Considering teacher cognitions in teacher professional development: Studies involving Ecuadorian primary school teachers

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This dissertation should be cited as follows:

ACKNOWLEDGMENTS

When Amanda Berry\textsuperscript{1} described the professional learning of teacher educators as "an individual task that cannot be accomplished alone", I immediately felt this single phrase could be the best definition of my doctorate experience.

My gratitude goes, in the first place, to Prof. Dr. Martin Valcke for his enthusiasm in setting up a research project in the Ecuadorian context, which is full of uncertainties. I admire his optimism and courage in taking risks, such as deciding to become my promoter without knowing much about me.

I am also thankful to my co-promoter, Prof. Dr. Tammy Schellens, for her challenging remarks on my writing and her thoughtful suggestions during our meetings. Likewise, I appreciate enormously the interest and feedback of Prof. Dr. Hilde van Keer, Prof. Dr. Lieven Verschaffel, and Prof. Dr. Wouter van Joolingen, members of my Guidance Committee.

I thank my colleagues for their moral support and for sharing with me their knowledge, tips, and experiences. Special thanks go to Dr. Jo Tondeur for his advice in moments of uneasiness. Jo Tondeur and Eline Van Laere kindly reviewed a couple of chapters. Prof. Dr. Bram de Wever gave important suggestions for the data analysis.

This project would not have been possible without the support of many Ecuadorian people. I acknowledge the kind collaboration of Prof. Dr. Enrique Peláez and Prof. Dr. Katherine Chiluiza from ESPOL University in Ecuador, who facilitated the data collection in three studies.

It is impossible to forget the school supervisors, principals, teachers, and pupils who opened to me the doors of their schools, the doors of their classrooms, and even the doors of their personal worlds. I feel in debt with those who could not participate in the intervention and wish I could include them in the future.

Last but not least, I thank my husband, Wim Mareydt, for his tender company. During the difficult moments of my doctorate, including the –sometimes- lonely stays in Ecuador, Wim has been the heart that listens, the presence that vitalizes, and the arms that comfort.

\textit{Maria Lucero-Mareydt}

Ghent, September 2013

\textsuperscript{1} Keynote speaker at the ISATT 2013 Conference.
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General Introduction
The idea that teacher cognitions are an integral part of teacher education is generally accepted in theory, but hardly applied in practice (Clarke & Hollingsworth, 2002; Korthagen, 2001; Schepens, Aelterman, & Van Keer, 2007; Smith & Ragan, 2005; Valcke, Sang, Rots, & Hermans, 2010). The present dissertation is a contribution to the particular application of this idea in the process of designing in-service teacher training. It also makes a contribution to teacher training approaches by confirming that incorporating teacher cognitions in the design of teacher training can enable us to understand better and influence teachers’ behaviour.

The general aim of the present dissertation is to solve a complex educational problem and to advance our knowledge about interventions that take into consideration teacher cognitions and the processes to design them. Accordingly, four empirical studies were conducted with a focus on a) the relationship between teacher cognitions and teacher behaviour, b) the gap between what teachers are expected to do and what they actually do, c) the identification of learning goals connecting personal and professional aspects of teaching, and d) the impact of a teacher professional development intervention. Survey research, qualitative/quantitative research methods, and a quasi-experimental pretest-posttest research design were adopted, including the coding of more than 40 video-recorded lessons.

The first part of the dissertation, the General Introduction, presents the conceptual framework on which the four empirical studies are based. It also outlines the context where the studies took place and the general research question. Finally, it introduces the purpose, research questions, and design of each study as well as the relationship between them.
1. Conceptual framework

The present dissertation builds on three main statements:

a) Teacher cognitions are important in any attempt to improve their behaviour (Meijer, Korthagen, & Vasalos, 2009; Zwart, Wubbels, Bergen, & Bolhuis, 2007).

b) Teacher professional development refers to the development of a person in his/her professional role (Beijaard, Meijer, & Verloop, 2004; Villegas-Reimers, 2003).

c) The design of instruction -for teachers- that neglects teacher cognitions does not contribute to teacher professional development (Clarke & Hollingsworth, 2002; Schepens et al., 2007)

Given the important roles assigned to the concepts of teacher cognitions, teacher professional development, and instructional design, this dissertation attempts to investigate further how a better understanding of these concepts can shed light on improving the quality of in-service teacher training programmes in the context of Ecuadorian public primary schools.

1.1. Teacher cognitions

In general, cognitions refer to beliefs, attitudes, opinions, and other types of judgements people hold (Wyer & Albarracín, 2005). Teacher cognitions can be interpreted as personal understandings that underlie teachers’ practice (Borg, 1999; Hennissen, Crasborn, Brouwer, Korthagen, & Bergen, 2010; Zwart et al., 2007). Specifically, Borg (1999) defines teacher cognitions as a set of beliefs, knowledge, theories, assumptions, and attitudes of the teachers regarding all aspects of their work. Zwart et al. (2007) refers to beliefs, orientations, personal goals, emotions, expectations, and attitudes with respect to their classroom practices. Hennissen et al. (2010) define teacher cognitions as a frame of reference -formed by beliefs, knowledge, notions, concerns, ideas, perspectives, and attitudes- on which teachers act.
Consequently, the study of teachers’ behaviour should touch upon teachers’ cognitions simply because cognitions influence behaviour (Meijer, Verloop, & Beijaard, 2002; Pajares, 1992; Riggs & Enochs, 1989). The argument also applies the other way around, that is, behaviour also influences cognitions (Clarke & Hollingsworth, 2002; Hennissen et al., 2010).

Nevertheless, in spite of much discussion of what teacher cognitions actually entail, the central role of teacher cognitions has been relatively overlooked in teacher education, in general, and teacher professional development interventions, in particular. Indeed, the application of contemporary learning theory to the development of teacher education programs has been “ironically infrequent” (Clarke & Hollingsworth, 2002, p. 947). Schepens et al. (2007) claim that the lack of a holistic approach including teacher cognitions is the main reason for the failure of many educational reforms. Smith and Ragan (2005) regret that attitudes, for example, have not been given appropriate consideration in educational practice. Similarly, beliefs have been disregarded in teacher education programs that are, on the other hand, strongly focused on knowledge transmission (Valcke et al., 2010). As Korthagen (2001) explains, “a major mistake when implementing innovations in education has been made by outsiders who wish to change things but who do not take into account the needs and concerns of the teachers and the circumstances in which they work” (p. 6).

A holistic approach to teacher development that acknowledges the critical interconnection between cognitions and behaviour is represented in Korthagen’s onion model (2004). As shown in Figure 1, the onion is made up of six layers: environment, behaviour, competencies, beliefs, mission, and identity. Alternatively called the “model of levels of change”, this model depicts that each level provides a standpoint from which we can look at the teachers (and/or the teachers can look at themselves) and analyse their behaviour more comprehensively. The model shows that the behaviour of the teachers depends not only on
their environment and competencies, but also on their beliefs, identity, and mission. In essence, every level of change is dependent upon each other.

The onion model has been widely adopted by teacher supervisors to support pre-service teachers’ reflection on practical situations (e.g., Korthagen & Vasalos, 2005, 2010; Meijer et al., 2009; Schepens et al., 2007; Tigchelaar, Brouwer, & Korthagen, 2008). However, its potential use in the design of in-service teacher training has yet not been investigated.

![Figure 1: The onion model (Meijer et al., 2009)](image)

In the present dissertation, the study of teacher cognitions is organized according to the onion model. Studies 1 (Chapter 1) and 3 (Chapter 3) measure two types of beliefs: a) self-efficacy beliefs, i.e., beliefs each teacher has on his/her capability to organize and execute the course of action required to produce given attainments (Bandura, 1997), and b)
context beliefs, i.e., beliefs in the possibility of achieving something, given the circumstances and the people around (Ford, 1992; Haney, Lumpe, Czerniak, & Egan, 2002; Lumpe, Haney, & Czerniak, 2000). Studies 1 and 3 also examine teachers’ personal understandings of their own behaviour, i.e., the frame of reference against which teachers analyse their own behaviour. This perspective is contrasted with the observation of teachers’ actual behaviour in the classroom. Study 2 (Chapter 2) explores teachers’ perspectives on their environment, more in particular, the environmental factors that influence their behaviour. This is complemented with factual data regarding environment, behaviour, and competencies (i.e., knowledge and skills). Teachers’ mission and identity, i.e., their image of a good teacher, are additionally explored in Study 3. Furthermore, teachers’ attitudes or orientations are inferred from observations of their behaviour in Studies 1 and 3. Finally, Study 4 (Chapter 4) concerns the implementation of instructional strategies that invite teachers to continuously examine their environment, behaviour, competencies, beliefs, mission, and identity from their personal point of view.

1.2. Teacher professional development

Over the years, traditional teacher training has mainly focused on behaviour, knowledge, and skills. In contrast, teacher professional development takes a more profound analytical approach and considers the whole complexity (as represented in the onion model). As a matter of fact, teacher professional development emerges as a critique to traditional teacher training that directs the teachers what to do without due consideration of their experience, knowledge, opinions, needs, or concerns (Villegas-Reimers, 2003). In this dissertation teacher professional development is understood as any intervention that takes

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1 In the onion model, attitudes are included in the level of competencies together with knowledge and skills (Korthagen, 2004).
into account what teachers personally desire and experience as good instead of unilaterally deciding what is good for them.

As McIntyre and Hagger (1992) explain, the concept of development implies working with what already exists instead of trying to replace it, that is, recognizing the value of teachers’ expertise and integrating it into the innovation. In line with Rogers’ humanism (2004), in-service teachers should be considered the experts in themselves. They act according to what fits them the best in a given environment.

As stated above, teacher professional development refers to the development of a person in his/her professional role (Beijaard et al., 2004; Villegas-Reimers, 2003). This definition stresses that the personal aspects of teaching are as important as the professional ones. The challenge is to design teacher development programs that take into account these two aspects.

1.3. Instructional design

According to Visscher-Voerman and Gustafson (2004), there are four perspectives on how educational design might be conducted. These perspectives are: a) instrumental, i.e., planning-by-objectives, b) communicative, i.e., communication to reach consensus, c) pragmatic, i.e., interactive and repeated try-out and revision, and d) artistic, i.e., creation of products based on connoisseurship.

The instrumental approach, commonly known as systematic instructional design, was chosen to guide the four studies described in the present dissertation. It was the preferred approach because it offers a systematic procedure or plan, which makes it easy to follow. Another advantage is that it ensures correspondence among objectives, activities, and assessment (for an overview see Branch, 2009; Dick, Carey, & Carey, 2009; Smith & Ragan, 2005).
In general, the systematic design of instruction consists of three phases: *analysis*, *strategy*, and *evaluation* (see Figure 2). “These three activities are the essence of most instructional design models” (Smith & Ragan, 2005, p. 10). The analysis provides a clear vision of where you are, and where you want to go, i.e., identification of the problem and learning goals. The strategy tells how you will get there, i.e., definition of instructional strategies to be implemented and instructional medium. Finally, the evaluation indicates how you will know when you are there, i.e., definition of method, instruments, and criteria. Importantly, a preliminary step in the analysis phase is the needs assessment. Needs assessment is the process of identifying a gap between “what is” and “what should be” (i.e., discrepancies between actual and desired performance) and deciding if instruction is the solution (Kaufman, 1997; Mager & Pipe, 1997; Romiszowski, 1981).

![Diagram of instructional design model]

**Figure 2.** A common model of instructional design

Even though vast literature is available for illustrating the application of this typical instructional design model, little has been said about how to enrich the model with a multidimensional approach that takes into account the multidimensional nature of human beings.
2. Research context

Since previous research was mostly carried out in developed countries, we seem to know very little about this research topic in the context of developing countries. Another gap that has been identified is related to the lack of attention to teacher cognitions in the practice of teacher education (Clarke & Hollingsworth, 2002; Korthagen, 2001; Schepens et al., 2007; Smith & Ragan, 2005; Valcke et al., 2010). This dissertation draws on the teacher training programmes in Ecuador. The Ecuadorian context was selected because it could represent a case in developing countries where there is an urgent need for teacher training. It is also noted that although considerable educational initiatives are taking place in Ecuador, teacher cognitions are not being taken into consideration in the training efforts. The following paragraphs describe the Ecuadorian case in terms of three scenarios:

2.1. Scenario 1

Over the years, given the dramatic situation of education in Ecuador (see more in Viteri, 2006), national and international institutions have implemented massive training programs for in-service teachers (e.g., Chiluiza-García, 2004). The bell rang in 2009 when the Ministry of Education launched, for the first time in Ecuadorian history, a national evaluation of public primary school teachers. The findings were alarming: more than 45% of the teachers were rated in the lowest category (unsatisfactory) for both their content and pedagogical knowledge (Ministerio de Educación del Ecuador, 2009). As a result of this evaluation, the Government has made a huge investment in in-service teacher training throughout the nation (Ministerio de Educación, 2012). The training is mandatory, extensive, and highly focused on content and pedagogical knowledge, e.g., science, mathematics, social studies, and language.
2.2. Scenario 2

Traditionally, developing projects in education mainly emphasize the acquisition of isolated teacher knowledge and skills without a prior analysis of the core of the problem. This omission has generated problems pertaining to waste of time, effort, and resources (Mager & Pipe, 1997; Romiszowski, 1981; Smith & Ragan, 2005). In the context of Ecuador, several stakeholders have criticized in-service teacher training because it is disconnected from the real needs of the teachers ("Maestros estudian", 2009; Ministerio de Educación & VVOB, 2008; "Sectores piden", 2010; "Un buen docente", 2009).

2.3. Scenario 3

From the scenarios above, it can be inferred that the National Curriculum has hardly been fully implemented. In the case of science education, for example, it has been recognized that it “centres on memorization” and “takes away the innate happiness of discovering” (Ministerio de Educación y Cultura del Ecuador, 1998, p. 85). Even though the National Science Curriculum Reform (NSCR) recommends the development of inquiry skills (already since 1996), these skills are probably rarely stressed in practice. Science curriculum reforms do not guarantee, per se, a change in teachers’ practices (Anderson, 2002; Rogan & Grayson, 2003). As stated by Keys and Bryan (2001), more research is required on teachers’ beliefs, knowledge, and practices of inquiry-based science to facilitate the implementation of science curriculum reforms.

Inquiry is about asking questions and searching for answers (Egbert, 2009; Quintana et al., 2004). The importance of inquiry-based science teaching has been broadly recognized in the literature (e.g. Bloom, 2006; Sanger, 2008; van Joolingen, de Jong, & Dimitrakopoulou, 2007; Williams, Papierno, Makel, & Ceci, 2004). In the practice, however,
the implementation of inquiry in the classroom is still a challenge -and even a dilemma- for the teachers and represents a complex educational problem (Anderson, 2002; Rogan & Grayson, 2003; Newman et al., 2004).

In conclusion, the research context can be characterized as follows: a) the quality of education in Ecuador is low; b) many teacher training efforts are currently taking place; c) teacher training does not cover teachers’ needs; and d) inquiry is probably not being implemented in the teaching of science. All this suggests the pertinence of setting up a research project in the context of Ecuadorian public primary schools and in the field of inquiry-based science teaching.

3. General research question

The context described above represents an opportunity to do research with a large potential for future practice. Within this context and on the basis of the conceptual framework, the general aim of this dissertation is to solve a complex educational problem and to advance our knowledge about interventions that take into consideration teacher cognitions and the processes to design them. The general research question is: Does considering teacher cognitions in teacher professional development have an influence on teachers’ and pupils’ inquiry behaviour during science lessons in Ecuadorian public primary schools?

4. Overview of the dissertation

To answer the general research question, we conducted four studies. Each study corresponds to a chapter in the dissertation and has been submitted/accepted as a research journal article. The following paragraphs describe the studies each chapter refers to, the purpose, the research questions or hypotheses, and the methodology used. Table 1 offers an overview.
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General discussion
4.1. Chapter 1: Teachers’ Beliefs and Self-Reported Use of Inquiry in Science Education in Public Primary Schools

The purpose of this study was to gather information as input for the analysis phase in the design of instruction. It focuses on the levels of behaviour and beliefs from the onion model and deals with two research questions:

RQ1: What inquiry activities do teachers adopt and what level of support and type of inquiry is reflected in these activities?

RQ2: Is there a difference between the levels of support and the type of inquiry used by teachers according to their beliefs?

To tackle these questions we conducted a survey study involving 173 teachers from the second to the seventh year in 70 Ecuadorian primary schools. Data regarding the level of behaviour was collected by using a self-report survey on the implementation of certain activities in the classroom. Data concerning the level of beliefs was obtained through two existing questionnaire surveys: the Science Teaching Efficacy Beliefs Instrument-STEBI (Enochs & Riggs, 1990) and the Context Beliefs About Teaching Science questionnaire-CBATS (Lumpe et al., 2000). This study was preceded by a pilot study (n = 27) to test the reliability and refine the instruments.

4.2. Chapter 2: Do teachers implement inquiry and are they able to do it? A needs assessment analysis in public primary schools

This study was designed to obtain information for the needs assessment, a preliminary step that is commonly skipped in the design of instruction (Goldstein & Ford, 2002; McKenney & Reeves, 2012; Visscher-Voerman & Gustafson, 2004).

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2 Second and seventh years correspond to first and sixth grades in the US educational system.
Chapter 2 explores three levels of the onion model (*behaviour, competencies, and environment*) as reflected in the following research questions:

RQ1: What is the actual behaviour as compared to the behaviour expected by the National Science Curriculum Reform (NSCR) in relation to inquiry-based science teaching?

RQ2: Do teacher have the competencies to perform as expected?

RQ3: Under what environmental conditions does the actual teaching behaviour take place?

To tackle these questions we used several methods: a) a self-report regarding the implementation of certain activities in the classroom, b) video-tapes of 20 science lessons, c) pre- and post-classroom observation interviews (Horizon Research, 2005), d) observation of school resources and facilities, and e) a test on inquiry knowledge and skills. The participants were 20 teachers from the seventh year of 13 schools.

4.3. Chapter 3: A holistic approach to the study of teachers’ questioning behaviour: implications for the design of teacher training interventions.

Informed by the results from the previous study (i.e., Study 2 in the dissertation), this chapter focuses on the analysis of the teachers’ questioning *behaviour*, which deserved particular attention. In line with the conceptual framework of the dissertation, this chapter is also concerned with the levels of *beliefs, mission, and identity*, which together uncover the personal aspects of teaching. The purpose was to gain in-depth information that could fuel the analysis phase in instructional design and would help to state the learning goals of future professional development initiatives. The research question was stated as follows:

RQ1: What is the questioning behaviour of the teachers, their beliefs, mission, and identity?

We conducted qualitative research involving 19 teachers from the seventh year of 13 Ecuadorian primary schools. We analysed a) 19 video recordings of science lessons, b) teachers’ reactions to the STEBI and the CBATS questionnaires, and c) teachers’ in-depth
personal reflections induced by a Contrast Analysis Exercise (Biesta, Korthagen, & Verkuyl, 2002).

4.4. Chapter 4: The impact of a teacher training intervention on teachers’ and pupils’ questioning behaviour

This chapter is related to the strategy and evaluation phases of instructional design. A seven-week teacher training intervention was designed to attend to all the levels of the onion model and to influence the teachers’ and pupils’ questioning behaviour. The training consisted of seven group sessions and 42 individual follow-up visits to the teacher and his/her class (seven per teacher). During group sessions, we employed argumentation, modelling, group discussion, reinforcement, role play, and sensitizing exercises. In the follow-up visits, we observed the practice of the teachers, provided positive feedback, and facilitated teachers’ reflections on all the levels of the onion model.

The purpose of this study was to test the following hypotheses:

H1: The teacher training intervention will increase the frequency of wait times that teachers and pupils make.

H2: The teacher training intervention will reduce the number of teacher questions and increase the number of pupil questions.

H3: The teacher training intervention will improve the types of questions that teachers and pupils formulate.

We conducted a quasi-experimental pretest-posttest study with a control group consisting of 5 teachers (178 pupils) and an experimental group composed of 6 teachers (239 pupils). A total of 22 videos were analysed.

