instructional Psychology, Minor in Applied Cognitive Science), McGill University. (Supervised by M. W. Aulls.) [H] "The stories of teacher-researchers inquiring into practice offer evidence of transformative learning (Mezirow, 1991), which may initiate and constitute living educational theory (Whitehead, 1993) . . . ." In this study that related to both the evaluation issues and the overall difficulty of doing inquiry, teachers' stories were searched for evidence of learning from participation in action research. Inquiry teachers are willing to grow and change in general, but so far there is little evidence that they grow or change as a specific result of their action research. This challenges the notion that teaching inquiry benefits from being an inquirer.

McKinnon, J. L. (2012). *Effects of scaffolding higher order thinking questions on reader self-efficacy and critical thinking.* EdD in Instructional Leadership, Department of Education

and Educational Psychology, Western Connecticut State University, Danbury, CT. (Supervised by F. LaBanca and M. A. B. Delcourt.) [S] Building higher-order questioning skills enhanced self efficacy and also facilitated a wide range of critical-thinking performance.

Mitchell, Sidney. (2001). *Describing the effects of an inquiry curriculum on low-achieving students' causal attributions*. PhD in Educational Psychology (Major in Instructional Psychology), McGill University. (Supervised by F. Gillian Rejskind.) [S] Making appropriate causal attributions was among the benefits of inquiry participation. Teaching from an inquiry approach is difficult. It requires considerable teacher skill as a manager. However, it is possible to teach even students seen as having intellectual or learning challenges if sufficient structure is given so that skills and strategies are taught at the same time as content. This requires a high level of reflection on the part of the teacher. Teachers who cannot simultaneously teach both content and strategy do not succeed at teaching inquiry.

Polotskaia, Elena Arkhipova. (2010-2014). *How elementary students learn to mathematically analyze word problems: The case of addition and subtraction.* PhD in Educational Studies, McGill University. (Cosupervised by A. Savard and Viktor Freiman, Université de Moncton.) [E] The ability to mathematically analyze and model a situation is one of the most important aspects of teaching and learning mathematics in school. The lack of nuanced understanding of the ways of reasoning students might employ to analyze and model a problem prevents teachers from effectively meeting their needs. Studied how grade two elementary school students solve additive problems to answer the following questions: (a) What kind of mathematizing do students use to solving additive word problems? (b) What are the relationships between the instruction implemented and students' development of mathematizing processes? Applying grounded theory methodology, the author analyzed multiple observations of students solving additive problems throughout one school year. Suggested models for six strategies of mathematizing, described the dynamics of change in the learners' ways of reasoning and the relationships between this change and the teaching implemented.

Ritchie (née Redden), Krista Corinne. (2009). *The process of problem finding in inquiry*

education: A focus on students' experiences. PhD in Educational Psychology (Applied Cognitive Science Stream), McGill University. (Supervised by B. M. Shore.) [S] Prospective descriptive-comparative study, documenting the social, emotional, and problem solving experiences of high school students over the course of one school year, who were enrolled in either a self-directed inquiry classroom in which they had to engage in problem finding (come up with their own research question to answer) versus a more teacher-directed inquiry classroom in which they engaged in inquiry activities within smaller-scale laboratory-based activities. Students who engaged in problem finding were two-to-five times more likely to engage in productive problem-solving heuristic strategies and, although they experienced similar high levels of positive emotional experiences in their classes compared to students in teacher-directed classes, they also experienced significantly more negative emotions. Open-ended video-based recall interviews to better understand students' experiences provided explanation for the heightened negative emotions. With personal investment in their research project, and with greater academic challenge, students experienced negative emotions such as frustration and fatigue. In the face of these challenges, they explained figuring out self-regulation strategies to distract themselves enough to recover from the negative experiences (often engaging socially with classmates) in order to regain a positive perspective and re-engage with their work.

Salon, Christine. (2008). *Student perceptions of mathematical self-efficacy in the context of the instructional setting and problem solving activities*. EdD in Instructional Leadership, Western Connecticut State University. (Supervised by M. A. B. Delcourt.) [E] Students in standards-based and other school settings experienced social learning, feedback, modeling, and strategy use, however, students in standards-based classrooms were exposed to higher levels of each. Because one of each type of class (more and less inquiry-intensive) was in each school, there could have been school effects that may have masked the presence of entirely different instructional events, but even within the same two schools, students in the [inquiry] classes experienced more inquiry-favorable instruction; other studies are needed to show that they were exposed to different kinds of experiences--there are a couple of these in our collected work. Quantitative differences were confirmed for inquiry; qualitative differences were perhaps masked by the design.

Saunders-Stewart, Katie Suzanne. (2008). *Student perceptions of important outcomes of involvement in inquiry-based teaching and learning.* PhD in School/Applied Child Psychology, McGill University. (Supervised by B. M. Shore.) [E, S] Inquiry provides optimal conditions for students to achieve outcomes less likely to be found in a more traditional classroom, for example, learning competencies, personal motivation, and increased responsibility for their own learning, and to engage less in such outcomes as memorization out of a larger context. Consistent with social-constructivist theory. Source of MTALIR, the *McGill Three-level Adapted Llewellyn Inquiry Rubric*.

Syer, Cassidy Anne. (2007). *Student teachers' understanding of inquiry instruction*. PhD in School/Applied Child Psychology, McGill University. (Cosupervised by B. M. Shore and M. W. Aulls.) [H] Groups that "had different types of exposure to the inquiry approach varied in how they understand inquiry instruction. Fourth-year Elementary preservice teachers held more sophisticated conceptualizations of the inquiry approach and greater appreciation for the components involved in carrying out an inquiry curriculum compared to first-year Elementary preservice teachers. After the completion of an inquiry-oriented course, Continuing Education students (including experienced teachers) were similar to fourth-year Elementary student teachers in conceptualizing and identifying important components of inquiry instruction. First-year Elementary and Secondary student teachers held different views of inquiry instruction. Finally, Honours Psychology students, who were engaged in scholarly research, held sophisticated conceptualizations of the inquiry approach. However, they did not use this knowledge of the inquiry method as extensively as fourth-year preservice teachers to identify important aspects of inquiry instruction. Therefore, although experience with the inquiry method may be necessary for conceptualizing inquiry as a pedagogical approach, it is not sufficient to enable undergraduates to identify important aspects of planning, enacting, and evaluating an inquiry curriculum." Includes validation study of the MSDIQ, *McGill Strategic Demands of Inquiry Questionnaire*.

Tabatabai, Diana. (2002). *Modeling information-seeking expertise on the Web*. PhD in Educational Psychology (Major in Instructional Psychology, Minor in Computer Applications in Education), McGill University. (Supervised by B. M. Shore.) [H] The

most significant differences in patterns of search between novices and experts were found in the Cognitive, Metacognitive, and Prior Knowledge strategies. Survival analysis revealed specific actions associated with success in Web searching: (a) using clear criteria to evaluate sites, (b) not excessively navigating, (c) reflecting on strategies and monitoring progress, (d) having background knowledge about information seeking, and (e) approaching the search with a positive attitude.

Tzokova-Vladimirova, Vessela. (2018). *Teachers' support and engagement in learning by academically struggling students.* PhD in School/Applied Child Psychology, McGill University. (Cosupervised by R. W. Stringer and B. M. Shore; the thesis was successfully defended in November, 2017.) [E] Based on social-motivational theory, teacher support was examined on measures of involvement, autonomy, and structure. Skinner's model, validated with typically achieving students, was employed. Measures of student behavioral and emotional engagement were examined separately for relations to teacher support. Academically struggling and typically achieving students in Grades 3 to 6 and their teachers participated. Teacher support and student engagement were evaluated by both students and teachers. Correlational analyses, ANOVAs, and a MANOVA were conducted. Consistent with previous research, involvement emerged as a key variable for student engagement based on ratings by all participants. Students with significant academic difficulties perceived more involvement from their teachers than did the other student groups. All students rated themselves as more autonomous and engaged in class than teachers believed them to be. Teachers provided more autonomy to their more skilled learners and were more structured in their approach to significantly struggling students. The findings emphasized the importance of coding, including students in the IEP process, and educating struggling learners about their strengths and weaknesses.

Walker [now Plouffe], Cheryl Lynne. (2013). *Examining role diversification through dialog from small-group interactions during unit activities within inquiry-based teaching and learning classrooms.* PhD in School/Applied Child Psychology, McGill University. (Supervised by B. M. Shore.) [E] How collaborative learning groups are formed (e.g., by teacher or students) affects their successful functioning and the types and numbers of roles that members adopt. In successful inquiry, learners and teachers add multiple roles

to their repertoires.

Wang, Xihui. (2014). *Emotional experiences and their relationship to epistemic change: A multiple case study of Chinese graduate students in a Canadian university.* PhD in Educational Psychology (Learning Sciences Concentration), McGill University. (Cosupervised by A. Saroyan and M. W. Aulls.). [H] Chinese international students experienced a rich and intense emotional life in academic as well as social settings in their initial stage of graduate studies. Most highlighted were stress, joy, and anxiety. These students were more affected by academic- and self-originated emotions rather than social-originated ones. No definitive relation was found between students' emotional experiences and epistemic change, but self-related sources (e.g., meta-emotion) influenced both the nature of emotions that students have as well as their readiness for epistemic change. Self-related emotions may play an important role in the change process. Adapting to inquiry is both an emotional and intellectual process.

Xenos-Whiston, M. (1989). *The distinguishing characteristics of demonstration teachers of the gifted.* Unpublished PhD thesis in education, Université de Montréal. [E, S] Teachers of the gifted were more likely to be inquirers themselves.

MA, MEd, MSc

Bellande, Nadia. (2001). *The experience of a 7th grade learning disabled student with two models of instruction: Conventional (work-book based) and inquiry.* MEd in Educational Psychology, McGill University. (Supervised by M. W. Aulls.) [S] [notes taken from 2007 SSHRC application] Teaching from an inquiry approach is difficult. It requires considerable teacher skill as a manager. However, it is possible to teach even students seen as having intellectual or learning challenges if sufficient structure is given so that skills and strategies are taught at the same time as content. This requires a high level of reflection on the part of the teacher. Teachers who cannot simultaneously teach both content and strategy do not succeed at teaching inquiry or with inquiry.

Birlean, Camelia. (2003). *Novice elementary school teachers' challenges in evaluating pupils' science inquiry projects*. MEd in Educational Psychology (Inclusive Education Concentration), McGill University. (Supervised by B. M. Shore.) [E] Subject-matter

experts were better able to evaluate the content of science-fair projects, but teachers were better able to articulate how to elicit projects from students. Need both kinds of knowledge (PCK).

Boisvert, Katie, & Roumain, Stéphanie. (2000). *Questionnaires to explore strategic demands of inquiry teaching and learning.* MEd in Educational Psychology (Special Populations Concentration). (Supervised by B. M. Shore.) [E] Initial criterion referencing of the MSDIQ, *McGill Strategic Demands of Inquiry Questionnaire*.

Carkner, Pamela. (1996). *Teachers' and students' participation in an inquiry-oriented curriculum: The types of questions they used and their perceptions of learning*. MEd in Educational Psychology (General Educational Psychology Concentration), McGill University. (Supervised by M. A. B. Delcourt.) [E, S] In an inquiry-oriented curriculum in a four-week summer program [Explorations at McGill]. (a) Numbers of teachers and students questions tapered off over time [perhaps the students were busy on their projects], (b) teachers consistently asked more questions than students over time, (c) the two teachers' styles of participation within the inquiry groups were different from each other, (d) teachers' and students' knowledge about research increased, (e) personal interest was influential in pursuing a research project, and (f) participants reported that certain new skills were gained while others were improved. Inquiry exposure impacts attitudes as well as knowledge and skills. It is also possible that the teachers were not well trained in inquiry but were enacting an inquiry curriculum to the best of their ability.

Cera Guy, Jade. (2016). *A comparative study of high-achieving students' and otherwise-achieving students' anticipations of group work.* MEd in Educational Psychology (Concentration in General Educational Psychology). (Supervised by B. M. Shore.) [E, S] This Special Activity is in two parts. The first (done jointly with Jade Cera Guy) is a combination of literature review covering gifted and nongifted students plus an empirical study of gifted students on this question. Retrospective and observational studies have reported the concerns of highly able students following group work in school, but there has been no report of their anticipations or expectations; these can potentially affect responses on attitudinal measures regarding group work and classroom collaboration. The study is being conducted in Winter and Spring 2016 and will result in two draft

articles, a review (Williams, Cera Guy, & Shore, advanced draft) and an empirical report (Cera Guy, Williams, & Shore, in preparation). The two articles are to be submitted to *Roeper Review* after they received the review and asked to see the two together. The second part of the Special Activity is to work on converting a thesis-based manuscript into a journal-article draft (Leung, Shore, & Williams, in preparation).

.Chichekian, Tanya. (2011). *The articulation of inquiry in research about teaching and learning in the International Baccalaureate.* MA in Educational Psychology (Learning Sciences Stream), McGill University. (Supervised by B. M. Shore.) [S] Inquiry is strongly stated as a core of the International Baccalaureate (IB), but it appears to be more rhetorical than exercised in practice due to increasing emphasis on content-based examinations across the three IB levels--the Primary Years Program (PYP), Middle Years Program (MYP), and Diploma Program (DP). This study used the MSDIQ as a template to examine the IB written materials.

Din, Saba. (2014). *Examining ways math teacher-educators support their professional growth and development—A study of a community of math teacher-educators.* MA (thesis option) in Education and Society, McGill University. (Cosupervised by A. Savard and K. Jackson.) [H] Practice-based teacher education supports preservice teachers in developing ambitious teaching practices by learning *in* and *from* the work of teaching. Teacher-educators enacting this new form of teacher education need support in developing the pedagogical practices for this work. This qualitative research used a Situated Learning framework to examine a community of five mathematics teacher-educators who taught a common practice-based curriculum for the mathematics methods course in a Bachelor of Education program in order to better understand how they were supported in developing practice-based pedagogies. Data were collected through observations and end-of-term interviews.

El Helou, Joseph. (2016). *Reflective writing for a better understanding of scientific concepts in high school.* MSc in Physics Education (Physics Department), Concordia University. (Supervised by C. S. Kalman.) [S] "This study evaluates the impact reflective writing has on high school students' understanding of scientific concepts and their attitudes and opinions toward learning science. Reflective writing is a part of the writing-to-learn

movement (Connolly, 1989), the aim of which is to incorporate informal writing into all disciplines. Reflective writing is a hermeneutic process during which a student writes, metacognitively on a paper, his or her ideas about a specific scientific topic, in an informal manner. The research done on the use and impact of Reflective Writing involved post-secondary students. This study aims to shed light on how reflective writing affects high school students' understanding of science. Participants in this study are high school students, from a Montreal school, who were asked to complete reflective writing tasks as a part of their science course work. Their writings are analyzed and compared to their attitudes and opinions toward the subject as probed by interviews conducted towards the end of the course." It led to improved understanding of scientific concepts.

Gube, Maren. (2015). *HAIR research goals report: Almost two decades of funded research goals and achievements of the High Ability and Inquiry Research Group (HAIR) at McGill University.* MEd in Educational Psychology (General Educational Psychology Concentration), McGill University. (Supervised by B. M. Shore.) [E, S, H] This report! Please see the opening sections for purposes, etc.

Gyles, Petra Dawn Tapper. (2011). *Student outcomes in inquiry instruction.* MA in Educational Psychology (School/Applied Child Psychology Stream), McGill University. (Supervised by B. M. Shore) [E, S] A newly generated list of 23 criterion-referenced student inquiry outcomes 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. 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 still existing within high levels of inquiry. Source of MISIO instrument.

Hua, Olivia (Liv). (2009). *How does faculty research activity affect undergraduate instruction in chemistry? An exploration of the perceived impacts of inquiry on pedagogy.* MA in Educational Psychology (Learning Sciences Concentration), McGill University.

(Supervised by B. M. Shore.) [H] Professors claimed research engagement (a) enhances student interest, (b) promotes subject-matter currency, (c) generates research examples, (d) models ways of thinking in the discipline, (e) provides contextualization guidance for instruction and (f) helps them explain difficult concepts. They appear to have increasingly reflected on this link.

Karovitch, Susan. (1994). *An exploration of gifted and nongifted school participants' persistence in French immersion*. MEd in Educational Psychology (Concentration in Family Life Education), McGill University. (Supervised by B. M. Shore.) [E, S] Gifted students who left French-immersion especially reported dissatisfaction with the highly formalized teaching and content. Failure to provide inquiry-based instructional context can cause able students to go to other programs.

Khanam, Wahidun Nahar. (2014). *Helping students to get a better understanding of physics concepts using the learning tool "Course Dossier Method."* MSc in Physics, Concordia University. (Supervised by C. S. Kalman.) [H] "The Course Dossier Method is a writing-to-learn tool . . . based upon Gadamer's hermeneutical approach (Kalman, 2008) and scaffolding using student reviewers based upon social constructivism (Vygotsky, 1978). . . . PHYS 200 (From Particles to Galaxies) was offered for non-science students in the winter semester 2014 at Concordia University . . . . Students were not required to do any mathematical problems in this course. This method was also used in the regular physics course PHYS 456 (Classical Electrodynamics) in 1995. . . . Students used different kinds of writing activities (during the course): writing reflections (before students came to class), 'Critiques' (after class) and final essay writing (Course Dossier with six entries) at the end of the course in lieu of the final exam for non-science students. For science students this method was used in conjunction with other activities. . . . Comparing their earlier Critiques with the later Critiques and also with different entries in students' Course Dossiers, showed that students' general understanding of physics concepts improved. . . . Students who are not in the course act as reviewers. Reviewers' comments were helpful for the students as those gave the students a way to rethink about the materials. . . . Students dealt with their misconceptions and this opportunity gave the students a way to construct and reconstruct their basic knowledge of

physics."

Lamb, Natasha (2010). *The impact of participation in an online professional community on the development of elementary pre- service teachers' knowledge of teaching mathematics.* MA in Educational Leadership, McGill University. (Supervised by A. Savard.) [H] "A qualitative analysis of the online discussions . . . shed light on the development of pre-service teachers as they moved from student to teacher. Pre-service teachers struggle to shed their student-perspective as they move from theory to practice, which ultimately affects their development of knowledge for teaching mathematics."

Lemay, David. (2010). *The effect of lesson topic characteristics on student participation in classroom discourse and student performance on multiple-choice tests*. MA in Educational Psychology (Learning Sciences Stream), McGill University. (Supervised by M. W. Aulls.) [H] When accounting for the influence of talk on learning, (a) talk has to be grouped into topically-ordered sets, and (b) the frequency of speech turns is a better predictor of learning than the patterning of turn-taking. Ensuring all learners have ample opportunity to express themselves in topically organized discourse seems to be key. Students themselves can take on this role of ensuring that other students get a chance to make their points (role diversification).

Leung, Daisy Angie. (in progress--final thesis passed). MA in Educational Psychology (Supervised by B. M. Shore.) [E, S] The *McGill Student Self-Efficacy on Specific Inquiry Learning Tasks* (MSESILT) comprised 70 items adapted from the MSDIQ. Students felt least efficacious planning inquiry (e.g., Make a plan for the inquiry, Divide the task into smaller steps, Create a back-up plan, Make a concept map or web or cluster, Start thinking about what will happen next during the inquiry) and most efficacious with tasks not exclusive to inquiry (e.g., Ask questions, Understand the important concepts, Figure out where to obtain data, Search the internet and world wide web). There was a curvilinear relation between inquiry self-ratings and recollections of the numbers of perceived experiences with inquiry. Students with some rather than no experiences were least efficacious and students with many experiences were most efficacious. Students appear to require many experiences with inquiry to become confident. Having only few or some experiences could be a barrier because students may accurately assess the

difficulty and complexity of inquiry, but not have had enough practice to have experienced repeated success and to feel efficacious.

