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\*Corresponding author: Tanya Chichekian, Department of Educational and Counselling Psychology, Faculty of Education, McGill University, 3700 McTavish, Montreal, QC, Canada H3A 1Y2  
E-mails: [tanya.chichekian@mail.mcgill.ca](mailto:tanya.chichekian@mail.mcgill.ca), [tchichekian@dawsoncollege.qc.ca](mailto:tchichekian@dawsoncollege.qc.ca)

Reviewing editor:  
Gregory Yates, University of South Australia, Australia

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## TEACHER EDUCATION & DEVELOPMENT | REVIEW ARTICLE

# Preservice and practicing teachers' self-efficacy for inquiry-based instruction

Tanya Chichekian<sup>1\*</sup> and Bruce M. Shore<sup>1</sup>

**Abstract:** This review synthesized what the research tells us about teachers' self-efficacy for the enactment of inquiry-based instruction in the classroom. We selected 33 empirical studies that met specific search criteria. Teachers with previous inquiry experiences, including the completion of inquiry-based methods courses in teacher-education and previous authentic investigations, were more disposed toward adopting an inquiry approach, even if they had limited experience in authentic inquiry-education settings. Number of years taught, the maximum degree held by the teacher, and prior educational and work experiences were not related to an inclination toward using inquiry in the classroom. In addition, success in teaching with inquiry depended on teachers' interpretations of the challenges associated with this pedagogy. Implications for research and practice are discussed.

**Subjects:** Classroom Practice; Early Years; Educational Psychology; Educational Research; Teaching & Learning - Education

**Keywords:** inquiry; inquiry-based instruction; self-efficacy; preservice teachers; practicing teachers; teacher education

A substantial body of classroom-based research supports the notion that students will benefit in many ways from being afforded opportunities to engage with the process of inquiry within the context of solving authentic problems (Krajcik et al., 1998; Wirkala & Kuhn, 2011). When encouraging



Bruce M. Shore and  
Tanya Chichekian

### ABOUT THE AUTHORS

Dr Tanya Chichekian and Prof. Bruce M. Shore are members of a research group based at McGill University and encompassing three other universities and colleges in Canada and the USA. The group has been publishing research about inquiry-based instruction in elementary and secondary schools, and in higher education, for more than two decades. Publications by members of the group also include several books about theory and application regarding inquiry in elementary, secondary, and higher education, as well as chapters in edited volumes. The group has also published extensively in the area of gifted education. The present review drew upon, and set the stage for the construction of, several validated instruments that assess value attached to specific inquiry-based instructional tasks, teachers' self-efficacy for enacting inquiry-based instruction, and outcomes of inquiry-based learning. Self-efficacy is, however, only one of the pillars supporting inquiry-based instruction.

### PUBLIC INTEREST STATEMENT

In many countries around the world, curriculum reform has included teaching and learning experiences that place the learner in the role of a producer of knowledge in addition to the continuing role of one who acquires knowledge and skills. This approach takes several forms with different names, but "inquiry-based instruction" is widely recognized in education. Teaching with inquiry is a relatively complex and demanding activity. Preservice and practicing teachers are still acquiring the competencies to teach through inquiry. Part of the challenge in doing so is feeling confident about one's ability to add this teaching method to one's repertory of teaching skills. This confidence is known as self-efficacy. Self-efficacy for inquiry teaching is an important part of making inquiry happen in classrooms and schools. This review of 33 research-based papers provides teachers and researchers with an up-to-date summary of the state of knowledge about teachers' self-efficacy for inquiry-based instruction.

these kinds of conducive learning processes within students becomes a teacher's conscious goal, we suggest that pedagogy, by definition, takes the form of inquiry-based teaching. Such teaching can be based partly on topics of student interest but the focus is developing student knowledge through the investigation of authentic questions. Teaching activities should also aim to foster the development of self-regulation and metacognitive strategies (e.g. organizing information, goal-setting, monitoring, understanding, self-evaluating). The intention is to enhance critical-thinking and problem-solving skills, to promote student initiative, curiosity, and confidence, and ultimately to foster the motivation for autonomous learning (Chichekian, Savard, & Shore, 2011; Llewellyn, 2002; National Research Council, 2000; Shore et al., 2009; UNESCO, 2008).

Inquiry-based teaching complements other instructional approaches, for example, didactic teaching and direct instruction, in that student understanding and achievement remain as fundamental goals. However, one key assumption is that motivation can be stimulated through appeal to more intrinsic resources and, further, the tools of assessment shift toward documenting evidence of deeper understandings, rather than fixing upon more superficial or surface knowledge. One of the unique qualities of inquiry as an instructional practice is the diversification of roles among both teachers and learners. This diversification occurs in different ways in different classrooms, depending on the content, learning goals, experiences of both groups, and such contextual variables as how learning groups are formed, for example, whether or not learners have some say in who works with whom in group activities (Walker, Shore, & Tabatabai, 2013). The teacher's role in a classroom extends far beyond managing a classroom to one that facilitates and scaffolds students' dialogic interactions as a means to promote learning.

As a heuristic construct, "inquiry" tends to be used as a generic term, rather than to refer to any one specific methodology. Indeed, it is possible to note conceptual overlap between the following variations: Inquiry-based instruction (see Abd-El-Khalick et al., 2004), authentic inquiry (Chinn & Malhotra, 2002), model-based inquiry, modeling, and argumentation (McNeill, Lizotte, Krajcik, & Marx, 2006), project-based instruction (Singer, Marx, Krajcik, & Clay Chambers, 2000), hands-on learning (Pine et al., 2006), and learning situated within a community of inquiry or community of learners (Brown & Campione, 1994; Dewey, 1938; Lipman, 2003).

### **1. Overview of the general concept of self-efficacy**

In general, whether with respect to teaching, teaching with inquiry, or any other task, self-efficacy is "the belief in one's capabilities to organize and execute the courses of action required to manage prospective situations" (Bandura, 1995; p. 2). Self-efficacy impacts the amount of perseverance and effort an individual undertakes when working toward achieving an objective (Bandura, 2000). It influences "the choices individuals make and the courses of action they pursue" (Pajares, 1996, p. 544).

