

# Teachers' Experiences of an Inquiry Learning Training Course in Finland

Essi Ahokoski, Miikka Korventausta, Koen Veermans, Tomi Jaakkola

Department of Teacher Education, University of Turku, Finland

\*Corresponding author: esamah@utu.fi

## ABSTRACT

This paper reports outcomes of a 2-day inquiry learning training course for in-service teachers (N=102) with a specific focus on teachers' self-efficacy beliefs, perceptions of inquiry learning, and satisfaction with the training course. Teachers' self-efficacy and their perceptions of inquiry learning were measured both at the beginning and at the end of the training course. Satisfaction with the training course was measured only at the end of the training. The study identified three distinct self-efficacy profiles among the participants: Low, moderate, and high. The self-efficacy of teachers belonging to the high and the moderate group remained unchanged throughout the training, while the self-efficacy for student engagement improved in the low-efficacy group. At the beginning of the training course, differences were found between the low and high self-efficacy profiles in terms of teachers' perceptions of resources for inquiry learning and their anxiety toward inquiry learning; however, only the former difference remained based on the post-test results. Interestingly, although there were three clear self-efficacy profiles and these groups also differed in terms of prior experiences with inquiry learning, all teacher groups were both satisfied in general with the training course and with the utility value of the training.

**KEY WORDS:** inquiry learning; self-efficacy; teacher training; professional development; science teaching

## INTRODUCTION

About a decade ago, several reports (e.g., OECD, 2006; Rocard et al., 2007; and Sjøberg and Schreiner, 2010) pointed out a decline in students' interest toward science. It was also highlighted that the development of students' conceptual understanding, critical thinking skills, and their expectations of studying for a career within the field of science are highly related to how science is being taught in schools. Together, these findings have resulted in initiatives that aim to provide students with science activities that are both effective and inspiring. The most recent PISA assessment from 2015 reported promising results in comparison to these previous outcomes (e.g., OECD, 2006; Rocard et al., 2007; Sjøberg and Schreiner, 2010) in terms of students' interest toward science (Gurría, 2016). These outcomes lend support for the European Union's decision to continue funding research and development projects that aim to reform the science and mathematics education across Europe.

### Ark of Inquiry and Inquiry Learning

Ark of Inquiry is one of the EU research and development projects that have received funding from the European Union's Seventh Framework Programme. The project aims to support teachers by providing training and resources for implementing inquiry learning in science education. The project also aims to make inquiry learning accessible to all students and educators due to an increasing consensus that science teaching should be based on an inquiry learning approach with a focus on developing understanding about scientific inquiry instead of

only focusing on the traditional subject matter (Anderson, 2007; Lederman et al., 2014; Mant et al., 2007; Slavin et al., 2014). More specifically, the project aims to increase students' interest in science by providing ideas and resources for implementing inquiry learning in schools. The project is founded on an idea of creating a "new science classroom" that provides challenging and exciting ways for learning science through authentic scientific learning experiences. An important part of this vision is to train teachers to support students' inquiry activities in a manner that attracts their interest and motivation toward science as a topic and profession. This study defines inquiry learning as a learner-centered pedagogical approach that aims to involve learners in the scientific discovery process by allowing them to act as real scientists and to participate in scientific investigation to construct new knowledge (Anderson, 2007; Keselman, 2003). In other words, inquiry learning is a form of self-directed learning that includes discovering causal relationships by following the steps of scientific inquiry: Formulating hypotheses, making observations, and/or conducting experiments to test the hypothesis (Pedaste et al., 2012).

### Challenges in Implementing Inquiry Learning in Classrooms

Even though recent meta-analyses (Furtak et al., 2012; Lazonder and Harmsen, 2016) have provided evidence on the effectiveness of inquiry learning in contrast to a traditional teacher-centered deductive approach, the pedagogical reform of implementing inquiry learning in science education has not

proceeded as expected. The development of science teaching in general is, according to Lewthwaite (2006), influenced by several factors simultaneously: Teachers' personal attribute factors (i.e., interest, motivation, teaching efficacy, and professional science knowledge), environmental factors (i.e., limited time and resources and insufficient external support from the school community), and the interaction of these factors. These factors are also in line with the previous studies (e.g., Choi and Ramsey, 2009 and Ramnarain, 2016) that have investigated factors that specifically influence the implementation of inquiry learning. Yoon et al. (2012) studied the implementation process in more detail, and they found that difficulties are often caused by the open nature of inquiry, teachers' uncertainty of the level of guidance needed in the learning process, teachers' insufficient knowledge of the role of hypotheses in scientific inquiry, and teachers' unconfidence about their science content knowledge.