Chapter 4 has been submitted to Teaching and Teacher Education.
The last part of the dissertation, the General Discussion and Conclusion, offers a summary of the main findings. These are later discussed in relation to the general research question. The general conclusion outlines the contribution of the dissertation to theoretical understandings that guide design efforts. Next, we present the limitations of the studies and directions for future research and, at the end, the implications of the research for policy and practice.

References


Teachers’ Beliefs and Self-Reported Use of Inquiry in Science Education in Public Primary Schools

Based on:
Chapter 1

Teachers’ Beliefs and Self-Reported Use of Inquiry in Science Education in Public Primary Schools

Abstract

This paper describes Ecuadorian in-service teachers and their science teaching practices in public primary schools. We wanted to find out to what extent teachers implement inquiry activities in science teaching, the level of support they provide and what type of inquiry they implement. Four questionnaires applied to 173 teachers resulted in the identification of high context beliefs and moderately high self-efficacy beliefs. Teachers declared to implement activities mostly to develop understanding of the material, as contrast to actual manipulation of data and/or coming to conclusions. They adopt rather a strictly guided approach in contrast to giving autonomy to learners to work on their own. Finally, teachers keep control with regard to question formulation and choice in solution procedures, which constrains the development of real inquiry. When comparing teacher beliefs, we found that teachers’ context beliefs make a difference in the level of support teachers provide to their students. Teachers with lower context beliefs ask students to perform inquiry activities on their own to a lesser extent as compared to teachers with higher context beliefs. This implies that further research on the implementation of inquiry in science teaching should take into account teachers’ differences in their context beliefs. We also found out that the use of high or low support in inquiry activities remained the same for teachers with either higher or lower self-efficacy beliefs.
1. Introduction

The most recent National Science Curriculum Reform (NSCR), from 1996, recognizes that primary science education in Ecuador centers on memorization and reflects a conceptual overload. ‘It takes away children’s innate happiness of discovering’ (Ministerio de Educación y Cultura del Ecuador, 1998, p. 85). It is also stated that the main emphasis is on ‘what to teach’ and little on ‘how to learn’. The NSCR recommends developing children’s skills through experiments and field research and expects that, by the end of primary education\(^1\), children are able to adopt the inquiry process in small scale research projects. Although these recommendations are mandatory in nature, we want to find out to which extent and how inquiry related activities currently occur in science teaching. Next, we want to identify the factors that play a role in this particular implementation of the curriculum.

1.1. Inquiry-based science teaching

Current studies on science teaching emphasize the importance of inquiry-based methods (e.g. J. Bloom, 2006; Sanger, 2008; van Joolingen, de Jong, & Dimitrakopoulou, 2007; Williams, Papierno, Makel, & Ceci, 2004). ‘The consensus among science educators seems to be that the objective of science learning and teaching should be developing science inquiry skills, not merely knowledge of scientific facts and concepts, and that inquiry skills are best developed by actually doing science’ (Bhattacharyya, Volk, & Lumpe, p. 200). ‘One obvious way to bring students into contact with the scientific way of working is to have them engage in the processes of scientific inquiry themselves’ (van Joolingen, et al., 2007, p. 111).

While the importance of inquiry in science teaching is rather clear, its definition is quite messy. Over a decade, science educators have discussed, agreed and disagreed over the

\(^1\) Primary education in Ecuador comprises ten years that in the US educational system correspond to kindergarten, primary education, and three years of secondary education. By the end of primary education a student might be 14-15 years-old.
definition of inquiry (J. Bloom, 2006). In our study we adopt the following descriptive
definitions: ‘Inquiry in education is also sometimes called “research”, “investigation”, or
“guided discovery”’. During inquiry students ask questions and then search for answers to
those questions’ (Egbert, 2009, p. 157). ‘Inquiry is the process of posing questions and
investigating them’ (Quintana et al., 2004, p. 341). In other words, we understand inquiry as
something to do; a series of steps or activities that can vary in order and can be adapted to the
individual’s personal way of doing inquiry. Inquiry is a never-ending cycle because the
answer to a question raises a new question (a new cycle). But inquiry is, certainly, not only
about following certain steps; it is also -and essentially- about thinking and deciding by
yourself. This is what makes inquiry real inquiry. Inquiry implies thinking or reasoning.
More important than performing certain activities is the ability to make a good question and a
plan to answer that question.

1.2. Teacher’s Inquiry Behaviour: Types of Inquiry and Levels of Teacher Support

From the perspective of the teacher, supporting student inquiry processes is a
challenge. In practice, researchers have identified a typology of inquiry originally postulated
by Herron (1971) and in current enforcement (e.g. Olson & Loucks-Horsley, 2000). Herron
distinguishes between three types of inquiry depending on who develops the research
question and the subsequent plan: structured inquiry (when the teacher provides the question
and the plan to find the answer), guided inquiry (when the teacher provides the question but
not the plan) and open inquiry (when the teacher lets students formulate the question and
define the plan themselves).

Molebash, Bernie, Bell, and Mason (2002) claim that only open inquiry is ‘real
inquiry’ because it emanates and expands from the students themselves. The authors
acknowledge, however, that open inquiry could rather be presented as a final goal after a structured and sufficiently supported instructional process.

Ideally, teachers should lead children to open inquiry, where the level of teacher support is low and children are autonomous during the process (from making a question to finding an answer). Little by little teachers should reduce the level of support and move from structured to guided inquiry and from guided to open inquiry. In the beginning, for example, the teacher can introduce inquiry by modelling for the children, by thinking aloud, and by providing a step-by-step example or a worked example (high support); later on, the teacher can do inquiry together with the children and make them co-protagonists of the decision-making process (medium support); finally, when the children are ready to do inquiry by themselves, the teacher can ‘step out from the stage’ and provide them with autonomy and feedback (low support). The gradual movement from high to low support is an overarching principle in instructional design (Smith & Ragan, 2005) that has been combined, in classroom practice, with the gradual move from one to another type of inquiry. Smithenry (2010) illustrates this with the following case:

In the first step, Ms Fisher prepares her students for a guided inquiry by engaging them in a mix of teacher-directed activities....In the second step, Ms Fisher transitions the students into the guided inquiry by stating the problem and transferring control of the classroom to her students (p. 1702).

Moreover, when preparing for guided inquiry, the teacher used modelling demonstrations, as we suggest in the paragraph above (see also Olson & Loucks-Horsley, 2000).

In conclusion, the type of inquiry is determined by who formulates the question and who defines the plan; this is related to the level of support the teacher provides to the pupils not only in the definition of the research question and plan but also in every inquiry-related
activity. The type of inquiry and the level of support teachers’ provide in the classroom make up what we, in this study, call teachers’ inquiry behaviour.

1.3. Teacher Beliefs

To understand teachers’ inquiry behaviour we should also study their beliefs. ‘Investigation of teacher beliefs is vital to a more complete understanding of teacher behaviour’ (Riggs & Enochs, 1989, p. 3). In the last decades, educational researchers have switched from a focus on teacher behaviour in relation to learners’ performance to an additional focus on teacher beliefs in relation to teacher behaviour (Hermans, 2009). Pajares (1992) highlights the importance of such a perspective; he states that ‘beliefs are the best indicators of the decisions individuals make through their lives (Bandura, 1986, Dewey, 1933, Nisbett & Ross, 1980, Rokeach, 1968)’ (p. 307).

The importance of studying teachers’ beliefs is also evident in the field of practice. Given the dramatic situation of education in Ecuador (see more in Viteri, 2006), national and international institutions have implemented massive training programs for in-service teachers (e.g. Chiluiza-García, 2004). However, developing projects in education place traditionally a good deal of emphasis on teacher training without taking into account teachers’ beliefs and, as a consequence, transfer often fails. Beliefs are very important in view of the transferability of innovations (Korthagen & Russel, 1999). Valcke, Sang, Rots, and Hermans (2010) emphasize the importance of considering teachers’ beliefs for teacher education to succeed. Being more specific, Riggs and Enochs (1989) suggest that research on teaching efficacy beliefs could facilitate training because it leads to our further understanding of differences in teacher behaviour. The study of context beliefs about teaching science is also useful for classroom practice. Low context beliefs reveal, for example, that teachers feel that external factors, like professional development, community involvement, parental involvement, and
others, are not likely to occur and they would not be helpful (probably due to bad experiences with these factors in the past). This is useful in assessing the perceived strengths and weaknesses of school science programs and in designing and monitoring professional development experiences for the teachers (Lumpe, Haney, & Czerniak, 2000).

1.4. Self-efficacy beliefs.

Bandura (1997) defines self-efficacy as ‘beliefs in one’s capability to organize and execute the course of action required to produce given attainments’ (p. 3). Gibson and Dembo (1984) report differences in behaviour between teachers with high and low self-efficacy. Such differences, however, seem to depend on the specificity of the behaviour under observation. Guo, Piasta, Justice, and Kaderavek (2010), for example, found no correlation between preschool teachers’ self-efficacy and the level of instructional support they provide in language lessons. Nevertheless, Woolfolk, Rosoff, and Hoy (1990) found that in-service religious school teachers with low self-efficacy beliefs keep high control in the classroom whereas teachers with high self-efficacy beliefs trust the children and give them responsibilities. Similar results derived from other studies with pre-service teachers (Enochs, Scharmann, & Riggs, 1995; Woolfolk & Hoy, 1990). We highlight the study of Enoch et al. (1995) because it refers specifically to science teaching efficacy beliefs. Indeed, the study of self-efficacy is preferably specific because self-efficacy is a situation specific construct and cannot easily be generalized across contexts (Bandura, 1997; Enoch & Riggs, 1990; Gibson & Dembo, 1984). Riggs and Enoch (1989) declare that ‘teacher efficacy beliefs do appear to be dependent upon the specific teaching situation.’ (p. 7). Therefore, we focus our study of self-efficacy beliefs in the area of science teaching.
1.5. Context beliefs.

Self-efficacy beliefs seem to be insufficient to sustain a person’s efficacy; beliefs about the science teaching environment are equally important because teachers do not act in isolation or individually. Teachers act in line with what they think is possible given the circumstances and the people around (Ford, 1992; Haney, Lumpe, Czerniak, & Egan, 2002; Lumpe, et al., 2000). When teachers believe that environmental factors will help them to be effective science teachers (*enabling beliefs*) and that these factors are likely to occur in the school context (*likelihood beliefs*), we can say these teachers have high context beliefs.

Context beliefs derive from Ford’s motivation systems theory, which states that an effective behaviour requires motivation, skills, and an environment. Motivation depends on the goals of the person and the combination of context beliefs and capability beliefs (Ford, 1992). This explains why in several studies (e.g. Bhattacharyya, et al., 2009; Lumpe, et al., 2000) the measurement of self-efficacy (*or capability* in Ford’s terminology) and context beliefs has been combined.

Bhattacharyya, et al. (2009) concluded that science teaching context beliefs were not consistent with the level of inquiry used in observed science lessons (i.e. some pre-service teachers with high context beliefs used inquiry and some others did not); but given the small sample (*n* = 7), this conclusion deserves further exploration. Woolfolk and Hoy (1990) noticed that pre-service teachers who believe in the impact of the school (contextual factors) on effective teaching were less custodial with the children, they encouraged self-discipline in the classroom rather than adopting strict control.

In summary, current literature has continuously searched for relationships between teacher’s beliefs and teaching practices. The findings lead us to the following research questions:
1. What inquiry activities do primary teachers adopt in their teaching practices and, accordingly, what level of teacher-to-pupil support and type of inquiry is reflected in these activities?

2. Is there a difference between the levels of support and the type of inquiry used by teachers according to their beliefs (efficacy and context)?

2. Method

2.1. Context and Sample

Our sample consisted of 173 primary school teachers from Huaquillas and Arenillas, two cantons in the province of El Oro (south of Ecuador). The most recent national census (2001) suggests that these cantons are very similar to each other and to the rest of the country in demographic indexes, such as poverty (61%), functional illiteracy (21%), and primary school completion (66%) (Ministerio de Coordinación de Desarrollo Social del Ecuador, 2008). The selection of the sample was based on the possibility of collecting data in the context of large training workshops organized by an official entity who granted us access to the respondents.

The sample was made up of 34% male and 66% female in-service teachers from second to seventh year\(^2\). Age varied from 29 to 74 (\(Mdn = 49; SD = 7.29\)). Years of experience varied from 3 to 53 (\(Mdn = 26; SD = 8.22\)). Seven percent of the teachers worked in ‘escuelas unidoentes’ (schools where only one teacher teaches all the groups); 17% worked in ‘escuelas pluridoentes’ (at least one of the teachers works with several groups); and 76% worked in ‘escuelas completas’ (schools with one teacher per group). The work load of the teachers in our sample was high as reflected in the number of groups in charge and their position. Eighty-six per cent of the teachers were teaching one group, 14% was

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\(^2\) Second and seventh years correspond to first and sixth grades in the US educational system.
teaching two, three, four, five, or even six groups at the same time. Besides being full-time teachers, 20% of the respondents were also the principal of the school.

2.2. Instruments

From the literature, we selected two instruments that were translated into Spanish. We also administered a demographic questionnaire and a self-report questionnaire. To adapt the instruments to the local terminology and context, we asked eight teachers from our target population to revise draft versions. A pilot study \((n = 27)\) was conducted to test the reliability and to find indicators in order to refine the instruments. The teachers in our pilot study belonged to public primary schools in a canton next to Huaquillas and Arenillas. The same teachers assisted in the formal training workshops. After administration during the main study, the reliability of the instruments was tested again.

2.2.1. Self-report on inquiry activities

A self-report questionnaire was used to determine to what extent teachers implemented particular inquiry activities in their classroom, the level of support they adopted and the type of inquiry teachers mainly used.

Literature provides a large number of inquiry teaching indicators (Ash & Kluger-Bell, n.d.; Brandon, Donald, Pottenger, & Taum, 2009; Gejda & LaRocco, 2006; Jarvis, 2006; McTighe & Lyman, 1998). We decided to focus on the adoption of particular steps in the process of inquiry and took, as a reference point, the spiral path of inquiry proposed by Molebash et al. (2002): 1) reflect, 2) ask questions, 3) define procedures, 4) gather/investigate data, 5) analyse/manipulate data, and 6) report findings/draw conclusions. These steps match the mandatory inquiry skills as stated in the NSCR.
In the literature, a considerable correspondence can be observed in the steps of the inquiry process and models related to the critical thinking process and the problem-solving process. According to Egbert (2009), the steps of critical thinking are 1) review content understanding, 2) analyse, 3) synthesize, and 4) evaluate; and the steps within a problem-solving cycle are 1) define the problem, 2) plan, 3) inquire, and 4) look back. The steps in the three cyclical processes can be linked to the classical taxonomy of Bloom and especially to the behaviour related to analysis, synthesis, and evaluation (B. Bloom, 1966). ‘Although the literature within these files uses different terminology, careful comparisons of the concepts of critical thinking, inquiry, and problem solving reveal substantial overlap’ (Quellmalz & Hoskyn, 1997, p. 105). This overlap helped us to understand the inquiry process in a more comprehensive way and to define six steps and 11 particular inquiry activities commonly distinguished in the literature and listed on Table 1.

**Table 1.** Particular activities suggested for each step of the inquiry process.

<table>
<thead>
<tr>
<th>Step</th>
<th>Particular inquiry activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. UNDERSTAND</td>
<td>A. Identify main ideas in previous or new material.</td>
</tr>
<tr>
<td></td>
<td>B. Find the meaning of difficult words (i.e. use encyclopaedia,</td>
</tr>
<tr>
<td></td>
<td>dictionary, text, etc.).</td>
</tr>
<tr>
<td></td>
<td>C. Review content understanding by drawing a concept map.</td>
</tr>
<tr>
<td></td>
<td>D. Associate information from diverse sources.</td>
</tr>
<tr>
<td>2. ASK</td>
<td>E. Ask a list of questions related to a science topic.</td>
</tr>
<tr>
<td>3. DEFINE</td>
<td>F. Determine research question or hypothesis and procedure.</td>
</tr>
<tr>
<td>4. GATHER</td>
<td>G. Use information resources (e.g. newspaper, magazines, books, etc.)</td>
</tr>
<tr>
<td></td>
<td>and data-gathering instruments surveys, interviews, etc.)</td>
</tr>
<tr>
<td>5. MANIPULATE</td>
<td>H. Use tools to manipulate data (e.g. calculator, Excel, Statistics, etc.)</td>
</tr>
<tr>
<td>6. CONCLUDE</td>
<td>I. Draw conclusions and support conclusions with data.</td>
</tr>
<tr>
<td></td>
<td>J. Present research results orally, in writing, and/or through graphical presentations.</td>
</tr>
<tr>
<td></td>
<td>K. Reflect on the research process that occur along the research.</td>
</tr>
</tbody>
</table>
We took into consideration that each particular inquiry activity could be executed in different ways depending on the level of support provided by the teacher (Molebash, et al., 2002; Olson & Loucks-Horsley, 2000). Consequently, in the self-report we made a distinction between high-supported activities (when the teacher shows the activity to the children, e.g. ‘I show how to prepare the presentation of research results orally, in writing, and/or through graphical presentations. I provide a step-by-step example.’), medium-supported activities (when the teacher carries out the activity together with the children, e.g. ‘I guide students in presenting their results orally, in writing, and/or through graphical presentations. We do it together.’), and low-supported activities (when the teacher requires the children to perform the activity on their own, e.g. ‘I require students to present their results orally, in writing, and/or through graphical presentations.’). This distinction was simple and functional given the lack of a shared understanding among practitioners and researchers of what each level of teacher support exactly implies (Minner, Levy, & Century, 2010). We asked teachers to indicate to what extent (in a rank from 1 to 3; 0 = never) they adopted each support level in relation to each of the eleven inquiry activities.

The statement above has special implications when looking at item F because we learn from the reply to this item the type of inquiry adopted by the teachers (Herron, 1971):

‘I indicate the research question or hypothesis and the procedure that children will follow to solve the question or confirm the hypothesis’. (Structured Inquiry)

‘I indicate the research question or hypothesis and let the students define their own research procedure’. (Guided Inquiry)

‘I provide the students with a general topic and ask them to formulate their own research question or hypothesis and to define, by themselves, the research procedure’. (Open Inquiry)

Both in the pilot study and in the main study, the reliability of the self-report questionnaire was high (α = 0.75) for the instrument as a whole and for the three subscales
focusing on support levels: low support ($\alpha = 0.77$), medium support ($\alpha = 0.75$), and high support ($\alpha = 0.83$).

### 2.2.2. Science Teaching Self-Efficacy scale (STSE).

We modified and administered one scale of the Science Teaching Efficacy Beliefs Instrument (STEBI) whose validity and reliability were established by Riggs and Enochs (1989) and improved by Enochs and Riggs (1990). The Science Teaching Self-Efficacy scale (STSE) was internal consistent in the large-scale administration (Cronbach’s $\alpha = 0.76$). The scale had 9 items which could be rated from 1 (strongly agree) to 5 (strongly disagree). Item example: ‘Even though I try very hard, I do not teach science as well as I do most subjects’. The highest the score, the strongest teachers believed in their own ability to teach science.

### 2.2.3. Context Beliefs About Teaching Science (CBATS).

Building on the theoretical base discussed above, the CBATS consists of two subscales: enabling and likelihood. The first scale measures participants’ beliefs about the degree to which certain context factors would enable them to become effective science teachers (1, strongly disagree - 5, strongly agree). Item example: ‘Team planning time with other teachers would enable me to be an effective science teacher’. Next to this subscale, the CBATS asks ‘How likely is it that these factors will occur in your school?’ Participants’ answers (1, very unlikely - 5, very likely) reveal their beliefs about the likelihood of experiencing enabling and hindering context factors. A high sum score (sum of both subscales) indicates that these teachers believe that environmental factors help them to be the most effective science teachers and that these environmental factors can occur in their schools. The validity and reliability of the CBATS was established earlier by Lumpe et al (2000). We obtained a Cronbach’s $\alpha$ coefficient of 0.92 for the entire instrument, 0.87 for the
enabling scale, and 0.88 for the likelihood scale. The modified version of the CBATS consisted of 23 items. From the original version we excluded 3 items that teachers in our pilot study declared not to be familiar with (i.e. hands-on science kits, involvement of scientists, and involvement of university professors).