There are several constructs that resemble self-efficacy, such as self-esteem and self-confidence, but each of these has unique features (Schunk, 1991). Self-esteem is an individual's perception of him or herself. Self-confidence is an individual's belief in his or her ability to perform tasks competently. The latter is analogous to self-efficacy. To be able to accurately predict how people will behave in specific situations and on specific tasks, Bandura (1989) and Schunk (1989) argued that we need to study individuals' self-perceptions within those situations. For example, with regard to teaching in general, whether or not using inquiry, teachers might judge their competence high in teaching mathematics, moderate in English, and low in social studies. Moreover, within mathematics, one might feel highly efficacious about teaching algebra, but not trigonometry. Individual teachers might have a high self-concept, but not necessarily feel confident in all academic areas or with all possible forms of pedagogy. Self-efficacy is not a singular dimension and will vary depending on domain-specific tasks and on the teacher's expertise with particular instructional approaches.

According to Bandura (1995), self-efficacy is developed from four major forms of influence: mastery experiences, vicarious experiences, social persuasions, and physiological and emotional states. It plays a major role in how one approaches goals, tasks, and challenges. Among the four, mastery

experiences provide the most authentic evidence of one's success. Successes are powerful indicators of the development of personal efficacy. However, only successes that have been achieved through consistent and perseverant effort tend to produce resilient self-efficacy.

The second way to strengthen self-efficacy is through vicarious experiences. In classrooms, observing an experienced teacher succeed at activities can provide a useful model enabling preservice teachers to both acquire pedagogical skills and gain confidence in being able to try out such activities in practice. Modeling can have an important impact on the observer, especially when observing individuals succeed at complex tasks such as stimulating intrinsic motivation in students or encouraging students to engage deeply with question-generating activities.

A third way to encourage beliefs about personal ability to succeed at a given task can stem from social persuasion. There at times when persuasion from significant others can be effective in helping an individual to reappraise his or her competencies. Most generally, persuasion helps an individual to focus on previous successful performances, and then provides reasons why such success ought to continue. Supporting someone's capacity to succeed on a given task through self-improvement leads to more sustainable outcome expectations. Unrealistic attempts at boosting efficacy through persuasion, however, can have undermining effects such as lowering beliefs about one's own capabilities.

The fourth way to influence efficacy beliefs is through the interpretation of physical and emotional reactions. Individuals' perceptions of affective arousal can be viewed either as energy or as an incumbency depending on their sense of efficacy. Similarly, efficacy can also depend partially upon an individual's state of health or level of fatigue.

The extent of expectations or intended outcomes, the expansion and diversification of roles, competing arguments about the merits or relative difficulty of direct and inquiry instruction and gradations of their combination, and the multitude of definitions create a challenge for any teacher, a situation that is probably highly amplified for new teachers and therefore a hurdle for self-efficacy to teach, perhaps in general, but specifically using inquiry. This review's overarching goal was therefore to synthesize what the research literature tells us about teachers' self-efficacy for the enactment of inquiry-based instruction in the classroom. Specifically, we wanted to know: (a) What role does a teacher's self-efficacy play in planning for and enacting inquiry-based instruction? and (b) What prior experiences contribute to the development of self-efficacy for teaching using inquiry?

This review focuses on instruction using inquiry, not learning, although one necessarily feeds the other. It was premised upon the notion that teachers in general and new teachers among them are more likely to plan for and conduct inquiry-based teaching when they feel confident (i.e. self-efficacious) about being able to appropriately use inquiry methods to achieve valued goals. Preservice teachers are part of the population of new teachers, therefore, their experiences are also relevant (Cochran-Smith & Zeichner, 2005).

## **2. Search process for previous research on self-efficacy for teaching using inquiry**

We searched for research studies about "self-efficacy for teaching using inquiry" in two major education databases: ERIC and PsycINFO. Sources cited above and in this description of the search process are all from the broader literature separately on self-efficacy or on inquiry teaching, and specifically did not include those found in the search described below. We combined the following descriptive terms and keywords in the searches to maximize the number of potential studies. Using the connector "and," the terms self-efficacy or inquiry were combined with the terms transition, teach, new, and preservice. We connected these terms until all possible combinations were exhausted. Each database's thesaurus was also checked to find out if other terms were used to refer to the same or similar concepts. As a result, other synonyms such as "beginning," "novice," "constructivism," "self-confidence," "teaching methods," and "induction" were included in the literature search. This search of the literature produced 196 articles. We scanned these articles to decide if they met the following inclusion criteria:

- (1) Population: The study questions, purpose, or hypothesis addressed teachers' (as opposed to students') self-efficacy either as a main, secondary, or minor focus of the investigation.
- (2) Context: Studies were conducted in school settings (K to 12) with teachers whose objectives were developing effective instructional strategies and not objectives that met the goals of school improvement such as curriculum or program development.
- (3) Source of publication: The studies must have been published in peer-reviewed journals. This excluded studies published in book chapters, technical reports, and conference proceedings.
- (4) Time range: The time period searched ranged from 1990 to 2012 because the early 1990s were a time for increasing emphasis on research about teachers' self-efficacy (e.g. in the broader literature, Bandura, 1993; Pajares, 1996, 1997; Schunk, 1991; Woolfolk & Hoy, 1990; Zimmerman, Bandura, & Martinez-Pons, 1992).
- (5) Research methods: The studies must be empirical and either quantitative, qualitative, or mixed designs. Thus, we did not select essays, literature reviews, editorials, or papers that addressed teachers' self-efficacy solely from a conceptual or narrative perspective.
- (6) Participants: The study participants were preservice or in-service teachers or both working in K-to-12 public schools.
- (7) Data variety: Studies included at least two data sources (e.g. pre- and post-surveys or questionnaires) either to document changes in teachers' self-efficacy or to triangulate qualitative and quantitative data.