Oppong, Ernestina (Tina). (2015). *Self-regulated learning, giftedness, and gifted education.* MEd in Educational Psychology (General Educational Psychology Concentration), McGill University. (First part of dual MEd Special Activity reports, this part becoming a draft of Oppong, Shore, & Muis (under review), Self-regulated learning and giftedness--see Publications; Part 2 was a draft paper, *High PISA performance in relation to general mathematics curricular suitability for gifted learners* that became Irving, Oppong, & Shore (2016), Alignment of mathematics curriculum associated with high PISA rankings and the curricular needs of gifted students--see publications. (Supervised by B. M. Shore.) [S] Part 1: There is a parallel between the qualities of giftedness redefined in contemporary theoretical terms and self-regulated learning (SRL). Part 2: Even a curriculum leading to superior PISA outcomes still lacks some key qualities of inquiry and suitability for gifted students. Inquiry instruction is complex and demanding, and needs support at different levels (curriculum, pedagogy, etc.).

Oppong-Nuako, Juliet. (2013). *How teacher interviews can reveal the inquiry level of a classroom.* MEd in Educational Psychology (Inclusive Education Concentration), McGill University. (Supervised by B. M. Shore.) [S] A three-question teacher interview (MITSI) provides sufficient data to make an estimate of the extent or level of inquiry practice in a classroom, validated against more complex measures and classroom observations. The interview needs to be coded or scored with a suitable template (e.g., MCLIC or MISIO) that tallies references to students' inquiry outcomes in the teachers' responses. (Source for the MITSI and MCLIC tools.)

Peetush, Anita. (1998). *Students' perceptions of effective teachers: Those who promote inquiry and those who do not.* MEd in Educational Psychology (General Educational Psychology Stream), McGill University. (Supervised by M. W. Aulls.) [E, S] Multiple case study of preservice teachers' descriptions of 18 very good secondary and postsecondary teachers suggested that good inquiry teachers differ from good teachers in that more roles are played by both teachers and students in effective inquiry classrooms, and effective inquiry teachers help students be more active in a variety of different ways, e.g.,

curricular choices. The teacher must overcome the fear of not covering the prescribed course of study, and allow students to make evaluations and set standards, even if not quite the standards of an expert. Overcoming the fear is an emotional element.– (Similar to study by Kimberley Wolfe.)

Redden [now Ritchie], Krista Corinne. (2006). *Constructive alignment in teacher education: Identifying contextually dependent student presage factors and associated learning outcomes.* MA in Educational Psychology (Learning Sciences Concentration), McGill University. (Supervised by M. W. Aulls.) [H] Students who attributed responsibility for learning to both the professor and students understood and applied course content more than those who attributed responsibility to either solely the professor or student on measures of understanding and application. Supports the idea of coconstruction.

Saunders [now Saunders-Stewart], Katie Suzanne. (2004). *Parents' and teachers' views of group work and reporting of inquiry products*. MA in Educational Psychology (School/Applied Child Psychology Stream), McGill University. (Supervised by B. M. Shore.) [E, S] Parents and teachers disagreed about the importance of sharing results and working collaboratively, but largely agree in their understanding of what inquiry is. The former is a potential barrier to successful student engagement in inquiry instruction. Seems to support concerns about "free-rider" effects--an issue raised elsewhere. (Source of MGWIQ.)

Schapiro, Michelle. (1998). *Sources of help for students in science fairs*. MA in Educational Psychology (School/Applied Child Psychology Stream), McGill University. (Supervised by B. M. Shore) [S] Students especially seek help from parents. A key concern is that help is not available as much as wished in class. Inquiry needs to be carefully scaffolded.

Syer, Cassidy Anne. (2002). MA in Educational Psychology (School/Applied Child Psychology Stream), McGill University. *Science fairs: Sources of help for students and the prevalence of cheating*. (Supervised by B. M. Shore.) [S] As many as 25% of science-fair projects were not actually done by the students or were otherwise not original. As with actual scientists who have been caught cheating, time pressures and inadequate resources are most often cited as pushing students to cheat. Inquiry needs to be carefully

scaffolded.

Walker [now Plouffe], Cheryl Lynne. (2010). *Myth busting: High-performance students rarely prefer to work alone.* MA in Educational Psychology (School/Applied Child Psychology Stream), McGill University. (Supervised by B. M. Shore.) [E] In general, high-performing (HP) students do not prefer to work alone; in only one case (easily-completed assignments) was this choice most preferred; notably, average performers do the same. Some conditions were low-stake (e.g., not counting for marks, classmate-marked, self-marked, easy, fun, boring), whereas others were high-stake (e.g., difficult but interesting, counts for marks, teacher-marked, difficult). Fourteen items or conditions contained "Working Alone" as one of the response options to be ranked but significant differences between groups emerged on only three of these 14 conditions. HP students had significantly stronger preferences in two of these instances compared to community-school (CS) students, both related to high-stake conditions. These preferences for working alone suggest a lingering partial truth in the old assertion that gifted individuals prefer to work alone; however, there were many more instances in which HP students preferred to work with others. Effect sizes were often small, suggesting that preferences are nuanced, and care is needed to avoid over-generalizing.

Williams, Jessica. (2016). *A comparative study of high-achieving students' and otherwise-achieving students' anticipations of group work.* MEd in Educational Psychology (Concentration in Inclusive Education). (Supervised by B. M. Shore.) [E, S] This Special Activity is in two parts. The first (done jointly with Jade Cera Guy) is a combination of literature review covering gifted and nongifted students plus an empirical study of gifted students on this question. Retrospective and observational studies have reported the concerns of highly able students following group work in school, but there has been no report of their anticipations or expectations; these can potentially affect responses on attitudinal measures regarding group work and classroom collaboration. The study is being conducted in Winter and Spring 2016 and will result in two draft articles, a review (Williams, Cera Guy, & Shore, advanced draft) and an empirical report (Cera Guy, Williams, & Shore, in preparation). The two articles are to be submitted to the Journal of Advanced Academics after they received the review and asked to see the

two together. The second part of the Special Activity is to work on converting a thesis-based manuscript into a journal-article draft (Leung, Shore, & Williams, in preparation).

Wolfe, Kimberley Maria. (2005). *Students' perceptions of the pedagogical qualifications of CEGEP instructors.* MEd in Educational Psychology (Concentration in Family Life Education), McGill University. (Supervised by M. W. Aulls.) [H] Multiple case study of preservice teachers' descriptions of college-level instructors. Good inquiry instructors differ from good teachers in that more roles are played by both teachers and students in effective inquiry classrooms, and effective inquiry teachers help students be more active in a variety of different ways, e.g., curricular choices. The teacher must overcome the fear of not covering the prescribed course of study, and allow students to make evaluations and set standards, even if not quite the standards of an expert. Overcoming the fear is an emotional element. (Similar to the study by Anita Peetush.)

PUBLISHED ARTICLES, CHAPTERS, BOOKS, and REPORTS (including items "in press" or "accepted for publication" as of 2017 December 31)

Aulls, M. W. (1998). Contributions of classroom discourse to what content students learn during curriculum enactment. *Journal of Educational Psychology, 90,* 56-69. http://dx.doi.org/10.1037/0022-0663.90.1.56 [S] Case study of a Grade 8 social-studies unit on ancient Egypt taught in two different classrooms over eight weeks. Significant quantitative content-learning differences between and within classrooms were associated with the forms of discourse used within curriculum events and the system of classroom discourse that evolved during a unit. Dialog is a powerful inquiry tool and what students experience directly impacts what they learn.

Aulls, M. W. (2002). The contributions of co-occurring forms of classroom discourse and academic activities to curriculum events and instruction. *Journal of Educational Psychology, 94,* 520-538. http://dx.doi.org/10.1037/0022-0663.94.3.520 [S] Class observation and interviews with experienced teachers and students in two classrooms revealed that teachers taught both history content and learning strategies. Social constructivism predicts that the discourse arising before, during, and after activities can explain variability in students' social and academic participation in curriculum events, as

can the nature of the instructional approach students experience when teachers hold similar goals. Patterns of co-occurring forms of discourse and activities across sequences of lesson events provided a useful window into interactions between learning and instruction.

Aulls, M. W. (2008). Developing students' inquiry strategies: A case study of teaching history in the middle grades. In B. M. Shore, M. W. Aulls, & M. A. B. Delcourt (Eds.), *Inquiry in education: Overcoming barriers to successful implementation* (pp. 1-46). New York, NY: Erlbaum (Routledge). [E, S] Illustrates the detail and complexity of making inquiry work well in a classroom.

Aulls, M. W., & Ibrahim, A. (2012). Pre-service teachers' perceptions of effective inquiry instruction: Are effective instruction and effective inquiry instruction essentially the same? *Instructional Science: An International Journal of the Learning Sciences, 40,* 119-139. http://dx.doi.org/10.1007/s11251-010-9164-z [H] This multiple case study examined pre-service teachers perceptions of effective post-secondary instruction. Pre-service teachers were asked to write essays describing an effective teacher of their choice. Twenty-one randomly selected essays were open-coded. Content analysis empirically derived dimensions of instruction and student and teacher roles. Effective inquiry instruction was associated with more and different teacher and student roles, more activities as part of instruction, and more student small group discussion than was effective instruction. Effective inquiry instructors significantly more often, and with medium to large effect sizes (for the third), were perceived to take on roles as elicitor, encourager, and facilitator. The most often cited role for effective inquiry instructors was model; for effective instructors (not inquiry) it was lecturer. Effective inquiry instructors alone took on the roles of co-partner, includer, informal lecturer, learner, model, nurturer, solicitor, and story-teller. Noninquiry effective instructors' uniquely cited roles were classifier, comedian, entertainer, helper, lecturer, mediator, peer, presenter, provider, and tutor. Student roles uniquely attached to effective inquiry instructors were analyser, critical thinker, decision-maker, discoverer, experimenter, explorer, imaginer, individual worker, interpreter, musician, reasoner, reflector, reporter, tester, and understander. Student roles uniquely associated with effective instructors were

brainstormer, memoriser, and presenter.

Aulls, M. W., Ibrahim, A., Peláez, S., Wang, X., & Orjuela-Laverde, M. (2009). *What happens as learning through WebCT? The correspondences between the quality of students verbal interchanges, approach to learning and perceptions of the contribution of Web CT to their learning*. Proceedings of the 2010 LINC Conference. Boston, MA: Massachusetts Institute of Technology. http://linc.mit.edu/linc2010/parallel.html [H] Students found face-to-face interaction more important to their content learning than online asynchronous verbal interaction, despite their positive ratings of most aspects of the online learning environment.

Aulls, M. W., Kaur Magon, J., & Shore, B. M. (2015). The distinction between inquiry-based instruction and non-inquiry-based instruction in higher education: A case study of what happens as inquiry in 16 education courses in three universities. *Teaching and Teacher Education, 51,* 147-161. doi:10.1016/j.tate.2015.06.011. [H] A close correspondence existed between inquiry-based instructors' conceptions of inquiry instruction and the place they accorded inquiry instruction in their course; not for non-inquiry-based courses. Quality of inquiry-based and non-inquiry-based courses differed most in course-plan design, tools to assess student learning, co-construction of instruction by teacher and students, number and quality of teacher and student roles, and frequency of small-group participation in instructional activities.

Aulls, M. W., & Lemay, D. (2013). *Exploring the learning benefits and outcomes of the IB extended essay in preparing students for university studies in Canada*. Phase I Research Report to the IBO [International Baccalaureate Organization]. Montreal, Quebec, Canada: Department of Educational and Counselling Psychology, McGill University. Retrieved from: http://www.ibo.org/research/policy/programmevalidation/diploma/documents/McGillFullReportPhase1FINAL.pdf [S, H] "When undergraduates in Science and Education are combined and compared to non-IB undergraduates, there are many significant differences favoring the IB trained undergraduate students. Specifically, IB trained students have more sophisticated epistemic beliefs, moderate surface motives associated with their approach to learning, and higher ratings of aspects of inquiry learning that represent self-

regulation of the inquiry process. When only Education students are considered, the evidence suggests IB undergraduates still have higher ratings of importance assigned to the reflective and self-regulatory dimensions of inquiry learning than non-IB students. But there is a lack of alignment between their motives and approaches to learning. On the positive side, the Education IB undergraduates who have high Inquiry Self-efficacy scores also highly rate the importance of inquiry instruction and learning. These students also rate the importance of the teacher and student co-construction of inquiry higher than non-IB students."

Aulls, M. W., & Peláez, S. (2013). *Exploring the learning benefits and outcomes of the IB Extended Essay in preparing students for university studies in Canada: Student perceptions of the impact of the Diploma Programme and the Extended Essay on the academic demands of first year in university.* Phase 2 Research Report to the IBO [International Baccalaureate Organization]. Montreal, Quebec, Canada: Department of Educational and Counselling Psychology, McGill University. Retrieved from: http://www.ibo.org/research/policy/programmevalidation/diploma/documents/McGillFullReportPhase2FINAL.pdf [S, H] "Participation in the EE revealed a large number of learning outcomes that are entailed in the accomplishment of inquiry tasks and foundational to reading, writing, study and search skills that are necessary to successfully accomplish common university academic tasks in most disciplines. . . . Most of the knowledge learned through EE participation served them to successfully cope with these academic demands. However, . . . first year students experienced research primarily through reading it, writing about it, and occasionally discussing it but never through actually doing it as part of their coursework or even outside the classroom."

Aulls, M. W., & Shore, B. M. (2008). *Inquiry in education (Vol. I): The conceptual foundations for research as a curricular imperative.* New York, NY: Erlbaum (now Routledge). [E, S, H] Three characteristics that seem to be common to all conceptualizations or implementations of inquiry in education are (a) it is based on student interest and curiosity, (b) student-student dialog is central to learning, and (c) and the exchange (better described as diversification) of roles among learners and teachers.

Aulls, M. W., Tabatabai, D., & Shore, B. M. (2016). What makes inquiry stick? The quality of

preservice teachers' understanding of inquiry. *SAGE Open, 6*(4), 1-12. doi:10.1177/2158244016681394. [H] This study used data from parts of the MIBST then used the MISIO-S to create a coding system for definitions of inquiry and descriptions of inquiry events. Having done research or inquiry predicted the quality of definitions of inquiry; having taken a research-methods course predicted the quality of the descriptions of an actual, well-regarded inquiry experience. Good general definitions of inquiry instruction are different from good descriptions of a personal inquiry experience. Having done research enhances abstract thinking about inquiry, but teaching student-teachers about research and inquiry instruction provides recent and accurate process-related vocabulary and probably benefits more from connections to familiar instructional experiences than to theoretical inquiry constructs.

Austin, L. B., & Shore, B. M. (1993). Concept mapping of high and average achieving students, and experts. *European Journal for High Ability* [now *High Ability Studies*]*, 4,* 180-195. [S, H] Concept maps of 20 core concepts from a gateway physics courses, as created by high-achieving students closely resembled the concept maps created by graduate students in physics. They were characterized by more and better-explained links, and fewer unlinked concepts.

Austin, L. B., & Shore, B. M. (1994). The use of concept mapping as an instructional strategy in college-level physics. *Scientia Paedagogica Experimentalis--International Journal of Experimental Research in Education, 31,* 249-264. [H] Teaching students to generate concept maps led to enhanced performance, especially in multistep problems in which students had to carry out transformations of the given information in order to proceed with a more algorithmic or formula-driven solution.

Austin, L. B., & Shore, B. M. (1995). Using concept mapping for assessment in physics. *Physics Education, 30*(1), 41-45. [H] The number of links in the map, one of the easiest indices to compute from a concept map, was well correlated with overall performance in a gateway college-level physics course, and notably in performance solving multistep problems in which the solution is not found by simply plugging numbers into a formula.

Austin, L. B., & Shore, B. M. (1998). Mappe concettuali come strumenti per accetare

l'apprendimento in fisica. *La Fisica nella Scuola, 31,* 109-113. (See Austin & Shore, 1995; translation of Using concept mapping for assessment in physics. *Physics Education, 30*(1), 41-45.) [H]

Barfurth, M. A., Ritchie, K. C., Irving, J. A., & Shore, B. M. (2009). A metacognitive portrait of gifted learners. In L. V. Shavinina (Ed.), *International handbook on giftedness* (pp. 397-417). Amsterdam, Netherlands: Springer. http://dx.doi.org/10.1007/978-1-4020-6162-2_18 [E, S] "Examining the cognitive psychological concept of metacognition in gifted children and adolescents illuminates the link between childhood giftedness and adult expertise, helping us to understand the ways very able children and adults think and solve problems. This chapter summarizes previous research on metacognition–the explicit awareness and conscious manipulation of one's own thoughts, abilities, and learning processes–and, from this perspective, ways in which giftedness is realized. It also introduces the concepts of flexibility and preference for complexity. . . . The chapter concludes with learning and teaching suggestions, for home and school, that result from thinking about giftedness in relation to metacognition, including inquiry-driven learning and exchanging or interchanging roles between teachers and learners." The link to inquiry is that self-regulated learning--a characteristic of highly able learners, for example, in the use of metacognition--is important to performance in nontraditional learning settings (the example was given of learning in mathematics to execute a solution sequence versus evaluating and selecting an appropriate strategy to execute).

Barfurth, M. A., & Shore, B. M. (2008). White water during inquiry learning: Understanding the place of disagreements in the process of collaboration. In B. M. Shore, M. W. Aulls, & M. A. B. Delcourt (Eds.), *Inquiry in education (vol. II): Overcoming barriers to successful implementation* (pp. 149-164). New York, NY: Erlbaum (Routledge). [E] Resolution of cognitive conflicts is frequently preceded by social moves to broaden the inclusion of individuals and ideas. The path to effective collaborative problem solving is not necessarily smooth.

Bernard, M.-C., Savard, A., & Beaucher, C. (2014). *Le rapport aux savoirs: Une clé pour analyser les épistémologies enseignantes et les pratiques de classe.* Québec, QC: Livres en ligne du CRIRES. http://lel.crires.ulaval.ca/public/le_rapport_aux_savoirs.pdf [H] A

microsociological approach to links among knowledge takes account of the social nature of knowledge. This view is especially relevant to understanding children's initial conceptions. Children's learning extends beyond school to the larger social context with multiple interactions with humans and nonhumans in which children create meaningful understanding. This paper reports the outcomes of a symposium explaining how different knowledges (plural intentional) depend on learners' epistemological beliefs (about the nature of knowledge). This topic provided a key to examine epistemological approaches in classrooms and to understand the ways learners give direction to their learning in different subject domains.

Chichekian, T., Hua, O. (Liv), & Shore, B. M. (2013). Inquiring minds in undergraduate instruction: An expression of the teaching-research nexus. Invited chapter in D. J. Salter (Ed.), *Cases on quality teaching practices in higher education* (pp. 146-180). Hershey, PA: Information Science Reference (IGI Global). doi:10.4018/978-1-4666-3661-3.ch010 [H] Illustrations of how inquiry-based practices can be built into undergraduate teaching; it is possible but not yet widespread.

Chichekian, T., Hua, O. (Liv), & Shore, B. M. (in press). Chemistry professors' perceptions of learning in undergraduate education. *Canadian Journal for the Scholarship of Teaching and Learning/La revue canadienne sur l'avancement des connaissances en enseignement et en apprentissage.* [H] Two-thirds "regarded students as passive receivers of information, five disagreed with this view, and four neither agreed nor disagreed. Acquiring basic facts of a discipline was regarded as necessary before engaging in research experiences. Professors who did not agree or disagree . . . observed undergraduates becoming more involved in the process of asking their instructors questions," mostly for clarification.