Inspired by the previous research, this study aimed at investigating whether an inquiry learning training course that was designed in the context of the Ark of Inquiry project had an effect on some of the external and personal attribute factors of teachers in the context of implementing inquiry learning in the classroom. The specific focus was to measure (1) teachers' self-efficacy beliefs in terms of instructional strategies, classroom management, and student engagement, (2) teachers' perceptions toward inquiry learning, and (3) their satisfaction with the training course.

### *Teachers' self-efficacy*

This study investigated teachers' self-efficacy beliefs, which are defined as teachers' own beliefs of their abilities to teach to reach desired educational outcomes (Skaalvik and Skaalvik, 2007). Moreover, teacher self-efficacy is seen as "teachers' belief or conviction that they can influence how well students learn, even those who may be considered difficult or unmotivated" (Guskey and Passaro, 1994, p. 628).

The definition of teacher self-efficacy springs from Bandura's (1997) theory of self-efficacy. He defines self-efficacy as an individual's belief of his or her own ability to perform an act at a certain level and in a given context to reach the desired outcomes (Bandura, 1997). According to Bandura (1997), personal efficacy is one of the most central mechanisms which has an influence on human behavior. It is found to be a multidimensional and a context-specific construct (Zimmerman and Cleary, 2006), which has an influence on the self-regulation of motivation and the amount and persistence of the effort used for performing an act (Bandura, 1977). Furthermore, these beliefs are found to have their own unique contribution beyond the capabilities for achieving the desired outcomes (Bandura, 1997).

Based on the previous research, teacher self-efficacy has been found to have an influence on teacher performance (Appleton and Kindt, 2002; Holzberger et al., 2013; Klassen and Tze, 2014; Rice and Roychoudhury, 2003), teachers' attitudes toward implementing new and innovative teaching strategies

(Evers et al., 2002; Guskey, 1988), the amount of effort teachers devote for teaching (Tschannen-Moran and Hoy, 2001), and students' academic achievement (Caprara et al., 2006; Klassen and Tze, 2014). On the contrary, in a longitudinal study by Holzberger et al. (2013), an increase of teacher self-efficacy has been found to be a consequence of different educational phenomena, i.e., students' positive experiences of cognitively challenging tasks and teachers' positive experiences of improved classroom management (Holzberger et al., 2013). Furthermore, it has been found to increase as a result of improved students' academic achievement (Caprara et al., 2006), improved student motivation (Collie et al., 2012), and improved student behavior (Collie et al., 2012). Positive experiences of collaboration between teachers (Collie et al., 2012; Shachar and Shmuelevitz, 1997) and teachers' experiences of support (Hoy and Spero, 2005) have also been found to strengthen teachers' self-efficacy beliefs.

This study aimed at investigating the effect of an inquiry learning training course on teachers' self-efficacy beliefs in the context of implementing inquiry learning in the classroom. A recent meta-analysis investigating the relationship between self-efficacy and training transfer suggested that the strength of teachers' self-efficacy beliefs prior and after the training has an influence on how productively the acquired knowledge and skills are implemented after the training. The study also found that the relationship was stronger after the training, highlighting both the possibility of influencing self-efficacy through training and its positive effect on transfer (Gegenfurtner et al., 2013). This suggests that an increase in self-efficacy could be an equally important outcome of teacher training as deepening content knowledge, which has traditionally been the primary focus in teacher training (Ertmer, 2001; Roberts et al., 2001; Tschannen-Moran and Johnson, 2011).

### *Teachers' perceptions toward inquiry learning*

A natural interest of exploring teachers' perceptions of inquiry learning rose from the fact that the topic of the training course was inquiry learning. Furthermore, as the aim of the training course was to influence teachers' teaching practices, further inspiration came from prior research on the positive association between teachers' conceptions of science teaching and the extent to which teachers used inquiry-based teaching methods in their classroom (Lotter et al., 2007). It has been suggested that to influence teachers' teaching practices also their understanding and beliefs need to be influenced (Kazempour, 2009). A case study by Choi and Ramsey (2009) found that teachers' beliefs and attitudes were positively influenced by a training course that focused on increasing their understanding about inquiry learning. In addition, most of the teachers reported that they had implemented an inquiry learning approach in their teaching at least in some degree after the training and that they were willing to plan more inquiry activities in the future. The study concluded that when teachers felt comfortable with inquiry-based teaching methods, they were more likely to use these methods with their students (Choi and Ramsey, 2009).

Previous research suggests that teachers would benefit from training courses that help to alleviate their uncertainty toward implementing inquiry learning in the classroom. In fact, training courses, in concert with good quality materials, may be the most efficient method for mitigating teachers' lack of academic preparation in science (Nowicki et al., 2013). As such, training courses can have an important role in reforming science education (Choi and Ramsey, 2009). As teachers' perceptions on teaching spring from their personal learning experiences, providing meaningful experiences through training for in-service teachers may therefore also affect their self-efficacy in this respect.