2.3. Data Collection and Analysis

Our survey included a demographic questionnaire, the self-report questionnaire on inquiry activities, the CBATS, and an adapted version of the STSE. The survey instruments were presented to 300 teachers from 70 public primary schools. In total, 210 responses were received (70%). The data collection took place at two locations and resulted in different response proportions. In Arenillas, we delivered 125 surveys the first day of a massive workshop and collected 86% the next day. In Huaquillas, we delivered 176 surveys the first day of a massive workshop and collected 58% three months later. The collection was largely delayed due to teachers’ total absenteeism the second day of the workshop\(^3\), the suspension of the next workshops due to a national electrical crisis and a one-month national strike of the teachers against the government. Data cleaning resulted in the removal of some incomplete responses and a final data set from 173 respondents. Given the significant events preventing the second group from returning the survey in the same way as the first group did, we analysed potential differences between schools. No significant differences were found in response patterns.

We started the main data analysis with descriptive statistics. Beliefs’ scores required benchmarks for interpretation. Based on Palmer (2006), we employed 3 as the neutral mark and considered *moderately low*, *low*, or *very low* the total mean one, two or three standard deviations below 3; and *moderately high*, *high*, or *very high* the total mean one, two or three

\(^3\) Both teachers from Arenillas and Huaquillas protested against and did not attend mandatory workshops on Saturdays.
standard deviations above 3. The second part of our analysis consisted in mean comparisons between pairs of independent groups. We applied the median split method to ensure a similar number of subjects in each group; this number changed, however, due to missing values. Before deciding on which statistical procedure to use for analysing independent groups, we tested the normality of the distribution in each group (either with the Kolmogorov-Smirnov, D or the Shapiro-Wilk test, W). When normal, we used the independent means t-test (t); when not normal, we used the Mann-Whitney test (U). We also tested the homogeneity of variance (Levene’s test, F). In case of finding a significant difference between two groups, we calculated also the effect size. Specifically, we calculated Cohen’s d because its formula \( d = (M_1 - M_2) / \sigma \text{ within} \) could be extended to unequal sample sizes in two groups with normal distribution (Rosenthal, Rosnow, & Rubin, 2000, p. 30). In the case of non-normal distributions, Field (2005, p. 532) offers the following formula to calculate the effect size:

\[
\begin{align*}
r &= \frac{Z}{\sqrt{N}}.
\end{align*}
\]

The z-score is shown on the SPSS output together with the U score (Mann-Whitney test). To interpret d and r measures, we refer to the following benchmarks: small effect, \( d = 0.20 \) or \( r = 0.10 \); medium effect, \( d = 0.50 \) or \( r = 0.30 \); and, large effect, \( d = 0.80 \) or \( r = 0.50 \) (Brysbaert, 2011; Field, 2005; Rosenthal, et al., 2000).

3. Results

To tackle the first research question, we analysed the self-report on inquiry activities. The three inquiry activities -considering a specific level of support- ranked first by most of the teachers were: ‘I present previous or new material and identify the main ideas in interaction with the children’ \( (n = 159, M = 2.50, SD = 0.61) \); ‘I present previous or new material and review content understanding by asking the meaning of some words. Both the pupils and myself look together for the meaning of some words’ \( (n = 154, M = 2.39, SD = 0.78) \); and, ‘I present previous or new material and review content understanding by
drawing - together with the pupils - a concept map’ \((n = 149, \ M = 2.34, \ SD = 0.71)\). These highly ranked inquiry activities reflect medium support. On the other hand, the three inquiry activities selected least reflect a low-support level: ‘In a research project or consulta\(^4\), I require the pupils to draw their own conclusions and to support these conclusions with data’ \((n = 128, \ M = 1.20, \ SD = 0.98)\); ‘I require pupils to manipulate data using the tools they find most appropriate’ \((n = 127, \ M = 1.43, \ SD = 0.96)\); and, ‘I ask the pupils to relate information from one source to information from another source’ \((n = 131, \ M = 1.44, \ SD = 0.88)\).

These results are congruent with the level of support adopted by the teachers in general. Teachers’ adoption of support levels in relation to the 11 particular activities, puts the adoption of medium support in the first position \((n = 173, \ M = 2.14, \ SD = 0.39)\), high support in the second place \((n = 173, \ M = 1.88, \ SD = 0.49)\) and low support in the third place \((n = 173, \ M = 1.60, \ SD = 0.39)\). As shown in Table 2, this pattern is constant from second to seventh year. Table 2 illustrates the implementation of inquiry activities and the level of support per school year. We observe that, regardless the school year, teachers adopt more medium support than high support or low support and more high support than low support. We also observe that the higher the school year, teachers tend to embrace more inquiry activities in their classroom practice.

Regarding the type of inquiry teachers implemented in their classroom, structured inquiry \((n = 143, \ M = 2.06, \ SD = 1.0)\) was selected to a larger extent than open inquiry \((n = 128, \ M = 1.54, \ SD = 1.05)\) and guided inquiry \((n = 127, \ M = 1.40, \ SD = 0.99)\). We notice that there were more missing values in the inquiry types selected least than in the inquiry types selected most. The high dispersion of data is noticeable, as well.

\(^4\) Consulta, in the Ecuadorian context, means homework that can be done from one day to another because the information required is easy to get. It is simpler and shorter than a research project.
Table 2. Mean Numbers Revealing the Frequency of Adoption of Inquiry Activities at Different Levels of Support and at Different School Years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1.43</td>
<td>2.21</td>
<td>1.31</td>
<td>4.95</td>
</tr>
<tr>
<td>3</td>
<td>1.48</td>
<td>1.94</td>
<td>1.94</td>
<td>5.36</td>
</tr>
<tr>
<td>4</td>
<td>1.42</td>
<td>2.17</td>
<td>1.80</td>
<td>5.39</td>
</tr>
<tr>
<td>5</td>
<td>1.46</td>
<td>2.18</td>
<td>1.88</td>
<td>5.52</td>
</tr>
<tr>
<td>6</td>
<td>1.69</td>
<td>2.15</td>
<td>1.92</td>
<td>5.76</td>
</tr>
<tr>
<td>7</td>
<td>1.77</td>
<td>2.11</td>
<td>1.96</td>
<td>5.84</td>
</tr>
</tbody>
</table>

Before continuing with our analysis, we observe that the efficacy beliefs of the entire sample are moderately high (M = 3.70, SD = 0.55) and the context beliefs are rather high (M = 4.00, SD = 0.40). To tackle the second research question: ‘Is there a difference between the levels of support and the type of inquiry used by teachers according to their beliefs (efficacy and context)?’, we applied the median split method and assigned the respondents to two groups: teachers with higher science teaching efficacy beliefs (n = 85) and teachers with lower science teaching efficacy beliefs (n = 87). Next, we test the normality of high (HS), medium (MS), and low support scores (LS) in each group. HS scores were normal for both low-efficacy, D (53) = 0.08, p = 0.20 and high-efficacy teachers, D (58) = 0.11, p = 0.09. There was also homogeneity of variance, F (1,109) = 0.68, p = 0.41. MS scores were normal for both groups, D (53) = 0.11, p = 0.20 and D (58) = 0.08, p = 0.20; and the variance was homogeneous F (1,109) = 0.42, p = 0.52. The assumption of homogeneity of variance was also met in the case of LS, F (1,109) = 2.04, p = 0.16; however, LS was normal for low-efficacy teachers, D (53) = 0.09, p = 0.20 but not for high-efficacy teachers, D (58) = 0.13, p = 0.02. Consequently, we used t-tests for HS and MS and the Mann-Whitney test for LS. We
found a significant difference in the use of medium support. On average, teachers with low-efficacy beliefs use less medium support ($M = 2.04, SD = 0.49$) than teachers with high efficacy beliefs ($M = 2.23, SD = 0.44, t (115) = -2.17, p = 0.03$). The difference represented a medium size effect $d = 0.40$; this means that there are 60% chances that a randomly chosen teacher with higher efficacy beliefs has a higher score in medium support than a randomly chosen teacher with lower efficacy beliefs.

Regarding context beliefs, the following groups were compared on the base of the median split method: teachers with higher science teaching context beliefs ($n = 87$) and teachers with lower science teaching context beliefs ($n = 86$). When looking at the scores each group assigned to each contextual factor, we find that the groups significantly differ in their reactions to all of them except one (please refer to Table 3 in the Appendix of this chapter for the detailed results). Regarding our main analysis, only HS scores reflected a normal distribution in both groups, $D (50) = 0.11, p = 0.20$ and $D (61) = 0.10, p = 0.20$; moreover, the Levene’s test indicated a sufficient homogeneity of the variance, $F (1,109) = 0.73, p = 0.39$. Therefore, we conducted the independent t-test for HS and the Mann-Whitney tests for MS and LS. We found a significant difference regarding low support. On average, teachers with higher context beliefs use more low support ($n = 66, Mdn = 1.64$) than teachers with lower context beliefs ($n = 52, Mdn = 1.36, U = 1355, p = 0.05$). The effect size was small, $r = -0.18$.

We also studied differences between the types of inquiry teachers reported to adopt during their science lessons. We observe that the distributions of structured, guided, and open inquiry were not normal; neither for low- nor for high-efficacy teachers. In a rank from 0 to 3, the median score of guided inquiry was exactly the same in both groups ($Mdn = 1.00$) and the median score of open inquiry was also the same in both groups ($Mdn = 2.00$). Low-
efficacy teachers, however, seem to use less structured inquiry (Mdn = 2.00) than high-
efficacy teachers (Mdn = 2.50), but the difference was not significant, U = 2129, p = 0.07.

In regard to context beliefs, the distributions of structured, guided, and open inquiry
were not normal neither for low- nor for high-context teachers. The median score of guided
inquiry was the same in both groups (Mdn = 1.00) and the median score of structured inquiry
was also the same in both groups (Mdn = 2.00). Apparently, low-context teachers, adopted
less open inquiry (Mdn = 1.00) as compared to high-context teachers (Mdn = 2.00), but this
difference was not significant, U = 1723, p = 0.12.

4. Discussion

Our first objective was to find out to what extent teachers implement inquiry activities
in their classroom, what level of support (low, medium, or high) they provide, and what type
of inquiry they implement (structured, guided, or open). Teachers declared to focus on all the
proposed inquiry activities, but some more frequently than others. Interestingly, the activities
reported the most correspond to the first step in the inquiry cycle (Understand) and the results
further suggest stagnation in the way the next steps in the inquiry process are pursued.
Moreover, the results also imply that teachers mainly work with the material they supply to
the pupils (i.e. ‘I present previous or new material...’). In contrast, the activities performed
the least imply that the pupils work with the material they generate themselves (by drawing
their own conclusions, manipulating data, or relating information).

Furthermore, the inquiry activities adopted the most represent a medium-support
level. This reflects a trend throughout the results in the study; even when focusing on the
different primary school years. Regardless of the school year, teachers prefer to adopt inquiry
activities set up in a collaboration between themselves and the pupils, instead of giving
autonomy to the learners (low support) and showing them exactly how to carry out the
activities (high support). We wonder if teachers are especially concerned about the isolated execution of the activities, rather than pursuing inquiry skills. We observe here a risk for real inquiry development. Though inquiry can be pursued in close collaboration between the teacher and the pupils, at one point the teacher should give up control (low support). Of course, this implies sufficient enhancement of specific thinking skills via modelling and thinking aloud (high support), which have been reported to be critical strategies to teach pupils to think (Smith & Ragan, 2005).

We could add that the use of support should vary according to the school year and that teachers from the lower school years are expected to adopt high support more often than teachers from the upper school years. It is an instructional principle to progressively move toward low support as learners gain skill, knowledge, motivation, and confidence (Smith & Ragan, 2005). In contrast, as reflected in Table 2, the adoption of high support tends to increase across the school years.

Apparently, it is difficult for teachers to give up control. We note that the kind of support teachers provide to their students anticipates the fact that teachers do not ask pupils to formulate their own research question and define, by themselves, the research procedure. Accordingly, our teachers are far removed from implementing real inquiry in the classroom; what takes place is structured inquiry.

A second objective was to explore internal factors that help to explain this particular teacher behaviour. We wanted to contribute to the debate regarding the possible relationship between teacher beliefs and teacher practices. The results suggest that self-efficacy beliefs hardly make a difference, except in the use of medium support. Nevertheless, the fact that teachers with higher efficacy beliefs adopt more medium support than teachers with lower efficacy beliefs does not give us much direction because medium support is to be seen as an in-between stage in developing inquiry skills in learners. On the other hand, the results
regarding context beliefs are more enlightening. Teachers with higher context beliefs adopt lower support levels as compared to teachers reflecting lower context beliefs. This suggests that teachers who believe that effective science teaching is possible in their schools also believe that pupils are able to perform effectively without much support from the teacher. This result has a practical implication. If we want teachers to give up control in developing inquiry, we should support their context beliefs (i.e. challenging personal evaluations of whether they have a supportive environment). Lumpe, et al., (2000) suggest, for example, that when low context beliefs are based on past experiences with administrators or the physical environment (e.g. lack of science equipment), professional development might be needed to establish more trust and more confidence. Indeed, to increase context beliefs, professional development could provide teachers with positive experiences with all related contextual factors, including the factor ‘professional development’.

In conclusion, this study stresses the importance of contextualizing conclusions from previous studies. We found that context beliefs make a difference in the use of low support and that structured inquiry is the teachers’ preferred type of inquiry. We suggest that efforts to move teachers from structured to guided inquiry (and ultimately, to open inquiry) should be accompanied by efforts to increase their beliefs in the possibility of reaching effective science teaching in their school environment. The latter could be achieved by identifying contextual factors believed to be beneficial and then increasing the likelihood that those factors will exist for the teachers.

4.1. Limitations

We acknowledge that the confirmation of the self-report questionnaire on inquiry activities should be confirmed with a small-scale classroom observation, which we plan to do in a next study.
Chapter 1

The fact that 210 out of 300 teachers returned the survey deserves our attention. We must highlight, firstly, that 70% is an acceptable response rate (Wiersma, 2000); secondly, that failing to return the survey was due to logistics and not to teachers’ unwillingness to respond; and thirdly, post hoc analysis did not reveal significant differences in teacher responses from Arenillas and Huaquillas. Furthermore, the non-response due to incomplete answers was low. From 210 returned surveys, 83% were complete. We recognize, however, that political circumstances at the time of data collection could have affected the honesty and completeness of the responses. Moreover, the delicate political situation impeded us from assessing teachers’ actual science content knowledge, which could have complemented our understanding of their science teaching self-efficacy. Based on this experience, we would recommend small-scale studies increasing the possibilities of establishing trust and collaboration with the participants.

References


APPENDIX

Table 3. Mann-Whitney test comparing the median scores assigned to each CBATS factor

<table>
<thead>
<tr>
<th>Factor</th>
<th>Group A</th>
<th>Group B</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mdn</td>
<td>SE</td>
<td>Mdn</td>
<td>SE</td>
</tr>
<tr>
<td>1. Professional development</td>
<td>4.00</td>
<td>0.09</td>
<td>4.50</td>
<td>0.05</td>
</tr>
<tr>
<td>2. National standards</td>
<td>3.75</td>
<td>0.10</td>
<td>4.50</td>
<td>0.10</td>
</tr>
<tr>
<td>3. Teacher support</td>
<td>4.00</td>
<td>0.11</td>
<td>4.50</td>
<td>0.07</td>
</tr>
<tr>
<td>4. Team planning</td>
<td>4.50</td>
<td>0.12</td>
<td>5.00</td>
<td>0.08</td>
</tr>
<tr>
<td>5. Community involvement</td>
<td>3.00</td>
<td>0.14</td>
<td>4.00</td>
<td>0.10</td>
</tr>
<tr>
<td>6. Funding</td>
<td>3.50</td>
<td>0.11</td>
<td>4.50</td>
<td>0.08</td>
</tr>
<tr>
<td>7. Class length</td>
<td>3.00</td>
<td>0.13</td>
<td>4.00</td>
<td>0.14</td>
</tr>
<tr>
<td>8. Planning time</td>
<td>4.00</td>
<td>0.10</td>
<td>4.50</td>
<td>0.05</td>
</tr>
<tr>
<td>9. Science equipment</td>
<td>4.00</td>
<td>0.12</td>
<td>5.00</td>
<td>0.10</td>
</tr>
<tr>
<td>10. Classroom environment</td>
<td>4.00</td>
<td>0.12</td>
<td>4.50</td>
<td>0.05</td>
</tr>
<tr>
<td>11. Adoption official curriculum</td>
<td>4.00</td>
<td>0.11</td>
<td>4.50</td>
<td>0.06</td>
</tr>
<tr>
<td>12. Expendable science suppliers</td>
<td>3.75</td>
<td>0.11</td>
<td>4.00</td>
<td>0.08</td>
</tr>
<tr>
<td>13. Principal</td>
<td>4.00</td>
<td>0.11</td>
<td>5.00</td>
<td>0.10</td>
</tr>
<tr>
<td>14. Materials</td>
<td>4.00</td>
<td>0.09</td>
<td>4.50</td>
<td>0.06</td>
</tr>
<tr>
<td>15. Technology</td>
<td>4.50</td>
<td>0.07</td>
<td>5.00</td>
<td>0.04</td>
</tr>
<tr>
<td>16. Parents</td>
<td>3.25</td>
<td>0.15</td>
<td>4.00</td>
<td>0.09</td>
</tr>
<tr>
<td>17. Students’ abilities</td>
<td>4.00</td>
<td>0.09</td>
<td>5.00</td>
<td>0.05</td>
</tr>
<tr>
<td>18. Supervisor</td>
<td>4.00</td>
<td>0.11</td>
<td>4.50</td>
<td>0.12</td>
</tr>
<tr>
<td>19. Teaching load</td>
<td>3.00</td>
<td>0.12</td>
<td>3.50</td>
<td>0.12</td>
</tr>
<tr>
<td>20. Amount of content</td>
<td>3.00</td>
<td>0.12</td>
<td>4.00</td>
<td>0.13</td>
</tr>
<tr>
<td>21. Class size</td>
<td>3.00</td>
<td>0.13</td>
<td>4.00</td>
<td>0.12</td>
</tr>
<tr>
<td>22. Classroom assessment</td>
<td>4.25</td>
<td>0.06</td>
<td>5.00</td>
<td>0.05</td>
</tr>
<tr>
<td>23. Teacher input</td>
<td>4.00</td>
<td>0.11</td>
<td>5.00</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Note. Group A = Teachers with lower context beliefs; Group B = Teachers with higher context beliefs.
Do teachers implement inquiry and are they able to do it? A needs assessment analysis in public primary schools.

Based on:
Chapter 2

Do teachers implement inquiry and are they able to do it? A needs assessment analysis in public primary schools.

Abstract

The present study explores the actual adoption of inquiry-based science teaching in public primary schools. In the context of a developing country, 20 in-service teachers are observed while teaching science in the last year of primary education. We also study the teachers’ inquiry-related knowledge and skills and the classroom environment. All this provides enlightening information for needs assessment, a preliminary phase in the design of training interventions. The descriptive findings show that a basic inquiry teaching orientation is missing; this was congruent with the teachers’ low scores in inquiry tests. During 20 regular science lessons, teachers made 1,600 questions to the pupils, whereas only three pupils (n = 634) made a question to the teacher. The overwhelming teacher questioning behaviour seriously hinders inquiry. Other limitations are the absence of libraries, science labs, and Internet in the schools. There are -however- other environmental factors, i.e., didactical resources and freedom to plan the lessons, that are not used in the advantage of inquiry education. The results suggest that the development of basic questioning skills should be the first step towards the adoption of inquiry in the classroom.

1. Introduction

Inquiry-based science teaching, recommended by several researchers in science education (e.g., J. Bloom, 2006; Sanger, 2008; van Joolingen, de Jong, & Dimitrakopoulou, 2007; W. Williams, Papierne, Makel, & Ceci, 2004), has been endorsed by the National Science Curriculum Reform (NSCR) in Ecuador since 1996. One of its objectives is that –by
the end of the 10 years of basic education\(^1\) pupils “will use the inquiry process in small projects and mainly as a living habit” (Ministerio de Educación y Cultura del Ecuador, 1998, p. 88). We wonder if teachers are implementing inquiry in their science teaching and if they are able to do it.