Chichekian, T., Savard, A., & Shore, B. M. (2011). The languages of inquiry: An English-French lexicon of inquiry terminology in education. *LEARNing Landscapes, 4*(2), 93-109. http://www.learninglandscapes.ca/images/documents/ll-no8/tchichekian.pdf [E, S] Inquiry is described by slightly different terminology reflecting underlying conceptual differences in different languages. International conversations need to take these variations into account. The strong influence of science inquiry on the language and

concepts is not an accident; several prominent physicists in France and the USA in particular, played a leading role in connecting scholarly and educational inquiry.

Chichekian, T., Savard, A., & Shore, B. M. (2012). Les troncs communs et les trajectoires divergentes dans les langues françaises et anglaises de l'approche par démarche d'investigation. *Le Grand N*, no. 90, pp. 33-48. http://anniesavard.com/wp-content/uploads/2014/03/2012-Chichekian-Savard-Shore-Lexicon-Fr.pdf (Published by the Instituts de recherche sur l'enseignement des mathématiques--IREM de Grenoble, France.) [E, S] Inquiry is described by slightly different terminology reflecting underlying conceptual differences in different languages. International conversations need to take these variations into account. The strong influence of science inquiry on the language and concepts is not an accident; several prominent physicists in France and the USA in particular, played a leading role in connecting scholarly and educational inquiry.

Chichekian, T., & Shore, B. M. (2013). Concept maps provide a window onto preservice elementary teachers' knowledge in the teaching and learning of mathematics. *Canadian Journal of Education, 36*(3), 47-71. http://www.cje-rce.ca/index.php/cje-rce/article/view/1542 [H] Concept maps reveal areas of strong and weak connections between content and pedagogy among student teachers..

Chichekian, T., & Shore, B. M. (2014a). Cognitive characteristics of the gifted: Reconceptualized in the context of inquiry learning and teaching. Invited chapter in J. A. Plucker & C. M. Callahan (Eds.), *Critical issues and practices in gifted education: What the research says* (2nd ed.; pp. 119-132). Waco, TX: Prufrock Press. [E, S] The chapter describes five major characteristics in gifted learners' cognitive performance as might be observed in inquiry settings: (a) co-construction of knowledge and group work and complex discussions, (b) extension of ideas, and divergent thinking, (c) development of expertise, (d) metacognitive awareness, self-regulated learning, and flexibility, and (e) role diversification (shift, exchange) of learners and teacher in the classroom. Some traditional cognitive strengths appear in more than one section--it is especially the combinations that vary, not necessarily the underlying individual abilities, as well as the emphases on socially-supported learning and a wider repertoire of cognitive abilities.

Chichekian, T., & Shore, B. M. (2014b). The International Baccalaureate: Contributing to the use of inquiry in higher education teaching and learning. In J. M. Carfora & P. Blessinger (Eds.), *Inquiry-based learning for faculty and institutional development: A conceptual and practical resource for educators* (Vol. 1 in the series, Innovations in Higher Education Teaching and Learning, series editor P. Blessinger) (pp. 73-97). Bingley, England: Emerald. Series ISSN: 2055-3641; ISBN: 978-1-78441-235-7 eISBN: 978-1-78441-234-0; doi:10.1108/S2055-364120140000001006 [H] Inquiry is strongly stated as a core of the IB, but it appears to be more rhetorical than exercised in practice due to increasing emphasis on content-based examinations across the three IB levels.

Chichekian, T., & Shore, B. M. (2016). Preservice and practicing teachers' self-efficacy for inquiry-based instruction. *Cogent Education, 3,* 1-19. http://dx.doi.org/10.1080/2331186X.2016.1236872 [H] This review of the literature indicated that high self-efficacy to teach with inquiry requires sustained mastery and vicarious experiences. Teaching specific research skills alone is related to lower self-efficacy to teach with inquiry; abstract and practical need to be linked. "Self-efficacy differences between elementary and secondary preservice teachers were more evident on tasks related to engaging students in problem finding rather than tasks involving linking knowledge. . . . Preservice teachers were learning more of what seemed to be a procedural and not a conceptual introduction to inquiry." (Report of initial development of the McGill Enactment of Inquiry Questionnaire-Self-Efficacy-Teachers, MEIQ-SET, that is based on part of the MSDIQ with items reworded to reflect efficacy rather than attainment value.)

Chichekian, T., & Shore, B. M. (2017a). Challenges to conducting a longitudinal study with classroom observations of teachers' first year of professional practice. In B. Flett (Ed.), *SAGE research methods cases--Education*. London, England: SAGE Online Library Products. http://methods.sagepub.com/case/challenges-longitudinal-study-of-teachers-first-year-of-practice http://dx.doi.org/10.4135/9781526419378 [E, S, H] "This case study focuses on methodological challenges to conducting an ecologically sound, mixed-methods, longitudinal, nonexperimental study of teaching. . . . The specific case we cite began with a study of 244 senior preservice teachers' self-efficacy for inquiry and

explored if and how self-efficacy for inquiry enactment differed between elementary and secondary levels. We then convened focus groups to identify what elements from teacher-education and field experiences might explain their understanding of inquiry instruction. We followed a sample of six of these teachers through their first year of professional practice as they struggled to implement inquiry in their classrooms. We administered the same survey to assess preservice baseline self-efficacy, then across the transition from student-teacher to novice teacher. We individual interviewed the six novice teachers at the beginning and at the end of the academic year to examine for changes in participants' responses regarding their conceptualizations of inquiry and challenges they identified as obstacles to implementing inquiry. We triangulated our data with five observations of each of the six teachers during the year. These multiple data sources divulged patterns among new teachers' alignment of self-efficacy, conceptualizations, and actual enactment of inquiry."

Chichekian, T., & Shore, B. M. (2017b). Hold firm: Gifted learners value standing one's ground in disagreements with a friend. *Journal for the Education of the Gifted, 40,* 152-167. doi:10.1177/0162353217701020 [S, H] In varying learning contexts, students prefer that their friends and they themselves hold to their positions during disagreement. The strengths of these preferences vary according to program admission requirements and processes. All interpersonal interactions occur in context.

Chichekian, T., Shore, B. M., & Tabatabai, D. (2016). First-year teachers' uphill struggle to implement inquiry instruction: Exploring the interplay among self-efficacy, conceptualizations, and classroom observations of inquiry enactment. *SAGE Open, 6*(2), 1-19. doi:10.1177/2158244016649011 [H] "This longitudinal study followed a sample of six first-year teachers during the transition from student-teacher to novice teacher and focused on three main variables: teachers' conceptualizations of inquiry-based pedagogy, their self-efficacy for inquiry-based teaching, and their actual practice of teaching with inquiry. We administered a self-report survey to measure their sense of self-efficacy for inquiry-based instruction and conducted individual interviews at the beginning and end of their first year of teaching. We also observed the six teachers in their classrooms five times over the course of the year. At the end of their first year of professional practice,

self-efficacy for teaching using inquiry underwent a general decline as was also found for the frequencies of concepts teachers used to describe inquiry enactment. Moreover, their descriptions of inquiry were based more on a set of interrelated procedures and less on a form of conceptual knowledge. Classroom observations revealed that teachers were least observed in pedagogical actions that required enabling students to communicate findings and the most in student engagement, however, over time observations of student engagement declined. Consistent patterns were observed between shifts in self-efficacy and enactment of inquiry as well as shifts between self-efficacy and conceptualizations of inquiry enactment. There was also evidence of beginning steps toward links between teacher's conceptualizations and classroom practice." Support from school leaders is important. (Fits with the "lots of practice" idea we expressed elsewhere.) (Report of early use of the McGill Enactment of Inquiry Questionnaire-Self-Efficacy-Teachers, MEIQ-SET, that is based on part of the MSDIQ with items reworded to reflect efficacy rather than attainment value.)

Clark, C., & Shore, B. M. (2004). *Educating students with high ability (rev. ed.).* Paris, France: UNESCO. (The revision of Chapter 4 was coauthored by J. A. Irving.) http://unesdoc.unesco.org/images/0013/001383/138328e.pdf [E, S] Includes a chapter historically linking gifted-education models with inquiry-based models and social constructivism.

Cyr, S., Savard, A., & Braham, E. (2016). Analyse d'un projet pilote d'intégration d'une approche par les situations dans l'éducation de base de la République Démocratique du Congo [Analysis of a pilot integration project of a situation-based approach in primary school of the Democratic Republic of the Congo]. *Comparative and International Education / Éducation Comparée et Internationale, 45*(3), Article 4. http://ir.lib.uwo.ca/cie-eci/vol45/iss3/4 [E, S] "In 2015, the Democratic Republic of the Congo (DRC) undertook a transitional approach to school reform by adopting the Situation-based Approach "Approche par les Situations (APS)" in the elementary school curriculum. In order to initiate this process, the country has set up an experimental pilot project to improve teaching and learning Mathematics and Language Arts in elementary school. To this end, learning situations were created and teachers were trained in the use

of these situations in class. This article presents the results from different data collection tools to account for this experimental approach in Mathematics with a view to enlargement at the national level. The results indicate not only a positive contribution of teacher education and use of classroom situations, but also expose functional problems of implementation of such a device in a country like the DRC."

Delcourt, M. A. B. (2001). Effects of talent development on science process skills. In F. A. Dixon & C. M. Adams (Eds.), *Research Briefs of the Division of Research and Evaluation of the National Association for Gifted Children* (pp.150-165). Washington, DC: The National Association for Gifted Children. [E, S] Both the child's personality and the types of opportunities available in the environment over a period of time play a large role in the development of talent. Applied to the school environment, talent development means honoring students' many abilities; seeking opportunities for children to thrive; providing opportunities for children's voices to be heard; pairing students with experts who have similar interests and strengths.

Delcourt, M. A. B. (2008). Where students get creative-productive ideas for major projects in the natural and social sciences, In B. M. Shore, M. W. Aulls, & M. A. B. Delcourt (Eds.), *Inquiry in education volume II: Overcoming barriers to successful implementation* (pp. 63-92). New York: Routledge. [S] By understanding and developing their own creative-productive behavior, students are better prepared to think of new ideas for scientific investigations. This information is related to the development of self-regulatory behavior in adolescents, namely: forethought regarding actions, actual performance, and self-reflection after activities are completed. Students revealed insights into how they matched their interests with ideas for projects (forethought), how they carried out their investigations (performance), and what they learned from their efforts (self-reflection).

Delcourt, M. A. B., Aslanian, A., & Duncanson, E. (2007). Inquiry in science education. In D. Pinou and M. A. B. Delcourt (Eds.) *WestConn's Institute for Science Teacher Research (WISTR) Program Report*, Danbury, CT: Western Connecticut State University. [S] Teachers who participated in the program showed no significant difference in the average number of [low level--Bloom] Knowledge/Comprehension questions asked during classes from fall to spring and no significant difference in the average number of Higher

Order Thinking Skills (HOTS) questions over the same period. There was, however, a significant increase in the number of higher order questions asked by students (not low level). Teachers provided more opportunities for students to ask advanced questions. They specifically added inquiry opportunities into their science classes by creating more project-oriented environments. Overall, teachers reduced their total use of questions during a typical lesson by 17%. Additionally, the total use of HOTS questions by students and teachers increased by 14.7%. Although teacher use of HOTS questions did not increase significantly, they clearly allowed more time and opportunities for students to pose better questions.

Delcourt, M. A. B., & McKinnon, J. (2011). Tools for learning: Improving questioning in the classroom. *LEARNing Landscapes, 4*(2), 145-160. http://www.learninglandscapes.ca/images/documents/ll-no8/mabdelcourt.pdf [E] Building higher-order questioning skills also facilitates critical thinking.

Delcourt, M. A. B., & Renzulli, J. S. (2013). The three-ring conception of innovation and a triad of processes for developing creative productivity in young people. In L. V. Shavinina (Ed.), *The International Handbook on Innovation Education* (pp. 128-141). New York, NY: Routledge. [E, S] Links creativity and inquiry-based instruction.

Delcourt, M. A. B., Treffinger, D. J., Woodel-Johnson, B., & Burke, K. (2015). Learning styles and problem-solving styles of talented secondary school students. *International Journal for Talent Development and Creativity, 3*, 179-192. [S] Significant correlations exist between learning styles and problem-solving styles, and both similarities and differences exist among students talented in athletics, science, and visual arts. Inquiry skills have common elements across disciplines.

Freiman, V., & Manuel, D. (2015). Relating students' perceptions of interest and difficulty to the richness of mathematical problems posted on the CAMI website. *Quadrante [Review of Research in Mathematics Education], 24*(2), 61-84. (Published by the Portuguese Association of Mathematics Teachers, APM) [E, S] "The CAMI website is a virtual community designed for francophone students from K-12 school levels in New Brunswick, Canada and elsewhere in the world. The main purpose of this learning

environment is to increase it members' opportunities to learn mathematics by proposing rich, interesting, and challenging problems. Although few studies have been conducted on CAMI website, none explored if richness of the problems is related to how interesting and difficult the members perceived the problems to be. The present article addresses this lack by investigating the possibility of links between members' perceptions of interest and difficulty of the mathematical problems posted, and the richness of the problems according to the creators of CAMI. Using a sequential mixed method design (Teddle & Tashakkori, 1990), and Manuel's (2010) model, we studied first the richness of 118 problems for which online surveys were conducted that questioned students about how interesting and difficult they found the problems to be. Then we studied how the richness is related to students' perceptions. Although the results showed no significant relation between the richness of the problem according to the researchers and the students' perceptions of interest and difficulty, some tendencies, however, prompt the need for further analysis." (Abstract)

Freiman, V., Polotskaia, E., & Savard, A. (2017). Using a computer-based learning task to promote work on mathematical relationships in the context of word problems in early grades. *ZDM Mathematics Education, 49,* 835-849. [E, S] "In Canada, as in other Western countries, solving word problems has comprised an important part of mathematics curricula. Traditionally, arithmetic thinking has largely been privileged as the main strategy for solving word problems at the elementary level, thus postponing the introduction of algebraic thinking to the secondary school. Drawing on the work of the Russian psychologist Davydov, we suggest that algebraic ways of thinking can be fostered as early as primary grades within the context of problem solving, thus enabling understanding of relational aspects of a problem's mathematical structure. In particular, we used Elkonin and Davydov's notion of *learning activity* to design a computer-based task that helps young students (ages 7–8) to analyse word problems and eventually engage in an algebraic way of thinking. The task also involves a whole-class discussion in which students probe their understanding of the problem and model its solution in a relational way, instead of instantly locking themselves into a numerical operation. Macro- and micro-levels of analyses were conducted using, inter alia, the lens of the didactical tetrahedron, which highlights the association between design of

learning tasks and students' capacity building in analysing and expressing relationships between quantities through non-numerical symbols. While further research on the relational approach is still needed, this paper demonstrates its potential to contribute to progressively shifting young children's understanding from one that relies heavily on arithmetic processes toward one that builds on algebraic thinking."

French, L. R., & Shore, B. M. (2009). A reconsideration of the widely held conviction that gifted students prefer to work alone. Invited chapter in B. Hymer, T. D. Balchin, & D. Matthews (Eds.), *The Routledge international companion to gifted education* (pp. 176-182 plus references). London, England: Routledge. [E, S] The textbook literature repeats the assertion that bright students tend to be loners, but there are many examples of research that suggest this stereotype needs to be re-examined in the specific context of the kind of instructional situation.

French, L. R., Walker, C. L., & Shore, B. M. (2011). Do gifted students really prefer to work alone? *Roeper Review, 33,* 145-159. doi:10.1080/02783193.2011.580497 [E, S] They do under some conditions such as very easy work (but so do other students prefer to work alone in such circumstances). They do not prefer to work alone when the stakes are higher and they have some influence over the choice of with whom they work. They are concerned about fairness in the distribution of work, who will grade the work, and whether it is worth little or "high stakes." More often than not, gifted students are not loners.

Gervais, C., Polotskaia, E. & Savard, A. (2013). La résolution de problèmes de structures additives chez les élèves du premier cycle du primaire : le développement du raisonnement. *Bulletin de l'AMQ (Association mathématique du Québec), 8*(3), 58-66. http://archimede.mat.ulaval.ca/amq/bulletins/oct13/08-maitre-Gervais.pdf [E] Examination of the difficulties encountered by elementary teachers when they teach students to analyze mathematical word problems, and approaches to overcome these challenges. This study highlights the need for teachers to intentionally develop specific inquiry-relevant skills for students to be able to succeed.

Getahun, D. A., Aulls, M. W., & Saroyan, A. (2014). The nature of undergraduate students'

conceptions of inquiry. *Electronic Journal of Science Education*, *18*(8), n.p. Retrieved from http://ejse.southwestern.edu/article/view/13837/0. [H] Found 13 categories of inquiry conceptions that they could be grouped into three superordinate categories of inquiry as: a learning process, an instructional process, and a research/scientific process. Inquiry as a learning process was the most prevalent and inquiry as a research/scientific process least. In particular, inquiry as a means of gaining information/knowledge was the most prevalent single conception. This implies more work is needed to help students develop conceptions that can stimulate productive inquiry engagement. Undergraduates have a somewhat constrained conception of inquiry, and it is entirely on the cognitive side. In addition to learning to do it, attention should be given to understanding what it is.

Gube, M., & Shore, B. M. (2018). *Report on a decade (plus) of funded research goals and achievements of the High Ability and Inquiry Research Group (HAIR) at McGill University.* To be posted on the HAIR website (www.mcgill.ca/inquiry) and in the McGill Library eScholarship collection (generating a unique URL). [E, S, H] This is the present document.

Ha, S., Lee, G., & Kalman, C. S. (2013). Workshop on friction: Understanding and addressing students' difficulties in learning science through a hermeneutical perspective. *Science & Education, 22,* 1423-1441. doi:10.1007/s11191-012-9465-5 [H] "Hermeneutics is useful in science and science education by emphasizing the process of understanding. The purpose of this study was to construct a workshop based upon hermeneutical principles and to interpret students' learning in the workshop through a hermeneutical perspective. When considering the history of Newtonian mechanics, it could be considered that there are two methods of approaching Newtonian mechanics. One method is called the 'prediction approach', and the other is called the 'explanation approach'. The 'prediction approach' refers to the application of the principles of Newtonian mechanics. We commonly use the prediction approach because its logical process is natural to us. However, its use is correct only when a force, such as gravitation, is exactly known. On the other hand, the 'explanation approach' could be used when the nature of a force is not exactly known. In the workshop, students read a short text offering contradicting ideas

about whether to analyze a friction situation using the explanation approach or the prediction approach. Twenty-two college students taking an upper-level mechanics course wrote their ideas about the text. The participants then discussed their ideas within six groups, each composed of three or four students. Through the group discussion, students were able to clarify their preconceptions about friction, and they responded to the group discussion positively. Students started to think about their learning from a holistic perspective. As students thought and discussed the friction problems in the manner of hermeneutical circles, they moved toward a better understanding of friction."

hannah, c. l., & Shore, B. M. (2008). Twice exceptional students' use of metacognitive skills on a comprehension-monitoring task. *Gifted Child Quarterly, 52,* 3-18. doi:10.1177/0016986207311156 [E] Faced with a reading task into which incongruous information was inserted, gifted students with learning difficulties (LDs) used monitoring strategies that resembled those used by gifted students, not by students with LDs. The implication is that twice-exceptional students should be educated as gifted students and not have their disability dominate their placement or program.

Hua, O. (Liv), & Shore, B. M. (2014). Chemistry professors' descriptions of the impact of research engagement on teaching. *Higher Education Research and Development, 33,* 298-311. doi:10.1080/07294360.2013.832158 [H] Professors claimed research engagement (a) enhances student interest, (b) promotes subject-matter currency, (c) generates research examples, (d) models ways of thinking in the discipline, (e) provides contextualization guidance for instruction and (f) helps them explain difficult concepts. They appear to have increasingly reflected on this link (fits with Ibrahim's fourth dimension of general reflection: deliberation).