A study needed to meet all seven criteria to be included in the review. After deleting duplicates and applying these selection criteria to the 196 identified publications, we identified 26 eligible articles. The most common reasons for which studies did not qualify for inclusion were that they focused primarily on students rather than teachers (e.g. Pintrich & de Groot, 1990) or examined other constructs (not self-efficacy) such as attitudes (Ghaith & Yaghi, 1997), academic achievement (Yeo, Ang, Chong, Huan, & Quek, 2008), self-regulation, or metacognition (Schraw, Crippen, & Hartley, 2006). We then scanned the titles of the references for these 26 articles and read the abstract of those that seemed relevant. Seven more articles were identified using this process, increasing the number of journal articles to 33. The reason why these seven additions did not appear in the initial search was because the keywords selected by their authors did not match our initial search descriptors. This situation occurred mainly when self-efficacy was not the main focus of the article.

Table 1 provides an overview of these 33 articles, including the type of inquiry used when specified in the study. Overall, 18 (55%) studies included preservice teachers, 14 (42%) practicing service teachers, and one (3%) study included both preservice and in-service teachers. Also, 22 studies (67%) took place at the elementary level, eight (24%) at the secondary, and three (9%) at both elementary and secondary levels. In addition, 29 studies (88%) were conducted either with teachers who taught science or mathematics; their years of teaching experience varied from none (18–55%) to less than five years (4–12%), to more than five years (5–15%). Four articles did not report on years of teaching experience (two studies included teachers of less than and more than five years of teaching experience). As indicated in Table 1 (column 5), self-efficacy for inquiry instruction (and generally) is typically measured by questionnaires, and sometimes by interviews and rating scales (also see Chichekian, Shore, & Tabatabai, 2016; Ibrahim, Aulls, & Shore, 2016, for two recently validated instruments and a sample interview schedule in the former).

Perhaps the most important general observation is that the vast majority of articles that met the search criteria were about teaching science, even though the term “science” was not one of the descriptors used during the search process. Inquiry and science do have a long and active history together which is, in turn, reflected in the resulting literature search. This prompted consideration of whether or not to limit the title and focus of this paper to science education; we chose not to because inquiry in principle and practice is not unique to science education (see an example of history in Ohn, 2013), even if the majority of published, empirical research on inquiry instruction is so

domain-limited, and the domain does make a difference in how inquiry is conducted, but not in the overall characteristics, for example, being student-interest based, involving increased diversity and sharing of responsibility in learners' and teachers' roles, and seeking evidence-based answers to nontrivial questions.

### 3. What the 33 studies tell us about self-efficacy to teach using inquiry

The 33 studies we identified conveyed three main categories of information about teachers' self-efficacy for teaching with inquiry: (a) correlates of different levels of self-efficacy, (b) fostering the development of this self-efficacy, and (c) challenges to enacting inquiry-based pedagogy. These are addressed in turn with reference solely to the 33 studies. Links to the broader literature follow.

### 4. Levels of self-efficacy for inquiry-based instruction

Effort, persistence, and resilience are important characteristics for teachers and for the classroom environment; their varying degrees determine if teachers will be more willing to plan and implement innovative instructional strategies. For example, within the literature, we noted that:

- (1) Self-efficacy has been correlated with teachers' beliefs about and willingness to improve methods of instruction using inquiry (Leonard, Barnes-Johnson, Dantley, & Kimber, 2011; Smolleck & Mongan, 2011).
- (2) Highly efficacious teachers attributed their high sense of teaching efficacy to their increased knowledge of teaching strategies, among them inquiry, interactive, and hands-on learning (Swars & Dooley, 2010).
- (3) Those with higher self-efficacy for teaching were more likely to be aware of various instructional approaches and were more open and willing to actually experiment with innovative approaches to promote autonomous learning among and better meet the needs of their students (Ross, Bradley Cousins, & Gadalla, 1996).

In the contexts of mathematics (Çakiroğlu & İşiksal, 2009) and science education (Narayan & Lamp, 2010), teachers with teaching experience and high self-efficacy beliefs were more in favor of creating inquiry-based classroom environments. For example, an increased sense of self-efficacy for teaching using inquiry has been attributed to continuous success in understanding the science content taught, learning different pedagogical techniques and practices, and being able to teach the learned science content to primary school children during the practicum. Narayan and Lamp did not specify what types or models of inquiry the student teachers experienced in their constructivist, inquiry-based physics class, but "students learned science content by doing several relevant, grade appropriate activities that they either worked on individually or group wise" (p. 753). A very basic introduction was provided to using hands-on inquiry-teaching activities, and the course modeled both content and how to teach it. Also, in one study, autonomous and professionally active elementary science teachers demonstrated higher self-efficacy for inquiry teaching than those driven by external motivators such as needing other people as helpers when teaching or a desire for collegiality (Ramey-Gassert, Shroyer, & Staver, 1996).

It has also been found that teachers with low self-efficacy might often avoid teaching particular subject matter (Enochs, Scharmann, & Riggs, 1995; Riggs & Enoch, 1990). In addition, several studies have described how beginning teachers with low general self-confidence for teaching (at both the elementary and secondary levels) avoided using an inquiry approach. Instead, they engaged in what they regard as low-risk instructional activities such as staying closer to the textbook and using reading- and writing-based teaching strategies rather than hands-on activities (Appleton & Kindt, 2002; Eick & Reed, 2002; Mulholland & Wallace, 2001).