Already in 1996, the NSCR recognized that Ecuadorian education was centred on memorization and has traditionally taken away pupils’ innate happiness of discovering. For the first time in Ecuadorian history, the Ministry of Education launched a national evaluation of public primary school teachers in 2009. The results were critical. More than 45% of the teachers were rated in the lowest category (*unsatisfactory*) for both their content and pedagogical knowledge (Ministerio de Educación del Ecuador, 2009). Another study in the same context suggests that teachers (*n* = 173) do not encourage the pupils to think by themselves (Lucero, Valcke, & Schellens, 2013).

To clarify this critical situation, a needs assessment approach was used in the present study. This implied checking particular assumptions about expected teacher behaviour, required knowledge and skills, and required environmental conditions. The investigation was led by the following research questions:

1) What is the actual behaviour in relation to the behaviour expected by the NSCR in relation to inquiry-based science teaching?

2) Do teachers have the competencies to perform as expected?

3) Under what environmental conditions does the actual teaching behaviour take place?

### 1.1. The expected teaching behaviour

Primary school teachers are expected to adopt inquiry in science teaching. According to the NSCR, in the seventh year (age 11-12) pupils should already possess certain inquiry

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\(^1\) In Ecuador, ‘basic education’ includes what in the US system is called kindergarten, the six years of primary school, and the first three years of secondary school.
skills, like question formulation, data collection, data interpretation, and data registry in graphics and tables. These skills perfectly match the steps of the inquiry process, as shown in Table 1. The identification of the steps in the table is the result of an extensive literature review (e.g., B. Bloom, 1966; Egbert, 2009; Molebash, Bernie, Bell, & Mason, 2002; Quintana et al., 2004) summarized elsewhere (Lucero, et al., 2013). The table could serve as a guide for teachers to integrate inquiry-oriented activities in their teaching.

**Table 1**: Steps of the inquiry process and inquiry-oriented activities

<table>
<thead>
<tr>
<th>STEPS</th>
<th>The teacher encourages the pupils to think; the teacher encourages the pupils to...</th>
</tr>
</thead>
</table>
| 1. Understand | - Identify main ideas.  
- Find the meaning of difficult words.  
- Review content understanding by drawing a concept map.  
- Associate information from diverse sources. |
| 2. Ask | - Formulate questions that could initiate an investigation. |
| 3. Define | - Define research question and procedure. |
| 4. Gather | - Use information resources and data-gathering instruments. |
| 5. Manipulate | - Manipulate data. |
- Present results.  
- Reflect on the research process. |

Inquiry is a process that implies a series of thinking strategies (Zohar & Peled, 2008). Thinking strategies are “mental tactics that lead to discovery, invention, or creativity [which] are helpful not only to solve but also to find problems” (Smith & Ragan, 2005, pp. 244-245). Inquiry is a combination of creativity, critical thinking, problem solving, and problem identification skills to pose questions and find answers. More than following steps in a process, inquiry implies being able to make decisions during each step. Consequently, doing inquiry is about encouraging the pupils to think (Olson & Loucks-Horsley, 2000).
1.2. The critical position of needs assessment

The implementation of inquiry in the classroom requires certain knowledge and skills from the teachers. To upgrade teachers’ knowledge and skills, the Ecuadorian government has made an important investment (more than 16 million dollars in the last four years) in mandatory in-service teacher training that has already reached 350 000 public primary school teachers (Ministerio de Educación, 2012). However, in-service teacher training has been criticized for being disconnected from the needs of the teachers ("Maestros estudian", 2009; Ministerio de Educación & VVOB, 2008; "Sectores piden", 2010; "Un buen docente", 2009).

If training interventions do not tackle the core problem, valuable time, effort, and resources can end up in frustration. This can be prevented from the beginning by conducting a needs assessment (Mager & Pipe, 1997; Romiszowski, 1981; Smith & Ragan, 2005).

Even though the importance of needs assessment is emphasized in the literature, its definition is not always explicitly stated. In our study we define needs assessment as the process of identifying a gap between ‘what is’ and ‘what should be’ (i.e., discrepancies between actual and desired performance) and deciding if instruction is the solution (Kaufman, 1997; Mager & Pipe, 1997; Romiszowski, 1981; Smith & Ragan, 2005). In the framework of the present study, we will provide information from which important needs assessment implications can derive.

Not every gap calls for educational solutions. If the cause of the gap is a lack of knowledge and skills, then an educational solution is required; on the other hand, if the gap is rooted on a lack of resources, incentives, or feedback, then an educational solution is not adequate (Branch, 2009; Clark, 1994; Mager & Pipe, 1997; Noe, 2002; Romiszowski, 1981). Unfortunately, innovators feel tempted to start with a potential solution instead of identifying the real problem first. Goldstein and Ford (2002) criticize, for example, that “trainers are
sometimes sold a particular approach such as the use of CD-ROM technology” (p. 25) before they have conducted a needs assessment. McKenney and Reeves (2012) add:

It is not uncommon to hear things like, “School leaders require training in intra-personal skills,” “Mathematics learning should be more practical,” or “Our teachers need to use more technology in the classrooms.” These are not legitimate problems. Rather, they are proposed semi-solutions or, in some cases, solutions in search of problems. (pp. 88-89)

An example in the Ecuadorian context is a teacher-training project promoting the use of computers for the development of pupils’ thinking skills. In the evaluation of this project it was concluded that teachers adapt computers to their traditional pedagogical practice, i.e., transmission of knowledge, instead of modifying their practice to take full advantage of computers; consequently, pupils remain being the passive spectators of the learning process (Peñaherrera, 2011, 2012). An earlier research set up in the Ecuadorian context identified additional problems. For instance, teachers had very little computer experience; 66% (n = 478) never used a computer independently (Lucero, 2008).

The above supports the statement that, despite the acknowledged importance of needs assessment, designers often skip this activity in educational practice (Visscher-Voerman & Gustafson, 2004). This brings us to the focus of the present study that connects the field of inquiry teaching with the field of instructional design. The results are expected to have important implications for the design of teacher training interventions aiming at fostering inquiry. The research questions, mentioned in the introduction, focus on the teachers’ current inquiry practices, their competences, and the environmental conditions.
2. Method

2.1. Context and participants

In the context of a particular collaboration between an Ecuadorian university and the government, the researchers got access to public primary schools in El Oro, a province in the southwest of Ecuador. Schools in El Oro can be considered to be representative for Ecuadorian schools. For example, regarding school resources to carry out inquiry, the percentage of students (5-17 years old) who have access to a school library is 50% in El Oro and 46% at the country level; 53% of students in El Oro have access to computers in schools as compared to 52% at country level; and 15% of students in El Oro have Internet access in schools while this is the case in 18% of the pupils at country level (Ministerio de Coordinación de Desarrollo Social del Ecuador, 2008).

To further select schools to be involved in the study, we adopted purposeful sampling and stipulated some school-related and teacher-related criteria (Wiersma, 2000). Given the geographical dispersion of schools, we selected sufficiently large schools located in populated areas to guarantee that there was at least one teacher in the seventh year of primary education. We focused on seventh year school teachers building on the findings of a previous study in which teachers reported that inquiry learning was mostly implemented during the later years of primary education (Lucero, et al., 2013). Moreover, to secure their participation in follow-up studies, we focused on tenured teachers, not retiring within the next two years. From an initial pool of 500 teachers from four cantons (Arenillas, Huaquillas, Las Lajas, and Santa Rosa), the largest group of teachers who satisfied our criteria was from Huaquillas: 20 teachers working in 13 different public primary schools.

The selected teachers and schools accepted to participate after a meeting where the research project was explained in detail to both teachers and principals. Given teachers’ general reluctance to be evaluated, it was stressed that the purpose was not to judge the
teachers, but to develop a diagnostic picture. Teachers reacted positively to a needs assessment that would take into account the reality of their classroom.

The participating teachers were, on average, 50 year-old. Half of them were female. Their teaching experience ranged between 10 and 33 years. Ten teachers had more than 27 years of experience. Besides being a full-time teacher, one of the participants was also the school principal. All teachers received instruction at a teacher-training institute (vocational higher education); twelve pursued or were pursuing studies at university level and one at a post-degree level.

2.2. The needs assessment approach

To frame the study of teachers’ actual behaviour, the different coding schemes and instruments started from the perspective of the expected behaviour, as described in section 1.1. Firstly, we observed the actual behaviour. Next, we measured the inquiry-related knowledge and skills that empower teachers to perform as expected. Lastly, we studied the environment -under which the actual behaviour occurs- taking also into account the perspective of the teachers.

2.3. Research instruments

2.3.1. Teaching behaviour

In a previous study (Lucero, et al., 2013), a self-report questionnaire was adopted to map the inquiry activities first to seventh year science teachers implemented the most and the least during a regular science lesson \(n = 173\). The self-report questionnaire collected responses in relation to 11 inquiry activities (derived from Table 1). Each activity was stated in three ways representing three teacher support levels, e.g., “I model for the children how to relate information from one source to information from another source. I think aloud. I
provide a step-by-step example.” (High support); “We, the children and me, relate information from one source to information from another source.” (Medium support); and, “I ask the children to relate information from one source to information from another source.” (Low support). Consequently, a total of 33 statements or items were presented. For the purpose of the present study, the teachers’ answers to the questionnaire were compared with their actual teaching behaviour in the classroom.

Furthermore, twenty regular science lessons (45 minutes each) were videotaped, transcribed, and coded. The coding scheme emerged from Table 1. It also included indicators of pupils’ inquiry behaviour.

Three native Spanish-speaking Educational Sciences student-assistants carried out the transcription and coding of the video-recorded lessons. They received training in coding and in the use of the Nvivo8 software. Moreover, to ensure inter-rater reliability, the following procedure was followed: 1) trainer and raters transcribed and coded together a first video-recorded lesson; 2) trainer and raters coded in pairs a second lesson on different computers but in the same room; 3) trainer and raters coded in pairs a third lesson on different computers in different rooms; and 4) raters coded independently a fourth lesson on separate computers in separate rooms. After each step, results were compared and discussed. The coding specifications were – when necessary – further refined and more indicators were added. After finishing the entire coding procedure, we calculated inter-rater reliability, based on the independent coding of the fourth lesson for which the three raters coded 179 units of analysis. To determine inter-rater reliability, we calculated Krippendorff’s alpha because a) in contrast to percentage agreement, it accounts for chance agreement, and b) in contrast to Scott’s pi and Cohen’s kappa, it allows for more than two raters (De Wever, Schellens, Valcke, & Van Keer, 2006). A Krippendorff’s alpha of 0.70 was achieved. This level is
acceptable when the kind of research is exploratory and when conservative indexes, such as Krippendorff’s alpha, are used (Lombard, Snyder-Duch, & Bracken, 2002).

To further develop an in-depth picture of teachers’ teaching behaviour, we conducted pre- and post-classroom observation interviews (based on Horizon Research, 2005). Before the lesson, we asked teachers what they planned to do. During the lesson, we made annotations about the topic, the instructional objectives, assessment criteria, and learning activities. After the lesson, we asked teachers if things went different from what they had planned, what activities helped them to understand what the pupils learned or still needed to learn, and what would be the next step. During the interviews, teachers had the chance to express any concerns related to the study. This was done to secure trust and confidentiality.

2.3.2. Inquiry-related knowledge and skills

A paper-based test was used to determine the extent to which teachers possessed knowledge and skills that would enable them to implement inquiry as stipulated in Table 1. The content validity of the test is based on the fact that each item is congruent with the inquiry-oriented behaviours shown on Table 1; moreover, the validity of the instrument is reinforced by the rigorous literature research supporting the behavioural statements (see more in Lucero, et al., 2013). As shown in Table 2, every test item corresponds to an objective that, at the same time, corresponds to an inquiry-oriented behaviour. For example, the inclusion of test items regarding Bloom’s taxonomy is explained by the correspondence between the levels of comprehension, analysis, synthesis, and evaluation (B. Bloom, 1966), the inquiry steps (Molebash, et al., 2002), and critical thinking phases (Egbert, 2009), which largely overlap each other (Quellmalz & Hoskyn, 1997).
Table 2: Test about inquiry related knowledge and skills. Relationship between inquiry-oriented behaviour and instructional objectives as exemplified with test items.

<table>
<thead>
<tr>
<th>Inquiry-oriented behaviours</th>
<th>Instructional objectives</th>
<th>Test section</th>
<th>Test items</th>
</tr>
</thead>
<tbody>
<tr>
<td>In order to...</td>
<td>teachers should be able to...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>▪ go through the inquiry process</td>
<td>order the steps of the inquiry process.</td>
<td>1</td>
<td>1-6</td>
</tr>
<tr>
<td>▪ define the research question and procedure</td>
<td>distinguish between open, structured, and guided inquiry.</td>
<td>2</td>
<td>7-9</td>
</tr>
<tr>
<td>▪ manipulate data</td>
<td>calculate average and percentage.</td>
<td>3</td>
<td>10-11</td>
</tr>
<tr>
<td>▪ go through the inquiry process</td>
<td>differentiate between the levels of Bloom’s taxonomy.</td>
<td>4</td>
<td>12-29</td>
</tr>
<tr>
<td>▪ ask questions or set up tasks that might initiate a research project</td>
<td>interpret graphical representations of data.</td>
<td>5</td>
<td>30-33</td>
</tr>
<tr>
<td>▪ understand</td>
<td>draw a concept map.</td>
<td>6</td>
<td>34-40</td>
</tr>
<tr>
<td>▪ make up conclusions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▪ review content understanding</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The reliability of objective-referenced tests is different from norm-referenced tests. It is not evidenced by an index of internal consistency; other characteristics are important, such as objectivity, clarity of the items and their directions, contextualization, preventing correct answers given by guessing, and reduced anxiety (Smith & Ragan, 2005). Thus, we secured reliability by a) using multiple choice and matching formats (items 1-33) and a checklist (items 34-40), b) using several options in multiple-choice items to reduce the possibility of correctly answering by guessing, and c) providing complete directions and introductory texts to contextualize the questions and avoid misunderstandings.

Differently from norm-referenced tests, in objective-referenced tests we are mainly interested in determining how well the respondents have performed in each of the instructional objectives rather than comparing or ranking them (Smith & Ragan, 2005). Each correct item resulted in an increase of the objective-score, which was then converted into a percentage. Teachers surpassing 75% of correct items were considered ‘competent’ on the knowledge and skills implied in the corresponding objective.
2.3.3. Classroom environment

We adapted the classroom observation record provided by Horizon Research (2005). Classroom resources could be rated from 1 (sparsely equipped) to 5 (rich in resources); classroom space, from 1 (crowded) to 5 (adequate space); and room arrangement, from 1 (inhibits interactions among students) to 5 (facilitates interactions among students).

Besides recording the number of students in the classroom, we asked teachers if there was any factor in the environment (e.g., classroom, school, policies, principal, supervisor, parents, or students) that could have affected the observed lesson.

3. Results

The following paragraphs provide an overview of descriptive results about teachers’ actual teaching behaviour, their mastery of inquiry-related knowledge and skills, and their classroom environment.

3.1. The actual teaching behaviour

To get a balanced picture of the actual teaching behaviour, a comparison was carried between results of the teacher self-reports and results of the video-analysis and interview analysis. In their self-reports, teachers declared to ‘implement’ on average 30 out of the 33 proposed inquiry-related items \( n = 20, M = 30, SD = 4.27 \). In contrast, on the base of the analysis of the videotaped lessons, we have to conclude that teachers made no reference to inquiry and the lessons were exclusively content-oriented. They did perform some of the activities as stated in the self-report instrument, but not with an inquiry orientation. Two teachers stated, for example, “I require students to present their results orally, in writing, and/or through graphical presentations”, but what they actually meant - as revealed in classroom observation - was that they required students to search for content regarding a
Do teachers implement inquiry and are they able to do it?

Two other teachers stated “I present previous or new material and review content understanding by drawing together with the children a concept map”, but what they actually meant was that they required students to fill-in the branches of the concept map instead of asking them to differentiate between main and secondary ideas; teachers used concept maps to recall content and not to review pupils’ understanding.

In the videotape analysis, we also observed that although ‘questioning’ was the dominant didactical strategy, this questioning was not geared towards inquiry. In general, teachers used questions neither to assess learning nor to promote thinking but to keep the class actively involved in a fast question-answer chain. Teachers presented these questions immediately one after the other, without giving the pupils time to think on the questions in view of developing an answer. In general, teachers did not provide feedback to wrong or correct answers. Sometimes they just ignored them; other times, they said “Wrong”, gave the correct answer or asked other pupils to answer. During the 15 hours of videotaped lessons, the twenty teachers formulated 1 600 questions in total. On the other hand, only three pupils - from 634 pupils in total - asked a spontaneous question to the teacher.

In the post-classroom observation interview we asked the teachers what the lesson told them about what the pupils were learning and still needed to learn. It was difficult for the teachers to answer because, in fact, they did not assess pupils’ learning. Seven of them skipped the question; the rest referred to the ‘active participation’ as an indicator of ‘learning’. One teacher explained that when a pupil did not answer correctly, he neglected the answer because he did not want the pupil to feel bad.

When pupils presented a topic in front of the class, they were required by the teacher to ask their classmates questions and vice versa. These – in total 13 - questions were about the content just presented (e.g., “What is the chamomile?”, “What does it mean to fertilize?”,

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“At what age the growing stage finishes in men and women?”); they required remembering and being attentive, but did not require an in-depth understanding or further analysis, nor an evaluation of the content.

Interestingly, during the pre-classroom observation interviews, seven teachers showed their lesson plan. They took the initiative of planning the lesson according to a guide\(^2\) that suggested several inquiry activities for every science topic. The guide also recommended organizing each lesson in three phases: 1) creating atmosphere and activating previous knowledge, 2) organizing previous information and processing new information, and 3) securing new information. Although the teachers followed this structure, they did not implement the inquiry activities suggested in the guide.

### 3.2. Inquiry-related knowledge and skills

The mean test score about inquiry-related knowledge and skills is 18.35 (\(n = 20, SD = 4.32\)). The maximum achieved -27- is far from the maximum score (40). Moreover, 75% of the scores do not exceed 23. Lower quartile = 13; upper quartile = 23.

Figure 1 illustrates teachers’ performance as related to the specific instructional objectives. As explained before, we adopted 75% as a benchmark to state that a teacher is ‘competent’. We observe that a) more than half of the teachers are competent in interpreting graphical representations of data; b) less than half are competent in calculating average and percentage, drawing a concept map, or distinguish between types of inquiry, and c) none of the teachers are competent neither with the steps of the inquiry process nor with the levels of Bloom’s taxonomy.

\(^2\) A Teachers’ Guide was provided during large-scale massive training program sponsored by the government.
3.3. Classroom environment

On the base of the results of the classroom observation record, we can state that 30% of the classrooms were sparsely or almost sparsely equipped (rated 1 or 2) and 45% were rich or almost rich in resources (rated 4 or 5). Twenty per cent of the classrooms were crowded (rated 1) and 70% were adequately spaced (rated 5). On average, there were 31 pupils per class. In 55% of the cases, the room arrangement inhibited or almost inhibited interactions among students (rated 1 or 2) and facilitated or almost facilitated interaction in 15% of the cases (rated 4 or 5).

Every school possessed a computer lab. However, the use of the computers was restricted to learning basic computer skills and there was no Internet access. All 13 labs were adequately spaced (rated 5) and, on average, there was one computer for every two students. The arrangement of the computers inhibited interactions among students in 15% of the cases (rated 1 or 2) and facilitated interaction in another 15% (rated 4 or 5); the rest were rated in the middle. Other facilities were a projector and a printer, and sometimes a DVD player and a TV, as well.
All schools had neither a library nor a science lab. When necessary, pupils visited the municipality library where few science books were available. At home, 16 teachers possessed a computer and 9 had Internet access.

Teacher input about environmental factors influencing their lessons, could be organized into the following categories:

a) No external influence on their lessons (i.e., teachers felt free to decide about their lessons), mentioned 7 times.

b) Lack of physical space, 6 times.

c) Lack of interest from the parents, the principal, or the pupils, 5 times.

d) Pupils with family problems, 5 times.

e) Pupils with unattended special needs, like learning difficulties and low vision, 4 times.

f) Scarcity of materials, 3 times.

During the lessons, we noticed a lot of background noise from classrooms next door or from the playground but the teachers did not mention this.