Hua, O. (Liv), Shore, B. M., & Makarova, E. (2014). Inquiry-based instruction within a community of practice for gifted-ADHD college students. *Gifted Education International, 30*(1), 74-86. doi:10.1177/0261429412447709 [H] "A number of characteristics are shared between attention-deficit hyperactivity disorder (ADHD) and gifted populations. They include . . . [issues with] sustaining attention, following directions, and completing tasks. . . . Inquiry-based instruction within an authentic community of practice can play an integral role in talent development for gifted

undergraduate students" with ADHD. Inquiry is appropriate for wide range of abilities and learning disabilities.

Huang, X., & Kalman C. S. (2012). A case study on reflective writing. *Journal of College Science Teaching, 42*(1), 92-99. [H] This paper reported a "multiple case study in two science courses in which students engaged in reflective writing. . . . Students with higher scores on an epistemology survey tended to use reflective writing in a more effective way to enhance their learning of textual material" (p. 92).

Huang, X., & Kalman, C. S. (2013). Relationship between students' epistemological beliefs and the evolution of science philosophy and hermeneutics. In *Proceedings of the biennial meeting of the International History and Philosophy of Science Teaching Group* (IHPST). Pittsburgh, PA: IHPST. http://archive.ihpst.net/2013-pittsburgh/conference-proceedings/ [H] Promoting opportunities for dialog and reflection in undergraduate classrooms enhances expert-like thinking about concepts.

Ibrahim, A., Aulls, M. W., & Shore, B. M. (2016a). Development, validation, and factorial comparison of the McGill Self-Efficacy of Learners For Inquiry Engagement (McSELFIE) survey in natural science disciplines. *International Journal of Science Education, 38,* 2450-2476. doi:10.1080/09500693.2016.1249531 [S, H] "Sociocognitive theory (Bandura, 1986, 1989, 1991) accords high importance to the mechanisms of human agency and how they are exercised through self-efficacy. In this paper, we proposed that self-efficacy for inquiry engagement mediates the effects of knowledge and personality on behavior and achievement. We defined inquiry engagement as engaging the practices of science and engineering, which are supported by personality characteristics, and that result in inquiry- learning outcomes. Based on these theoretical perspectives, we developed and validated the McGill Self-Efficacy for Inquiry Engagement (McSELFIE) instrument with undergraduate students in STEM disciplines. The McSELFIE is a 60-item, learner-focused survey that addresses three components that are theoretically important for engaging in scientific inquiry: (a) students' personalities, (b) inquiry learning outcomes, and (c) practices of science and engineering. Evidence for content validity was obtained by using experts' judgments and confirmatory factor analysis (CFA) with a sample of 152 undergraduates who had experience with scientific

inquiry in diverse STEM fields. All the McSELFIE factors resulting from CFA predicted students' reported prior inquiry experience, offering strong criterion validity evidence. Internal consistency and construct validity were also examined. The McSELFIE instrument is a reliable and valid instrument for measuring undergraduate students' self-efficacy for scientific inquiry in STEM disciplines. Implications for theory and practice are discussed." (Source of McSELFIE instrument--derived from the MSDIQ and MAVIES instruments)

Ibrahim, A., Aulls, M. W., & Shore, B. M. (2016b) Teachers' roles, students' personalities, inquiry learning outcomes, and practices of science and engineering: Development and validation of the McGill Attainment Value for Inquiry Engagement Survey [MAVIES] in STEM disciplines. *International Journal of Science and Mathematics Education, 15,* 1195-1215. doi:10.1007/s10763-016-9733-y. [H] "Expectancy value theory posits that attainment values are important components of task values that, in turn, directly influence students' achievement-related choices and performance. The current paper developed and validated the McGill Attainment Value for Inquiry Engagement Survey (MAVIES) with undergraduate students in STEM disciplines. The MAVIES is a 67-item, learner-focused survey that addresses four components that are theoretically important for engaging in scientific inquiry: (a) teachers' roles, (b) students' personalities, (c) inquiry learning outcomes, and (d) practices of science and engineering. Evidence for internal consistency and construct, content, and criterion validity was obtained from 85 undergraduates who had experience with scientific inquiry in diverse STEM fields. Confirmatory factor analyses confirmed factors that were aligned with role theory, Big Five personality traits, revised Bloom's learning outcomes, and the Next Generation Science Standards. The MAVIES instrument is a reliable and valid instrument for measuring undergraduate students' attainment values for scientific inquiry in STEM disciplines." (Source of MAVIES instrument--derived from the MSDIQ)

Ibrahim, A., Kalman, C. S., & Milner-Bolotin, M. (2013). "Sources of knowledge" for students entering a gateway science course. In *Proceedings of the 6th MIT LINC [Massachusetts Institute of Technology Learning International Networks Consortium] conference*. Cambridge, MA: MIT. doi:10.13140/RG.2.1.2113.8642 [H] "Epistemology has been

shown to have an important role on how students learn. The current paper focuses on one epistemological dimension, which is the "sources of knowledge" for students entering a gateway science course. Eight students were interviewed and asked about their sources of knowledge, and sources of physics knowledge. The qualitative analysis revealed that the students' sources of knowled, and sources of physics knowledge range across relying on the teacher, lecture, peers, textbooks, Internet resources, experiences, or experiments. Students who mentioned experiments as their sources of knowledge emphasized the importance of lab work."

Irving, J. A., Oppong, E., & Shore, B. M. (2016). Alignment of a high-ranked PISA mathematics curriculum and the *Parallel Curriculum* for gifted students: Is a high PISA mathematics ranking indicative of curricular suitability for gifted learners? *Gifted and Talented International, 31,* 114-131. http://dx.doi.org/10.1080/15332276.2017.1356657 [S] Even a curriculum leading to superior PISA outcomes still lacks some key qualities of inquiry and suitability for gifted students. Inquiry instruction is complex and demanding, and needs support at different levels (curriculum, pedagogy, etc.).

Kalman, C. [S.]. (1997). Conceptual writing exercises, essay questions, group exercises. In S. Tobias & J. Raphael (Eds.), *The hidden curriculum--Faculty-made tests in science, Part 1: Lower division courses* (pp. 149-192). New York, NY: Plenum Press. [H] Promoting opportunities in undergraduate classrooms that get students to examine textual material metacognitively, specifically with one or more interactive interventions such as dialog and reflection, produces epistemological change and enhances expert-like thinking about concepts. Validly assessing learning outcomes requires examination practices that explicitly tap these experiences.

Kalman, C. S. (1998). Developing critical thinking using cooperative learning techniques. *Physics in Canada, 54*(1), 15-17. (Letters Section) [H] Promoting opportunities in undergraduate classrooms that get students to examine textual material metacognitively, specifically with one or more interactive interventions such as dialog and reflection, produces epistemological change and enhances expert-like thinking about concepts.

Kalman, C. S (2001a). Teaching students to solve quantitative problems in science by writing

their way into the solution. *The Successful Professor,* Sample Issue, 3-4. [H] Promoting opportunities in undergraduate classrooms that get students to examine textual material metacognitively, specifically with one or more interactive interventions such as dialog and reflection, produces epistemological change and enhances expert-like thinking about concepts.

Kalman, C. S. (2001b). Developing critical thinking in undergraduate courses: A philosophical approach. *Science & Education*, *11*(1), 83-94. [H] "This paper is centred on twentieth century philosophers of science. . . . Students study one philosopher all semester as a group project and report regularly on how their philosopher would view the subject matter of the course. As a consequence of this use of philosophers of science, the students seem to have made a marked improvement in their critical thinking skills and in their grasp of the underlying concepts of the subject matter of the courses."

Kalman, C. S. (2002). Generating effective in-class discussions. *The Successful Professor*, *1*(5), 7-9. Retrieved from http://www.usask.ca/gmcte/newfiles/oldfiles/tsp_vol1_5.pdf [H] Promoting opportunities in undergraduate classrooms that get students to examine textual material metacognitively, specifically with one or more interactive interventions such as dialog and reflection, produces epistemological change and enhances expert-like thinking about concepts.

Kalman C. S. (2003). Course design for an introductory science course. *Academic Exchange Quarterly, 7*(4), 194-198. [H] "This paper presents a course design for an introductory science course that encourages students to take greater responsibility for constructing their own knowledge of science with their professor and fellow students. The course includes two writing activities and a conceptual-conflict activity. (A conceptual-conflict activity is one in which two or more opposing viewpoints are discussed.) All of the students became more involved in constructing their own understandings of the subject."

Kalman, C. S. (2007). *Successful science and engineering teaching in colleges and universities*. Bolton, MA: Anker. [H] "This book offers broad, practical strategies for teaching science and engineering courses and describes how faculty can provide a learning environment that helps students comprehend the nature of science, understand science

concepts, and solve problems in science courses. The student-centered approach focuses on two main themes: reflective writing and working in collaborative groups. When faculty incorporate methods into their courses that challenge their students to critically reflect, collaborate, and problem solve, students gain a better understanding of science as a connected structure of concepts rather than as a simple tool kit of assorted practices."

Kalman, C. S. (2008). *Successful science and engineering teaching: Theoretical and learning perspectives* (Innovation and change in professional education series, volume 3, series editor Wim Gajselaers). New York, NY: Springer. [H] "The invention of inertia requires an examination of what would be needed to have the Earth to rotate around its axis and a ball fall straight down beside the high tower. Such a notion requires a high order of critical thinking, hardly the abilities found in most students entering an introductory course. Duhem's viewpoint is that a single hypothesis by itself whether induced by observation or postulated by a guess is not really science. The essential difference between science and pseudoscience and non-science is that a scientific theory should provide coherent, consistent, and wide-ranging theoretical organization. Kalman (2002) discusses how very important it is that students become aware of how science works so that they can undergo conceptual change; confront their personal (alternative) scientific conceptions."

Kalman, C. S. (2009a). The need to emphasize epistemology in teaching and research. *Science & Education, 18,* 325-347. [H] "Enabling students to develop a scientific mindset is complicated by student's views on the Nature of Science. Students need to appreciate the history of science and to contrast different frameworks. In order to do this, students have to be able to follow presentations in class and read their textbooks. Although individual words are understandable, the sentences appear to take the form of an unknown language. The solution utilized in this paper is to get students to approach their reading of their textbooks in the manner of the hermeneutical circle through an activity called Reflective Writing."

Kalman, C. S. (2009b). Why should I use collaborative groups in my course? *Physics in Canada, 65,* 137-138. [H] Promoting opportunities in undergraduate classrooms that get students to examine textual material metacognitively, specifically with one or more interactive

interventions such as dialog and reflection, produces epistemological change and enhances expert-like thinking about concepts.

Kalman, C. S. (2010a). Enabling students to develop a scientific mindset. *Science & Education, 19*(2), 147-163. [H] "Students study one philosopher all semester as a group project and report regularly on how their philosopher would view the subject matter of the course. Almost all of the students were able to argue successfully on the final examination about all three philosophers. Students become aware that the same textual material can be viewed in a variety of ways. The answers that students give about the NOS [nature of science] have become clearer at the end of the course."

Kalman, C. S. (2010b). Reading the book of nature: The hermeneutical circle in science. In M. R. Gueldry (Ed.), *Consistent incorporation of professional terminologies into the world's languages: The linguistic engine of a global culture* (pp. 39-58). Lewiston, NY*:* Mellen Press. [H] Promoting opportunities in undergraduate classrooms that get students to examine textual material metacognitively, specifically with one or more interactive interventions such as dialog and reflection, produces epistemological change and enhances expert-like thinking about concepts.

Kalman, C. S. (2011a). Enhancing students' understanding of concepts by getting students to approach text in the manner of a hermeneutical circle. *Science & Education, 20,* 159-172. doi:10.1007/s11191-010-9298-z [H] "Part of the reason for students' difficulties is that for a student taking a science gateway course the language, ontology, and epistemology of science are akin to a foreign culture. . . . The hermeneutical circle involves the interplay between our construct of the unfamiliar with our own outlook that deepens with each pass. . . . For novice students to acquire a full understanding of scientific texts, they also need to pursue a recurrent construction of their comprehension of scientific concepts. . . . An activity, reflective-writing, can enhance students' understanding of concepts in their textbook by getting students to approach text in the manner of a hermeneutical circle."

Kalman, C. S. (2011b). How do we teach? How do students learn? In F. Saroglu, V. Koulountzos, & A. Siastras (Eds.), *Science & culture: Promise, challenge and demand.*

Book of Proceedings, 11th International IHPST and 6th Greek History, Philosophy and Science Teaching Conference (pp. 380-383). Athens, Greece: Epikentro. ISBN:978-960-458-325-6. [H] "This article addresses the general problem of changing how students learn in introductory science "gateway" courses so that they can not only succeed in the courses, but also emerge with the kinds of skills needed to promote research and entrepreneurship in both developed and developing countries."

Kalman, C. S. (2017a). *Successful science and engineering teaching in colleges and universities* (2nd ed.). Charlotte, NC: Information Age. [H] Promoting opportunities in undergraduate classrooms that get students to examine textual material metacognitively, specifically with one or more interactive interventions such as dialog and reflection, produces epistemological change and enhances expert-like thinking about concepts.

Kalman, C. S. (2017b). *Successful science and engineering teaching: Theoretical and learning perspectives* (2nd ed.). Seacaucus, NJ: Springer. [H] Promoting opportunities in undergraduate classrooms that get students to examine textual material metacognitively, specifically with one or more interactive interventions such as dialog and reflection, produces epistemological change and enhances expert-like thinking about concepts.

Kalman, C. S. (2017c). Research on thinking. Review of R. Wegerif , L. Li, & J. C. Kaufman (Eds.), Routledge handbook of research on teaching thinking. Oxford, England: Routledge, 2015. *Science & Education, 26, 743-745*. doi:10.1007/s11191-017-9907-1 [E, S, H] "A problem with this handbook is that it basically features articles by education faculty and does not include other faculties pursuing science education research. Thus in discussing epistemic practices there is no mention of the debate within the science education community on the nature of the knowledge structures of students in introductory science courses. My own research has shown that there is a strong indication that a combination of an activity that gets students to examine textual material metacognitively with one or more interactive interventions can produce statistically significant epistemological change . . ." (p. 745).

Kalman, C. S., & Aulls, M. W. (2003). Can an analysis of the contrast between pre-Galilean and Newtonian theoretical frameworks help students develop a scientific mindset? *Science &*

Education, 12, 761-772. [H] "Students use two writing activities and collaborative group activities to examine the conceptual structure of the calculus-based introductory Physics course. Students are presented with two alternative frameworks; pre-Galilean Physics and Newtonian Physics. The idea of the course design is that students would at first view the frameworks almost in a theatrical sense as a view of a drama involving a conflict of actors; Aristotle, Galileo, Newton and others occurring a long time ago. As participants passing through a series of interventions, the students become aware that the frameworks relate concepts from different parts of the course and learn to evaluate the two alternative frameworks. They develop a scientific mindset changing their outlook on the course material from the viewpoint that it consists of a tool kit of assorted practices, classified according to problem type, to the viewpoint that it comprises a connected structure of concepts."

Kalman, C. S., Aulls, M. W., Rohar, S., & Godley, J. (2008). Students' perceptions of reflective writing as a tool for exploring introductory textbooks. *Journal of College Science Teaching, 37*(4), 74-81. http://www.nsta.org/publications/browse_journals.aspx?action=issue&thetype=all&id=6572 [H] "This study explored how . . . reflective writing is perceived and accomplished by students in a gateway physics course. A survey, semi-structured interviews at the beginning, middle and end of the course, and students' writing products were collected. Thematic and contents analysis showed this tool falls within the framework of Bereiter and Scardamalia's knowledge-transforming model of writing. Students increase their knowledge acquisition through an interaction between content and discourse processes. Students understood that engaging in reflective writing enables them to determine when they do not understand a concept as it is being read and that reflective writing promotes self-dialogue between the learner's prior knowledge and new concepts in the textbook."

Kalman, C. S., Milner-Bolotin, M., & Antimirova, T. (2010). Comparison of the effectiveness of collaborative groups and peer instruction in a large introductory physics course for science majors. *Canadian Journal of Physics, 88,* 325-332. [H] "We report on an experiment comparing examinations of concepts using slightly modified peer instruction (MPI) interventions with a conceptual conflict strategy based on collaborative groups

(CG). Four interventions were utilized in two sections of an introductory physics course for science students. . . . The gain on the Force Concept Inventory (FCI) used as a pre- and post-test is essentially the same in both classes. The instructors were experienced in use of MPI, but this was the first time that these instructors had used a collaborative group activity in their classes and only used it for the two interventions in each class described in this paper. CG appears to be more effective as a teaching method than PI."

Kalman, C. S., Milner-Bolotin, M., Aulls, M. W., Charles, E. S., Coban, G. U., Shore, B. M., Antimirova, T., Kaur Magon, J., Xiang, H., Ibrahim, A., Wang, X., Lee, G., Coelho, R. L., Tan, D. D. N., & Fu, G. (2014). Understanding the nature of science and nonscientific modes of thinking in gateway science courses. In M. F. Taşar (Ed.), *Proceedings of the World Conference on Physics Education 2012* (pp. 1291-1299). Ankara, Turkey: Pegem Akademi. ISBN:978-605-364-658-7 [H] "This study investigated if and how a combined set of specially developed activities--(a) reflective writing, (b) critique-writing activities, and (c) reflective write-pair-share combined with the collaborative conceptual-conflict group exercises--can help students change their approach to learning physics and their actual learning. Each of these activities was previously successfully tested as a stand-alone activity. We also developed new rubrics for evaluation of the impact of the activities. Data were collected at two different institutions over a two-year period. At each institution the same instructor taught students in two sections. At the first, a comprehensive university, classes were relatively large sections (over 100 students each) in a typical calculus-based course in mechanics. At the second, a community college, there were relatively small classes (32 students each) of a typical algebra-based introductory course in mechanics, electricity, and magnetism. The two institutions used different textbooks and had different formats. Measured outcome variables included student interviews and writing products. Students in the experimental groups better identified key concepts, related concepts to their own prior understanding of the same and other concepts, and used a paradigm-based rather than template-based approach to solving new problems. Moreover, the experimental teaching approach had a significant positive impact on students' final examination results in one of the settings. The *Discipline-focused Epistemological Beliefs Questionnaire* was administered at the beginning and end of the semester. Overall, results in the dimension of

simplicity/certainty showed that novice science learners become more expert-like after the one-semester intervention, beginning to see physics knowledge as interconnected and evolving, which can be better learned by relating to their prior knowledge and their life experience. The same trend of development was also found with their beliefs in the attainability of truth: students believe more and more that truth is attainable. The main results of this study are the changes in students approach to learning physics."

Kalman, C. S., Morris, S., Cottin, C., & Gordon, R. (1999). Promoting conceptual change using collaborative groups in quantitative gateway courses. *American Journal of Physics, 67*(S1), S45-S51. [H] "Four basic concepts for which many students enter the class with alternative conceptions were treated in fall 1995 and fall 1996 in two sections taught by the same instructor. In fall 1995, in one section all four concepts were taught using the collaborative group approach and the other by standard professor-centered methods. In fall 1996, two sections were taught in section A using the collaborative group approach and in section B by standard methods. The other two concepts were taught in section B using the collaborative group approach and in section A by the standard professor-centered technique. (Subject matter in the traditional section was delivered using lectures, but delivery of concepts in both sections was supplemented with interactive computer programs, video disks, and VCR based materials.) Statistically significant greater conceptual change occurred in the treated groups compared to the control groups."