### 5. Fostering self-efficacy for inquiry-based instruction

This section focuses on how university and workplace experiences can influence preservice and practicing teachers' self-efficacy for teaching using inquiry. "The identities that beginning teachers

**Table 1. Data sources and sample of selected studies (n = 33)**

Author(s)	Participants	Level taught	Years of teaching experience	Data sources	Subject (if specified)	Type of inquiry addressed (if specified)
Appleton and Kindt (2002)	In-service (n = 9)	Elementary	Less than five years	Semistructured interviews, field notes	Science	Not about any specific inquiry type or model
Brand and Moore (2011)	In-service (n = 30)	Elementary	Not reported	Interview, semantic maps	Science	Nonspecific: "inquiry-based science instruction"
Cody et al. (2006)	Preservice (n = 12)	Elementary (n = 7)	None	LCQ (survey), MBS (survey) individual interviews	Mathematics	Not about any specific inquiry type or model (collaborative learning environments)
		Secondary (n = 4)				
Çakiroğlu and İşiksal (2009)	Preservice (n = 358)	Adults (n = 1)	None	ATMS (survey), MSES (survey)	Mathematics	Not about any specific inquiry type or model
	Preservice (n = 135)	Secondary	None	INTASC readiness survey	General	Not about any specific inquiry type or model
Charalambous and Philippou (2010)	In-service (n = 167)	Elementary	Not reported	Questionnaire, teacher logs	Mathematics	Not about any specific inquiry type or model
Crawford (2007)	In-service (n = 1)	Secondary	More than five years	Semistructured interviews, researcher's journal notes of informal conversations, classroom observations, questionnaire, students' artifacts	Science	Range of inquiry types from noninquiry to structured and open inquiry
	Students (n = 20)					
	Researcher (n = 1)					
Eick and Reed (2002)	Preservice (n = 12)	Secondary	None	Written reflections, interview	Science	Structured inquiry
Enochs et al. (1995)	Preservice (n = 73)	Elementary	None	STEBI-B (survey)	Science	Not about any specific inquiry type or model
Feiman-Nemser (2001)	In-service (n = 1)	Elementary	More than five years	Classroom observations, individual interviews	General	Not about any specific inquiry type or model
Gabriele and Joram (2007)	In-service (n = 10)	Elementary	More than five years	Semistructured interviews	Mathematics	Not about any specific inquiry type or model
Jung and Tonso (2006)	Preservice (n = 24) and In-service (n = 42)	Elementary	Not Reported	Survey (name not reported), field notes, classroom observations, focus-group interviews, individual interviews	Science	Guided inquiry (at out-of-school sites)
Leonard, Barnes-Johnson, Dantley, and Kimber (2010)	Preservice (n = 13)	Elementary	None	STIR (classroom observations), STEBI-B (survey)	Science	Inquiry broadly, from "cook-book" labs to open inquiry; not about any specific inquiry type or model

(Continued)

**Table 1. (Continued)**

Author(s)	Participants	Level taught	Years of teaching experience	Data sources	Subject (if specified)	Type of inquiry addressed (if specified)
Liang and Richardson (2009)	Preservice (n = 54)	Elementary	None	STEBI-B (survey), questionnaire	Science	Structured and guided inquiry ("scaffolded, student-centered")
Marshall et al. (2007)	In-service (n = 1222)	Secondary (n = 372) Elementary (n = 850)	More than five years	EQUIP (survey)	Mathematics & science	Not about any specific inquiry type or model; "inquiry" used broadly
Melville et al. (2008)	Preservice (n = 12)	Secondary	None	Questionnaire, semistructured interviews, placement reports	Science	Not about any specific inquiry type or model; "inquiry" and "scientific inquiry" used broadly
Morrell and Carroll (2003)	Preservice (n = 399)	Elementary	None	STEBI-B (survey)	Science	Not about any specific inquiry type or model
Mulholland and Wallace (2001)	In-service (n = 1)	Elementary	Less than five years	Reflective journal, semistructured interview, classroom observations, audiotape of classroom interactions	Science	Not about any specific inquiry type or model
Narayan and Lamp (2010)	Preservice (n = 70)	Elementary	None	Individual interviews, focus group interviews, field notes, and artifacts	Science	Hands-on, activity-based inquiry
Palmer (2006)	Preservice (n = 55)	Elementary	None	STEBI-B (survey), informal survey, and individual interviews	Science	Not about any specific inquiry type or model
Ramey-Gassert et al. (1996)	In-service (n = 23)	Elementary	Not Reported	STEBI-A (survey), interviews	Science	Not about any specific inquiry type or model
Richardson and Liang (2008)	Preservice (n = 50), Instructor (n = 4)	Elementary	None	STEBI-B (survey), artifacts	Mathematics science	Guided inquiry
Riggs and Enochs (1990)	In-service (n = 331)	Elementary	Less than five years (n = 53) More than five years (n = 268)	STEBI (survey)	Science	Not about any specific inquiry type or model
Ross et al. (1996)	In-service (n = 52)	Secondary	More than five years	Questionnaire, part focus on sex differences	General	Not about any specific inquiry type or model
Sherman and MacDonald (2007)	Preservice (n = 31)	Elementary	None	Survey (name not reported), focus group interviews	Science	Structured inquiry with hands-on science experiences
Smith et al. (2007)	In-service (n = 1073)	Secondary	Less than five years (n = 440) More than five years (n = 633)	NAEP (survey)	Science	Not about any specific inquiry type or model, but some attention to problem solving, writing, and reporting (NRC)

(Continued)

**Table 1. (Continued)**

Author(s)	Participants	Level taught	Years of teaching experience	Data sources	Subject (if specified)	Type of inquiry addressed (if specified)
Smith and Ingersoll (2004)	In-service (n = 3235)	Elementary, Secondary	Less than five years	TFS (Teacher Follow-up Survey)	General	Not about any specific inquiry type or model
Smolleck and Mongan (2011)	Preservice (n = 38)	Elementary	None	TSI (survey), reflections	Science	Science inquiry (NRC)
Smolleck and Yoder (2008)	Preservice (n = 120 for pre-test, n = 116 for post-test)	Elementary	None	TSI (survey)	Science	Science inquiry (NRC)
Smolleck et al. (2006)	Preservice (n = 190)	Elementary	None	TSI (survey)	Science	Science inquiry (NRC)
Swars and Dooley (2010)	Preservice (n = 21)	Elementary	None	STEBI-B (survey), questionnaire	Science	Guided inquiry
Windschittl (2003)	Preservice (n = 6)	Secondary	None	Written descriptions, reflective journals, individual interviews, classroom observations	Science	Guided and open inquiry
Windschittl et al. (2008)	In-service (n = 11)	Secondary	Less than five years (first year)	Multicase study, videotapes, classroom observations, student-created artifacts, interviews, and field notes	Science	Collaborative inquiry

develop combine parts of their past, including their own experience in school and in teacher preparation, with pieces of their present in their current school context” (Feiman-Nemser, 2001, pp. 1029–1030).