### *Satisfaction with training*

This study also focused on exploring teachers' reactions to the training by exploring how satisfied they were with the training course. The aim was to investigate whether the training course was able to provide sufficient tools and support for teachers with different levels of self-efficacy and different perceptions toward inquiry learning and to collect information on how to improve the design and delivery of the training course in the future. Measuring teachers' satisfaction was considered important since this study did not specifically measure the development of teachers' professional science knowledge in terms of how to implement inquiry learning in the classroom. Gathering information on participants' reactions to the training is, according to Guskey (2000), one of the five levels of evaluating the process of professional development.

### **Ark of Inquiry Training Course**

With the above notions in mind, an inquiry learning training course was developed as a part of the Ark of Inquiry project to address the needs of science educators in Europe. The training course aims to enhance teachers' knowledge base with regard to inquiry learning. It provides teachers with experiences in inquiry learning (both from a learner and from a teacher perspective) based on less open and well-designed inquiry learning activities. It also encourages reflecting upon these experiences to take away some of the uncertainties that teachers may have towards inquiry learning and that withhold them from a higher uptake of inquiry learning in their classrooms. Ideally the training course also aims to even affect teachers' general self-efficacy in teaching.

The training course consists of the following three modules:

1. In teachers as learners, module teachers are given an opportunity to experience the same inquiry learning journeys that their pupils are expected to follow.
2. In teachers as thinkers, module teachers reflect on the learning process that they experienced as learners, identify key elements of that experience (e.g., core content and potential difficulties pupils might experience), and based on these experiences, design an inquiry learning lesson.
3. In teachers as reflective practitioners, module teachers reflect on the implementation of the inquiry learning lesson in the classroom.

The localized version of the training course, on which the results of the present study are based on, consisted of the following three sessions.

1. Training day 1: The first session lasted for approximately 4 h, and it covered the above modules 1 and 2.
  - a. At the beginning of this session, the teachers were given a general introduction to the Ark of Inquiry project and inquiry learning, after which they conducted a miniature inquiry activity as learners (they had to figure out the underlying mechanism of a "misbehaving" water container based on the output data).
  - b. After this, the teachers were given an in-depth explanation of the Ark of Inquiry learning model with the idea that the model would help teachers to identify different aspects and phases of inquiry, and thus enable them to have more control over the implementation of inquiry learning and the monitoring of students' progress. The Ark of Inquiry model is based on a systematic literature review on inquiry learning models and is cyclic in nature (Pedaste et al., 2015). This model consists of five phases, of which some include subphases: Orientation, conceptualization (subphases: Questioning and Hypothesis Generation), investigation (subphases: Exploration or Experimentation, which lead to Data Interpretation), and finally, the conclusion phase. The discussion phase (subphases: Reflection and Communication) is embedded within all of the abovementioned inquiry phases as it is seen as an important feature of all phases of scientific inquiry. The inquiry cycle is an entity in which the phases are flexibly connected, and hence, it can be widely implemented in different learning contexts (Pedaste et al., 2015).
  - c. In the next step, the teachers were given hints on how they could evaluate pupils' knowledge and skills regarding inquiry learning and how they could tailor existing inquiry activities according to their needs. For these purposes, the project has developed pedagogical scenarios and evaluation instruments. It is common that learning materials need modifications and additions before they can be used in the classroom. Six pedagogical scenarios have been developed that guide teachers to evaluate, redesign, improve, and adapt inquiry activities in their classrooms. The evaluation system (that includes various evaluation instruments) used throughout the Ark of Inquiry project assesses pupils' progress in inquiry proficiency by measuring their inquiry skills.
  - d. In the last part of the first training session, the teachers registered and logged into the Ark of Inquiry platform, after which they were given guidance on how to search for inquiry activities within the platform. The current version of the Ark of Inquiry online platform includes approximately 560 ready-to-use inquiry

learning activities in 13 different languages that are targeted at students from 7 to 18 years of age. The activities have been evaluated and carefully selected based on how well they support practising of scientific inquiry in STEM domains. The activities follow the Ark of Inquiry learning cycle that constitutes a frame for scientific investigation.

- e. As a “home assignment,” the teachers were asked to search and select one inquiry activity from the platform or to use their own pre-existing materials and modify them if necessary with the help of the six pedagogical scenarios. Teachers were then asked to implement that inquiry activity in the classroom. This setup gave teachers two options to lower potential feelings of uncertainty. The first, using an activity from the platform, ensured that they were using a structured and well-designed inquiry activity, while the second gave them the opportunity to connect new perspectives from the first session with a familiar activity.
2. Implementation of inquiry learning in the classroom: In the second session, the teachers implemented the self-selected or -designed inquiry activity in their classrooms on their own. They had about a month from the 1<sup>st</sup> training day to implement the activity with their students. Depending on the selected activity, the duration of the second session varied from 2 to 6 h.
3. Training day 2: In the third and final session, which lasted for approximately 3 h, a group of teachers exchanged their ideas and experiences from the implementation of the inquiry activities. More specifically, everyone gave a short (~10 min) presentation of the inquiry learning lesson that they had designed and implemented and reflected on their experiences from it. Each presentation was followed by a group discussion feedback session. The day ended with a general discussion on how these experiences could be used and extended to further innovate the teaching practices of the school.