Kalman, C. S., & Rohar, S. (2010). Toolbox of activities to support students in a physics gateway course. *Physical Review Special Topics--Physics Education Research, 6*(2), 1-15. doi:10.1103/PhysRevSTPER.6.020111 [H] ". . . in the standard Physics gateway course. The set of instructional activities . . . included . . . reflective writing, collaborative groups, critiques, and an essay question on the examination. Each activity was designed to lead into and connect with the other activities, with the intention that students would establish links between different parts of the course. . . . The combination of instructional activities [was] successful in scaffolding the students and getting them to view the course in a holistic manner."

Kalman, C. S., Rohar, S., & Wells, D. (2003). Promoting conceptual change using writing-to-learn methods which enhance critical thinking in quantitative gateway courses. *American Journal of Physics, 66,* 212-224. [H] Promoting opportunities for reflection in undergraduate classrooms enhances expert-like thinking about concepts. Writing about new concepts supports this process. (Also see Kalma, Rohar, & Wells, 2004.)

Kalman, C. S., Rohar, S., & Wells, D. (2004). Enhancing conceptual change using argumentative essays. *American Journal of Physics, 72,* 715-717. [H] "We show the utility of following up collaborative group work with written exercises. . . . Students were required to follow up the conceptual conflict exercises with a written critique. Evaluations were done using the same enhanced version of the force concept inventory as administered to the students in the previous study."

Kalman, C. S., Shore, B. M., Aulls, M. W., Antimirova, T., Kaur Magon, J., Lee, G., Coelho, R., Unal Coban, G., Huang, X., Ibrahim, A., Wang, X., Minh Tan, D. D., Fu, G., & Khanam, W. [N.] (2017). Changing students' approach to learning physics in postsecondary gateway courses. *International Research in Higher Education, 2*(3), 16-33. [H] "This study investigated if and how a combined set of specially developed activities can help students change their approach to learning physics. These activities included (a) reflective-writing activities, (b) critique-writing activities, and (c) reflective write-pair-share activities combined with conceptual-conflict collaborative-group exercises. Each of these activities was previously successfully tested as a stand-alone activity. This investigation was conducted at two different institutions over a three-year period. At each institution the same instructor taught students in two sections. At the first, a university with a substantial graduate school, sections were relatively large (over 100 students each) covering a typical introductory calculus-based mechanics course. At the second, a community college, there were relatively small classes (32 students each) covering a typical algebra-based introductory course in mechanics, electricity, and magnetism. The courses at the two institutions used different textbooks and had different formats. Measured outcome variables included student interviews and writing products. We developed rubrics for evaluation of the impact of the writing products and interviews of students. The main results of this study were the changes in students' approaches to

learning physics, especially as revealed in the interviews. Students who experienced the full suite of activities (a) changed their understanding of physics from solving problems to creating a network of interrelated concepts, and they also (b) modified their approach to learning physics from repetitious review to consideration of the interconnections of the subject matter and (c) related their new learning to key concepts in an overall physics framework."

Kalman, C. S., Sobhanzadeh, M., Thompson, R., Ibrahim, A., & Wang, X. (2015). A combination of interventions can change students' epistemological beliefs. *Physical Review Special Topics--Physics Education Research. 11,* Whole Number 020136, 1-17. [H] "This study was based on the hypothesis that students' epistemological beliefs could become more expertlike with a combination of appropriate instructional activities: (i) preclass reading with metacognitive reflection, and (ii) in-class active learning that produces cognitive dissonance. This hypothesis was tested through a five-year study involving close to 1000 students at two institutions, in four physics courses. Using an experimental design, data from student interviews, writing product assessments, and the Discipline-Focused Epistemological Beliefs Questionnaire (DFEBQ) we demonstrate that the beliefs of novice science learners became more expertlike on 2 of the 4 DFEBQ factors. We conclude that a combination of an activity that gets students to examine textual material metacognitively (Reflective Writing) with one or more types of in-class active learning interventions can promote positive change in students' epistemological beliefs."

Kalman, J., & Kalman, C. [S.] (1996). Writing to learn. *American Journal of Physics, 64,* 954-955. [H] Writing about newly encountered concepts in undergraduate classrooms enhances expert-like thinking about concepts.

Karovitch, S. K., Shore, B. M., & Delcourt, M. A. B. (1996). Gifted and nongifted students' reasons for leaving French-immersion programs. *Gifted and Talented International, 11,* 30-33. [E, S] Gifted students who left French-immersion especially reported dissatisfaction with the highly formalized teaching and content.

Khanam, W. N., & Kalman, C. S. (2017). Implementation and evaluation of the course dossier

methodology. *The Canadian Journal for the Scholarship of Teaching and Learning*, 8(1), Article 7. http://ir.lib.uwo.ca/cjsotl_rcacea/vol8/iss1/7 [H] "It has been argued that for novice students to acquire a full understanding of scientific texts, they also need to pursue a recurrent construction of their comprehension of scientific concepts. The course dossier method has students examine concepts in multiple passes: (a) through reflective writing on text before it is considered in the classroom, (b) in a one-page essay at the end of the week, and (c) through a final essay at the end of the term. Students are encouraged to relate to the text in their reflective writing and critiques in the manner of a hermeneutical circle. Students are further scaffolded in writing their final essay by the use of student reviewers. This study explored how students in a humanities course perceived and accomplished the course dossier method. It was found that students' understanding of concepts improved as the course progressed."

LaBanca, F. (2011). The 21st century oral presentation toolbag: How to effectively implement oral presentation in your science classroom. *The Science Teacher, 78*(7), 51-55. [S] A "how to" paper on strategies to improve the quality and engagement of students for effective oral presentations. This is one of the skills that are part of being able to learn to be an inquirer.

LaBanca, F. (2016). Developing an inquiring community of practice: Case stories from one middle school's efforts for partnership. *Learning Landscapes, 10*(1), 135-152. [E, S] "At a start-up urban magnet middle school, we are committed to a student-centered inquiry-based learning environment that values extended project-based learning. In order to make projects relevant, we work with community members to harness their expertise in the design, execution, and evaluation of student work. We recognize that partnerships that allow community members to showcase their own talents, skills, and knowledge forge meaningful relationships that enhance student learning."

LaBanca, F., & Ritchie, K. C. (2011). The art of scientific ideas: Teaching and learning strategies that promote effective problem finding. *The Science Teacher, 78*(8), 48-51. [S] This paper defines problem finding as a creative and open-ended problem solving task, and outlines strategies for teachers and for students to successfully engage in the problem-finding stage of the inquiry process.

Lee, G., Schulz, R., Kalman, C. S., & Coelho, R. (2013) Toward a hermeneutic-historical approach in resolving dilemmas in teaching: Newton's First Law as an exemplar. In *Proceedings of the12th biennial meting of the International History and Philosophy of Science Teaching Group (IHPST)*. Pittsburgh, PA:IHPST http://archive.ihpst.net/2013-pittsburgh/conference-proceedings/ [H] Promoting opportunities for dialog and reflection in undergraduate classrooms enhances expert-like thinking about concepts.

Main, L. F., Delcourt, M. A. B., & Treffinger D. J. (2017). Effect of problem-solving style training on Future Problem Solving performance. *Journal of Creative Behavior*. Advance on-line publication (May 11, 2017). doi:10.1002/jocb.176 [S] "Future Problem Solving Program (FPSPI) high school participants who also received problem-solving styles training along with FPSPI (treatment) were compared to FPSPI curriculum-only on Qualifying Problem scores. After controlling for pretest scores, the treatment group outperformed the comparison group and more often qualified for state competition and training in problem-solving styles. Program type significantly predicted QP scores; Torrance test creativity scores did not significantly predict QP. Treatment-group participants made more statements related to an understanding of self and others; FPSPI-only participants made more statements about the technical aspects of FPSPI."

Manuel, D., Freiman, V., & Bourque, J. (2012). Richesse des problèmes posés et créativité des solutions soumises dans la Communauté d'apprentissages scientifiques et mathématiques interactifs (CASMI). *Éducation francophone en milieu minoritaire*, 7(1), 1-18. http://www.reefmm.org/Notrerevue/v7n1manuelfreimanbourque_000.pdf [E, S] "This research focuses on the richness of mathematical problems posted and the creativity of the solutions submitted by members of the CASMI (Communauté d'apprentissages scientifiques et mathématiques interactifs), a virtual resource used by Francophone students from New Brunswick and elsewhere. After reviewing issues identified by researchers preoccupied by the few opportunities offered to students to solve rich mathematical problems and develop their creativity in the classroom, we develop a conceptual framework in order to : 1) analyze the richness of the mathematical problems posted on the CASMI website; 2) assess the creativity of the solutions to the problems submitted on this website; and 3) verify the link between the richness of the

problems and the mathematical creativity of the solutions. Our results suggest that rich mathematical problems bring more original solutions and multiple answers. These results also reveal the need for a broader conceptual framework in order to enhance the richness of mathematical problems offered to students, as well as for continuing research in this area."

Manconi, L., Aulls, M. W., & Shore, B. M. (2008). Teachers' use and understanding of strategy in inquiry instruction. In B. M. Shore, M. W. Aulls, & M. A. B. Delcourt (Eds.), *Inquiry in education (vol. II): Overcoming barriers to successful implementation* (pp. 247-270). New York, NY: Erlbaum (Routledge). [E, S, H] "Four postulated constructs of inquiry, process, content, strategy, and context [these are the first dimension of the Aulls-Shore model], were found in the literature and in experienced inquiry teachers' detailed conceptualizations of inquiry as shown in their definitions, interviews, and concept maps. Inquiry teachers were distinguished from the non-inquiry teachers by the relative difference in the frequency of their use of the four constructs. The inquiry teachers each had one predominant construct that they emphasized more in their teaching, and their identity could be expressed in terms of their pedagogical use of these four constructs. The non-inquiry teachers made fewer inquiry statements when compared to the literature and when compared to their own personal statements" about their approach to teaching.

Martini, R., & Shore, B. M. (2008). Pointing to parallels in ability-related differences in the use of metacognition in academic and psychomotor tasks. *Learning and Individual Differences, 18,* 237-247. doi:10.1016/j.lindif.2007.08.004 [E] Theoretical overview of metacognition as it might apply to learners in psychomotor as well as cognitive domains. Strong links were suggested.

Martini, R., Wall, A. E., & Shore, B. M. (2004). Metacognitive processes underlying psychomotor performance in children with differing psychomotor abilities. *Adapted Physical Activity Quarterly, 21,* 248-268. http://journals.humankinetics.com/AcuCustom/Sitename/Documents/DocumentItem/3932.pdf [E] Student athletes in contrast to other students with "clumsiness syndrome" performing a psychomotor task (bouncing a nerf ball off a wall) use metacognitive processes corresponding to those used by gifted and other students on cognitive tasks.

Self-regulation generalizes widely across domains.

Masden, C. A., Leung, O. N., Shore, B. M., Schneider, B. H., & Udvari, S. J. (2015). Social-perspective coordination in gifted adolescent friendships. *High Ability Studies.* Advance online publication (2015 May 11). Retrieved from http://dx.doi.org/10.1080/13598139.2015.1028613 [S] "Academic ability, sex, and grade significantly predicted social-perspective coordination (an indicator of psychosocial maturity) in multiple regression analyses. Social-perspective coordination, perceptions (self-concept) of ability to make and keep friends, academic ability, sex, and grade predicted perceptions of the overall quality of friendships. Being a female, seventh grader, or adolescent not identified as gifted, significantly predicted higher friendship quality. Social-perspective coordination and self-concept based on having a close friend predicted higher levels of friendship quality for the gifted participants."

Oh, Y. J., Jia, Y., Lorentson, M., & LaBanca F. (2013). Development of the Educational and Career Interest Scale in Science, Technology, and Mathematics for High School Students. *Journal of Science Education and Technology, 22,* 780-790. http://eric.ed.gov/?id=EJ1038529 [S] The Educational and Career Interest scale, a self-report instrument measuring high school students' educational and career interest in STEM, was developed and validated in two studies conducted during 2010 and 2011. Study 1 included data from 92 high school students, in which exploratory factor analysis (EFA) was conducted with an initial item pool of 20 items. EFA identified three factors: educational and career interest in science, educational and career interest in technology, and educational and career interest in mathematics. Study 2 utilized data from 658 students to revisit the three-factor model using confirmative factor analysis. The two studies provide strong evidence that the scale is both valid and reliable."

Oh, Y. J., Jia, Y., Sibuma, B., Lorentson, M., & LaBanca, F. (2013). Development of the STEM College-Going Expectancy Scale for High School Students. *International Journal of Higher Education, 2*(2), 93-105. [S] "This study tested, developed, and validated an instrument to assess high school students' belief in their capability to attend college to study STEM and persist in college activities successfully in the future. The study modified the CGSES (Gibbons, 2005) to measure college-going expectancy in STEM

learning and work in college" (p. 100). "The STEM CGES is a self-report instrument measuring college-going expectancy, specifically for science, technology, engineering, and mathematics (STEM) domains. In Study 1, 95 students in an urban high school completed an 11-item online questionnaire to measure college-going expectancy in STEM domains. Exploratory factor analysis (EFA) retained 6 out of the 11 items for inclusion. In Study 2, Confirmatory Factor Analysis (CFA) used data collected from 658 students in 31 urban, suburban, and rural high schools. The results provide strong evidence that the STEM CGES is a valid and reliable instrument for measuring college-going expectancy for STEM domains" (p. 93). The measure is one of self-efficacy, indirectly related to inquiry based on what stuents understand to be the nature knowledge and acquiring knowledge in STEM domains. A sample item is "I believe that I can get into college after high school to study science, technology, engineering, or math (STEM) if I want." (p. 99) (available on-line from Yueming Jia_reprint 3.pdf)

Oppong-Nuako, J., Shore, B. M., Saunders-Stewart, K. S., & Gyles, P. D. T. (2015). Using brief teacher interviews to assess the extent of inquiry in classrooms. *Journal of Advanced Academics,* 197-226. Retrieved from joa.sagepub.com, doi:10.1177/1932202X15588368 [S] A three-question teacher interview (MITSI) provides sufficient data to make an estimate of the extent or level of inquiry practice in a classroom, validated against more complex measures and classroom observations. The interview needs to be coded or scored with a suitable template (e.g., MCLIC or MISIO) that tallies references to students' inquiry outcomes in the teachers' responses. (Source for the MITSI and MCLIC tools.)

Ormrod, J. E., Saklofske, D. H., Schwean, V. L., Andrews, J. J. W., & Shore, B. M. (2010). *Principles of educational psychology (2nd Canadian ed.).* Toronto, ON: Pearson. [E, S, H] Textbook in an Educational Psychology course observed in some of our studies. The 2010 revision started to move the chapter questions and exercises in the direction of inquiry-based learning and relevant research content was also included.

Pelletier, S., & Shore, B. M. (2003). The gifted learner, the novice, and the expert: Sharpening emerging views of giftedness. In D. C. Ambrose, L. Cohen, & A. J. Tannenbaum (Eds.), *Creative intelligence: Toward theoretic integration* (pp. 237-281). New York, NY:

Hampton Press. [E, S] Moving on from IQ-based definitions of giftedness, one of the most promising approaches is to use the expert-novice literature as a framework and regard giftedness as evolving expertise. Because expertise is acquired (not withstanding individual differences in the ability to acquire that expertise), giftedness also becomes a quality that to some degree can be taught and learned.

Polotskaia, E., Savard, A., & Freiman, V. (2011). A "fairy" tale to represent a holistic approach to additive word problem solving. In J. Novotna & H. Moraova (Eds.), *Proceedings of the International Symposium on Elementary Mathematics Teaching* (pp. 275-282). Prague, Czech Republic: Charles University. [E] Explored difficulties encountered by elementary students while solving word problems with simple additive structures. Used the context of the folk tale about the three little pigs and their effort to protect themselves against the wolf and the cold wind as a metaphor. Analysed the pigs' "solutions" to the "problem" in order to clarify some important pedagogical issues about additive problem solving. This issue is related to problem-representation or formulation skills.

Polotskaia, E., Savard, A. & Freiman, V. (2015). Duality of mathematical thinking when making sense of simple word problems: Theoretical essay. *Eurasia Journal of Mathematics, Science & Technology Education, 11,* 251-261. [E] "This essay proposes a reflection on the learning difficulties and teaching approaches associated with word problem solving. We question the development of word problem solving skills in the early grades of elementary school. We are trying to revive the discussion for two reasons. First, the knowledge in question—reversibility of arithmetic operations and flexibility of mathematical thinking—is the key element in elementary mathematics. Second, we hope to create a shift in the understanding of this knowledge development in students. Using the folk tale "The Three Little Pigs" as a metaphor, we analyze difficulties students experience while learning to solve word problems involving addition and subtraction. We formulate a hypothesis about the cognitive duality of word problem solving. This hypothesis explains a number of well-known learning difficulties and suggests teaching principles that could help avoid developmental obstacles and pitfalls within the teaching/learning process."

Polotskaia, E., Savard, A. & Freiman, V. (2016). Investigating a case of hidden misinterpretations of an additive word problem: Structural substitution. *European Journal of Psychology of Education*, 31(2), 135-153. [E] "We have studied how and why elementary school students misinterpret the mathematical structure of a simple additive word problem and what kind of possible (hidden) misinterpretation may occur. We analysed possible mechanisms of misinterpretations in word problem solving, discussing various examples of correct and incorrect solutions resulting from the misinterpretation of a problem. We gave the elementary school students a word problem, which could potentially be misinterpreted, and observed their solving strategies. Our results show how the particular form of mathematical misinterpretation--structure substitution--may help students obtain a correct answer and thereby hinder the development of their mathematical reasoning. We further discuss different ways of addressing this phenomenon in teaching practice."

Redden [now Ritchie], K. C., Simon, R. A., & Aulls, M. W. (2007). Alignment in constructivist-oriented teacher education: Identifying pre-service teacher characteristics and associated learning outcomes. *Teacher Education Quarterly, 34*(3), 149-174. http://search.proquest.com/docview/222853509?accountid=12339 [H] Students who attributed responsibility for learning to both the professor and students understood and applied course content more than those who attributed responsibility to either solely the professor or student on measures of understanding and application. Supports the idea of coconstruction.

Reid, D., Simmt, E., Savard, A., Suurtaam, C., Manuel, D., Lin, T. W. J., Quigley, B., & Knipping, C. (2015). Observing observers: Using video to prompt and record reflections on teachers' pedagogies in regions of Canada. *Research in Comparative and International Education, 10,* 367-382. [E, S, H] "Regional differences in performance in mathematics across Canada prompted us to conduct a comparative study of middle-school mathematics pedagogy in four regions. We built on the work of Tobin, using a theoretical framework derived from the work of Maturana. In this paper, we describe the use of video as part of the methodology used. We used videos of teaching activities as prompts for discussions among teachers and the video recordings of such

discussions became the data sources for our comparative research. Our use of video revealed a number of advantages and disadvantages which influenced the research."

Ritchie, K. C., Shore, B. M., LaBanca, F., & Newman, A. (2011). The impact of emotions on divergent thinking processes: A consideration for inquiry-oriented teachers. *LEARNing Landscapes, 5*(1), 211-225. [E, S] Divergent thinking is a key component to creativity, and learning processes that we aim for in inquiry approaches to teaching and learning. A review of theory and existing research that explains the role of emotions in divergent-thinking processes.

Robinson, A., Shore, B. M., & Enersen, D. L. (2006). *Best practices in gifted education: An evidence-based guide.* Waco, TX: Prufrock Press (jointly published as a Service Publication of the National Association for Gifted Children, Washington, DC). [E, S] Includes a chapter historically linking gifted-education models with inquiry-based models and social constructivism. [Second edition in preparation by Robinson, Jolly, Shore, & Enersen]

Sagel, F., & Shore, B. M. (2004). *Report on the Workgroup of the Applicability of the Boyer Report at McGill University.* Montreal QC: Senate Committee on Teaching and Learning (Document TL. 04-05-20). [H] The Boyer Report provides several ideas for implementing inquiry-based learning experiences in undergraduate programs and teaching, but they have proven challenging to implement.