4. Discussion

In view of answering our research questions, we developed a projection of what we can expect from teachers when they implement inquiry-oriented science lessons (see Table 1). Although – already since 1996 – inquiry learning has been formally recommended in the NSCR (Ministerio de Educación y Cultura del Ecuador, 1998), results of the video analysis reveal that teachers are not adopting inquiry when teaching science. In line with the large-scale study in Lucero et al. (2013), teachers are more focused on recalling previous material rather than in the generation of new information and, apparently, they erroneously assume that by recalling material they are exercising pupils’ understanding. This interpretation is supported by the results of the inquiry test. The test revealed a clear lack of knowledge about
inquiry, especially regarding Bloom’s taxonomy, which would help teachers distinguish between recalling and understanding. Additionally, the analysis of the actual teaching behaviour shows that teachers may actually carry out what they report to do (as in the self-report) but not with an inquiry orientation. The video analysis clearly helped to interpret teacher answers to the self-report from their particular context and perspective.

The results also show that the lack of inquiry-oriented behaviours can be related to the lack of inquiry knowledge and skills, as revealed in the test. Another explanation for our findings can also be found in the guidelines of the educational authorities. The National Science Curriculum Reform (NSCR) mandates the development of inquiry skills but does not enforce the integration of inquiry in the teaching of science content. Furthermore, the NSCR refers to inquiry as a method to be taught but it should also be inculcated as a thinking strategy, as emphasized in Olson and Loucks-Horsley (2000).

The lack of inquiry-oriented behaviours suggests the lack of an inquiry attitude in the teachers. When compared to the absence of pupils’ questions, the excess of teacher questions can be interpreted as the result of a controlling orientation (G. C. Williams & Deci, 1996). In the context of developing countries, it has been observed that teachers keep control with regard to question formulation and do not support the autonomy of the pupils (Jegede & Olajide, 1995; Lucero, et al., 2013). The fact that only teachers ask questions seriously hinders inquiry because pupils’ questions are a critical element of the inquiry cycle (Herron, 1971; Molebash, et al., 2002).

It is important to highlight that the environment was very limiting given the complete absence of a library, science labs, and Internet at school. Nevertheless, even enabling environmental factors (e.g., resources and freedom to plan the lessons) were not used in the advantage of inquiry teaching and learning. Didactical resources, such as a teacher guidebook with inquiry activities, are ineffective when inquiry knowledge and skills are missing. The
same can be observed in relation to computers, which can be used in many different ways to scaffold inquiry (Egbert, 2009; van Joolingen, et al., 2007). The restricted use of computers suggests the lack of an inquiry approach when making decisions about the selection and use of resources. Underused resources were also observed in the evaluation of a teacher training project where teachers were expected to use computers for the development of pupils’ thinking skills (Peñaherrera, 2012). Similarly, Stronkhorst and van den Akker (2006) developed innovative materials to support new teaching strategies and observed that teachers adapted them to their usual way of teaching.

Implications for educational innovations: the primacy of needs assessment

The present study attends a general critique about educational innovations that often neglect needs assessment (Clark, 1994; Goldstein & Ford, 2002; McKenney & Reeves, 2012). To illustrate the importance of needs assessment, we studied the case of primary school teachers expected to use inquiry in science teaching. In this section we will discuss the implications of the results.

After studying teachers’ behaviour, environment, and competencies we conclude that a) there is a gap regarding teachers’ implementation of inquiry in the classroom, b) there is a lack of inquiry knowledge and skills, and c) there are environmental factors that inhibit as well as others that would facilitate the consecution of the desired results. By principle, the lack of knowledge and skills justifies the design of a training intervention (Branch, 2009). In this sense, the needs assessment has been useful in deciding whether training is the solution regarding the lack of inquiry-related behaviours. Most importantly, the classroom observation informs us that training should also pay attention to teachers’ attitudes or orientations, as revealed in their overwhelming questioning behaviour. Inquiry-oriented attitudes, knowledge,
and skills are necessary to take advantage of existent environmental factors, like didactical resources and freedom to plan the lessons.

Taking into account the baseline as reflected in our findings, the results suggest that a first step in view of fostering inquiry might be to train the teachers to differentiate between recalling and understanding and to optimize their questioning behaviour, for example by inviting the pupils to think and make questions themselves. In this sense, the information we got for the needs assessment allowed us to orient correctly a future teacher training intervention. As stated in the literature (Branch, 2009; Kaufman, 1997; Mager & Pipe, 1997; Romiszowski, 1981; Smith & Ragan, 2005; Visscher & Visscher-Voerman, 2010), the needs assessment allows us to modify the original scope of the desired results and reach a level at which the desired results are manageable.

The next step in the design of instruction is the definition of learning goals for a new intervention training program. For that purpose, further exploration of the teachers’ questioning behaviour is required. Moreover, we acknowledge that more attention to the affective domain could be necessary. The study of teachers’ affective-related internal characteristics (e.g. beliefs, identity, and mission) may contribute to a comprehensive understanding of the gap. A deeper analysis would increase the chances of identifying and tackling the correct core of the problem.

In conclusion, this study stresses the importance of exploring the actual situation of the teachers instead of initiating educational innovations based on assumptions. In this particular Ecuadorian setting, we found that teachers do not do what they are expected to do and do not know how to do it. Besides, school resources and facilities are limited or underused. The desired implementation of inquiry-oriented science lessons can only become true when teachers are adequately trained. This training should respect the complex nature of teacher professionalism and focus – next to inquiry knowledge and skills – on adopting
related attitudes and beliefs (e.g., teachers giving up part of control and encouraging pupils to think).

The present study has a practical value because it informs policy makers, leaders of educational projects, and researchers about teachers’ behaviour, competencies, and environment in relation to inquiry in public primary schools in developing countries. It especially informs instructional designers about the fundamental necessity to start innovations with an elaborate needs assessment exercise.

References


Do teachers implement inquiry and are they able to do it?


A holistic approach to the study of teachers’ questioning behaviour: implications for the design of teacher training interventions

Based on:
Chapter 3

A holistic approach to the study of teachers’ questioning behaviour: implications for the
design of teacher training interventions.

Abstract

To understand holistically the lack of inquiry in science teaching, we explore the
behaviour, beliefs, mission, and identity of 19 in-service teachers from 13 public primary
schools. These dimensions are part of Korthagen’s onion model, which has been widely
adopted to guide teachers’ reflections on their practice. Nevertheless, it has hardly been
applied in the design of instruction for in-service teachers. The purpose of this study is to use
the onion model to enrich the analysis phase of instructional design by looking deeply into
the teachers and their behaviour.

As to the behaviour, we centre in particular on the types of questions teachers
formulate. These were coded from video recordings of 19 science lessons. Teachers’ beliefs
were measured with two questionnaires: the Science Teaching Self-Efficacy scale (STSE)
and the Context Beliefs About Teaching Science questionnaire (CBATS). Finally, a
reflection exercise was used to explore teachers’ mission and identity.

Video analysis revealed that the majority of questions teachers formulate seriously
limit the development of inquiry. Teachers hold, however, moderately high self-efficacy and
context beliefs; apparently, they do not take inquiry learning as a parameter in science
teaching efficacy. Personal reflections revealed that teachers are mainly concerned with the
way they relate to the pupils, which -according to the literature- is linked to their poor
questioning behaviour. Implications for the design of a teacher professional development
intervention are derived from the research results.
1. Introduction

The present study is set up in the context of science teaching in public primary schools in Ecuador. According to science teaching literature (e.g., Bloom, 2006; Egbert, 2009; McTighe & Lyman, 1998; Sanger, 2008; W. Williams, Papierno, Makel, & Ceci, 2004) and the National Science Curriculum Reform (Ministerio de Educación y Cultura del Ecuador, 1998), teachers are expected to integrate inquiry in the teaching of science. The reality, however, is different. In-classroom observations revealed that teachers do not use inquiry at all and science lessons are completely content-oriented (Lucero-Mareydt, Valcke, & Schellens, 2013b). The authors also observed an alarming predominance of teacher questions. During twenty science lessons, 1 600 questions from the teachers (n = 20) and only 3 questions from the pupils (n = 634) were counted. Furthermore, the quality of these questions was very low. In general, they were not meant to stimulate pupils’ thinking neither to review their understanding. Teacher questions were directed to the classroom group in general and used to stimulate a kind of ‘Who knows the answer?!’ teacher-pupil fast verbal interaction where the teacher continuously invited the pupils to answer quickly, like in a competition. questions. No time was given for the pupils to develop an answer. Likewise, no time was allocated neither to give feedback nor to formulate questions that build on the pupils’ answers.

After a needs assessment that took into account the teachers’ behaviour, competencies, and environment, it was concluded that there was an important gap between teachers’ actual and expected use of inquiry in science teaching and a lack of inquiry competencies (Lucero-Mareydt et al., 2013b). It was also acknowledged that further exploration of teachers’ inquiry behaviour –their questioning behaviour, in specific- was required before defining the learning goals of a teacher professional development intervention. Moreover, it was recognized that the study of teachers’ internal characteristics
(e.g. beliefs, identity, and mission) would help to understand the gap between teachers’ actual and expected use of inquiry in a more comprehensive way. A deeper analysis would increase the chances of identifying and tackling the correct core of the problem.

1.1. The personal and professional aspects of teaching

The present study endorses the reconciliation between two approaches to teacher education: one approach focuses on knowledge and skills that make a teacher professionally competent; the other one emphasizes the more personal characteristics of the teachers, contributing to their personal fulfilment. This is a dichotomy that has been discussed continuously since the 1970s (Korthagen, 2004; Meijer, Korthagen, & Vasalos, 2009). To bring together these positions, Korthagen (2004) introduced the onion model (see section 1.2), which has been widely used to guide student teachers’ reflection on their practice (e.g., Korthagen & Vasalos, 2005, 2010; Meijer et al., 2009; Schepens, Aelterman, & Van Keer, 2007; Tigchelaar, Brouwer, & Korthagen, 2008). However, its use in the design of educational programs for in-service teachers has not been explored yet.

In view of developing adequate professional development approaches, Beijaard, Meijer, and Verloop (2004) recommended to link the personal and professional aspects of teaching by, for example, taking into account what the teachers personally desire and experience as good instead of unilaterally deciding what is good for them. In general, developing projects fail because they are externally imposed and neglect the particular aspirations and experiences of the target group (UNDP, 2001). This extends also to teacher developing interventions. As Grion and Varisco (2007) highlighted: ‘Many people asserted that the greatest part of knowledge provided during professional preparation was nullified and replaced by the whole of experiences, role models, needs, routines that constituted the beliefs of teachers’ (p. 272). Therefore, in contrast to policy-makers generally emphasizing the
importance of outcomes in terms of knowledge and skills, many researchers emphasize the more personal characteristics of teachers’ (Korthagen, 2004).

Teachers have traditionally been considered as objects to look at from above and from the outside (Akkerman & Meijer, 2011). An insider perspective, on the other hand, allows the understanding of the personal meaning that teachers give to their teaching practice (Korthagen, 2010). As McLean (1999) claims, it is impossible to separate the person from the teaching task. Likewise, Lipka and Brinthaupt (1999) declare that effective teaching requires a balance of professional, interpersonal, and intrapersonal skills that far from being mutually exclusive complement each other.

In an effort to attend both the personal and professional development of teachers, supervisory interventions have been conceived to support pre-service teachers in ‘developing the necessary teaching competencies in line with who they are and what motivates them to become a teacher’ (Meijer et al., 2009, p. 298). After practicing what has been learned, teacher supervisors help pre-service teachers to reflect on their behaviour, their environment, competencies, beliefs, mission, and identity. When the behaviour responds effectively to the demands of the environment and fulfils the person in the pre-service teacher, a connection between the person and the profession can be observed (see more in Korthagen & Vasalos, 2005, 2010; Meijer et al., 2009; Schepens et al., 2007; Tigchelaar et al., 2008).

1.2. The onion model or model of levels of change

Korthagen’s onion model (2004) is made up of several layers that represent teachers’ environment, behaviour, competencies, beliefs, mission, and identity (see Figure 1). ‘Environment’ refers to classroom and school factors that enable or inhibit teacher behaviour. ‘Behaviour’ refers to what the teacher does in the particular environment. ‘Competencies’ refer to knowledge, skills, and attitudes necessary to behave in a certain way. ‘Beliefs’ are
statements that teachers accept to be true (Richardson, 2003). ‘Identity’ is how teachers see themselves; the meaning they (and others) attribute to their profession. ‘Mission’ refers to their utopian, visionary or spiritual inspiration to be in the world.

![Image of onion model](image)

**Figure 1:** The onion model (Korthagen, 2004)

As explained by Korthagen (2004), the onion model -also called *model of levels of change*- proposes a holistic approach towards teacher development:

Looking at teachers from the perspective of the different levels may add validity to scientific analyses of how teachers function, and may broaden our view of what makes a good teacher…. From a more integrative perspective, a good teacher may be characterized by a state of harmony between the various levels. This means that a teacher educator will ideally devote attention to all the levels –preferably in relation to one another. (pp. 93-94)

The onion model has been successfully adopted in pre-service teacher education and research as a framework to reflect on the personal and professional aspects of teaching and
find a balance between them (Korthagen & Vasalos, 2005, 2010; Meijer et al., 2009; Schepens et al., 2007; Tigchelaar et al., 2008). We believe that such balance should also be considered in the analysis phase of instructional design (see section 1.3) and that the onion model helps to direct the overall instructional design.

1.3. The analysis phase of instructional design

In general, the design of instruction consists of three phases: analysis, strategy, and evaluation (Smith & Ragan, 2005). This study focuses on the analysis phase, which provides a clear vision of where you are and where you want to go. Even though there is vast literature explaining how to conduct an analysis (e.g., Branch, 2009; Goldstein & Ford, 2002; Kessels, 2000; Noe, 2002; Smith & Ragan, 2005), little has been said about a holistic approach that takes into account the multidimensional nature of the teachers as explained above. Exceptionally, McKenney and Reeves (2012) call for ‘a holistic understanding of the problem and how components in its system interact’ (p. 90) and, to this aim, the onion model could be used in the analysis phase of instructional design.

The analysis phase starts by conducting a needs assessment: if there is a gap between desired and actual performance, on one hand, and a lack of knowledge and skills, on the other hand, it may be concluded that instruction is the solution. Next, the learning goal is defined. Obviously, the learning goal should tackle the lack of knowledge and skills identified in the needs assessment but, as discussed above, the emphasis on professional competencies must be counterbalanced with an emphasis also on more personal characteristics of the teachers.

1.4. Purpose of the present study

The purpose of this study is to enrich the analysis phase of instructional design with results derived from a holistic approach that takes into account personal and professional
aspects of teaching. In a first application of this approach, we set up an investigation in the context of science teaching, specifically, the use of inquiry in science teaching in the seventh year of primary school\(^1\). Already in a previous study (Lucero-Mareydt et al., 2013b), we conducted an analysis of twenty teachers at the levels of environment, behaviour, and competencies. Given the lack of inquiry-related activities and the notorious frequency of teacher questions, our general research question aims at studying teachers’ questioning behaviour and to complement these findings with research results about teacher beliefs, mission, and identity. From the results, we will infer implications for the design of a teacher development program. In particular, we expect to be able to sketch out a learning goal that goes in line with diverse levels of change as reflected in the onion model.

2. Method

2.1. Participants

To select participants, we adopted purposive sampling (Cozby, 2005) because we wanted to include in this study the same teachers that participated in a previous study (Lucero-Mareydt et al., 2013b). Nineteen out of twenty teachers accepted to participate. They taught in the seventh year and belonged to 13 public primary schools in Huaquillas, a town in the southwest of Ecuador. Ten were female. On average, they were 50 year-old (range 38-56) and had 25 years of experience (range 10-33). All of them were full-time teachers and one was also the principal of the school. Seven teachers held a vocational higher education degree (teacher training institute); eleven were pursuing or had pursued a bachelor’s degree, and one held a post-bachelor degree.

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\(^1\) Seventh year in Ecuador equals sixth grade in the United States. Children are 11-12 years old.
2.2. Data collection procedure and analysis

2.2.1. Questioning behaviour

We analysed teachers’ questioning behaviour in 19 videos of regular science lessons (one per teacher). The coding scheme developed from a) King’s typology of questions (King, 1997, 1999): review, probing, hint, thinking, and metacognitive questions and b) additional types of questions that did not fit in King’s typology but were predominantly observed and emerged during coding.

**Review questions** assess and consolidate prior knowledge before moving on with the construction of new knowledge; e.g., ‘What are the parts of the water cycle?’ **Probing questions** ask for clarification or development of a given answer; e.g., ‘I don’t understand. What do you mean with “condensation”?’ **Hint questions** help pupils to complement or re-think their answers without giving the correct answer to the pupil, e.g., ‘Aren’t you forgetting something about the clouds?’ **Thinking questions** are used to relate or connect ideas (comparison-contrast, cause-effect), or link new and prior knowledge; they ask for integration of concepts to construct knowledge, e.g., ‘What is the difference between precipitation and evaporation?’; ‘What do you think would happen to the river that crosses our town if it does not stop raining?’ **Metacognitive questions**, also called ‘monitoring’ or ‘thinking-about-thinking’ questions, invite students to think about how they arrived to a certain answer; e.g., ‘What steps did you take to reach that conclusion?’

We coded the questions observed during the first 25 minutes of a lesson because, after that time, most of the teachers asked the pupils to work quietly in the workbook. Transcription and coding were done by three native Spanish speaking Educational Sciences student-assistants who were exhaustively trained, as detailed in Lucero-Mareydt et al. (2013b). The inter-rater reliability of the coding reached an acceptable 0.70 Krippendorff’s alpha.
2.2.2. Beliefs

At the level of beliefs, we administered two instruments that were previously translated into Spanish and proved to be valid and reliable in the same population of Ecuadorian teachers (Lucero, Valcke, & Schellens, 2013a): the Science Teaching Self-Efficacy scale, STSE ($\alpha = 0.76$) and the Context Beliefs About Teaching Science questionnaire, CBATS ($\alpha = 0.92$).

The STSE is based on 9 items (e.g., ‘I am typically able to answer students’ science questions.’) that can be rated from 1 (strongly disagree) to 5 (strongly agree). A high score suggests that teachers believe in their ability to teach science. The STSE is a sub-scale of the Science Teaching Efficacy Beliefs Instrument, STEBI. The STEBI was created by Riggs and Enochs (1989) and has been repeatedly used in related studies (e.g., Enochs & Riggs, 1990; Ramey-Gassert, Shroyer, & Staver, 1996; Riggs, Enochs, & Posnanski, 1998).

The CBATS tells how teachers perceive their environment in relation to their own effectiveness as teachers. Following a list of 23 environmental factors (e.g., professional development, support from other teachers, increased funding, etc.), the respondent must answer - from 1 (strongly disagree) to 5 (strongly agree) - if such a factor will enable him/her to be an effective science teacher and - from 1 (very unlikely) to 5 (very likely) - if that factor will occur in his/her school. Thus, the higher the score the more teachers believe their environment is not a problem for them to be effective science teachers. The validity and reliability of the CBATS was originally established by Lumpe et al. (2000).

The interpretation of the CBATS and STSE scores was based on Palmer (2006): taking 3 as the neutral value, scores one standard deviation (SD) above 3 were moderately high, scores two SDs above 3 were high, and scores three SDs above 3 were very high.
2.2.3. Identity and mission

Studying teachers’ identity and mission is complex and challenging (Beijaard et al., 2004). We were interested in a fair approximation of their images of a good teacher and adopted, therefore, the contrast analysis exercise (Biesta, Korthagen, & Verkuyl, 2002). The objective was to provoke in-depth personal reflections starting with the recall of the best and worst teaching experiences. Teachers followed the instructions on the paper and answered the following open questions: ‘From my personal characteristics, which one made the difference between the good and the bad experience?’ and ‘What is obviously essential to me in education?’ Next, they completed three statements: ‘I am someone for whom ______ is important. I am someone that needs ______. I am someone who strives for ________.’ Working in pairs, teachers listened attentively to each other’s experiences and helped each other to organize their thinking and synthetize their answers.