## Research Questions

The main research questions of this study are as follows:

1. What kind of self-efficacy profiles can be identified among teachers attending the inquiry learning training course?
2. Does the inquiry learning training course change teachers' self-efficacy beliefs within different self-efficacy profiles?
3. How do the perceptions of inquiry learning vary between different self-efficacy profiles, and do these change during the training?
4. Does the satisfaction with the inquiry learning training course vary between different self-efficacy profiles?

## METHODS

### Participants

The participants of the study were 106 in-service teachers from six schools in five Finnish cities who attended the Ark of

Inquiry training course. The training course was mandatory to all teachers in five of the participating schools, whereas it was optional for teachers in one of the schools (n=9). The answers of four participants were excluded from the data analysis as their pre- and post-test answers were not distinguishable due to inaccurate dates on questionnaires. The final participant group included 102 teachers, of which 81 were females (79.4%) and 21 males (20.6%). The average age of the participants was 42.0 (standard deviation [SD]=9.25) years, with a range from 23 to 62 years old. Within this sample, 70 teachers worked in primary education, 17 worked in secondary education, 10 worked in both, and 1 teacher worked in both secondary and upper secondary education. Four teachers did not report the level of education at which they were teaching.

### Instrumentation

A Finnish translation of the Ohio State Teacher Efficacy Scale (Tschannen-Moran and Hoy, 2001), which in the recent research has been referred to as Teachers' Sense of Efficacy Scale (TSES) (e.g., Daniels et al., 2017; Dixon et al., 2014; and Klassen and Chiu, 2010), was used to measure teachers' self-efficacy beliefs in three areas of teaching. TSES was chosen because it has been widely used in the field of education for assessing factors that influence teachers' self-efficacy (e.g., Çetin, 2017; Fives and Buehl, 2009; and Poulou, 2007). It is available in two versions: A 24-item version and a shorter 12-item version, of which the longer was used in this study. Items were answered on a 9-point scale ranging from 1 (nothing), 3 (very little), 5 (some influence), 7 (quite a bit) to 9 (a great deal). TSES contains three subscales. The first, efficacy for instructional strategies (8 items, pre-test  $\alpha=0.82$ , post-test  $\alpha=0.83$ , e.g., to what extent can you use a variety of assessment strategies?), assesses teachers' self-reported abilities to use and vary between different teaching strategies to adjust the lessons according to students' ability levels. The second subscale, efficacy for classroom management (8 items,  $\alpha=0.77$ , post-test  $\alpha=0.79$ , e.g., how much can you do to control disruptive behavior in the classroom?), assesses teachers' self-reported abilities to maintain order in the classroom. The third, efficacy for student engagement (8 items, pre-test  $\alpha=0.81$ , post-test  $\alpha=0.75$ , e.g., how much can you do to get students to believe they can do well in school work?), assesses teachers' self-reported abilities to support and motivate students.

Teachers' perceptions of inquiry learning were assessed with a 23-item questionnaire that was devised in the context of the Ark of Inquiry project and translated into Finnish to fit the purposes of this study. The items included in the scale asked teachers to rate their perceptions toward inquiry learning on a 4-point scale ranging from “strongly disagree” (1) to “strongly agree” (4). The questionnaire had no a priori subscales. Cronbach's alpha for the full questionnaire was 0.711, which can be considered low with 23 items. The low total alpha together with some items having almost zero correlation with the total indicated that the questionnaire did not measure a single construct. Exploratory factor analysis (maximum likelihood with Oblimin rotation) was conducted to form subscales based

on the pre-test. The analysis indicated the presence of six factors, of which the last two factors were discarded because they centered around one question, and therefore, did not form reliable subscales. In addition, one item was excluded because it had only weak loadings on multiple factors. The four remaining factors explained 45% of the variance in the questionnaire. After inspection of the items, the four factors could be labelled in accordance with previous research (van Aalderen-Smeets et al., 2012). Positive attitude toward inquiry learning (7 items, pre-test  $\alpha=0.79$ , post-test  $\alpha=0.78$ ) included statements indicating a general positive stance toward inquiry learning. Anxiety toward inquiry learning (4 items, pre-test  $\alpha=0.79$ , post-test  $\alpha=0.81$ ) included items relating to uncertainty and unconfidence to implement inquiry learning in the classroom. Resources for inquiry learning (4 items, pre-test  $\alpha=0.74$ , post-test  $\alpha=0.65$ ) included statements relating to availability of materials, time, and tools for implementing inquiry learning. These three factors formed reliable subscales without modifications. The last factor, external support for inquiry learning, included statements relating to the external support from colleagues or the curriculum. Here, one item (successful IBL requires students to have extensive content knowledge) was excluded to maintain a moderate reliability of the subscale on the post-test (4 items, pre-test  $\alpha=0.72$ , post-test  $\alpha=0.69$ ). This resulted in a 19-item scale, which was used in later analyses. Examples of items within the subscales and the four excluded items are presented in Appendix 1.