### **5.1. Preservice experiences**

During practicum experiences, preservice teachers are often concerned about adhering to the local curriculum and become focused on a day-to-day survival instead of putting into practice their beliefs about inquiry instruction (Gabriele & Joram, 2007). This creates a misalignment between their idealization of inquiry instruction and what they are probably able to accomplish.

In studies investigating experiences that support inquiry science teaching by preservice secondary-school teachers, use of inquiry was strongly correlated with previous long-term research experience and the types of roles played in previous authentic investigations. Beliefs about pedagogy, schools, student learning, and the nature of scientific inquiry importantly influenced choice of, and eventual success in, teaching science as inquiry. For example, a mentor’s beliefs and preferred instructional approaches influenced prospective teachers to extend themselves beyond their comfort zones with regard to pedagogical practice and create inquiry-based lessons (Crawford, 2007; Windschitl, 2003).

Experiences lived during the completion of a teacher-education program, however, do not explain teachers’ self-efficacy for inquiry instruction without also taking into account the environment that contextualizes student teachers’ learning (Liang & Richardson, 2009; Narayan & Lamp, 2010; Sherman & MacDonald, 2007). For example, the participatory nature of inquiry-based activities, the professor’s consistent modeling of grade-appropriate activities, and participation in hands-on activities in an inquiry-based science-methods course increased preservice teachers’ confidence in their ability to master content and effective inquiry-based pedagogical techniques. Two other preservice interventions increase preservice teachers’ self-efficacy to implement inquiry in their own classrooms: Developing their own questions then designing their own investigations during an inquiry project in an interdisciplinary science course, and reflecting on the impact of inquiry-based learning they previously encountered as a student on their current teaching (Charalambous & Philippou, 2010; Liang & Richardson, 2009; Melville, Fazio, Bartley, & Jones, 2008).

Out-of-school teaching sites (such as museums and nature centers) can provide preservice teachers a nonthreatening environment conducive to inquiry-based instruction. Elements of inquiry they facilitate included seeing and experiencing hands-on science teaching, team-teaching, peer support, more opportunities for actual teaching, connecting ideas learned in methods classes to actual teaching, teaching lessons to students from different grades, opportunity to teach the same lesson repeatedly, and modifying instructional practices to the different developmental stages of children (Jung & Tonso, 2006). Such environments might be perceived as nonthreatening because they are relatively free from the curricular evaluation that students and teachers experience more frequently in school settings. These settings often have the words discovery or exploration in their names and educational missions.

Above all, actually seeing the benefits of student learning and engagement has provided the catalyst for preservice teachers to continue implementing inquiry-based learning experiences, despite the fact these lessons take more time to plan in comparison to some other forms of teaching (Smollock & Mongan, 2011). The impact of inquiry-based field experiences during teacher education (Capraro, Capraro, & Helfeldt, 2010; Leonard et al., 2011) supports the idea that teacher preparation can be enhanced through a more specifically structured, extensive field experience that explicitly focuses on inquiry-learning procedures (Jung & Tonso, 2006).

### **5.2. Workplace experiences**

For practicing teachers, confronting the realities of their workplace and school expectations, often meant turning to “safe” activities, ones that they had experienced during their teacher preparation

and had predictable outcomes or that were manageable (i.e. nothing unexpected would happen for the students or the teacher). Specifically for inquiry-based instruction, Marshall, Horton, Igo, and Switzer (2007) tested four independent variables (grade level taught, content area taught, level of support received, and self-efficacy for teaching inquiry) that had the potential to influence the use of inquiry instruction and were thought to be related to the typical amount of time teachers spent on inquiry in the classroom. For example, elementary school teachers suggested that support of colleagues and administrators played an important role in the amount of inquiry that occurred in classrooms. Teachers were more tempted to challenge and change pre-existing frameworks, when they were provided with strong (e.g. professional development opportunities or peer teachers). Several other variables, however, were found to be unrelated to the percentage of time devoted to inquiry instruction, namely, number of years taught, the highest degree held by the teacher, and prior educational and work experiences. Just as mentoring was influential in preservice experiences, it can also be valuable in the workplace (Smith & Ingersoll, 2004).

In addition to providing inquiry-based learning opportunities to increase teachers' self-efficacy or the belief in their ability to teach (Morrell & Carroll, 2003; Palmer, 2006; Richardson & Liang, 2008), Brand and Moore (2011) noticed a change in elementary school teachers' pedagogical skills in teaching science as inquiry, specifically the way they introduced ideas during instruction, when a constructivist sociocultural professional-development model was adopted in a two-year school-wide initiative. The teachers began adapting inquiry-based conceptions and related strategies developed during a professional development workshop. By developing adaptive philosophies, these teachers realized that their perceptions of how students learn began to change. They also noticed changes in their instruction; for example, they began introducing ideas with questions and providing more opportunities for students' discussions. Long-term professional development rather than one-time workshops were recommended, especially if teachers lacked a long-term sustained commitment to change (Brand & Moore, 2011; Marshall et al., 2007; Smith et al., 2007).

## **6. Challenges associated with inquiry-based pedagogy**

Success in teaching with inquiry depends on teachers' interpretations of the challenges associated with this pedagogy. Melville et al. (2008) investigated the relation between 12 preservice secondary science teachers' inquiry-learning experiences (they all had an undergraduate science degree) and their capacity to reflect on the challenges involved in implementing inquiry into classrooms. Those with extensive inquiry-learning experiences (four of the 12) either had completed an honors thesis or had research-laboratory experience. They viewed the challenges of teaching inquiry in terms of their roles as teachers, such as guiding and scaffolding students through the process of scientific inquiry. Despite inexperience in "real teaching," these preservice teachers used their reflective capacity to focus on the content of teaching inquiry and created age-appropriate learning situations using the pedagogical content knowledge that they had experientially acquired.