The contrast analysis exercise was translated from Dutch to Spanish with the translation-back translation technique (Behling & Law, 2000). Teachers’ answers were coded with Nvivo8 according to three categories derived from Collinson (1996, July, 1999). Based on teachers’ conceptions of their work, Collinson identified three groups of characteristics that make up a good teacher, i.e., professional, interpersonal, and intrapersonal. The interpersonal teacher is concerned with the relationships with students, the educational community, and the local community. The intrapersonal teacher is primarily concerned with virtues that make up his/her own character and that the pupils can learn for life beyond the classroom (e.g., reflection, curiosity, creativity, problem finding and solving, dedication, self-discipline, etc.). The professional teacher is primarily concerned with the subject matter, the curriculum, and the pedagogical knowledge.
3. Results

3.1. Teachers’ questioning behaviour

As shown in Table 1, 22% of the coded questions reached the levels of review and thinking. The remaining questions were different in the sense that they a) did not revise previous knowledge, b) did not connect ideas, and c) did not invite pupils to think about how they arrived to a certain answer, as King’s questions do.

**Table 1.** Types of questions used by teachers during science lessons \((n = 19)\).

<table>
<thead>
<tr>
<th>Type</th>
<th>Counts</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>King’s typology</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Review</td>
<td>224</td>
<td>19%</td>
</tr>
<tr>
<td>Thinking</td>
<td>30</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guessing</td>
<td>270</td>
<td>23%</td>
</tr>
<tr>
<td>Agitation</td>
<td>210</td>
<td>18%</td>
</tr>
<tr>
<td>Ending phrase</td>
<td>192</td>
<td>17%</td>
</tr>
<tr>
<td>Observation</td>
<td>126</td>
<td>11%</td>
</tr>
<tr>
<td>Contextualization</td>
<td>63</td>
<td>5%</td>
</tr>
<tr>
<td>Self-answered</td>
<td>28</td>
<td>3%</td>
</tr>
<tr>
<td>Checking doubts</td>
<td>12</td>
<td>1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1155</td>
<td>100%</td>
</tr>
</tbody>
</table>

The other types of questions were labelled as follows:

a) **Guessing**.- The most common type of questions was labelled as *guessing questions* because pupils were not expected to think, but rather to guess the answer. Among this type of questions, we include the following:

a.1) Questions wrongly formulated; for example:

Teacher: Where could we find this plant?

Pupils: In the market! In the garden! In the forest!

Teacher: No, no, no. In the coastal region! That is the right answer.
a.2) Questions the teacher repeats till she/he hears the precise wording of the text; for example:

Teacher: What is the name of these plants, which have no chemicals?

Pupil: Medicinal plants!

Teacher: Let’s see, all these plants… how do you call them?

Pupil: Industrial plants! Ornamental plants! Natural plants!

Teacher: Let’s see. You are intelligent pupils. Think.

Pupil: Natural medicine!

Teacher: Very good, they are called ‘natural medicine’!

In this case the term ‘natural medicine’ was the title of the chapter in the textbook, which seemed to be more important to the teacher than pupils’ own words.

a.3) Questions to fill-in words; for example:

Teacher: And what is the difference? That each technique has a function and each function is spe____?

Pupil: Special!

Teacher: Specific. Specific.

a.4) Questions to fill-in statements; for example:

Teacher: Every illness requires opportune treatment. Every illness requires opportune ________?

Pupils: Treatment!

b) Agitation.- Questions to keep students’ excitement (e.g. ‘And here!? And there!? Who knows the answer!?’ ‘What else!?’ ‘Who else!?’).

c) Ending phrase.- Questions used at the end of every statement as a way of talking; no answer was expected (e.g. ‘Right?’ ‘Isn’t it?’).
d) **Observation.**- Questions requiring pupils to observe something (e.g., ‘What do you see in the classroom?’ ‘What do you see on this poster?’).

e) **Contextualization.**- Questions that relate the topic to daily life events (e.g., ‘What does your mother do when somebody at home has a cold?’ ‘Do you know any alcoholic?’).

f) **Self-answered.** Questions the teacher made and answered her/himself. Apparently, these questions helped teachers to connect their ideas and organize their speech (e.g., ‘What is an infusion? To boil the water, to wash the leaves…’ ‘And they become, what? Slaves of drugs!’).

g) **Checking doubts.**- Questions to check whether pupils have doubts about the content, but nobody replies to them and the teacher moves on to the next topic. (e.g., ‘Did you understand?’ ‘Any questions till here?’).

The absence of **probing, hint, and metacognitive** questions was consistent with the absence of following up pupils’ responses. Only in three cases teachers built on the answer of the pupils.

### 3.2. Teacher self-efficacy and context beliefs

Teachers filled out both questionnaires completely. The Science Teaching Self-Efficacy scale revealed that teachers hold moderately high self-efficacy beliefs ($M = 3.75, SD = 0.55$). Similarly, the Context Beliefs About Teaching Science questionnaire revealed moderately high context beliefs ($M = 3.91, SD = 0.56$).

### 3.3. Teacher identity and mission

Throughout the contrast analysis exercise, teachers provided a total of 143 answers that helped us to uncover their image of a good teacher. Even though the questions were open, we found some common answers; the most frequent were in reference to:
- providing individual attention to the pupils (mentioned 20 times)
- building trust with their pupils (15 times)
- patience (12 times)

It is important to highlight that, from 23 different answers to the statement ‘I am someone who needs…’, patience was mentioned the most (6 times); together with the need to build trust, give individual attention, and understand the children, these interpersonal skills summed up almost half of the needs expressed by the teachers (47.83%).

After assigning the responses to the categories previously stated in the literature (Collinson, 1996, July, 1999), we could conclude that the image of a good teacher -for these teachers in particular- mainly mirrors interpersonal than intrapersonal or professional characteristics.

Interpersonal.- According to the respondents, a good teacher should a) provide individual attention to the pupils, b) be empathetic, c) create an environment of warmth and trust, and d) be patient = 51.05% of total responses.

Intrapersonal.- A good teacher should a) have a disposition toward continuous learning, improvement, and innovation b) achieve goals and be proud of it, c) be responsible, self-confident, and helpful = 34.26%

Professional.- A good teacher should a) plan the lessons beforehand, b) manage pedagogical processes and techniques, and c) express him/herself in a way that pupils understand = 14.69%

4. Discussion

In view of adopting a holistic approach to instructional design, we built on a previous study (Lucero-Mareydt et al., 2013b), in which we studied teachers’ inquiry behaviour, related competencies, and environment. In the present study, the approach was extended to
the analysis of teachers’ questioning behaviour, beliefs, mission, and identity. The results provide us with implications regarding learning goals for professional development initiatives that – as such – should take into account both the personal and professional aspects of teaching.

Our results on teachers’ questioning behaviour reveal that teachers are still far from integrating inquiry in science teaching. We observed that 78% of teacher questions do not lead to the clarification of ideas, neither the negotiation of meaning, nor the integration of concepts, as King’s questions do (King, 1997, 1999). It could be argued that the nature of some of these questions is justified; for example, those that relate a science topic to daily life events (see contextualization in section 3.1). We wonder, however, if contextualization questions should surpass the number of thinking questions. We are concerned with ‘the teachers’ understanding and assessment of individual student construction of meaning’ which is ‘an essential element of good teaching’ (Fenstermacher & Richardson, 2005, p. 205). Other questions, like those to conclude a topic before moving on to the next topic (see checking doubts) might be useful if they were truly meant to review pupils’ understanding. However, this was not the case in our study. Remarkably, pupils hardly respond to this type of questions - exempt from a vague ‘yes’ answer - and teachers did not insist on the further development of pupil answers. Apparently, teachers did not really expect a deeper level reply. As Karabenick (1994) indicates, students can perceive when their questions or particular answers are not welcome. Regarding guessing questions, their frequency is particularly alarming because it exceeds the number of questions to think and review altogether. The fact that teachers rejected answers freely developed by the pupils and rather encouraged answers that replicate the content of the textbook, seriously restrains inquiry.

It is debatable that teachers avoid higher-order questions because they are afraid of not being able to answer. Thinking questions, however, can be answered from the same text
from where they emerge. Even 9-year-old pupils are able to ask and answer thinking questions (King, 1997). The advantage of using King’s typology is that it provides clear and simple models/examples pupils and teachers can refer to when formulating questions. The problem is that developing good questions implies listening carefully to the pupil answer before posing a new question. This important element is missing in the teacher-pupil interactions observed.

The results regarding teachers’ beliefs suggest that teachers feel confident about their own abilities to bring about expected learning outcomes (self-efficacy beliefs) and they believe that environmental factors will help them to be the most effective science teachers and that these environmental factors can take place in their schools (context beliefs). However, what teachers actually pursue is hardly related to inquiry learning. This indicates that teachers do not adopt inquiry learning as a parameter in science teaching efficacy. In a study where teachers with strong capability and context beliefs performed relatively poor in the teaching of science, Haney, Lumpe, Czerniak, and Egan (2002) explain that these beliefs were probably ‘rooted without proper reflection or feedback’ (p. 181). Our results about teachers’ beliefs are, therefore, congruent with previous results regarding their lack of inquiry competencies (Lucero-Mareydt et al., 2013b).

When we recapitulate our results in view of the core layers of the onion model, mission and identity, we see that the image of the interpersonal teacher is more predominant in teachers as compared to the image of the professional or intrapersonal teacher. Similarly, in another study, ‘teachers saw teaching as an interaction between practitioners and pupils [and] consistently rated characteristics related to classroom relationships in action as essential characteristics for teachers for excellence’ (Grieve, 2010, pp. 274-275). Grieve concludes that communication skills and relationship skills - considered important by the teachers - will empower them to move from a traditional transmission of knowledge to more participative
methods and the facilitation of deeper level learning. The importance of teachers’ interpersonal skills has also been highlighted by Stemler, Elliott, Grigorenko, and Sternberg (2006), who claim that ‘teaching is about interpersonal interactions as much as instructional delivery’ (p. 103).

Our contrast analysis exercise (Biesta et al., 2002) was useful to uncover the personal aspects of teaching, such as the teachers’ concern about the way they relate to the pupils. As revealed in their needs statements, teachers are acutely aware of their lack of interpersonal skills. This is also reflected in their behaviour. We take, for example, the excess of teacher questions compared to the absence of pupils’ questions as a signal of an asymmetric relationship. When we link this interpretation to the teacher reflections on their mission and identity, the picture suggests that the roots of the dominant teacher directed questioning behaviour might be related to the teacher-pupil relationship. To further illustrate this, we take as an example the following reaction of a teacher to a pupil’s question: At the end of the lesson, Sabrina (pupil) asked the teacher a question she found in the workbook. ‘What a good question!’ answered the teacher ironically, ‘Look children what Sabrina is asking! And Sabrina was here today in the lesson or not?’ As Graesser and Person (1994) explain, ‘the student reveals ignorance and loses status when a bad question is asked. There are social barriers even when a good question is asked, such as interrupting the teacher and changing the topic of the conversation’ (p. 106). Similarly, Jegede and Olajide (1995) claim that authoritarianism influences the questioning behaviour of pupils. The personal aspects of teaching are clearly linked to the quality of questions teachers ask. Good questions require from the teachers the attitude of paying attention to and building upon what pupils put forward. Apparently, our teachers hardly differentiate between types of questions and hardly listen to their pupils. The complete absence of hint, probing, and metacognitive questions suggests that teachers do not revise what the pupils say. Moreover, when teachers ask: ‘Did
you understand?’ or ‘Any questions till here?’ (see checking doubts in section 3.1), they ignored vague answers of the pupils and moved on to the next topic. The fact that teachers neglect pupils’ input defines, indirectly, a particular pupil-teacher relationship.

The attitude of paying attention to and building upon what pupils say is related to the teacher’s interactional positioning. According to Oliveira (2010), teacher’s interactional positioning is evidenced in the types of questions they ask. He observed that the teacher who positions her/himself as a guide establishes a more symmetric relationship evidenced in student-centred questions (i.e., ‘What do you think?’). On the other hand, a teacher who positions her/himself as an authority establishes an asymmetric relationship evidenced in teacher-centred questions (i.e. right-or-wrong testing questions). Artzt and Armour-Thomas (1998) observed that teachers who viewed themselves as facilitators encouraged the pupils to talk and used questions to verify their understanding (e.g., ‘What do you mean?’ ‘How do you get that?’ ‘Explain it to the class’). These teachers were far from playing the role of experts or authorities and viewed the pupils as responsible for their own learning. The way teachers talk to students and about students, can create a feeling of (in)equality that hinders/promotes quality student-teacher and student-student talk (Mitchell, 2010; Mitchell & Mitchell, 2011). Teacher questions have -as such- both a cognitive and a social function (Oliveira, 2010) and reflect status differences (Carlsen, 1991).

4.1. Implications for defining learning goals in view of professional development

In view of effective and efficient teacher professional development, learning goals aligned with the current characteristics of these teachers have to be made explicit. Due to our multi-dimensional analysis -based on the onion model- we are in a position to sketch out learning goals that attend both personal and professional aspects of teaching.
From our results about teacher questioning behaviour, we can recommend introducing teachers to inquiry knowledge and skills, starting from the adoption of a wider variety of types of questions. Nevertheless, limiting our professional development goals to this set of competences might be a too simplistic approach. The results, discussed above, suggest that the learning goal should take into account different levels of change (see also section 1.2).

We propose that the critical need to promote in teachers the use of a wider range of questions (i.e., building on King’s typology) should be done while also attending to the teachers’ image of the interpersonal teacher. We foresee a teacher development program that fosters the attitude of paying attention to the pupils and helping them develop their thinking skills.

What is relevant to the profession does not conflict with what teachers personally desire. By nourishing the interpersonal teacher (e.g., the ability of listening, putting themselves in the place of the pupils, and accepting their individual differences) as an indicator of teachers’ identity and mission, we will increment their patience and, consequently, their wait times. Wait times are pauses teachers should make after they present a question and after pupils answer. This has been found to increase the quality of questions and related answers (Rowe, 1986, 2003; Tobin, 1987). Equally necessary, teachers and pupils should learn to adopt a variety of verbal moves, e.g., pupil asks, pupil answers, pupil evaluates, teacher asks, teacher answers, teacher evaluates (Rowe, 2003), to change their traditional questioning pattern (i.e., teacher asks - pupil answers). Again, this should be done while attending the ideal of the interpersonal teacher. Carlsen (1991) sustains that a change in questioning patterns will not last unless the relationship between the speakers also changes. In this context, Gunel (2008) recommends that for the pupils to adopt different verbal moves, they have to function in a nonthreatening environment. Other researchers recognize, as well, that a teacher who creates an environment of trust (see the interpersonal teacher, section 3.3)
facilitates, at the same time, pupils’ learning autonomy (Black & Deci, 2000; Fenstermacher & Richardson, 2005; Mitchell, 2010; Mitchell & Mitchell, 2011; G. Williams & Deci, 1996), which is expected to foster pupil questioning behaviour. The literature about questioning behaviour clearly directs attention to the teacher-pupil relationship and corroborates our observations about the nexus between the personal to the professional aspects of teaching.

In summary, the professional aspects of teaching require that teachers know about types of questions, wait times, and questioning patterns. Moreover, the personal aspects of teaching require that teachers are willing to provide individual attention to the pupils, listen actively (empathy), create an environment of trust, and be patient. This introduces professional development learning goals focused on the development of questioning knowledge and skills as much as on the development of teachers’ interpersonal skills.

4.2. Limitations

Though our study helped to develop a more holistic picture of what makes up a good teacher and helped to identify professional development goals that can be connected to the different layers in the onion model, it reflects some limitations. Firstly, our focus was on a particular subset in teacher behaviour: inquiry-based science teaching. Future studies can focus on the broader range of subjects. Moreover, although the study was time consuming, the number of teachers, classes, and schools involved remains limited. Replication studies are needed to corroborate the present findings. Future research should be set up from a longitudinal perspective and study the differential impact of alternative road-maps to develop the teachers’ characteristics in balance.
4.3. Conclusions

Teacher professional development is a challenging endeavour. Whereas traditional teacher training mostly adopts an isolated approach to improve teacher behaviour, the present study endorses a more holistic approach. The onion model has been a helpful framework to analyse in-depth the teachers and their behaviour, uncover the core of the problem and, finally, identify critical learning goals for future teacher development directions. Future research could adopt this approach to analyse particular teacher training needs and to develop a longitudinal perspective that respects the interrelated nature of teacher’s environment, their behaviour, competences, beliefs, mission and identity.

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Meeting of the National Association for Research in Science Teaching, San Francisco, CA.


The impact of a teacher training intervention on teachers’ and pupils’ questioning behaviour

Based on:
Chapter 4

The impact of a teacher training intervention on teachers’ and pupils’ questioning behaviour

Abstract

An intervention was implemented in public primary schools to improve teachers’ and pupils’ questioning behaviour during science lessons. Compared to a control condition, the intervention succeeded in influencing elements of questioning behaviour; in particular (1) increasing the frequency of wait times, (2) reducing the amount of questions from the teachers and increasing the amount of questions from the pupils; and (3) improving the types of questions from both teachers and pupils. Our teacher training intervention paid special attention to the affective component of asking questions, which appears to be a promising approach in view of developing future in-service teacher training.

1. Introduction

The particular focus of this study on teachers’ and pupils’ questioning behaviour lies on the essential role that inquiry plays in science education (J. Bloom, 2006; Sanger, 2008; van Joolingen, de Jong, & Dimitrakopoulou, 2007; Williams, Papierno, Makel, & Ceci, 2004). Inquiry is, by definition, the process of asking a question and searching for answers (Egbert, 2009; Quintana et al., 2004). Even though good questions are the motor of inquiry, their importance is sometimes underestimated. In this sense, the results of a previous study in Ecuadorian public schools are alarming: in the seventh year\(^1\) of primary education, twenty teachers generated 1 600 questions during the science lesson; in contrast, only three pupils -

\(^1\) Seventh year in Ecuador corresponds to sixth grade in the US educational system.
from a total of 634 - made a spontaneous question to the teacher. Furthermore, the quality of the teacher questions remained low: they were neither geared to assess learning nor to instigate higher level cognitive processing. Instead, the questions invoked a fast teacher-pupil verbal interaction during which pupils competed answering what came up in their mind and teachers limited their reaction to “right!” “wrong!” or “who else?!”. No time was given to think about neither the question nor the answer. Teachers did not build on the answers, most of which were simply ignored (Lucero-Mareydt, Valcke, & Schellens, 2013c). In view of fostering inquiry in science education, the present study is concerned about improving teachers’ and pupils’ questioning behaviour which, in the literature, has been analysed in terms of a) wait times, b) verbal moves, and c) types of questions.

1.1. Wait times

The lack of wait times in science lessons was already noticed in the 1970s by Rowe (1974) and provoked “a large number of studies throughout the world” (Tobin, 1987, p. 70). Wait times are silent pauses of 3 seconds or more after a question or an answer. In classrooms where wait times are used, researchers have observed a) fewer teacher talk and more student talk, b) fewer low-level cognitive questions, c) more high-level cognitive questions, d) more student appropriate responses, e) fewer teacher initiated questions and more student initiated questions, and f) higher achievement. This is supported by more than 40 studies reviewed by Tobin (1987).

Being judged as one of the most influential in the last forty years (Holliday, 2003), Rowe’s pioneering article on wait times was republished in 2003 (see Rowe, 2003). Nevertheless, strategies to implement wait times are rarely found in the recent research literature. From 2002 to up to date, several authors have recognized the importance of wait times in teacher questioning behaviour (e.g., Chin, 2006, 2007; Cho et al., 2012; Edmunds &
Brown, 2010; Lin, Hong, & Cheng, 2009; Minor, Onwuegbuzie, Witcher, & James, 2002; Mitchell & Mitchell, 2011), but none has reported empirical studies about wait times. The present study helps to revive this research strand.

1.2. Verbal moves

Regarding the high frequency of teachers’ questions in contrast to the low frequency of pupils’ questions, this appears to be a “universal phenomenon” (Graesser & Person, 1994). When we talk about reducing teachers’ questions and increasing pupils’ questions, we refer to changing questioning patterns. From the perspective of inquiry teaching, the ideal is that teachers and pupils adopt four kinds of verbal moves: structuring (proposing activities or experiments), soliciting (asking), responding (answering), and evaluating (reacting) (Carlsen, 1991). In our previous study, we observed that teachers predominantly take the structuring and soliciting moves and pupils mainly adopt the responding move (Lucero-Mareydt et al., 2013c). In this “inquisition” pattern teachers play the expert and adopt the authority role (Artzt & Armour-Thomas, 1998; Chin, 2007). Rowe (2003) and others have tried to modify this pattern by extending the wait times and giving both teachers and pupils the opportunity to practice with different types of verbal moves (e.g., in a game where teachers and pupils have to show a “card” every time they want to say something; given that each card represents a different verbal move, the players must use all the moves to finish the cards). As a result, “students begin to suggest experiments (structuring) or they converse and react to each other’s statements (responding and reacting)” (ibid, p. 21).