Teachers' satisfaction with the training course was measured with 13 items that asked teachers to rate their satisfaction with the inquiry learning training course on a 4-point scale ranging from "strongly disagree" (1) to "strongly agree" (4). Following the same procedure as for the perceptions of inquiry learning items, two subscales were created that together explained 61.8% of the variance among the items. The first, general satisfaction (8 items,  $\alpha=0.92$ ), included statements relating to the length, structure, and relevance of the training. The second, utility satisfaction (5 items,  $\alpha=0.76$ ), included statements relating to tools and concepts for implementing inquiry learning in the classroom. Examples of items within the subscales are presented in Appendix 2.

Self-efficacy and perceptions of inquiry learning instruments were both used at the pre-test (at the beginning of the first session) and at the post-test (at end of the third session). Satisfaction with the training course questionnaire was used only at the post-test.

## RESULTS

### Teacher Self-efficacy Profiles

To identify teacher self-efficacy profiles, k-means cluster analyses were conducted based on the responses of 79 teachers that responded to the self-efficacy questionnaire at the pre-test<sup>1</sup>. Based on the results, a three-cluster solution was chosen

1 The sample size dropped from 102 to 79 due to the fact that the training course was run with a tight schedule and with the primary emphasis on the

because it (a) gave clusters of meaningful size and (b) allowed a clear interpretation of the profiles (low, moderate, and high self-efficacy). The cluster sizes resembled normal distribution with 23% of the teachers belonging to the low<sup>2</sup>, 47% to the moderate, and 30% to the high cluster.

The low self-efficacy profile cluster included 18 teachers. In this profile, the mean of every self-efficacy subscale was the lowest compared to the other self-efficacy profiles, and within the three subscales, the teachers were the most unsure about their abilities in relation to instructional strategies. Within this profile, 16 teachers were females (89%) and 2 were males (11%). Seven teachers (39%) had previous experiences in inquiry learning, 8 teachers (44%) did not, and 3 teachers (17%) did not answer the question.

The moderate self-efficacy profile cluster included 37 teachers making it the largest of the three profiles. This group included teachers with an already rather high sense of efficacy for instructional strategies, classroom management, and student engagement, with the efficacy for classroom management being a bit higher even than the others. There were 27 females (73%) and 10 males (27%) within this profile. Twenty-five teachers (68%) in this profile had previous experiences in inquiry learning, 6 teachers (16%) did not, and 6 teachers (16%) did not answer the question.

The high self-efficacy profile cluster included 24 teachers who reported the highest level of self-efficacy on all three self-efficacy subscales. Within this profile, there were 20 females (83%) and 4 males (17%). Sixteen teachers (67%) in this profile had previous experiences in inquiry learning, 2 teachers (8%) did not, and 6 teachers (25%) did not answer the question.

Descriptive statistics for each self-efficacy factor for each self-efficacy profile are shown in Table 1. One-way ANOVA and Tukey's *post hoc* tests revealed that with the exceptions of efficacy for classroom management between the moderate and the high self-efficacy profile and efficacy for student engagement between the low and moderate self-efficacy profiles, the three clusters differed significantly on all self-efficacy subscales,  $p<0.05$ .

### Changes in Teachers' Self-efficacy

Paired-samples t-tests were conducted to investigate the changes of the self-efficacy scores within the self-efficacy profiles between the pre- and post-test. These tests showed no significant pre-post differences within the moderate and high self-efficacy profiles ( $p>0.05$ ), whereas in the low self-efficacy profile teachers' self-efficacy for student engagement increased significantly during the training. The means, standard deviations, and the t-test results are shown in Table 2.

training; some teachers simply run out of time and thus could not answer to the questionnaires.

2 Based on scores alone the low self-efficacy could be qualified as moderate, but because it is lower in comparison to the other two clusters, and because teachers should have at least moderate self-efficacy, they are considered low in the context of this study.