In contrast, teachers with limited inquiry experience (five of the 12) did not identify any inquiry exposure either at the undergraduate level or at an employment. They perceived time, curriculum, and materials as challenges and the reaction of students (e.g. frustration, reluctance, intimidation) as the major impediments to the use of inquiry. They also stressed the negative reactions of parents, colleagues, and school personnel as issues that would place major constraints on inquiry. Lack of time, planning content that is developmentally suitable, balancing inquiry with academic standards, lack of resources (Smolleck & Mongan, 2011), and a lack of support from supervising teachers during student teaching (Sherman & MacDonald, 2007) were also challenges identified by preservice teachers.

Cady, Meier, and Lubinski (2006) focused their longitudinal study on the transition from preservice education to being a practicing mathematics teacher. As student-teachers, the 12 participants had been intentionally provided with collaborative practicum experiences. Their beliefs about mathematics instruction were influenced by those interventions, but, in follow-up interviews, only two then reported basing their teaching choices on data about their student's thinking processes and

estimated skills, and only four reported asking students to justify their solutions or proofs. However, their performance improved with experience and professional-development experiences. Preservice and practicing teachers need to deal explicitly, and receive suitable scaffolding, with connecting their beliefs and knowledge into routine practice.

Another misalignment can arise from preservice and practicing teachers' conceptions about inquiry. Windschitl, Thompson, and Braaten (2008) reported a synthesis of several studies of what preservice science teachers understood inquiry instruction to mean. The students were hampered by limited notions of the so-called scientific method that did not accurately reflect how scientists think and work. For example, excessively focusing on testing predictions rather than on ideas and framing questions in terms of disciplinary or cross-disciplinary understanding. This kind of barrier can occur in any subject matter.

The difference between a teacher who allows more inquiry-based instructional time for a subject and one who does not could be related to self-efficacy (Smolleck & Yoder, 2008; Smolleck, Zembal-Saul, & Yoder, 2006). However, teachers must first have a sophisticated understanding of teaching with inquiry, as well as opportunities to experience success with inquiry teaching and learning if they themselves are expected to enact such a pedagogical approach.

Fears of not meeting local, regional, or national mandates and feeling incompetent pose challenges when teachers consider committing to inquiry-based instruction. In particular, many young teachers will experience a deep fear of losing control of the learning environment. Teachers have no choice but to remain professionally "in control." This concern about control might lead to relying on teacher-centered techniques with which they might feel "safer." This could change as teachers become more confident and experienced with planning and enacting other pedagogical approaches. Hence, exposure to well-run inquiry classrooms in which experienced teachers can be seen to routinely use their managerial skills to assist their students become effective and autonomous learners must be viewed as a key element in teacher preparation. Such exposure can instill confidence in assisting novice teachers find, within their own teaching style and repertoire, the balance between a didactic-based approach and an inquiry-based emphasis.

### **7. Summary and links of the 33 selected studies to the broader literature**

The messages gleaned from the 33 studies we identified using the above-mentioned inclusion criteria are consistent those of other studies that met some but not all of our search criteria.

### **8. Levels of self-efficacy for inquiry-based instruction**

Four main points arose from the identified studies. Higher self-efficacy for inquiry teaching is correlated with:

- (1) More extensive knowledge of teaching strategies.
- (2) Teaching experience and general self-efficacy for teaching.
- (3) Deeper understanding of the subject-matter content.
- (4) A personal sense of autonomy and being actively engaged professionally.

These four points are very likely interrelated.

Other studies have also found that highly efficacious teachers were more likely to adjust current strategies, were more persistent in the face of classroom challenges, and generally had a more positive classroom environment evaluated, for example, on students with less anxiety, support for students' ideas, use of praise and individual attention to students, and monitoring students' progress in learning (Ashton & Webb, 1986; Hoy & Woolfolk, 1993; Tschannen-Moran & Hoy, 2001; Woolfolk & Hoy, 1990). They also more likely employ constructivist approaches in their teaching (Temiz & Topcu, 2013).

Regarding familiarity with the content and inquiry, Fulp (2002) provided informative descriptive data. The average time spent per day teaching elementary school science was 25 min compared to 114 min per day for language-arts instruction. In addition, only 41% of the time for science instruction was allocated to teaching inquiry skills. Teachers with low self-efficacy for teaching with inquiry across studies and different disciplines seemed to avoid planning classroom activities that were beyond their scope of capabilities, spent relatively less time searching for relevant curriculum material, and exerted less effort to seeking appropriate ways to teach subject matter in a manner that promotes students' better understanding.

The broader literature also pointed to another potential correlate of the level of inquiry self-efficacy. Depending on the types and sources of uncertainty, some teachers harbor doubts about the use of any new or innovative pedagogical approaches. Such doubt can lead teachers to avoid teaching a subject and eventually devalue the importance of the curriculum content or the effectiveness of the instructional methods in question (Wheatley, 2000). Although teachers' doubts are usually associated with problematic situations, they can also be regarded as informative for purposes of professional development. For example, doubts about the efficacy of one's current practices can be an impetus to support educational change or implement different pedagogical approaches. Teachers can also progress from strength to strength, expanding their successful repertoires of content and pedagogy. Schunk (1994) described how students' positive efficacy beliefs about learning lead to greater effort, self-regulation, and achievement, despite doubts regarding their present level of self-efficacy.