1.3. Types of questions

A third problem observed during science lessons is the type of questions teachers used. In our earlier study, 78% of 1 155 questions did not revise previous knowledge, did not
connect ideas, and did not invite pupils to think about how they arrived to a certain answer (Lucero-Mareydt, Valcke, & Schellens, 2013b). The majority of these questions were labelled as **guessing questions** because pupils had to guess what the teacher was asking (e.g. “When you are sick you go to the doc____? And he gives you a pres____?”). It was also observed that teachers tend to make questions and answer themselves, as if they were talking alone. These were labelled as **self-answered questions**.

Questions that revise previous knowledge, connect ideas, or invite pupils to think about how they arrived to a certain answer are described under the typology of King (1997, 1999). **Review**, **hint**, or **probing questions** are used to assess and consolidate knowledge before moving into a higher level, the level of thinking questions. **Thinking** or **connection questions** require to go beyond the explicit material and to think about how ideas connect to each other. Finally, **metacognitive questions** require the pupil to look back into his/her thinking process; that is, to think about his/her thinking. Table 1 shows some examples.

**Table 1.** King’s typology of questions

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review</td>
<td>Reviews pupil’s retaining or understanding.</td>
<td>• What does… mean?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Describe… in your own words.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Where?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• How?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• When?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Which?</td>
</tr>
<tr>
<td>Hint</td>
<td>Insinuates the answer without giving it to the pupil.</td>
<td>• Aren’t you maybe forgetting about…?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• And have you also thought about…?</td>
</tr>
<tr>
<td>Probing</td>
<td>Examines what the pupil is saying.</td>
<td>• I do not understand, what do you mean with…?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• I do not understand, could you tell me more?</td>
</tr>
<tr>
<td>Thinking</td>
<td>Makes connections between two concepts.</td>
<td>• What would happen to… if…?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• What is the difference between … and …?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• What is the similarity between … and …?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• How could you use… in…?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• How could… help you in…?</td>
</tr>
<tr>
<td>Meta-cognitive</td>
<td>Thinking about thinking</td>
<td>• What led you to that belief?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Describe how you arrived to that answer.</td>
</tr>
</tbody>
</table>
1.4. The affective component of the questioning behaviour

The literature above suggests that training teachers on wait times, verbal moves, and types of questions has an impact on their questioning behaviour. But that might be a too narrow approach to the problem. Attention should also be paid to the affective component underlying their questioning behaviour. Thus, for example, pushing the pupils impatiently to produce the right answer is a behaviour that denotes a controlling orientation (Reeve, 2009). Interestingly, one of the reasons why teachers adopt a controlling style is the difference of positions in the teacher-pupil relationship. The extent of the difference makes those one level down in the relationship, i.e., the pupils, vulnerable to being controlled (Deci & Ryan, 1987; Reeve, 2009).

Teacher questions reveal the position from where they interact to the pupils. Carlsen (1991) claims that “questions may reflect and sustain status differences in the classroom. Research on questioning has generally failed to recognize that classroom questions are not simply teacher behaviours but mutual constructions of teachers and students” (ibid, p.157). Teachers who position themselves in a rank above the pupils and play an authoritarian/expert role use teacher-centred questions (i.e., right-or-wrong testing questions). On the other hand, teachers who position themselves as facilitators use questions to help pupils develop their thinking (e.g., “What do you think? “What do you mean?”) (Artzt & Armour-Thomas, 1998; Oliveira, 2010b).

The attitude of teachers towards the pupils and their questioning influences the pupils’ questioning behaviour. It influences the nature of their mutual relationship and their beliefs regarding what they are expected to do. Students perceive whether the teacher welcomes questions or not - even if this is not explicitly stated - and act accordingly (Karabenick, 1994). Students’ silence may be due to fears; the fear of revealing ignorance, losing status, or interrupting the teacher (Graesser & Person, 1994). Jegede and Olajide (1995) claim that
teachers’ authoritarianism negatively influences the classroom environment and, consequently, the inquiry and questioning habits of both teachers and students. On the other hand, a teacher that establishes a nonthreatening environment enables the pupils to ask, propose, respond, and evaluate (Gunel, 2008).

In conclusion, a new questioning behaviour requires attention to the way teachers relate to the pupils. Interestingly, in previous findings regarding teachers’ mission and identity (Lucero-Mareydt et al., 2013b), teachers recognized that they needed to be more patient and develop their interpersonal skills. These skills would enable them to put in practice a new questioning behaviour. Thus, for example, to put in practice wait times requires patience. The use of challenging questions requires an environment of trust: the teachers should trust the pupil (“He/she can do it”) and the pupil should trust the teacher (“He/she wants to help”). Likewise, breaking down the typical questioning pattern (i.e., inviting pupils to evaluate answers and make questions) requires both patience and confidence in the pupils’ capabilities.

On the basis of the literature and the rationale presented above, a seven-week experimental in-service teacher training intervention was designed and implemented to test the following hypotheses:

1) The teacher training intervention will increase the frequency of wait times that teachers and pupils make.
2) The teacher training intervention will reduce the number of teacher questions and increase the number of pupil questions.
3) The teacher training intervention will improve the types of questions the teachers and pupils formulate.
2. Method

2.1. Research design and sample

The study was set up involving a research sample of 11 teachers and their classes (417 pupils in total) from five public primary schools in Cotocollao, a parish in the north of Quito, Ecuador. To select the schools, a specific procedure was followed. In a meeting with all the principals of schools in the Cotocollao parish and their general supervisor, we presented the research project and discussed the following criteria for participation:

- Participants have time to carry out the activities proposed in the project.
- Participants can rely on the school principal during the project.
- There are at least two teachers teaching in the seventh year in the same school.
- The school is easy to reach either by bus or at a walking distance.
- Pupils are matched as to (within and between research conditions) their economic, social, cultural, and family background.

The principals of the schools that matched the criteria decided in which condition (control or experimental) to participate. This resulted in five schools and 16 teachers. This initial number dropped down to 11 because one teacher was selected as a model-teacher for a training session; another teacher could not join due to sick leave and three others quitted after four weeks of training due to diverse reasons\(^2\). As a result, complete data sets were available from five teachers and their classes in the control condition and six teachers in the experimental condition.

Since the study involved existing classes with their respective teachers, a quasi-experimental pretest-posttest research design was adopted. To guarantee a sufficient level of internal validity, we established beforehand the equivalence between control and

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\(^2\) The first teacher said he had no time to practice the exercises in the classroom. The second teacher was planning to retire the next year and said “It is too late for me to change.” The third teacher was relocated to another school.
experimental conditions prior to the intervention. As shown in Table 2 (section 3.2) there were –initially- no significant differences in verbal moves neither at teacher nor at pupil level and, as shown in Table 3 (section 3.2), there were also no significant differences in the types of questions that teachers and pupils made except in the percentage of review questions at teacher level, which was lower in the experimental than in the control condition.

In addition, also variables at school level were checked: all schools involved ran in the morning shift\(^3\); they were urban, public, complete\(^4\), and located in the same parish. All schools shared comparable resources, were driven by comparable educational policies, jurisdiction (supervisor), and attracted pupils with the same socio-economic background. Teachers in both conditions used the same textbooks. This implied that the lessons observed were comparable in terms of learning content, learning objectives, and instructional activities.

All the teachers were female, except for two male teachers in the experimental condition. No significant differences between teachers in both research conditions were found regarding their age (\(Mdn = 53, SE = 3.53\)), years of experience (\(Mdn = 30, SE = 3.45\)). No differences in class size were observed (\(Mdn = 37, SE = 1.22\)).

2.2. Learning goals and strategies of the experimental in-service teacher training intervention

Building on the problem statement and the theoretical base for the study, the learning goals for the experimental intervention were geared to introduce wait times, reduce the disparity of verbal moves, and improve the types of questions.

Behaviour, in general, is not only about knowing and doing but also about wanting to do (Martin & Briggs, 1986; Smith & Ragan, 2005). Therefore, to influence the questioning behaviour, we set up learning goals with a focus on the what (e.g., “Teachers know what wait

\(^3\) In Ecuador, some schools run in the morning and others in the afternoon.
\(^4\) Complete schools have one teacher per class. There are also schools where one teacher teaches two or more classes and single-teacher schools where a single teacher teaches all the classes.
times are about”), the how (e.g., “Teachers will know how to adopt wait times and they will actually do it”), and the why (e.g., “Teachers will know why other teachers and themselves adopt wait times. From the benefits they experience during practice, teachers feel it is necessary they adopt wait times”). The learning goals, objectives, and activities per session are displayed in the trainer’s guide (Appendix).

To achieve the learning goals, the intervention strategies built on principles of Bandura’s social learning theory (1977). The social learning theory postulates that people learn from a) experiencing directly the consequences of their own behavior, b) watching the consequences of others’ behavior, c) reading or hearing about the consequences of a behavior, and d) associations that arouse emotions (Martin & Briggs, 1986, p. 127). Furthermore, we use strategies derived from humanism (Rogers, 2003, 2004; Rogers & Freiberg, 1994) to influence the teacher-pupil relationship. Finally, to secure the association of a positive emotion to the experience, we adopt key elements of the positive psychology (Seligman & Csikszentmihalyi, 2000) and, more specifically, core reflection (Korthagen & Vasalos, 2005, 2010; Meijer, Korthagen, & Vasalos, 2009). Core reflection emphasizes the strengths of the teacher when looking back at his/her behaviour. Instead of focusing on particular competencies teachers do not master, core reflection centres on the qualities they already have and can develop further through new experiences. The core reflection approach was especially implemented through individual follow-up meetings.

Based on the core reflection approach, the trainer presented guiding questions to help the teacher realize what he/she wanted in his/her interrelation with the pupils, the limitations the teacher imposes to him/herself, and the personal strengths the teacher could use to overcome limitations. Teachers were also invited to put themselves in the place of the pupils and to contrast what they wanted with what the pupils wanted/experienced. Other guiding questions presented in this context, were: “What did you do?” “What did the pupils do?”
“What were you thinking?” “What were the pupils thinking?” “How did you feel?” “How did the pupils feel?” (Korthagen & Vasalos, 2005).

2.3. Implementation

The experimental intervention built on two in-service training modes: group training sessions and individual follow-up meetings. Seven separate training sessions were set up; one per week. The first four sessions focused on wait times, verbal moves, and types of questions and included argumentation, modelling, practice, group discussion, and reinforcement. The last three weeks focused on the teacher-pupil relationship and included role-play and other exercises inviting the teachers to put themselves in the place of the pupils.

Every session was set up on a Monday and lasted approximately three hours. Teachers were asked to practice the particular behaviours in the classroom during the rest of the week. Once a week, the trainer set up an individual follow-up meeting during which she observed the teacher practice and supported the teacher to reflect on his/her experiences.

2.4. Data collection method and data analysis procedure

Prior to and after the intervention, lessons from all the teachers were video-recorded for 25 minutes. In total, 22 video-recorded lessons from 11 teachers were transcribed and coded by four native Spanish speaking Educational Sciences student-assistants trained in the use of Nvivo8 coding software and questioning behaviour, i.e., wait times, verbal moves, and types of questions. To ensure common understanding of the coding scheme and to develop their coding skills, the coders followed the method described in Lucero-Mareydt et al. (2013c). Approximately twenty hours of training and coding resulted in a four-coder interrater reliability of Krippendorff’s alpha = 0.78, which is acceptable given the
conservative nature of the Krippendorff’s alpha index (Lombard, Snyder-Duch, & Bracken, 2002).

The coding scheme consisted of several nodes organized in a) teachers’ moves, b) pupils’ moves, c) types of questions from the teachers, d) types of questions from the pupils, and e) wait times. Types of questions included, originally, King’s typology (King, 1997, 1999). We extended the coding scheme to other categories that did not fit in the typology of King but were predominantly observed: guessing and selfanswered questions (see section 1.3).

To identify wait times, video-recordings of the lessons were imported in Nvivo8 and divided into one-minute video segments. The audio of every video segment was graphically represented in an oscillogram, displayed through Nvivo8. Due to external noise, some wait times could not be observed in the oscillogram; therefore, we did a double check by listening to the audio after every question or answer.

From the total of all moves in a lesson (teacher and pupil moves together), we calculated the proportion of every move in the total lesson. Next, we calculated the average proportion per move in the control condition and, later, in the experimental condition. We applied the same strategy to teacher questions and, finally, to pupil questions apart.

Statistical analysis started by checking assumptions of normality (Kolmogorov-Smirnov test and Shapiro-Wilk test) and homogeneity of variances (Levene’s test). In case these were met, independent t-tests were used to analyse differences between research conditions after the intervention and dependent t-tests to calculate differences in the experimental condition from time 1 (before the intervention) to time 2 (after the intervention).

If the assumptions were not satisfactory, we applied the non-parametric tests MannWhitney and Wilcoxon, respectively. Sometimes it was possible to obtain normality by transforming the data (log transformations).
When the assumptions of normality, homogeneity of variance, linearity, and homogeneity of regression slopes were met, we used ANCOVA to calculate differences between conditions regarding the dependent variables while controlling for or removing the effect of the pre-test scores.

When the ANCOVA was performed, we calculated the effect size \( r \) by taking the square root of the eta squared value (\( \eta^2 \)) provided by SPSS. When assumptions of normality were violated, we applied the formula \( r = \frac{Z}{\sqrt{N}} \). The \( z \)-score was provided by SPSS. To interpret \( r \) we referred to the following benchmarks: small effect, \( r = 0.10 \); medium effect, \( r = 0.30 \); and, large effect, \( r = 0.50 \) (Field, 2005, pp. 32, 357 & 532).

3. Results

3.1. Descriptive results

Before testing our hypotheses, we provide first an overview of the questioning behaviour (see also Tables 2 and 3). Prior to the intervention, 11 teachers asked in total 665 questions that could be assigned to the coding scheme (i.e., review, probing, hint, think, guess, and self-answered). After the intervention, the total number of questions in both research conditions dropped to 450. Before the intervention, only one of the 417 pupils spontaneously asked a question to the teacher. Another pupil asked three questions to her classmates regarding the topic she just presented in front of the class. The number of pupil questions increased – in both research conditions - from 4 to 69 after the intervention. It is important to indicate that pupils’ questions in the control condition were previously prepared by pupils who presented a topic to check if their classmates had paid attention to the presentation. In contrast, pupils’ questions in the experimental condition were directed either to the teacher or the classmates; moreover, these questions were either spontaneous or encouraged by the teacher and not previously prepared in view of a presentation.
3.2. Testing the hypotheses

To test the first hypothesis, we analysed teachers questioning behaviour in terms of wait times. When examining the number of wait times after the intervention, we find a significant difference between the control ($M = 1.40$, $SD = 1.52$) and the experimental condition ($M = 9.50$, $SD = 2.66$, $t = -6.00$, $p = 0.00$). There is no difference in wait times prior to the intervention. After controlling for pre-test wait times (ANCOVA), we observe a significant and large effect of the intervention on the post-test wait times, $F(1,8) = 71.94$, $p = 0.00$, $r = 0.95$.

As stated in the second hypothesis, we expected a reduction in the number of teacher questions and an increment in the number of pupil questions. Table 2 provides an overview of the moves that teachers and pupils made during the classroom observations.

**Table 2.** Differences regarding the moves (in percentages) that the control and the experimental condition made before and after the intervention.

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th></th>
<th></th>
<th>Post-test</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Experimental</td>
<td>Control</td>
<td>Experimental</td>
<td>Control</td>
<td>Experimental</td>
</tr>
<tr>
<td></td>
<td>$M%$</td>
<td>$SD$</td>
<td>$M%$</td>
<td>$SD$</td>
<td>$M%$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Teachers$^a$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>asked</td>
<td>42.94</td>
<td>3.84</td>
<td>41.48</td>
<td>9.35</td>
<td>n.s</td>
<td>43.60</td>
</tr>
<tr>
<td>answered</td>
<td>0.29</td>
<td>0.42</td>
<td>1.49</td>
<td>1.50</td>
<td>n.s</td>
<td>0.00</td>
</tr>
<tr>
<td>evaluated</td>
<td>6.65</td>
<td>5.14</td>
<td>10.62</td>
<td>8.59</td>
<td>n.s</td>
<td>6.00</td>
</tr>
<tr>
<td>Pupils$^b$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>asked</td>
<td>0.31</td>
<td>0.68</td>
<td>0.14</td>
<td>0.33</td>
<td>n.s</td>
<td>1.27</td>
</tr>
<tr>
<td>answered</td>
<td>49.62</td>
<td>5.92</td>
<td>45.36</td>
<td>8.92</td>
<td>n.s</td>
<td>48.65</td>
</tr>
<tr>
<td>evaluated</td>
<td>0.19</td>
<td>0.42</td>
<td>0.91</td>
<td>1.44</td>
<td>n.s</td>
<td>0.48</td>
</tr>
<tr>
<td>Total%</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>858</td>
<td>633</td>
<td>542</td>
<td>707</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^a$n = 5 in control condition; n = 6 in experimental condition

$^b$n = 178 in control condition; n = 239 in experimental condition

$^c$t-test

$^d$Mann-Whitney test

The t-test reveals a significant difference in the average number of teacher questions in both conditions: this percentage is significantly lower in the experimental condition ($N = 6$, $M = 30.90$, $SD = 7.61$) as compared to the control condition ($N = 5$, $M = 43.60$, $SD = 6.53$, $t = 2.93$, $p = 0.02$). No difference was present before the intervention (experimental condition
The impact of a teacher training intervention  

$M = 41.48$, $SD = 9.35$; control condition $M = 42.95$, $SD = 3.84$, $t = 0.33$, $p = 0.75$). After controlling for pre-test differences in teacher-asks moves, the effect of the intervention appears to be significant, with a large effect size, $F(1,8) = 12.07$, $p = 0.01$, $r = 0.77$.

To compare pupils’ questioning behaviour before/after the intervention, non-parametric tests had to be adopted. The Mann-Whitney test reveals that the percentage of pupil-asks moves in the experimental condition is significantly higher ($N = 6$, $Mdn = 8.54$, $SE = 1.60$) as compared to the percentage in the control condition ($N = 5$, $Mdn = 0.00$, $SE = 0.96$, $U = 2.00$, $p = 0.02$); the effect size is large, $r = -0.72$. To check whether these differences were not already present prior to the intervention, Mann-Whitney tests was calculated. The results point at no significant differences between the conditions before the intervention (experimental condition $Mdn = 0.00$, $SE = 0.14$, control condition $Mdn = 0.00$, $SE = 0.31$, $U = 14.00$, $p = 0.79$).

We also hypothesized that the teacher training intervention would improve the types of questions teachers and pupils formulate. An overview of the results is provided in Table 3.

**Table 3.** Differences regarding the types of questions (in percentages) that the control and the experimental condition made before and after the intervention.