**Table 1: Self-efficacy subscale scores of the self-efficacy profiles**

Profile	n	Mean ± SD		
		Student engagement (1–9)	Classroom management (1–9)	Instructional strategies (1–9)
Low self-efficacy	18	5.78±0.57	5.94±0.75	5.49±0.67
Moderate self-efficacy	37	6.31±0.52	6.81±0.47	6.41±0.44
High self-efficacy	24	7.39±0.60	7.46±0.47	7.50±0.45

SD: Standard deviation

**Table 2: Pre- and post-test means of the self-efficacy subscales across the profiles**

Profile	Variable	Mean ± SD		t	p
		Pre-test	Post-test		
Low self-efficacy (n=11)	SE	5.85±0.49	6.27±0.51	2.590	0.027
	CM	6.13±0.51	6.37±0.76	1.737	0.113
	IS	5.50±0.71	5.92±0.65	1.457	0.176
Moderate self-efficacy (n=29)	SE	6.35±0.51	6.55±0.47	1.846	0.076
	CM	6.78±0.47	6.81±0.65	0.205	0.839
	IS	6.39±0.44	6.56±0.58	1.583	0.125
High self-efficacy (n=17)	SE	7.44±0.60	7.27±0.79	-1.552	0.140
	CM	7.40±0.48	7.22±0.61	-1.217	0.241
	IS	7.59±0.40	7.36±0.64	-1.277	0.220

SE: Student engagement, CM: Classroom management, IS: Instructional strategies. The sample of these analyses includes only teachers who responded to all scales on the pre- and post-test (n=57), and as a result, means are not exactly the same as in Table 1. No corrections against type I error were made for paired t-tests. This decision was based on the results of the linear mixed model (LMM) analyses that were run on the data. In particular, the LMM for self-efficacy on student engagement suggests that, by correcting against type I error, we would most likely conduct a violation against type II error; the LMM showed both a significant main effect for test phase,  $F(1, 61.685)=5.382, p=0.024$ , suggesting overall significant change from pre-to-post, and a significant interaction effect between the test phase and the self-efficacy profile,  $F(2, 61.346)=4.836, p=0.011$ , suggesting that the pre-post change differed between the profiles, as also indicated by the t-tests. For the remaining paired t-tests, there were no significant results, meaning that the corrections would have no effect on the results.

### Perceptions of Inquiry Learning

To address the research question related to teachers' perceptions of inquiry learning, these perceptions were first compared on the pre-test, then on the post-test, and eventually from the perspective of change. One-way ANOVA on pre-test scores showed significant differences between the profiles in anxiety toward inquiry learning, resources for inquiry learning, and external support for inquiry learning,  $F(2,76)=6.352, p=0.027$ ,  $F(2,76)=3.776, p=0.003$ , and  $F(2,76)=3.425, p=0.038$ , respectively. Tukey's *post hoc* test results revealed that the differences were significant between the low and high self-efficacy profiles in anxiety toward inquiry learning and resources for inquiry learning,  $p=0.002$  and  $p=0.021$ , respectively, whereas no significant differences were detected between the conditions in external support for inquiry learning subscale. No other significant differences were detected. Similar analyses on inquiry learning perceptions at the end of the training course (post-test) revealed significant differences between the self-efficacy profiles in resources for inquiry learning,  $F(2,54)=3.316, p=0.044$ , again between the low and high self-efficacy profiles,  $p=0.034$ . However, the differences in anxiety and external support that were observed in the pre-test disappeared during the training as no differences were found on these factors in the post-test.

Paired sample t-test on inquiry learning perceptions did not reveal significant changes from pre- to post-test within any of the self-efficacy profiles. In the context of this study, it is noteworthy that all profiles scored above 3 on the positive attitude toward inquiry learning subscale, suggesting that the teachers generally felt very positive toward inquiry learning. Similarly, relatively low scores on anxiety toward inquiry learning subscale do not immediately suggest high anxiety levels toward inquiry learning (Table 3). In the resources for inquiry learning subscale, the post-test scores between the profiles varied from 2.16 to 2.76, with the high self-efficacy group estimating the availability of resources significantly higher than the low-efficacy group. The pre- and post-test scores for external support for inquiry learning (group averages ranging from 3.00 to 3.56) indicate that teachers generally receive sufficient external support for implementing inquiry learning. The means, standard deviations, and the results of the t-test are shown in Table 3.

### Satisfaction with the Training Course

Both the general satisfaction with the inquiry learning training course ( $M=3.10; SD=0.58$ ) and the utility satisfaction ( $M=2.82; SD=0.61$ ) were high. A one-way ANOVA did not show significant differences between the self-efficacy profiles, suggesting that the groups perceived the training equally