## 9. Fostering self-efficacy for inquiry-based instruction

### 9.1. Preservice and earlier experiences

The 33 selected studies highlighted nine prior experiences that enhanced self-efficacy for inquiry teaching. Many can possibly be encompassed by the frequent reference to authentic inquiry being built into teaching-methods courses. All are also, in a way, variations or extensions of the first. Specific examples reported in the studies were:

- (1) Receiving extensive practice implementing inquiry instruction.
- (2) Modeling inquiry instruction.
- (3) Having research experiences during teacher education.
- (4) Support from mentors for trying inquiry, such as from instructors and practicum teachers.
- (5) Visiting inquiry classes in action.
- (6) Experiencing out-of-school teaching sites such as museums and nature centers.
- (7) Reflecting on past inquiry experiences in relation to planning instruction.
- (8) Examining personal beliefs with regard to learning and teaching.
- (9) Having had earlier research experiences.

Other research by Crawford (1999) addressed having a mentor, reflection, having a clear vision of one's objectives, and collaboration using outside resources. The importance of research experiences has been reiterated by Hohloch, Grove, and Bretz (2007) who, in addition, stressed active engagement in inquiry-based experiences. Gitlin, Barlow, Burbank, Kauchak, and Tracy Stevens (1999) elaborated upon preservice teachers having research experiences, notably, reflecting on what is meant by research, and having field placements that welcome research and inquiry. They specifically recommended action research a way to connect these elements. Eick, Ware, and Williams (2003) also emphasized specifically structured, extensive field experiences that focus on inquiry-learning procedures.

Several additional studies have supported the importance of extensive practice with inquiry to overcome a propensity to focus on day-to-day survival in the classroom (Haney & McArthur, 2002; Zembal-Saul, Blumenfeld, & Krajcik, 2000; Zembal-Saul, Krajcik, & Blumenfeld, 2002). Practice with variability is, of course, key to mastering any complex skill. Chichekian et al. (2016) demonstrated the kind of misalignment to which the earlier-cited literature referred, and the need to actually observe teaching in addition to assessing self-efficacy (this study met the search criteria but it was conducted later). Six teachers, part of a larger group followed through their final year of preservice teacher education, were observed five times over the course of their first year as full-time teachers. Although self-efficacy to teach with inquiry decreased during that year, the observed implementation of elements of inquiry persisted or increased in their teaching. The authors interpreted the divergence as reflecting increasing awareness of the challenge of teaching in general and with inquiry in particular, accompanied by determination to keep trying to create what they had learned was an appropriate learning environment. This outcome also challenges the premise with which we began, namely, that teachers would be more likely to plan for and conduct inquiry-based teaching when they are self-efficacious about being able to appropriately use inquiry methods to achieve valued goals. The equation clearly contains more than just these two variables.

### **9.2. Workplace experiences**

The selective search identified two main workplace contributors to continued development of self-efficacy for inquiry instruction:

- (1) Having support and mentoring from colleagues and administrators.
- (2) Participating in extended, inquiry-focused professional development.

The initial search appeared to capture the key sources on these relatively specialized insights. Shulman (1987) further emphasized the importance, however, in both initial training and professional development, of integrating or balancing subject matter with instructional capabilities, the combination of which he labeled pedagogical content knowledge.

### **10. Challenges associated with inquiry-based pedagogy**

The criterion-selected 33 studies identified main challenges to self-efficacy for implementing inquiry-based teaching:

- (1) Having had insufficient opportunities to experience success with inquiry teaching.
- (2) Lacking a sophisticated understanding of teaching with inquiry.
- (3) Having limited notions of how knowledge is created in disciplines (teachers or their students).
- (4) Anticipating or experiencing negative student reactions.
- (5) Anticipating or experiencing negative reactions or lack of support from supervising teachers, parents, colleagues, and school personnel.
- (6) Working with curriculum and materials that are not designed with inquiry in view.
- (7) Fearing failure to meet standards or balance them with inquiry.
- (8) Perceiving a lack of time or resources.

The reality of lack of support from parents for specific inquiry-related pedagogical practices was demonstrated by Saunders-Stewart, Walker, and Shore (2013). Parents rated the importance of working in groups and sharing results lower than did the teachers in the sample. Teachers described these as essential in practice, but parents put conditions on the acceptability, primarily related to equitable student contributions.

With regard to how knowledge is created, understanding inquiry processes in more than one domain can also influence teachers' self-efficacy (Levy, Thomas, Drago, & Rex, 2013). Elementary-school teachers in particular, and many secondary-school teachers, sometimes need to provide students with inquiry experiences in which they have not been trained or even to scaffold cross-disciplinary curriculum projects.

In a substantial review of the literature, also informed by his many empirical investigations, Windschitl (2002) observed that teachers find implementing what he referred to as constructivist instruction more difficult than experts at the time were acknowledging. His analysis was highly consistent with the above list. He noted that barriers existed at many levels including conceptual, pedagogical, cultural, and political. What teachers do and perceive they are allowed to do is a combination of their beliefs and external influences (some likely real, some perceived). The end result, in practice, can be compromised in instructional choices, time allocations, and selection of curricular materials. Windschitl supported actions that enable teachers to allow them to reflect on and question personal beliefs as well as practices in their classrooms and schools.

### **11. Concluding remarks and future directions**

This review reinforced that teachers with previous research experience and early exposure to inquiry instruction during their undergraduate years feel more self-efficacious implementing inquiry as a pedagogical approach. Previous studies typically analyzed whether or not students had previous inquiry experiences. One of the contrasts that caught our attention in the literature we reviewed was that teachers with extensive inquiry experiences viewed implementation challenges in terms of teaching and student learning. They were convinced of the value of inquiry notably for their students and believed that perseverance was the key to promoting inquiry, even when confronted with negativity during their placement experience. Their reflective capacity distinguished them from the pre-service teachers with limited inquiry experiences whose main concerns related to time, curriculum, materials, and the potential negative reactions of others.

Despite the predominance of research about science education and the specific list of practices in scientific inquiry, other disciplines feature their own distinct educational processes and ways of producing knowledge. Examining self-efficacy in specific discipline-based inquiry tasks can highlight commonalities as well as those that are unique to each area. Understanding how inquiry-based instruction differs from one discipline to another is especially beneficial for elementary school teachers who can make this distinction visible to their students.