Saunders-Stewart, K., Gyles, P. D. T., & Shore, B. M. (2012). Student outcomes in inquiry instruction: A literature-derived inventory. *Journal of Advanced Academics, 23,* 5-31. doi:10.1177/1932202X11429860 [E, S] Through a criterion-referenced literature search, a list of 23 main inquiry outcomes in inquiry (MISIO) was identified for students. Some items included sub-items and prompts. This checklist became the basis of other tools (MISIO-S, MISIO-T, and MCLIC).

Saunders-Stewart, K. S., Gyles, P. D. T., Shore, B. M., & Bracewell, R. J. (2015). Student outcomes in inquiry: Students' perspectives. *Learning Environments Research, 18,* 289-311. doi:10.1007/s10984-015-9185-2 [S] Inquiry provides optimal conditions for students to achieve outcomes less likely to be found in a more traditional classroom, for

example, learning competencies, personal motivation, and increased responsibility for their own learning, and to engage less in such outcomes as memorization out of a larger context. Consistent with social-constructivist theory.

Saunders-Stewart, K. S., Walker, C. L., & Shore, B. M. (2013). How do parents and teachers of gifted students perceive group work in classrooms? *Gifted and Talented International, 28*(1-2), 99-106. [E] Parents and teachers disagreed about the importance of sharing results and working collaboratively, but largely agree in their understanding of what inquiry is. The former is a potential barrier to successful student engagement in inquiry instruction. Seems to support concerns about "free-rider" effects--an issue raised elsewhere.

Savard, A. (2014a). Developing probabilistic thinking: What about people's conceptions? In E. J. Chernoff & B. Sriraman (Eds.), *Probabilistic thinking: Presenting plural perspectives* (pp. 283-298). Berlin, Germany: Springer. [E, S] "Since the important work on reasoning under uncertainty by Kahneman and Tversky in the 1970s, the description of how people think about probability by using intuitions, conceptions and misconceptions [has] been studied in psychology and mathematics education. Over the years, the body of literature [has] identified and studied many of them. But not all of the conceptions have been studied many times and the conceptions presented in the literature don't relate them to each other. Therefore, it is now difficult to have a broader perspective on people['s] conceptions of probability. In addition to that, some epistemological differences exist between the conceptions. Not all of them use thee same kind of reasoning for addressing different aspects of probability. Thus, a broader perspective of people['s] conceptions of probability involves not only knowing about conceptions and links them together; it also includes knowing about the mathematical concept involved."

Savard, A. (2014b). Enseigner à enseigner: Regards croisés sur l'épistémologie et le rapport à l'apprendre d'une professeure. In M.-C. Bernard, A. Savard & C. Beaucher (dir.), *Le rapport aux savoirs : une clé pour analyser les épistémologies enseignantes et les pratiques de classe* (pp. 78-92). Québec, QC, Canada: Livres en ligne du CRIRES. Available from http://lel.crires.ulaval.ca/public/le_rapport_aux_savoirs.pdf [H] This

reflective self-study, in the course of the author's professional practice, revealed different types of knowledge related to her epistemological stance. These types of knowledge were linked to three components of identity: sense of direction, value, and the learning project. The learner can be seen as a cartographer planning a voyage. There are different epistemologies related to different kinds of learning.

Savard, A. (2014c). Transition between university students to teachers: Practice in the middle. *Canadian Journal of Science, Mathematics and Technology Education, 14,* 359-370. [H] This article presents a study done in an elementary mathematics methods course that focused on the transition of novice teachers' epistemological stances: former elementary student, university student, and teacher stances. In order to help them develop the teacher stance, we designed a three-phase activity, where two phases took place inside class and the last one occurred outside of class. Novice teachers were given an assignment where they had to rehearse a count in class and enact it in front of a small group of students. They had to write reflections on their rehearsal and enactment. Interviews were done 4 months after the end of the course. The results show that the reflections about mathematics in relation to the use of new teaching practices on eliciting students' thinking allowed the novice teachers to develop the teacher stance.

Savard, A., & Corbin, N. (2012). La communauté d'apprentissage professionnelle comme dispositif d'implantation de la démarche d'investigation en science et technologie au primaire. *Revue Canadienne de l'éducation, 35,* 355-378. (http://www.cje-rce.ca/index.php/cje-rce/article/view/1288) ISSN 1918-5979 [E] This article presents the results of a study on the introduction of the inquiry process in science and technology in an elementary school in Quebec. A professional learning community was created to facilitate implementation. The three dimensions of the professional learning community-- cognitive, emotional and ideological--were pooled with the eight principles characterizing the winning conditions of teachers' professional development. Constraining and facilitating conditions that affect the implementation of this inquiry-based approach will were presented for each of the eight principles.

Savard, A., & DeBlois, L. (2013). Enumerating all possible outcomes: An analysis of students' work. *Scientia in Educatione, 4*(1), 49-62.

http://www.scied.cz/Default.aspx?PorZobr=1&PolozkaID=134&ClanekID=359 [E] "A variety of contexts in the learning of probability could provide opportunities for students to reason under uncertainty. This kind of reasoning could support students to develop critical thinking practices. This paper presents a study on how children in a grade four classroom developed strategies about enumeration of combinatorics using critical thinking. A preservice teacher taught those students and the analysis of their work showed the procedures they used. Then, these results emerge from a secondary analysis. . . . students need opportunities to develop increasingly sophisticated methods of reasoning probabilistically. . . . critical thinking is both necessary to develop these modes of reasoning and is developed through this work."

Savard, A., & Freiman, V. (2016). Investigating complexity to assess student learning from a robotics-based task. *Digital Experiences in Mathematics Education, 2,* 93-114. [E, S] "While robotics is becoming a popular tool to introduce an integrated STEM curriculum into both, elementary and secondary schools, its impact on students' learning remains underexplored. This article addresses the complexity of assessing mathematics learning within a robotics-based task by identifying the different types of knowledge and processes related to digital, mathematical and sociocultural contexts inherent in robotics-based learning. We also studied the ways students interpreted the feedback received when performing an assessment task. In the context of the Innovative Learning Agenda implemented in New Brunswick schools, one team of Grade 5–6 students and one team of Grade 6–7 students were asked to perform a robotics-based assessment task. Analysis of students' performance within this task showed that the interpretation of feedback that students make leads them to think and to act differently when solving different challenges that arise during their work on the assessment task. The identification of this variety may help teachers in dealing with complexity related to this kind of assessment."

Savard, A., Lin, T. W. J., & Lamb, N. (2017). Pre-service elementary school teachers becoming mathematics teachers: Their participation in an online professional community. *Journal of Education and Learning, 6*(1), 41-53. [E, H] "Pre-service teachers struggle to shed their student-perspective as they transition from theory to practice. This was readily

evident in how they used their mathematical knowledge for teaching in their online exchange. Our work contributes to understanding the complexity of becoming a mathematics teacher in elementary school."

Savard, A. & Manuel, D. (2016). Teaching statistics in middle school mathematics classrooms: Creating an intersection for intra and interdisciplinarity. *Statistics Education Research Journal, 15*(2), 239-256. [E, S] "Statistics is a domain that is taught in Mathematics in all school levels. We suggest a potential in using an interdisciplinary approach with this concept. Thus the development of the understanding of a situation might mean to use both mathematical and statistical reasoning. In this paper, we present two case studies [in which] two middle school Mathematics teachers taught a lesson in Statistics [in which] the students had the task [to] create a pie graph representing the data. . . . Their procedural vision of Statistics lead them to focus more on a graphical representation and thus led to avoid all statistical reasoning development (Garfield, 2002)."

Savard, A., & Polotskaia. E. (2014). Gérer l'accès aux mathématiques dans la résolution de problèmes textuels: du côté de l'enseignement primaire. *Éducation et Francophonie, 17,* 140-159. [E] This article presents the management of mathematics accessibility in solving word problems that contain additive structures created by grades 1 and 2 teachers. Teachers assign multiple roles to solving these problems and the educational actions they pose geared to these roles can negatively affect this access. To equip them to recognize the roles they assign and their effects on the students' access to mathematics, and to support them in modifying these roles to improve their classroom interventions, we developed a training activity on the analysis and representation of additive structures in word problems.

Savard, A., & Polotskaia, E. (2017). Who's wrong? Tasks fostering understanding of mathematical relationships in word problems in elementary students. *ZDM Mathematics Education, 49,* 823-833. [E] "Mathematical relationships are crucial elements to consider for learning mathematics. However, too often students pay more attention to the calculations to be done rather than the reasons for doing them. Relying on the relational paradigm to support elementary school students, we proposed two

specially designed tasks to help students recognize and formalize the relationships in additive and multiplicative word problems. These tasks were also designed to have them learn how to represent the relationships using models and to manipulate the mathematical structure of a problem to find the required arithmetic operation. In this paper, we present the task design principles to create mathematically incoherent situation (MIS) tasks and we highlight their implementation with elementary school students. Our findings suggest that students working on MIS tasks really engage in the analysis of the mathematical relationships, which corresponds to the teacher's intentions in problem-solving activities."

Shore, B. M. (2000). Metacognition and flexibility: Qualitative differences in how the gifted think. In R. C. Friedman & B. M. Shore (Eds.), *Talents unfolding: Cognition and development* (pp. 167-187). Washington, DC: American Psychological Association. http://dx.doi.org/10.1037/10373-008 [E, S] Summary of emerging expertise-based, inquiry-related understanding of thinking processes in gifted students.

Shore, B. M. (2009). Giftedness is not what it used to be, school is not what it used to be, their future, and why psychologists in education should care. *Canadian Journal of School Psychology, 20*(10), 1-19. doi:10.1177/0829573509356896 [E, S, H] Overview of pedagogical changes arising from the fact that instruction has started to move from direct teaching toward inquiry, and theory is certainly pulling in that direction. Implications for school psychologists advising teachers because in inquiry there may be a need to redefine what is maladaptive in classrooms.

Shore, B. M. (2010). Giftedness, inquiry, and expertise: Leading with new connections. In *Multicultural and gifted education in Canada: Insights for strategies and policies of Korean education--Proceedings of the biennial meeting of the Korean Association for Canadian Studies* (pp. 52-68). Seoul, Korea: Korean Association for Canadian Studies and Chung-Ang University College of Education and Research Institute of Korean Education. [E, S] Overview of pedagogical changes arising from the fact that instruction has started to move from direct teaching toward inquiry, and theory is certainly pulling in that direction.

Shore, B. M. (2014). *The graduate advisor handbook: A student-centered approach.* Chicago, IL: The University of Chicago Press (in the series *Chicago Guides to Academic Life*). doi:10.7208/chicago/9780226011783.001.0001; ISBN-13: 978-0-226-01150-9 (cloth), ISBN-13: 978-0-226-01164-6 (paper), ISBN-13: 978-0-226-01178-3 (e-book) [H] This book emphasizes that inquiry in higher education is a collaborative effort and therefore the interpersonal interactions between instructors and learners are a critical part of the success of helping students become inquirers. It also addresses core topics such as student interests, but this is not as much emphasized an element as the preceding.

Shore, B. M. (2017). Foreword. In G. Kidman & N. Casinader, *Inquiry-based teaching and learning across disciplines: Comparative theory and practice in schools* (pp. vii-ix). Basingstoke, England: Palgrave Macmillan. [E, S] "A quick look at international comparisons of educational accomplishment reveals that, with few exceptions, top-performing jurisdictions have implemented inquiry-based education. Inquiry is not easy for policy makers, curriculum designers, educational administrators, teachers, or learners. It requires intensive knowledge of pedagogy and knowledge creation within and across disciplines, and development of children's abilities, concepts, motivation, and autonomy."

Shore, B. M., Aulls, M. W., & Delcourt, M. A. B. (Eds.). (2008). *Inquiry in education (Vol. II): Overcoming barriers to successful implementation.* New York, NY: Erlbaum (now Routledge). [E, S] Inquiry teaching is complex but worth the effort. The book gives several diverse examples of barriers and facilitators to making inquiry happen in learning.

Shore, B. M., Birlean, C., Walker, C. L., Ritchie, K. C., LaBanca, F., & Aulls, M. W. (2009). Inquiry literacy: A proposal for a neologism. *LEARNing Landscapes, 3*(1), 139-155. (available on-line at http://www.learninglandscapes.ca) [E, S] "Literacy definitions, the growth of inquiry literacy in science education, and the developmental nature of inquiry literacy within learners' experiences in diverse content domains are outlined. . . . A preliminary list of qualities of student inquiry literacy is presented."

Shore, B. M., & Chichekian, T. (2011). *Educational Psychology (EDPE 300) instructors' handbook 2011-2012.* Montreal, QC: Department of Educational and Counselling

Psychology, McGill University. (39 pp.) [H] Social constructivism can be widely adopted and practiced in an undergraduate class. This handbook provides examples for a full introductory course in educational psychology.

Shore, B. M., Chichekian, T., Gyles, P. D. T., & Walker, C. L. (accepted for publication). Friendships of gifted children and youth: Updated insights and understanding. In B. Wallace, J. Senior, & D. A. Sisk (Eds.), *SAGE handbook on gifted education.* London, England: SAGE. [E, S, H] This chapter summarized several conference presentations and prior articles, plus new data from a university sample of Golden Key International Honour Society members. "The literature on gifted children and youth for nearly a century has suggested that highly able young people tend to be loners. Some research noted that their favored friendships are often with older children, whereas other research suggested a pattern of asynchronous development in which areas such as social-emotional competence might develop more slowly than cognitive abilities. This chapter proposes that gifted young people's friendships cannot be so simply described. They welcome and enjoy friendships in patterns somewhat different from those experienced by other children. They differ in the number of pillars supporting stable and quality friendships, actual and preferred numbers of friends, and the qualities they seek in their friends. Numbers of friends do increase at university, and social-emotional contributions are most often cited as the foundations of their friendships. They also welcome friendly competition."

Shore, B. M., Chichekian, T., Syer, C. A., Aulls, M. W., & Frederiksen, C. H. (2012). Planning, enactment, and reflection in inquiry-based learning: Validating the McGill Strategic Demands of Inquiry Questionnaire. *International Journal of Science and Mathematics Education, 10,* 315-337. doi:10.1007/s10763-011-9301-4 [H] Publication version of part of Cassidy Syer's PhD thesis. Groups that "had different types of exposure to the inquiry approach varied in how they understand inquiry instruction. Fourth-year Elementary preservice teachers held more sophisticated conceptualizations of the inquiry approach and greater appreciation for the components involved in carrying out an inquiry curriculum compared to first-year Elementary preservice teachers. After the completion of an inquiry-oriented course, Continuing Education students (including experienced

teachers) were similar to fourth-year Elementary student teachers in conceptualizing and identifying important components of inquiry instruction. First-year Elementary and Secondary student teachers were different in their views of inquiry instruction. Finally, Honours Psychology students, who were engaged in scholarly research, held sophisticated conceptualizations of the inquiry approach. However, they did not use this knowledge of the inquiry method as extensively as fourth-year preservice teachers to identify important aspects of inquiry instruction. Therefore, although experience with the inquiry method may be necessary for conceptualizing inquiry as a pedagogical approach, it is not sufficient to enable undergraduates to identify important aspects of planning, enacting, and evaluating an inquiry curriculum." Includes validation study of the MSDIQ, *McGill Strategic Demands of Inquiry Questionnaire*.

Shore, B. M., & Delcourt, M. A. B. (1996). Effective curricular and program practices in gifted education and their interface with general education. *Journal for the Education of the Gifted, 20,* 138-154. [E, S] Gifted education and inquiry-based practices share several pedagogical priorities.

Shore, B. M., Delcourt, M. A. B., Syer, C. A., & Schapiro, M. (2008). The phantom of the science fair. In B. M. Shore, M. W. Aulls, & M. A. B. Delcourt (Eds.), *Inquiry in education (vol. II): Overcoming barriers to successful implementation* (pp. 83-118). New York, NY: Erlbaum (Routledge). [S] As many as 25% of students cheat in science fairs, and they do so for the same reasons as "real" scientists cheat--limited resources including time, and the pressure for recognition (whether grades or publications). Inquiry projects need to be scaffolded in time, resources, and help, as well as careful joint progress monitoring by teachers and students.

Shore, B. M., & Gube, M. (2018). A historical overview of instructional theory and practice in the USA and Canada: The double Slinky phenomenon in gifted and general Education. In S. Pfeiffer, E. Shaunessy-Dedrick, & M. Foley Nicpon (Eds.), *APA handbook of giftedness and talent* (pp. 39-54). Washington, DC: American Psychological Association. http://dx.doi.org/10.1037/0000038-003 [E, S] Pedagogy in gifted education had a head start over general education in incorporating inquiry-based instruction, but not everywhere and not consistently, especially due to poor alignment with identification.

(Published in 2017 with a 2018 imprint.)

Shore, B. M., & Irving, J. A. (2005). Inquiry as a pedagogical link between expertise and giftedness: The High Ability and Inquiry Research Group at McGill University. *Gifted and Talented International, 20,* 37-40. [E, S] Inquiry is a pedagogical link between expertise and giftedness; both can be learned and taught to some degree.

Shore, B. M., Pinker, S., & Bates, M. (1990). Research as a model for university teaching. *Higher Education, 19*(1), 21-35. [H] Disciplines vary in the extent to which core teaching practices bring learners into contact with core inquiry practices in scholarly work.

Shore, B. M., Rejskind, F. G., & Kanevsky, L. S. (2003). Cognitive research on giftedness: A window on creativity. In D. C. Ambrose, L. Cohen, & A. J. Tannenbaum (Eds.), *Creative intelligence: Toward theoretic integration* (pp. 181-210). New York, NY: Hampton Press. [E, S] Theoretical overview of how linking expertise- and inquiry-based conceptions of giftedness provide a vehicle for integrating creativity as part of the definition of giftedness.

Slapcoff, M., Dobler, E., Tovar, M. (Eds.), Chromik, R., Cossette, I., Ellis, J., Fallon, K.M., Fitzgibbons,M., Harris, D., Hébert, T., Laver, S., McCourt, G., Radziszewski, P., Ragsdale, D. & Savard, A. (Contributors). (2011). *Using coursework to enhance students' understanding of research/scholarship. A report from the Inquiry Network.* Montreal, QC: McGill University, Teaching and Learning Services. http://www.mcgill.ca/tls/files/tls/slapcoff_et_al_using_coursework_to_enhance_students_understanding_0.pdf [H] "This report identifies ways in which instructors can use coursework to cultivate students' understanding of research regardless of discipline, academic level, or class size. It provides . . . examples from ten instructors in the Inquiry Network who have developed an aspect of an undergraduate course to enhance students' learning about and engagement in research" (p. 3). It also made 3 general conclusions: (a) "Integrating research into coursework is an effective means of communicating to students the value of attending a research-intensive university while improving student engagement and learning. Accordingly, identifying instructors who already integrate

research into their teaching and sharing their examples is an important to support institutional learning"; (b) "The means by which an understanding of research can be promoted within undergraduate coursework are various and will be influenced by factors such as discipline, academic level, class size, and students' background knowledge"; (c) "Determining how to integrate research into coursework is a complex process and thus requires that instructors have the time and support necessary for designing or redesigning their courses in ways that promote meaningful student learning. This support can take many forms, but to be most effective, it must include opportunities for reflection and cross-disciplinary dialogue and be reflected in policies and practices at the departmental, Faculty, and institutional levels" (p. 4).