**Table 3: Pre- and post-test means of perceptions of inquiry learning subscales across the profiles**

Profile	Variable	Mean±SD		t	p
		Pre-test	Post-test		
Low self-efficacy (n=11)	POS	3.07±0.62	3.12±0.53	0.491	0.634
	ANX	2.30±0.51	2.14±0.62	-0.939	0.370
	RES	2.00±0.59	2.16±0.59	0.971	0.190
	EXT	3.00±0.45	3.14±0.55	1.406	0.355
Moderate self-efficacy (n=29)	POS	3.07±0.50	3.03±0.53	-0.484	0.632
	ANX	2.00±0.53	1.78±0.56	-1.674	0.105
	RES	2.41±0.57	2.54±0.58	1.166	0.253
	EXT	3.11±0.58	3.32±0.53	1.279	0.212
High self-efficacy (n=17)	POS	3.36±0.36	3.39±0.33	0.339	0.739
	ANX	1.69±0.65	1.76±0.68	0.676	0.509
	RES	2.66±0.81	2.76±0.70	1.022	0.322
	EXT	3.56±0.38	3.56±0.43	0.000	1.000

POS: Positive attitude toward inquiry learning, ANX: Anxiety toward inquiry learning, RES: Resources for inquiry learning, EXT: External support for inquiry learning, SD: Standard deviation

positively, general satisfaction  $F(2,55)=1.490$ ,  $p=0.234$ , and utility satisfaction  $F(2,55)=0.847$ ,  $p=0.434$ . Although the ANOVA did not reveal significant differences between the self-efficacy profiles, it is interesting that it was the moderate group that had the lowest mean on both general and utility satisfaction (Table 4).

## CONCLUSION

Although high expectations are directed toward inquiry learning in the context of reforming science education, and even though the teachers are at the center of this reform, there are surprisingly few studies that have investigated teachers' perceptions of inquiry learning and their attitudes and beliefs around this concept. This study has reported outcomes related to teachers' self-efficacy beliefs, perceptions of inquiry learning, and satisfaction with the training course in the context of an inquiry learning training course. The first aim was to identify self-efficacy profiles among the participating teachers, which resulted in three clearly defined and different teacher profiles which were used as a basis in further analyses. The first notable difference in relation to the profiles was that the low self-efficacy profile contained a much larger percentage of teachers that had never used inquiry in their classroom before. This result is in line with prior research on teachers' previous experiences and exposure to inquiry learning and their confidence to implement the method in their classroom (Choi and Ramsey, 2009).

A study by Lumpe et al. (2000) suggests that teachers who doubt their capabilities need training courses that focus on supporting their beliefs on succeeding. Given the specific nature (inquiry learning) and the relatively short duration of the training course, it was not obvious that the course would be able to change the participants' beliefs of their teaching self-efficacy. The fact that teachers' self-efficacy for student engagement improved during the training course within the low self-efficacy group can therefore be considered an encouraging

**Table 4: Satisfaction with the training course**

Variable	Mean±SD		
	Low S-E	Moderate S-E	High S-E
GEN	3.12±0.66	2.98±0.66	3.30±0.38
UTI	2.82±0.63	2.73±0.66	2.98±0.52

GEN: General satisfaction, UTI: Utility satisfaction, SD: Standard deviation

outcome because the same factors that led to this increase may also stimulate these teachers to implement inquiry in their classrooms more often in the future. The result suggests that even relatively short training courses may have the potential to affect teachers' self-efficacy, at least among those teachers that initially have a lower sense of self-efficacy. Given that the training course reported in the present study did not focus on teachers' self-efficacy explicitly, the above outcome lends support to the general idea that training courses could and maybe should pay more explicit attention on supporting teachers in developing their sense of self-efficacy, as it has been suggested also in the literature (Ertmer, 2001; Roberts et al., 2001; Tschannen-Moran and Johnson, 2011). A reason for why the teachers of the present study experienced an increase particularly in their efficacy for student engagement could be that they were able to directly observe students' engagement and enthusiasm while working on an inquiry activity, which then immediately influenced their confidence on the matter. In case of instructional strategies, for instance, the link is perhaps less obvious and may require more explicit processing and reflection of the training experiences. Future studies should explore whether an inquiry learning training course with a longer duration could influence teacher self-efficacy on all three dimensions measured in this study.

Apart from teachers' self-efficacy, this study also investigated teachers' perceptions related to inquiry learning. At the beginning of the training course, differences were found

between the low and high self-efficacy profiles in terms of teachers' perceptions of resources for inquiry learning and their anxiety toward inquiry learning. At the end of the training course, the differences between the teacher profiles regarding resources for inquiry learning had remained, but the differences in terms of anxiety toward inquiry learning were no longer significant. Although the change from pre- to post-test was not significant, the trend of decreasing the anxiety of teachers in the low self-efficacy profile suggests that a prolonged training may be able to reduce the anxiety substantially (and significantly). In relation to the view of external resources, an interesting follow-up question would be to see whether these figures are a reflection of the reality (these teachers have less resources, which may partly explain their self-efficacy) or teachers' perceptions (meaning that self-efficacy influences how one perceives resources).