Although past research has explored self-efficacy for inquiry-based teaching, and has typically done so within disciplines (notably science), there has not been research comparing the nature of such self-efficacy in relation to the different ways of knowing (e.g. what constitutes evidence and how best to gather and evaluate evidence) across disciplines. It would be useful to directly compare the nature of self-efficacy for inquiry instruction in different disciplines; the challenge would be to find teachers at the elementary level with anything close to comparable pedagogical-content knowledge across subject matter, or secondary teachers trained in and teaching in more than one domain. To do this, the literature-search strategy would need to shift from teachers to learners and teaching to learning.

### **12. Future directions**

Education is currently changing paradigms toward models valuing and requiring inquiry-based pedagogy (e.g. European Commission, 2007; NGA/CCSSO, 2010; UNESCO, 2008). Greater protection and support need to be in place when considering the induction-year experiences of novice teachers. Beginning teachers are often handed the least-desirable classes and most challenging teaching roles because of their lower ranking in the status hierarchy. However, from a social-learning theoretical perspective, that would be a dysfunctional practice because it encourages novice teachers to lean toward a lower sense of efficacy that, unless modified in a short period of time, could lead to decreased effort and enthusiasm on the part of the novice teacher for the length of his or her career.

Teachers' self-efficacy has become an important construct in educational research and continuing to explore how this construct develops during teacher education and during the first years of the profession is imperative to determining the contributing factors that encourage strong and positive teaching efficacy in varied domains. Given that information can be filtered such that similar beliefs can have differing outcomes, it would be insightful to investigate how teachers make the link between their self-efficacy beliefs and practice, which conditions produce different outcomes within teachers with similar self-efficacy beliefs, and how one transfers self-efficacy without losing motivation. Lastly, concerns about self-reporting inflated self-efficacy perceptions with regard to inquiry-based instruction also need to be investigated because of social-desirability bias (Ones, Viswesvaran, & Reiss, 1996). Social-desirability bias refers to the possibility of respondents reporting what they perceive is socially desirable or thought to be expected, rather than what might be the actual case. There is a possibility for social-desirability bias to occur within this line of research because inquiry-based instruction involves a complex decision-making process in which teachers struggle with the tension between guiding students toward a set of predetermined goals and sharing with goal-setting with students. Teachers are also aware of policies leaning in favor of such pedagogy.

Understanding how a teacher's actual instruction is influenced by self-efficacy would call for an investigation about connections between current findings and future teaching practices. Preservice teachers and teachers in general are likely to vary in their levels of self-efficacy; some will be more self-efficacious for some types of inquiry models, and less efficacious for other types of inquiry models. For example, how does a preservice teacher's self-efficacy fluctuate when we remove support systems such as the cooperating teacher or supervisor's support? Would this lack of support lead to teaching practices that no longer reflect inquiry-oriented teaching methods? Understanding the connections between self-efficacy and teaching using inquiry, as well as the ability to apply this knowledge to classroom practices might also shed light on the long-term effects of inquiry-oriented undergraduate instruction. Moreover, it might also help find an answer as to why teachers frequently combat lack of time for inquiry teaching versus content coverage.

Despite abundant research about teachers and teacher-education, limited studies have described specifically the expectations and challenges faced during the transition phase in which a preservice teacher who just graduated from a teacher-education program that uses various instructional strategies to create a social-constructivist learning environment, enters the first year of the teaching profession as an inquiry-oriented teacher. There appears to be a need for more research that investigates self-efficacy beliefs for specific approaches to inquiry-based instruction: How do sources of self-efficacy (mastery, vicarious experiences, social persuasion, physiological state) contribute to the development of self-efficacy for inquiry-based instruction? How do preservice teachers' self-efficacy beliefs for different instructional approaches (e.g. inquiry, direct instruction) compare to one another? As indicated in Table 1, the literature speaks about self-efficacy in a nonspecific way and does not divide it in terms of inquiry experience. Empirical explorations about which particular inquiry approaches teachers appear self-efficacious for enacting inquiry in the classroom and in what domains—these could differ—and which inquiry methods are regarded as less efficacious for implementing, would render theoretically and methodologically stronger constructs. This could lead to further discussion as to why preservice and new teachers might be more confident about using certain inquiry methods and less confident about others.

Given that most efficacy research has been self-report, survey, and correlational in nature, other research designs that are more experimental, quasi-experimental, or longitudinal are more likely to shed light on the complex interplay between sources of efficacy information and efficacy development, not just give a snapshot of teacher perceptions and capabilities as revealed by cross-sectional studies. With the current and potential educational value of the self-efficacy construct, efforts to impact changes in teacher efficacy would be valuable in moving this line of research beyond correlational designs to also include the context of the daily realities of teaching which could indicate why there is a mismatch between teachers' ideas about instruction and their actual practices. Pajares (1997) noted two strategies to address this methodological weakness: Investigate through direct

observation rather than rely on self-reports, and increase the use of experimental techniques (i.e. manipulations and interventions). The causality question remains a challenge; although it is clear that prior inquiry experiences (they are prior by definition) impact later efficacy, we do not know if we should try to improve self-efficacy by first providing the previously missing underlying research experiences, or if we should proceed directly to teaching inquiry-related instructional skills. Research on professional development suggests that the latter can work, but can both approaches work better?

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### Author details

Tanya Chichekian<sup>1</sup>

E-mail: [tanya.chichekian@mail.mcgill.ca](mailto:tanya.chichekian@mail.mcgill.ca)

Bruce M. Shore<sup>1</sup>

E-mail: [bruce.shore@mcgill.ca](mailto:bruce.shore@mcgill.ca)

<sup>1</sup> Department of Educational and Counselling Psychology, Faculty of Education, McGill University, 3700 McTavish, Montreal, QC, Canada H3A 1Y2.

<sup>5</sup> Current address: Tanya Chichekian is now at Dawson College and Université du Québec à Montréal.

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