Sobhanzadeh, M., Kalman, C. S., & Thompson, R. I. (2017). Labatorials in introductory physics courses. *European Journal of Physics. 38*(6), No. 065702. https://doi.org/10.1088/1361-6404/aa8757 [H] "Traditional lab sections in introductory physics courses at Mount Royal University were replaced by a new style of lab called 'labatorials' developed by the Physics Education Development Group at the University of Calgary. Using labatorials in introductory physics courses has lowered student anxiety and strengthened student engagement in lab sessions. Labatorials provide instant feedback to the students and instructors. Interviews with students who had completed Introductory Physics labatorials as well as the anonymous comments left by them showed that labatorials have improved student satisfaction. Students improved their understanding of concepts compared to students who had taken traditional labs in earlier years. Moreover a combination of labatorials and reflective writing can promote positive change in students' epistemological beliefs."

Syer, C. A., Chichekian, T., Shore, B. M., & Aulls, M. W. (2013). Learning "to do" and learning "about" inquiry at the same time: Different outcomes in valuing the importance of various intellectual tasks in planning, enacting, and evaluating an inquiry curriculum. *Instructional Science, 41,* 521-537. doi:10.1007/s11251-012-9242-5 (available online at http://www.springerlink.com/openurl.asp?genre=article&id=doi:10.1007/s11251-012-924) [H] Senior student teachers who learned about inquiry as pedagogy (albeit mostly in procedural terms as shown in other studies in this list) had comparable understanding

of the importance of inquiry tasks compared to psychology students who had done an honors thesis or major project. The student-teachers could also better articulate how to help others undertake inquiry. Merely having done inquiry is insufficient to being able to teach through inquiry. The study included material relevant to validation of the MSDIQ that was later adapted to measure self-efficacy as well (by Chichekian, Getahun, Ibrahim, and D. Leung).

Syer, C. A., Jad-Moussa, R., Pelletier, S., & Shore, B. M. (2003). Adaptive-creative versus routine-reproductive expertise in hypermedia design: An exploratory study. *Cognition, Technology and Work, 5*(2), 94-106. doi:10.1007/s10111-002-0106-7 [H] Part of the process of linking high ability through expertise (that included processes noted in inquiry) and creativity, this distinction was visible in the work of three hypermedia designers.

Syer, C. A., & Shore, B. M. (2001). Science fairs: Sources of help for students and the prevalence of cheating. *School Science and Mathematics, 101,* 206-220. doi:10.1111/j.1949-8594.2001.tb18023.x [S] As many as 25% of students may be cheating in science fairs by obtaining excessive help, copying projects, etc. Students reported that the undertakings were often beyond their abilities to do independently and they were not being able to get the help (or scaffolding) they sought from teachers. The lack of resources and time that students cite reflect the reasons adult scientists offer for their cheating.

Tabatabai, D., & Shore, B. M. (2005). How experts and novices search the Web. *Library and Information Science Research, 27,* 222-248. doi:10.1016/j.lisr.2005.01.005 [H] The most significant differences in patterns of search between novices and experts were found in the cognitive, metacognitive, and prior-knowledge strategies. Survival analysis revealed specific actions associated with success in Web searching: (a) using clear criteria to evaluate sites, (b) not excessively navigating, (c) reflecting on strategies and monitoring progress, (d) having background knowledge about information seeking, and (e) approaching the search with a positive attitude.

Walker, C. L., & Shore, B. M. (2012). Five gifted ways to lose your creative intelligence. In D.

Ambrose & R. J. Sternberg (Eds.), *How dogmatic beliefs harm creativity and higher-level thinking* (pp. 171-184). New York, NY: Routledge. ISBN-978-0-4158-9460-9 [E, S] Overview of how dogmatic thinking can interfere with metacognition, superior perspective taking, interconnected knowledge base, preference for complexity, and flexibility--qualities of creative intelligence and inquiry-based learning.

Walker, C. L., & Shore, B. M. (2015a). Myth busting: Do high-performing students prefer working alone? *Gifted and Talented International, 30,* 85-105. http://dx.doi.org/10.1080/15332276.2015.1137461 [E] In general, high-performing (HP) students do not prefer to work alone; in only one case (easily-completed assignments) was this choice most preferred; notably, average performers do the same. Some conditions were low-stake (e.g., not counting for marks, classmate-marked, self-marked, easy, fun, boring), whereas others were high-stake (e.g., difficult but interesting, counts for marks, teacher-marked, difficult). Fourteen items or conditions contained "Working Alone" as one of the response options to be ranked but significant differences between groups emerged on only three of these 14 conditions. HP students had significantly stronger preferences in two of these instances compared to community-school (CS) students, both related to high-stake conditions. These preferences for working alone suggest a lingering partial truth in the old assertion that gifted individuals prefer to work alone; however, there were many more instances in which HP students preferred to work with others. Effect sizes were often small, suggesting that preferences are nuanced, and care is needed to avoid over-generalizing.

Walker, C. L., & Shore, B. M. (2015b). Understanding classroom roles in inquiry education: Linking role theory and social constructivism to the concept of role diversification. *SAGE Open, 5*(4), 1-13. doi:10.1177/2158244015607584 [E, S] Role diversification in inquiry is a good fit to social-constructivist theory. These should therefore be an important part of the theory taught to teachers as they learn techniques to implement inquiry.

Walker, C. L., Shore, B. M., & French, L. R. (2011). A theoretical context for examining students' preferences across ability levels for learning alone or in groups. *High Ability Studies, 22*(1), 119-141. doi:10.1080/13598139.2011.576082 [E, S] "Through the topic of cooperative and collaborative learning, the need for refinement of definitions and

expanded methodologies is identified. Past research has . . . often ignored contextual variables, and has been limited by the use of forced-choice survey data. Research that adopts a social learning or social constructivist theoretical framework can help to overcome some of these limitations by considering the context of the learning environment, and taking into account individual differences."

Walker, C. L., Shore, B. M., & Tabatabai, D. (2013). Eye of the beholder: Investigating the interplay between inquiry role diversification and social perspective taking. *International Journal of Educational Psychology, 2,* 144-192. doi.org/10.4471/ijep.2013.23 [E, S] Social perspective-taking roles were dynamic and susceptible to influences including the nature of the classroom activities and instructional choices, student personality differences, and group-work dynamics. Students active in choosing their work partners and who were assigned a task that required a consideration of the audience's understanding tended to adopt more Imagine Other roles as opposed to Imagine Self roles and also adopted more emotionally-based SPTs compared to students in teacher-formed groups who were assigned more cognitively-based assignments.

Wang, X., & Kalman C. [S.] (2014). Improving the way students understand their knowledge of physics. *Physics in Canada, 70*(2), 78-80. [H] "Students' beliefs about the nature of knowledge and knowing (i.e., epistemic beliefs) in physics have important effects on how they learn physics, and thus three learning activities were designed and implemented to advance students' epistemic beliefs in a physics gateway course." Part of what needs to be addressed in making inquiry happen in classrooms, in addition to teachers' content knowledge, inquiry pedagogical knowledge, self-efficacy, etc.

Wang, X., Saroyan, A., & Aulls, M. W. (2016). Epistemic dissonance encountered: Academic adaptation experiences of Chinese students in a Canadian university. In K. Bista & C. Foster (Eds.), *Global perspectives and local challenges surrounding international student mobility* (pp. 243-261). Hershey, PA: IGI Global. doi:10.4018/978-1-4666-9746-1 [H] Chinese international students experienced a rich and intense emotional life in academic as well as social settings in their initial stage of graduate studies. Most highlighted were stress, joy, and anxiety. These students were more affected by academic- and self-originated emotions rather than social-originated ones. No definitive relation was found

between students' emotional experiences and epistemic change, but self-related sources (e.g., meta-emotion) influenced both the nature of emotions that students have as well as their readiness for epistemic change. Self-related emotions may play an important role in the change process.

Woodel-Johnson, B., Delcourt, M. A. B., & Treffinger, D. J. (2012). Relationships between creative thinking and problem solving styles among secondary school students. *International Journal of Creativity and Problem Solving*, *22*(2), 79-95. [S] By understanding and developing their own creative-productive behavior, students are better prepared to think of new ideas for scientific investigations. This information is related to the development of self-regulatory behavior in adolescents, namely: forethought regarding actions, actual performance, and self-reflection after activities are completed. Students revealed insights into how they matched their interests with ideas for projects (forethought), how they carried out their investigations (performance), and what they learned from their efforts (self-reflection).

ARTICLES, CHAPTERS, BOOKS, REPORTS IN PROGRESS

Aulls, M. W., Kaur Magon, J., & Shore, B. M. (under review). What happens as inquiry in undergraduate science courses: A collective case study in search of its defining instructional practices. [Submitted in December 2017 to *FACETS*.] [H] All instructors agreed that student motivation was the most important science-instructional quality, and learning was rarely expressed as a goal. Only one of the four noninquiry science instructors claimed to actually have created a plan for the course; all three inquiry instructors planned either for the whole course or on a weekly basis in light of reflections on the previous class. All the noninquiry instructors leaned heavily upon a textbook as the primary content source. Inquiry instructors noted student responsibility for their own learning. More Inquiry courses included opportunities for dialog and discourses. All NRC Practices of Science were observed in the inquiry-approach classes but none explicitly instructed students in how to conceive or conduct original research or inquiry, even though it was a requirement in upper-years courses.

Aulls, M. W., & Shore, B. M. (in early stages of preparation). Development and initial validation

of a model of inquiry in education. [Journal to be selected.] [E, S, H] From working notes (slightly expanded): Our 4-element conceptual model usefully categorizes inquiry objectives and reflects teachers' self-perceptions as inquiry instructors in terms of process, content, strategy, and context. Preliminary analyses of school visits and teacher interviews revealed (a) the 4 elements have 2 sides: inquiry understood [itself] and taught through each; (b) an inquirer has specific knowledge, skills, and dispositions (Shore, Birlean, Walker, Ritchie, LaBanca, & Aulls, 2009) that explicitly include beliefs [link to Krista Muis]; (c) the specific tasks of doing inquiry form 3 engagement stages--planning, execution, and reflection (Shore, Chichekian, Syer, Aulls, & Frederiksen, 2012)--Ibrahim identified another engagement stage: inquiry deliberation--thinking about an inquiry question or problem and imagining outcomes, asking questions or defining the problem, and formulating hypotheses or proposing solutions; and (d) there are 4 phases--committing to, initiating, building, and sustaining inquiry as a learner, teacher, or school. The actors (students, teachers--including their past inquiry experience, etc.), discipline, and school level are important contextual variables. The phases are relevant to any publication on beginning inquiry in a school.

Birlean, C., LaBanca, F., & Shore, B. M. (in preparation). The confluence of pedagogical and content expertise: Insights from a case study of an inquiry-inspired secondary science teacher. [Journal to be selected.] [S] Expertise in the subject-matter is an important variable underlying teachers' openness and disposition to implementing inquiry instruction in their own classes. Strong subject-matter knowledge, even if not essential to the initial development of pedagogical-content knowledge, increases instructional effectiveness.

Birlean, C., & Shore, B. M. (under revision--a). Novice versus expert teachers' planning and evaluation of elementary school students' inquiry-based science projects. To be submitted to *The Science Educator*. [E] Subject-matter experts were better able to evaluate the content of science-fair projects, but teachers were better able to articulate how to elicit projects from pupils. Need both pedagogical and content knowledge (PCK).

Birlean, C., & Shore, B. M. (under revision--b). Teachers' pedagogical and subject-matter knowledge in planning and enacting science-inquiry instruction, and in assessing

students' science-inquiry learning. Revision and resubmission requested by the *Journal of Research in Science Teaching*. [E, S] Teachers with both pedagogical and content expertise were better able to plan and evaluate inquiry-based learning.

Borovay, L. A., Shore, B. M., Caccese, C., Yang, E., & Hua, O. (Liv). (advanced draft under revision pending resubmission). High and average achieving students' experiences of Flow as an outcome of engagement in inquiry-based learning. [Journal to be selected] [E, S] Csikszentmihalyi's notion of Flow is optimal when the task is well scaffolded and taps student interest, and when the difficulty level is perceived as challenging but not overpowering (as in Vygotsky's "Zone of Proximal Development). Inquiry theory could usefully include this to support teacher planning. Inquiry theory could usefully include this to support teacher planning.

Cera Guy, J. N. M. T., Williams, J. M., & Shore, B. M. (in preparation). (Working title) High and average achieving students report their anticipations about what they will experience in classroom group work. [To be submitted to *Roeper Review* as a paired article with Williams, Cera Guy, & Shore, advanced draft] [E, S] As of 2017 December 31, data had been fully coded and reduced to summary statements, but the synthesis of results was still in progress. The following statements are based on preliminary overview of the derived data, but have not been verified. All students anticipated more work, learning, issues working with others, positive social experiences and negative social experiences in group work. Both preferred one working partner to large groups and being able to choose their group-work partners. Some members of both groups imagined the teaching walking around the classroom giving advice and feedback, but more of the lower-achieving students saw the teacher working at his or her desk taking a less active role in instruction. The high achieving students anticipated group work more often. High group more often expresses the expectation (concern) that they will have to devote attention, energy, or time to keeping the group on task or not being distracted. Being Kind is an anticipated outcome more (but not exclusively) by the Average and Lower Achieving group. The lower achieving group more often anticipated negative social effects working in a group. Only some of the higher achievers mentioned the impact people can have on the success of group work. More of the high achievers anticipated themselves working well with

others.

Chevalier, T., Deacon, H., Parilla, R., & Ritchie, K. C. (under revision). The role of metacognitive reading, study, and learning strategies, and behavioral strategies in predicting academic success in students with and without a history of reading difficulties. *Journal of Learning Disabilities.* [H] Comparing study and reading strategies of first-year university students who did versus did not have a history of reading difficulties, the profile of strategies used most often are different, and the most effective strategies (as defined by significantly predicting GPA) were different for these two groups of students.

Chichekian, T., & Shore, B. M. (in preparation). Early signs of inquiry in first-year teachers' classrooms (working title). [Journal to be selected; possibly *Journal of Expertise*] [E, S, H] No abstract or summary yet; these notes are edited excerpts from Tanya Chichekian's PhD dissertation. This longitudinal study tracked changes in self-efficacy for teaching with inquiry during the first year of professional practice and how that is reflected in first-year teachers' conceptualizations of inquiry as well as in their enactment. Variability in students' interest in the subject, their academic abilities, as well as students' role in the classroom (including interacting with the teacher) raised doubts among first-year teachers about the feasibility of this instructional approach and decreased their self-efficacy for using inquiry in the classroom across their first year of teaching. Four of the six started with lower self-efficacy than at the end of their teacher education months earlier; two had equal levels. All six teachers began the school year with enthusiasm and a high self-efficacy for inquiry-based instruction, but their willingness began to fade mainly as a result of an increased responsibility for taking on more teaching tasks, but also because of students' resistance to new methods of instruction, lack of time to cover course material, evaluation, and other teachers' reactions to using inquiry approaches. On the other hand, classroom observations revealed an increasing frequency of elements of inquiry instruction, but mostly among the more basic inquiry steps. In short, persistence in teaching behavior was observed despite dropping self efficacy. Self-efficacy alone is not a sufficient predictor of new teachers' inquiry enactment.

Delcourt, M. A. B., & Carkner, P. A. (under revision in preparation for resubmission). Student

and teacher participation in an inquiry-oriented learning program. To be resubmitted to *Roeper Review*. [E, S] In an inquiry-oriented curriculum in a four-week summer program [Explorations at McGill]: (a) Numbers of teachers and students questions tapered off over time [perhaps the students were busy on their projects], (b) teachers consistently asked more questions than students over time, (c) the two teachers' styles of participation within the inquiry groups were different from each other, (d) teachers' and students' knowledge about research increased, (e) personal interest was influential in pursuing a research project, and (f) participants reported that certain new skills were gained while others were improved. Inquiry exposure impacts attitudes as well as knowledge and skills. It is also possible that the teachers were not well trained in inquiry but were enacting an inquiry curriculum to the best of their ability.

El Helou, J., & Kalman, C. S. (in preparation). *Reflective writing for a better understanding of scientific concepts in high school.* To be submitted to *The Physics Teacher*. [S] From the thesis: "This study evaluates the impact reflective writing has on high school students' understanding of scientific concepts and their attitudes and opinions toward learning science. Reflective writing is a part of the writing-to-learn movement (Connolly, 1989), the aim of which is to incorporate informal writing into all disciplines. Reflective writing is a hermeneutic process during which a student writes, metacognitively on a paper, his or her ideas about a specific scientific topic, in an informal manner. The research done on the use and impact of Reflective Writing involved post-secondary students. This study aims to shed light on how reflective writing affects high school students' understanding of science. Participants in this study are high school students, from a Montreal school, who were asked to complete reflective writing tasks as a part of their science course work. Their writings are analyzed and compared to their attitudes and opinions toward the subject as probed by interviews conducted towards the end of the course." It led to improved understanding of scientific concepts.

Gyles, P. D. T., & Shore, B. M. (completed draft under revision). Mindsets, mastery, and inquiry: A framework for examining development of implicit theories in educational contexts. Revision and resubmission requested by *Educational Psychology Review.* [E, S] Learners with growth mindsets tend to adopt mastery goals and believe their abilities

can be learned and developed, employing effortful learning and persisting in the face of challenge. Student-centered, interest-driven, collaborative, project-based learning, in which students have opportunities to pursue in-depth investigations of questions of interest with scaffolded, core principles of inquiry-based teaching and learning practices, are well aligned in classroom structures that promote mastery mindsets.

Gyles, P. D. T., Shore, B. M., & Hoover, M. L. (advanced draft in preparation). Mindsets, mastery, and inquiry: Classroom impact on students' achievement goals. [Journal to be selected.] [E. S] This paper tested the hypothesis that inquiry-based classrooms may be a context in which to promote the adoption of mastery goals and incremental theories: (a) Do students' implicit theories differ in guided-inquiry versus teacher-structured learning environments? Are implicit theory and instructional setting correlated to one another? (b) Are students in inquiry settings more likely to hold mastery-goal orientations? Is there an additive or interactive effect of instructional style and implicit theory on achievement goals? (c) How are instruction and implicit theory related to learning strategies and achievement emotions and behaviors? High-school students sampled from highly inquiry-based classrooms and comparison teacher-structured classes with lower inquiry use were given questionnaires assessing their implicit theories and related variables. Students were interviewed about what motivated them in their classes to determine if there were significant differences in reported achievement goals or measured implicit theories between the instructional groups. As hypothesized based on theory and past research, inquiry instruction and incremental theories of ability predicted student motivation and reports of mastery goals.

Hua, O., Ibrahim, A., & Shore, B. M. (data collected). Alignment of intent between presenters and attendees at a professional development workshop for teachers. [Journal to be selected.] [H] This study explored the alignment between the training objectives of the workshop presenters and the learning objectives of the teachers. The topic was building inquiry into classroom teaching. The data used tailor-made evaluations completed by the participants and have not yet been analyzed.

Hua, O. (Liv), Yang, E., & Shore, B. M. (data collected). Thirty-year follow-up of the evolution of teaching conceptualizations in a university chemistry department in relation to the

teaching-research nexus. [Journal to be selected] [H] Initial impressions from the interviews indicated limited awareness of Boyer report, more awareness of teaching-research nexus, some progress toward beginnings of inquiry in undergraduate classes. Subsets of the questions were analyzed and reported in Chichekian, Hua, and Shore (in press), and Hua and Shore (2014). Hua (2008; thesis) contains the full interview questionnaire on pp. 51-53). Shore, Pinker, and Bates (1990) sampled 18 different disciplines then replicated the first study with nearly every member of the English and Chemistry departments at a major research university. The latest studies focused on the same Chemistry department more than three decades later. Data for most of the questions are still being analyzed. The 1990 and current questionnaires are closely parallel but not identical, however they are similar enough to make a 30-year comparison in support of the validation of the McSPARTN instrument and describing how the research-teaching nexus has (or has not) changed in one department that has over this extended time period regarded both teaching and research as important. The question of interest is how well teaching and research are linked in the professors' articulations of the two processes.