This study also assessed teachers' satisfaction with the training, and one of the interesting outcomes was that even though the training course did not have a significant impact on teachers' perceptions of inquiry learning, and although there were three clearly different profiles of teachers with respect to perceived teaching self-efficacy and these groups also differed in terms of prior inquiry learning experiences, all teacher groups were both satisfied in general with the training course and with the utility value of the training. Even though the differences were not statistically significant, it is interesting that it was the moderate self-efficacy group that reported the lowest satisfaction on both scales. This suggests that though they were not unsatisfied, there might still be something missing for the teachers in this self-efficacy profile that would enhance both their general and utility satisfaction. In the future studies, it might therefore be of interest to find more about the origins of general and utility satisfaction for teachers as this may help the design of a course that can differentiate support for teachers from all self-efficacy profiles.

This study has some limitations that should be addressed in the future research. One limitation is that the results are based solely on self-report data. Although the opinions diverge around the reliability and validity of self-reported data (e.g. Chan, 2009; Cook and Campbell, 1979), it is clear that to obtain a higher reliability, follow-up studies should employ a variety of data gathering methods (e.g., classroom observations and teacher interviews).

Another limitation was that the data were gathered only at the beginning and at the end of the training course, that is, no data were gathered during the actual implementation phase in the classrooms, though the success of the implementation likely has an effect on both teachers' self-efficacy beliefs and perceptions of inquiry learning. In relation to this limitation, more specific studies on the relationship between training, implementation of inquiry learning in classrooms, and teachers' inquiry perceptions are needed because it is surprising that the training had an effect on teachers' self-efficacy beliefs but not on their perceptions of inquiry learning. The questionnaire

that was used for measuring teachers' perceptions of inquiry learning would also benefit from further testing, for instance, can other studies replicate the subscales that were derived from EFA and could the scales be extended with new items to obtain higher reliability? In general, since inquiry learning and teachers are envisioned to play a key role in the reform of science education, more and different kinds of interventions, training courses, and studies are needed on this theme. The present study and the training course that was implemented in the context of the study form a foundation for future work.

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# Appendix

## Appendix 1: Items and reliabilities of the four subscales forming the perceptions of inquiry learning scale

Positive attitude toward inquiry learning (7 items,  $\alpha$  [pre-test]=0.79,  $\alpha$  [post-test]=0.78)

1. IBL is well suited to overcome problems with students' motivation
2. IBL provides material for fun activities
3. IBL is well suited to approach students learning problems
4. I would like to implement more IBL practices in my lessons
5. I would like to have more support to integrate IBL in my lessons
6. IBL is not effective with lower-achieving students
7. I see no need to use IBL approaches

Anxiety toward inquiry learning (4 items,  $\alpha$  [pre-test]=0.79,  $\alpha$  [post-test]=0.81)

1. I worry about students' discipline being more difficult in IBL lessons
2. I do not feel confident with IBL
3. I think that group work is difficult to manage
4. The number of students in my classes is too big for IBL to be effective

Resources for inquiry learning (4 items,  $\alpha$  [pre-test]=0.74,  $\alpha$  [post-test]=0.65)

1. I do not have enough time to prepare IBL lessons
2. I do not have sufficient resources such as computers, laboratory
3. There is not enough time in the curriculum
4. I worry about my students getting lost and frustrated in their learning

External support for inquiry learning (4 items,  $\alpha$  [pre-test]=0.72,  $\alpha$  [post-test]=0.69)

1. The curriculum does not encourage IBL
2. My colleagues do not support IBL
3. My students have to take assessments that don't reward IBL
4. I do not have access to any adequate professional development programs involving IBL

To help interpretation, the scales resources for inquiry learning and external support for inquiry learning were reversed for the reporting. The items I already use IBL a great deal, and I do not have adequate teaching materials were excluded from the scale because they formed factors that centered around one question. The item I do not know how to assess IBL was excluded because it had only weak loadings on multiple factors. The item Successful IBL requires students to have extensive content knowledge was excluded from the external support for inquiry learning subscale to maintain a moderate reliability of the subscale on the post-test. A Finnish translation of the questionnaire was used in the data collection.

## Appendix 2: Items and reliabilities of two subscales forming the satisfaction with the training course scale

General satisfaction with the training (8 items,  $\alpha$ =0.92)

1. Training was well organized
2. The lengths of the training days were appropriate
3. The content of the training was essential
4. The content of the training corresponded to my needs
5. The material presented in the training was useful
6. Training has been useful for carrying out inquiry learning in my own teaching
7. I enjoyed the training
8. Training motivated me to carry out inquiry learning with my students

Utility satisfaction (5 items,  $\alpha$ =0.76)

1. I have become more familiar with the term "inquiry learning" during the training
2. I have become more familiar with the term "responsible research and innovation" during the training
3. Training helps me to utilize suitable materials for my own and the needs of my students
4. Training helps me to assess the skill levels of inquiry learning
5. Training helps me to develop responsible research and innovation activities in my teaching through a reward system

A Finnish translation of the questionnaire was used in the data collection.