Ibrahim, A., Aulls, M. W., & Shore, B. M. (in preparation--a). Working title: Undergraduate education students' self-efficacy regarding teachers' roles, students' personalities, and practices of education in educational inquiry: Development and validation of the McGill Self-Efficacy of Learners' Inquiry Engagement Survey (McSELFIE) in Education. [Journal to be selected.] [H] Final not yet available. Addresses inquiry Self-Efficacy for university-level learners, but likely useful at other levels of education. Based on an MSDIQ subset covering all three planning, enactment, and reflection phases, with an initial validation samples in science, using self-efficacy perspective. The new factor analysis revealed a fourth phase, Deliberation, that precedes the framework used in the MSDIQ and from which was sampled for the MEIQ-SET (enactment only). (Compare with MCSESILT and MEIT-SET.)

Ibrahim, A., Aulls, M. W., & Shore, B. M. (in preparation--b). Working title: New insights from comparing undergraduate science and engineering students' and undergraduate education students' ratings of the importance of teachers' roles, students' personalities, and inquiry

practices (factorial comparison within and between attainment value for STEM and education). [Journal to be selected.] [H] Abstract not yet available. (This is the paper that will also reveal the deliberation phase that occurs before planning, enactment, and reflection.)

Ibrahim, A., Aulls, M. W., & Shore, B. M. (in preparation--c). Working title: New insights from comparing undergraduate education and undergraduate science and engineering students' self-efficacy with regard to teachers' roles, students' inquiry personalities, and inquiry practices (factorial comparison within and between self-efficacy for STEM and education). [Journal to be selected.] [H] Through the lens of self-efficacy, found a fourth and front-end phase of inquiry: "self-efficacy for inquiry deliberation [new], [then] self-efficacy for inquiry planning, self-efficacy for inquiry enactment, and self-efficacy for inquiry reflection. Self-efficacy for inquiry deliberation is composed of thinking about an inquiry question or problem and imagining outcomes, asking questions or defining the problem, and formulating hypotheses or proposing solutions."

Ibrahim, A., Aulls, M. W., & Shore, B. M. (in preparation--d). Working title: New insights from comparing undergraduate science and engineering students' and education students' ratings of the importance versus self-efficacy regarding teachers' roles, students' personalities, and practices of science in scientific inquiry (factorial comparison of attainment value and self-efficacy for STEM and education). [Journal to be selected.] [H] Abstract not yet available.

Kaur Magon, J., Aulls, M. W., & Shore, B. M. (in early preparation--data collected). Case study of the theoretical and practical implementation of inquiry-based teaching and learning in an undergraduate teacher-education course. [Journal to be selected.] [H] Social constructivism can be widely adopted in an undergraduate class. A research base supports many of the practices in that course, especially the need to provide repeated, sustained practice that is not just procedural knowledge but is also connected to understanding inquiry. What that course could not achieve was to ensure that student-teachers (they were in their first year, as well) had a high level of content knowledge in the areas in which they intended to teach.

Kaur Magon, J., & Shore, B. M. (advanced draft under revision). Building and sustaining online communities of learners in gifted education. [Journal to be selected.] [S] An "online community can be a support and resource for dialogues in which these types of thinking skills are taught, applied, and learned. . . . community-and ability-based characteristics that enabled the group to deal with social stigma, co-construct knowledge, and promote metalearning skills, and also highlighted barriers faced by both the members and the tutors. Principal enablers were anonymity, encouragement, feedback, collaboration, and the ongoing support for both emotional and cognitive needs provided by the tutors in a nonjudgmental, risk-taking environment. Amongst principal barriers were time delay between postings, the growing size of the community, and the need for structured questioning."

Kowgios, N., Burke, K., Cyganovich, P., Delcourt, M. A. B. & Shore, B. M. (under revision). Effects of conceptual assessments on critical thinking skills and literary analysis. [Journal to be selected.] [S] Creative problem solving, scholarly rigor, and literary analysis were enhanced when (a) teachers created and administered a multiple choice exam that asked conceptual questions; (b) students participated in a Socratic test debate in which they were required to support their answers using specific textual references; and (c) students wrote a metacognitive reflection of the evolution of their thought process including an initial interpretation of the question, the points gleaned during the debate, and their final interpretation of the course concept or theme addressed in the question. Reinforces the roles of dialog and reflection in inquiry.

LaBanca, F., Delcourt, M. A. B., Yulo, R. J., & Dimock, A. W. (under revision). Problem-finding behaviors in open inquiry precollege science-research experiences. [Journal to be selected] [S] Quality of student science and engineering fair projects was directly impacted by the quality of their problem finding. Effective problem finding resulted from using resources from previous, specialized experiences in an idiosyncratic, nonlinear, and flexible use and understanding of inquiry. Problem finding was influenced and assisted by the community of practicing scientists, with whom the students had an exceptional ability to communicate effectively. They had a positive self-concept and a temperament for both the creative and logical perspectives of science research.

Leung, D. A., Shore, B. M., & Williams, J. (in preparation). Specific inquiry tasks on which

pupils express the most and least efficacy. [Journal to be selected] [E, S] The *McGill Student Self-Efficacy on Specific Inquiry Learning Tasks* (MSESILT) comprised 70 items adapted from the MSDIQ. Students felt least efficacious planning inquiry (e.g., Make a plan for the inquiry, Divide the task into smaller steps, Create a back-up plan, Make a concept map or web or cluster, Start thinking about what will happen next during the inquiry) and most efficacious with tasks not exclusive to inquiry (e.g., Ask questions, Understand the important concepts, Figure out where to obtain data, Search the internet and world wide web). There was a curvilinear relation between inquiry self-ratings and recollections of the numbers of perceived experiences with inquiry. Students with some rather than no experiences were least efficacious and students with many experiences were most efficacious. Students appear to require many experiences with inquiry to become confident. Having only few or some experiences could be a barrier because students may accurately assess the difficulty and complexity of inquiry, but not have had enough practice to have experienced repeated success and to feel efficacious.

Margison, J. A., Shore, B. M., & Cera Guy, J. (in preparation). Interactional dynamics of interprofessional collaboration. [Journal to be selected.] [H] From thesis: "The purpose of this study was to investigate the interactional dynamics that occur when health-care professionals collaborate on a medical case. Social exchange theory and the literature on collaboration and teamwork provided the theoretical basis from which interaction was investigated. The participants in the study were 13 health-care professionals and one patient. They participated in two workshops during which they collaborated on an interprofessional care plan. Their interactions were audio-and video-taped. The recordings were transcribed and analyzed using the Roter Interaction Analysis System (RIAS), a widely used method developed for analyzing the dynamics of physician-patient interactions. The data were analyzed using chi-square standardized residuals. The study concluded that while the RIAS format was useful, the original RIAS categories needed to be extensively supplemented with items that specifically addressed the interprofessional interaction. An examination of the categories with variability indicated that the majority of the interactions were task-related and that the response patterns varied depending on whether the categories were grouped according to participant, workshop group, or profession. This study demonstrated that it is possible to assess the degree of

interprofessionalism in interactions using a scenario that is more ecologically valid than that offered by attitude questionnaires completed individually. The study offers a methodology by which it might be possible to chart the growth of interprofessionalism in communication among medical and other professionals in the course their work."

Oppong, E., Shore, B. M., & Muis, K. R. (under review). Clarifying the connections among giftedness, metacognition, self-regulation, and self-regulated learning: Implications for theory and practice. [Submitted to *Gifted Child Quarterly.*] [E, S, H] This paper distinguishes among and relates the concept of giftedness to metacognition, self-regulation, and self-regulated learning (SRL), then provides guidance for instruction particularly in gifted education.

Pelletier, S., Birlean, C., & Shore, B. M. (in preparation). The gifted learner as novice: Clues from performance-related differences between high performance mathematics students and experts in the categorization of mathematical problems. [Journal to be selected.] [S, H] All students use metacognition to guide their progress through a problem, but gifted students also exercised the option of solving the problem in a different way. They spontaneously use fewer categories to group related problems, are more likely to use deep rather than surface characteristics in this categorization, and they initially and when prompted are able to create more sublevels. They also took longer to do these tasks.

Ritchie, K. C., Lajoie, S. P., & Shore, B. M. (advanced draft under revision). Taking stock: Methodological approaches to accounting for social and emotional processes in models of problem solving. [To be submitted to the *Journal of Cognitive Psychology*.] [E, S, H] Review of empirical literature that measures both problem-solving processes or abilities and social or emotional processes or experiences. Summary of which theoretical frameworks are being used to understand this area, as well as how we are measuring problem solving, emotional and social constructs together (an alignment issue).

Ritchie, K. C., Shore, B. M., LaBanca, F., Fitzpatrick, M., & Bracewell, R. J. (in preparation). Inquiry students' social, emotional and cognitive classroom experiences: Making a case for hands on research education in secondary education. [To be submitted to the *International Journal of Science Education.*] [E, S] Prospective descriptive-comparative

study, documenting the social, emotional, and problem solving experiences of high school students over the course of one school year, who were enrolled in either a self-directed inquiry classroom in which they had to engage in problem finding (come up with their own research question to answer) or a more teacher-directed inquiry classroom in which they engaged in inquiry activities within smaller-scale laboratory-based activities. Students who engaged in problem finding were two-to-five times more likely to engage in productive problem-solving heuristic strategies and, although they experienced similar high levels of positive emotional experiences in their classes compared to students in teacher-directed classes, they also experienced significantly more negative emotions. Open-ended video-based recall interviews to better understand students' experiences provided explanation for the heightened negative emotions. With personal investment in their research project, and with greater academic challenge, students experienced negative emotions such as frustration and fatigue. In the face of these challenges, they explained figuring out self-regulation strategies to distract themselves enough to recover from the negative experiences (often engaging socially with classmates) in order to regain a positive perspective and re-engage with their work.

Sajjadi, S. H., Morisano, D., Shore, B. M., Rejskind, F. G., Carson, A. D., Rysiew, K. J., & Leeb, R. T. (under revision pending resubmission). Re-examining multipotentiality among the gifted: Longitudinal data give renewed life to the concept. [Journal to be selected.] [S] "The proposition that gifted persons are multipotentialed, that is capable of superior performance in many areas, especially related to career thinking and development, has tempted psychologists and educators for three quarters of a century. The concept is, however, controversial, and despite its conceptual attractiveness and wide acceptance in the field, it has recently come under severe criticism. The main objection is that the term is not supported empirically. This paper challenges the challenge, summarizing the evidence from many sources that multipotentiality is a viable construct, and presenting new longitudinal data on multipotentiality and its correlates from early teens to early twenties. At the center of the debate is the kind of data in which one expresses confidence. It is at least premature to discard the notion and there are useful insights to be gained from further exploration. Better control or comparison groups are needed in future studies."

Savard, A. & Freiman, V. (under review). Robotics and mathematics: An intersection for authentic learning? Submitted to *Digital Experiences in Mathematics Education.* [E] The use of robotics with materials developed by LEGO© in primary and secondary classrooms is a rapidly emerging phenomenon. This paper emphasized the complexity of learning tasks and assessment of students' knowledge in robotics-based learning environments when students, while seeing the utility of the experience and showing a high level of engagement, tend to use a trial-and-error strategy program the robot, but need to be equipped with metacognitive tools to overcome challenges to find what does not work. Our findings bring attention to the importance of transdisciplinary competences to be better developed in young learners.

Savard, A., Lin, T. W. J., & Manuel, D. (under review). The influence of the research contract in a collaborative research project in mathematics education. Submitted to *Learning, Culture and Social Interactions.* [S, H] "Collaborative research gives teachers opportunities to work with researchers, and all collaborators work toward goals that they each set. Such a project was developed as a professional development on teaching and learning probability between a grade 3 Inuit teacher from Northern Quebec and a researcher in mathematics education. The goal of the teacher was to learn more about mathematics while the researcher initially aimed at studying Inuit students' probabilistic reasoning. Four learning situation were created collaboratively using Savard's (2008) ethnomathematical model. However, discrepancies occurred between what was planned and agreed upon by both collaborators and what was enacted during the project. This motivated the researcher to study these discrepancies, which we define as breaches in the research contract created by both collaborators, and to make sense of the adaptations made by the collaborators for each breach examining the collaborator's learning intentions and representations of the situation. By analysing the enactment videos, the audio-recorded interviews and the researcher's field notes, we found breaches in three components of the contract: in the discrepancies between what was planned and what happened during the enactment of the lesson in the resources used, in the pedagogies used, and in the tasks; in the initial roles agreed upon by both collaborators; and in the goals of the collaborators. In general, the adaptations made by the researcher were aligned with the mathematical context (to learn probability), while the ones made by the

teacher remained aligned with the sociocultural and citizenship contexts of the project."

Shore, B. M., Aulls, M. W., Tabatabai, D., & Kaur Magon, J. (in preparation). *I is for inquiry: An ABC of inquiry instruction for elementary teachers and schools.* Prospectus being drafted for submission. [E] Book in preparation. Illustrates the need to blend theory and real-life examples for elementary-school teachers as they try to build inquiry experiences for their pupils.

Shore, B. M., Birlean, C., Ritchie, K. C., Margison, J. A., & The McGill Educational Initiative on Interprofessional Collaboration: Partnerships for Patient and Family-Centred Practice, Faculty of Medicine, McGill University, Montreal, QC. (in preparation). Development of the McGill Interprofessional Reciprocity Questionnaire (MIRQ): How collaborating medical professions regard each other--an assessment tool for collaborative practice and education. [To be submitted to *Medical Education*.] [H] This was developed first to evaluate how different health professionals value the input and roles of other health professionals. The idea and form of the instrument can generally be adapted to education because it is also an interprofessional occupation (classroom teachers, consultants, specialists, different levels and subjects, counsellors, psychologists, administrators, etc.). It could also be a basis for looking at how collaborating students view each other in inquiry work.

Shore, B. M., Birlean, C., Ritchie, K. C., & Steinert, Y. (in preparation). Changes in the conceptualization of medical interprofessional practice and education in a scientist-practitioner team over two years of promoting change in both domains. [Journal to be selected.] [H] Abstract not yet available.

Stringer, R. W., & Shore, B. M. (in early stages of conceptualization). Old and new approaches to the study of peripheral attention and visual target location in student problem solving. [Journal to be selected.] [E, S] This study is designed to compare the processes and results of computer-based eye-tracking versus circling targets on a printed page as indices of attention to centrally and peripherally located visual targets. Different approaches to target location have in the past been linked to high ability and learning difficulties.

Tabatabai, D., Shore, B. M., & Aulls, M. W. (advanced draft). Secondary student teachers'

choice of specialization in relation to their own best-recalled prior inquiry experiences. [Journal to be selected.] [S] There was a significant relationship between preservice teachers' present area of concentration and the subject area they remembered as their best inquiry experience. Student-teachers who recalled their best inquiry experience in Languages (n = 35, 24%) chose to teach Languages (n = 26; 33%). Similarly, those who recalled their best inquiry in Personal Development (n = 14, 9.6%) selected Personal Development (n = 9, 23%) as their teaching-subject concentration. There were, however, two surprises. The first surprise was in the teaching area choices of participants who recalled their best inquiry in Mathematics, Science, and Technology. Although 31 participants (21%) reported their best inquiry experiences in mathematics, only eight (26%) chose to teach mathematics. The largest number of these participants (n = 11, 7.5%) chose Personal Development instead. The second surprise was in the teaching area choices of participants who recalled their best inquiry in Social Sciences. Sixty-six participants (45%) recalled their best experience in social sciences but only seven (10.6%) chose it as their area of teaching concentration. The largest number of these participants (n = 39, 59%) chose Languages instead. Student-teachers who recalled their best inquiry in physical education chose to teach physical education. This could mean that inquiry experiences are generic and transferable, but do senior student-teachers remember their best inquiry subject because they are now preparing to teach it or vice-versa? Also higher-paying mathematics and science jobs are available outside education.

Tabatabai, D., Shore, B. M., Delcourt, M. A. B, & Aulls, M. W. (in early stage of preparation, data coded). In what ways do student teachers perceive the applicability of inquiry instruction with students with differing levels of abilities? [Journal to be selected.] [H] Most published studies of the relation between high ability and inquiry address the academic abilities and knowledge of student teachers and not their anticipation of the role of ability of their learners. Inquiry-based teaching and learning, even when called by other names, are the evolving goal for curriculum in many countries. Student interests and questions, diversification of teachers' and learners' roles, and interactions among learners are key elements. Ensuring that students with different abilities are well served by inquiry in schools requires that new and experienced teachers understand how to teach with inquiry and differentiate instruction in inquiry contexts. Gifted students, in

particular, respond differently from most others to the exigencies of inquiry learning, especially group or collaborative work. However, we anticipated limited awareness of this issue. We asked 175 senior preservice teachers, "In what ways might students of different abilities vary in the nature and frequency of their participation in inquiry-base instruction in a classroom? Reply from the point of view of a learner." We synthesized the 386 different replies, reduced them to 35 response categories, and ordered them by frequency. The most frequent single category of reply (37 instances, 9.6% of the responses) was about the impact of shyness, which is not specifically an ability. Overall, 156 (89%) of the 175 respondents mentioned shyness at some point. "High ability" and "gifted" were 5th and 10th in frequency out of the 35 categories, and appeared in 5.4% and 3.6% of the replies, respectively (total, 10%). We might still face an up-hill path, not only providing future teachers with an understanding of different abilities but also of inquiry, and especially in bringing these concepts together for maximum impact on learners with diverse abilities.

Walker, C. L., Gyles, P. D. T., Hou, D., Shore, B. M., Muis, K., & Schneider, B. H. (in preparation). Gifted children [may] differ in the number of pillars supporting stable and quality friendships, actual and preferred numbers of friends, and the roles friends play in their lives. [Journal to be selected.] [E, S] Able students' friendships appear to be based on fewer and more individualized or specialized connections. They prefer to work with others, for example, in classroom projects, when they can choose to work with friends who will contribute in fair measure to the work. (Source of the MBoFS instrument.)

Walker, C. L., Shore, B. M., & Tabatabai, D. (advanced draft). On the trail of authentic classroom inquiry: Evidence for role diversification as a key theoretical footprint. [To be submitted to *Contemporary Educational Psychology*.] [E] Classroom context, teacher personalities and teaching styles, individual student personalities, and group-work dynamics affect the nature and numbers of roles undertaken by students and teachers when engaged in complex inquiry. Role diversification can be a nonacademic indicator of inquiry success for students.

Williams, J. M., Cera Guy, J. N. M. T., & Shore, B. M. (advanced draft). High achieving students' expectations about what happens in classroom group work: A review of

contributing research. Revisions requested by *Roeper Review* (to be resubmitted paired with Cera Guy, Williams, & Shore, in preparation) [E, S] "High-achieving students' preference to work alone has been shown to be largely false and to depend on the learning context. However, the literature has not distinguished between preferences and expectations, nor directly examined what students expect will occur in classroom group work. An attempted systematic review of group-work expectations yielded just one relevant study from 768 initial sources. Instead, a generic (or critical) review gathered evidence primarily from the preferences literature indicating hypotheses about expectations. High-achieving students' expectations might be influenced by seven variables: prior acceptance or rejection of their contributions in group work, choice with whom one works, having a supportive friend in the group, control over the group-work structure, fairness of work distribution, task difficulty, and parental opinions."