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th></th>
<th>Post-test</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Experimental</td>
<td>Control</td>
<td>Experimental</td>
</tr>
<tr>
<td></td>
<td>$M%$ $SD$</td>
<td>$M%$ $SD$</td>
<td>$M%$ $SD$</td>
<td>$M%$ $SD$</td>
</tr>
<tr>
<td>Teachers$^a$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Review</td>
<td>55.58 16.04</td>
<td>26.49 120.54</td>
<td>54.50 35.55</td>
<td>37.80 13.28</td>
</tr>
<tr>
<td>Probing</td>
<td>0.00 ---</td>
<td>5.56 13.61</td>
<td>0.00 ---</td>
<td>2.91 4.11</td>
</tr>
<tr>
<td>Hint</td>
<td>0.00 ---</td>
<td>0.69 1.70</td>
<td>0.00 ---</td>
<td>1.63 3.20</td>
</tr>
<tr>
<td>Think</td>
<td>4.30 7.45</td>
<td>8.78 9.95</td>
<td>2.90 3.95</td>
<td>15.60 11.02</td>
</tr>
<tr>
<td>Guess</td>
<td>27.29 11.26</td>
<td>45.13 22.90</td>
<td>34.14 31.00</td>
<td>35.52 20.74</td>
</tr>
<tr>
<td>Self-answered</td>
<td>12.83 7.04</td>
<td>13.34 12.22</td>
<td>8.46 10.64</td>
<td>6.55 7.45</td>
</tr>
<tr>
<td>Total%</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Frequency</td>
<td>400</td>
<td>265</td>
<td>226</td>
<td>224</td>
</tr>
<tr>
<td>Pupils$^b$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Review</td>
<td>20.00 44.72</td>
<td>16.67 40.82</td>
<td>40.00 54.77</td>
<td>40.28 35.13</td>
</tr>
<tr>
<td>Probing</td>
<td>0.00 ---</td>
<td>0.00 ---</td>
<td>0.00 ---</td>
<td>21.11 25.53</td>
</tr>
<tr>
<td>Think</td>
<td>0.00 ---</td>
<td>0.00 ---</td>
<td>0.00 ---</td>
<td>38.61 26.68</td>
</tr>
<tr>
<td>Total%</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>100.00</td>
</tr>
<tr>
<td>Frequency</td>
<td>3</td>
<td>11</td>
<td>58</td>
<td></td>
</tr>
</tbody>
</table>

$^a$n = 5 in control condition; $n = 6$ in experimental condition  

$^b$n = 178 in control condition; $n = 239$ in experimental condition  

$^c$t-test was used  

$^d$Mann-Whitney test
At teacher level, the Mann-Whitney test reveals an effect of the intervention on the percentage of thinking questions. We transformed the data (log10) to obtain a normal distribution and homogeneity of variance. The t-test corroborated that the percentage of thinking questions in the experimental condition was, indeed, significantly higher ($M = 1.10$, $SD = 0.40$) as compared to the control condition ($M = 0.42$, $SD = 0.44$, $t = -2.72$, $p = 0.02$). No difference is found in the percentage of thinking questions before the intervention (experimental condition $M = 0.70$, $SD = 0.62$, control condition $M = 0.44$, $SD = 0.52$, $t = -0.73$, $p = 0.49$). After controlling for the percentage of thinking questions before the intervention, the effect of the intervention is significant and large, $F(1,8) = 6.26$, $p = 0.04$, $r = 0.66$.

At pupil level, we also observe a significant difference in the type of questions, specifically in the percentage of questions to think and to probe. From all the types of questions that pupils made, the percentage of thinking questions in the experimental condition is significantly higher ($Mdn = 36.67$, $SE = 10.89$, $U = 2.50$, $p = 0.01$) as compared to the control condition; the effect size is large, $r = -0.75$. No thinking questions were observed in the control condition. Probing questions were completely absent as well; the percentage of this type of questions in the experimental condition is significantly higher, with a large effect size ($Mdn = 13.33$, $SE = 10.42$, $U = 5.00$, $p = 0.03$, $r = -0.64$). This differentiation did not exist before the intervention. As shown in Table 3, prior to the intervention, none of the pupils made a question neither to think nor to probe. It should also be noticed that Table 3 does not report on metacognitive or hint questions because these types of questions were not observed in any condition and in any measurement time.
4. Discussion

4.1. Questioning behaviour and the pupil-teacher relationship

The aim of this study was to find out whether an experimental intervention had a differential impact on teachers’ questioning behaviour: a) changes in wait times, b) changes in verbal moves, and c) changes in the types of questions. We found a differential and significant impact on the frequency of wait times, teacher-asks moves, and teacher thinking questions; differences with large effect sizes: \( r = 0.95 \), \( r = 0.77 \), and \( r = 0.66 \) respectively. We also found the intervention to have a significant differential impact on pupils’ questioning behaviour. Changes in pupil questioning behaviour seem to mirror changes in teachers’ questioning behaviour: they co-participated in the increment of wait times, they altered the traditional pattern of verbal moves (\( r = -0.72 \)), and adopted thinking and probing questions (\( r = -0.75 \) and \( r = -0.64 \), respectively). Again these significant changes reflected large effect sizes.

We believe it takes more than just inviting the pupils to wait, to ask, or to apply certain types of questions; pupils need to feel comfortable and this depends on the teacher-pupil relationship. During a practice, for example, a teacher said: “From this moment on I will not ask the questions. You will do it.” But the pupils remained silent. The teacher angrily replied: “What is wrong with you?! Have you learned nothing today?!”. Visibly afraid, the pupils kept silent\(^5\). Similarly, in a previous study (Lucero-Mareydt et al., 2013b), we notice that although some teachers explicitly said: “Did you understand?” or “Any questions till here?”, the pupils never asked a question. As Karabenick (1994) explains, “how students construe teacher behaviour is perhaps more important than teacher behaviour itself” (p. 188).

\(^5\) This teacher dropped out of the intervention because she would retire the next year.
4.2. Intervention strategies and questioning behaviour

It is difficult for teachers to change their teaching practice, even when they know what they are expected to do (Clarke & Hollingsworth, 2002; Grion & Varisco, 2007; Stronkhorst & van den Akker, 2006; Waeytens, Lens, & Vandenberghhe, 2002; Yip, 2004). This includes improving their questioning behaviour (Gunel, 2008). From a review of more than 40 studies on wait times, for example, Tobin (1987) concludes that teachers appear to have difficulties implementing wait times and assisting them to do so represents a challenge for teacher educators. This highlights the value of the intervention discussed in the present study. Tobin adds that practice and feedback are important. The latter has been found to be the most effective means to change science teacher behaviour in general according to the meta-analysis of Yeany and Padilla (1986). Similarly, in our intervention we adopted practice, core reflection (e.g., “How did you feel during the exercise? What did you want to achieve? Did you achieve it?”), and feedback focusing on the positive characteristics of the experience (“I noticed the pupils reacted well to your new behaviour. What do you think?”).

In the present study, the intervention also focused on improving the types of questions. This can partly be related to wait times. If teachers do not introduce in the classroom questions to think, then time to think is not required (Tobin, 1987). “There are many classroom contexts in which shorter pauses between speakers can be justified. For example, when rote memorization or recall of facts is required” (ibid., p. 91). From the available question typologies found in the literature (B. Bloom, 1966; King, 1999; Oliveira, 2010b; Yip, 2004), we focused on questions to assess and consolidate knowledge (i.e., review, hint, and probing questions) and questions to connect concepts (i.e., thinking questions). This is in line with Yip (2004), who trained teachers on a wider range of types of questions and realized that before shifting towards higher levels of questions (e.g., application), connection questions should be in place.
Some of the strategies adopted in the experimental intervention were in line with previous interventions focusing on teacher questioning behaviour, such as practical exercises in the classroom, reflection, sharing of experiences, life modelling, observation of videos of good and poor practices, and small group discussions (Lin et al., 2009; Oliveira, 2010a, 2010b; Yip, 2004). Our study adds empirical evidence to the efficacy of the particular combination of these strategies.

The same applies to the combination of principles of the social learning theory, humanism, and core reflection, which goes in line with the interconnected model of professional growth presented by Clarke and Hollingsworth (2002). This model postulates teachers as *reflective practitioners* and emphasizes that teachers need to experience the impact of new behaviour: “Significant changes in beliefs and attitudes are likely to take place only after changes in student learning outcomes are evident, that is, once teachers have ‘field-tested’ change proposals in classrooms” (ibid, p. 949).

**4.3. Questioning behaviour and inquiry**

From the six possible moves that teacher and pupils could make in a lesson, around 40% were teacher-ask moves in both conditions. Even though this percentage was significantly lower in the experimental condition after the intervention, it was still higher than the percentage of pupil-asks moves in the same condition after the intervention (8%). We wonder what the ideal balance should be since no related benchmarks are available. Graesser and Person (1994) suggest that it is unrealistic to expect large changes in the proportions observed in many classrooms around the world: 4% pupil questions versus 96% teacher
questions. Interestingly, we observed a major change in proportions: 21% versus 79% respectively.

The higher presence of pupil questions is already a step forward towards inquiry related communication patterns. In view of developing inquiry, questions that foster understanding is important. Understanding is the first step in inquiry (Lucero, Valcke, & Schellens, 2013a). Additionally, pupils’ questions support the development of pupils’ higher levels of thinking, creativity, and problem solving (Graesser & Person, 1994; King, 1997), which are necessary to go through the entire inquiry process.

4.4. Implications

Although the National Science Curriculum Reform from 1996 recommends the gradual adoption of inquiry in Ecuadorian primary education (Ministerio de Educación y Cultura del Ecuador, 1998), current instructional practices show that this ideal is far from being reached. This observation is corroborated by previous large scale and small scale studies (Lucero et al., 2013a; Lucero-Mareydt et al., 2013b, 2013c). However, the current study shows it is possible to move into the direction of inquiry. The present paper especially suggests that efforts to implement related curriculum reforms should start by understanding the current situation as it is and setting up learning goals that take into account the affective component of behaviour.

Our research results show that a teacher training intervention can affect the questioning practices of in-service teachers; but, as stated earlier, the nature of the training intervention should consider state-of-the-art strategies that enforce the knowing, the doing, and the wanting to do (Martin & Briggs, 1986; Smith & Ragan, 2005). In particular, sufficient practice of the new questioning behaviour should be accompanied by group and

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6 The frequency of questions (see Table 2) divided by 6 classes results in a mean of 10 pupil and 37 teacher questions per class, which represent 21% and 79% respectively.
personal reflections about the consequences of the behaviour. As a result, teachers will experience why certain questioning behaviour is useful according to the literature and according to their own experiences. Secondly, teachers should put themselves in the place of their pupils during the training sessions and during personal reflections. Thirdly, teacher behaviour is to be assessed in a non-judgemental way, by emphasizing the positive characteristics and every sign of progress.

Regarding the impact of the intervention on pupils’ questioning behaviour, the literature suggests that one-to-one tutoring and one-to-one peer tutoring are highly effective strategies (Graesser & Olde, 2003; Graesser & Person, 1994; King, 1997). The present study reveals, however, that by influencing the teachers it is also possible to influence indirectly pupils’ questioning behaviour. We hypothesize that this results from the teacher explaining to the pupils what he/she is trying to achieve, modelling for the pupils the new questioning behaviour, and inviting them explicitly to behave accordingly. As noticed by King (1999), pupils do not often ask questions unless they are prompted to do so and they require training to reach the level of thinking questions. The questioning behaviour of the teacher is therefore connected to the behaviour of the pupils and vice versa. This interconnectedness should not be neglected in teacher professional development.

5. Conclusions

Given the high quantity and low quality of teacher questions and the complete absence of pupil questions during science lessons, a specific teacher training intervention was implemented in the present study. The experimental intervention focused on the adoption of wait times, verbal moves, and King’s types of questions. This was complemented with in-classroom practice and personal and group reflections. During personal reflections, the
teacher participants were invited to highlight their positive qualities and to put themselves in the place of the pupils.

After seven weeks of training, an analysis of teaching activities reflected an increase in wait times, an overall reduction in the amount of questions, and an adoption of more thinking questions. At the same time, pupils increased their questions and used, for the first time, probing and thinking questions. The results of the study have clear implications for future teacher training practices. Future research could expand the scope of the intervention to other inquiry-related behaviours and contribute, consequently, to the high aspirations of educational reforms.

References


General Discussion and Conclusion
General Discussion and Conclusion

Even though state-of-the-art literature claims that teacher cognitions hold a key to understanding and improving teacher behaviour (Meijer, Korthagen, & Vasalos, 2009; Zwart, Wubbels, Bergen, & Bolhuis, 2007), teacher cognitions are hardly considered in the practice of teacher education (Clarke & Hollingsworth, 2002; Korthagen, 2001; Schepens, Aelterman, & Van Keer, 2007; Valcke, Sang, Rots, & Hermans, 2010). Teacher educational interventions that ignore teacher cognitions are stated to hardly contribute to teacher professional development (Clarke & Hollingsworth, 2002; Schepens et al., 2007), that is, the development of a person in his/her professional role (Beijaard, Meijer, & Verloop, 2004; Villegas-Reimers, 2003). When the personal and professional aspects of teaching are not aligned, teachers experience friction between what they believe is important or necessary and what is externally expected from them. As a result, teachers prefer to resume their old behaviour.

On the basis of the conceptual framework briefly summarized above and presented extensively in the different research chapters, the present dissertation studied the following general research question: Does considering teacher cognitions in teacher professional development have an influence on teachers’ and pupils’ inquiry behaviour in the context of Ecuadorian public primary schools? This question has been addressed in the four empirical studies reported in Chapters 1 through 4.

In the following sections, the main findings from these studies will be summarized and discussed in relation to the general research question. The general conclusion outlines the contribution of the dissertation to theoretical understandings that guide design efforts. Next, limitations of the studies with directions for future research are presented. Finally, implications of the research for policy and practice are discussed.
1. Results overview

1.1. Study 1: Teachers’ beliefs and self-reported use of inquiry

The first study was described in Chapter 1. It was based on a teacher survey that revolved around two questions concerning the *behaviour* and *beliefs* of in-service primary school teachers. Results from the first question, namely “What inquiry activities do teachers adopt and what level of support and type of inquiry is reflected in these activities?”, indicate that most of the activities of the teachers centre on understanding the learning material or content knowledge. Understanding previous or new material is a preliminary step in inquiry and other thinking processes (Bloom, 1966; Egbert, 2009; Molebash, Bernie, Bell, & Mason, 2002; Quintana et al., 2004). As revealed in the study, teachers prefer to conduct these activities together with their pupils rather than showing them how to do it (i.e., explaining it step-by-step, modelling, and so on) or asking them to do it. Moreover, they prefer structured rather than open inquiry, which means that they are the ones who indicate the research question or hypothesis and the procedure that pupils will follow to solve the question or confirm the hypothesis. According to Molebash, Bernie, Bell, and Mason (2002), structured inquiry is not real inquiry. Instead, asking the pupils to formulate their own research question and to define, by themselves, the research procedure (i.e., open inquiry) can be considered real inquiry.

Regarding the second research question, “Is there a difference between the levels of support and the type of inquiry used by teachers according to their beliefs?”, we found out that teachers with higher context beliefs about teaching science favour asking the pupils to do the activities by themselves more than the teachers with lower context beliefs. Context beliefs refer to believing in the possibility of achieving something, given the circumstances and the people around (Ford, 1992; Haney, Lumpe, Czerniak, & Egan, 2002; Lumpe, Haney, &
Czerniak, 2000). The finding of this study suggests that teachers who believe that it is possible for them to achieve effective science teaching in their school context also believe that their pupils are able to perform effectively without much support from the teacher. That is probably why these teachers can give some control away (Woolfolk & Hoy, 1990).

1.2. Study 2: The gap between “what is” and “what should be”

The second study, described in Chapter 2, answers three questions regarding teachers’ behaviour, competencies, and environment. The first question, “What is the actual behaviour as compared to the behaviour expected by the National Science Curriculum Reform (NSCR) in relation to inquiry-based science teaching?”, was concerned with a potential gap between “what is” (i.e., actual implementation of inquiry in the classroom) and “what should be” (i.e., expected implementation of inquiry according to the NSCR). Video analysis of science lessons revealed the complete absence of inquiry and a strong emphasis on content rehearsal. Moreover, teacher questions dominated the pupil-teacher interaction. In 20 lessons, 1600 questions were asked by the 20 teachers involved in the study. In contrast, only 3 questions originated from the 634 pupils.

The second research question, “Under what environmental conditions does the actual behaviour take place?” uncovered the absence of libraries, science labs, and Internet access in the schools. Interestingly, only 9 out of 20 interviewed teachers could access Internet at home. This could frustrate the adoption of inquiry in the teaching of science. However, teachers do have the freedom to plan their lessons as they wish. This suggests that they could adopt inquiry if they wished so or, perhaps, if they knew how to do it.

The third research question, “Do teachers have the competencies to perform as expected?” was assisted with a paper-based test about inquiry-related knowledge and skills that would enable the teachers to comply with the NSCR regarding inquiry. The NSCR
mandates that seventh year teachers teach question formulation, data collection, data interpretation, and data registry in graphics and tables (Ministerio de Educación y Cultura del Ecuador, 1998). More than half of the teachers proved to be competent in interpreting graphical representations of data; less than half were competent in calculating average and percentage, drawing a concept map, or distinguish between types of inquiry; finally, none of the teachers were competent in describing neither the steps of the inquiry process (Molebash et al., 2002), nor the levels of Bloom’s taxonomy (Bloom, 1966). Both the steps of the inquiry process and the levels of Bloom’s taxonomy require similar cognitive and meta-cognitive operations (Quellmalz & Hoskyn, 1997).

1.3. Study 3: Learning goals connecting personal and professional aspects of teaching

The third study, described in Chapter 3, is concerned with the teachers’ overwhelming questioning behaviour as identified in Study 2. It also addresses teachers’ beliefs, mission, and identity in order to understand teachers’ behaviour in a comprehensive way. The research question, “What is the questioning behaviour of the teachers, their beliefs, mission, and identity?” uncovers personal and professional aspects of teaching that demand attention in the design of an intervention. Video analysis of 19 science lessons revealed that the problem was related to not only the large number of teacher questions but also the poor quality of these questions. From 1 155 teachers’ questions, 78% did not revise previous knowledge, nor did they connect ideas and invite pupils to think about how they arrived at a certain answer. Most of these questions could be labelled as “guessing questions” because it was difficult for the pupils to give a meaning to these questions based on the information provided; all they could do was guessing. These “guessing questions” include a) questions wrongly formulated, b)
questions the teacher repeats till she/he hears the precise wording of the text; c) questions to fill-in words, and d) questions to fill-in statements.

The Science Teaching Self-Efficacy scale –STSE (Enochs & Riggs, 1990; Riggs & Enochs, 1989) and the Context Beliefs About Teaching Science questionnaire -CBATS (Lumpe et al., 2000) disclosed moderately high self-efficacy beliefs and moderately high context beliefs, which means that teachers believe in their own capacity to perform effectively, and believe that effective teaching can lead to desirable outcomes. However, what teachers actually pursue is not related to inquiry learning. This indicates that teachers do not take inquiry as a parameter or point of reference in science teaching efficacy.

Via reflection interviews (Biesta, Korthagen, & Verkuyl, 2002), teachers provided us with interesting insights regarding their mission and identity. The reflection interview consisted of open questions and the answers were coded. More than half of the answers indicated that –from the perspective of the teachers- a good teacher should have *interpersonal skills*, i.e., the ability of listening, putting him/herself in the place of the pupils, recognizing and accepting their individual differences. Furthermore, concerning filling in the statement “I am someone who needs………..” most of the answers were “patience” and other interpersonal skills (49% of self-recognized needs).

**1.4. Study 4: The impact of a teacher professional development intervention**

This is an intervention study described in Chapter 4. Diverse instructional strategies that correspond to the levels of *environment, behaviour, competencies, beliefs, mission, and identity* were implemented in view of influencing the questioning behaviour of both teachers and pupils. Specifically, the intervention aimed at increasing the use of wait times (Rowe, 1986, 2003; Tobin, 1987), changing questioning patterns (Carlsen, 1991; Rowe, 2003), and influencing the types of questions formulated during science lessons (King, 1997, 1999). Its
impact was measured in terms of the following three hypotheses studied in a quasi-experimental pretest-posttest research design:

H1: The teacher training intervention will increase the frequency of wait times that teachers and pupils make.

H2: The teacher training intervention will reduce the number of teacher questions and increase the number of pupil questions.

H3: The teacher training intervention will improve the types of questions the teachers and pupils formulate.

As detailed in Chapter 4, the three hypotheses were confirmed. The frequency of wait times, teacher questions, and pupil questions were the same in both conditions before the intervention. After the intervention, we observed more wait times, less teacher questions, and more pupil questions in the experimental condition. Regarding the types of questions, the frequency of thinking questions from the teachers, thinking questions from the pupils, and probing questions from the pupils was the same in both conditions before the intervention. After the intervention, we observed more thinking questions (from teachers and pupils) and more probing questions (from the pupils) in the experimental condition. Thinking questions are useful to connect ideas (comparison-contrast, cause-effect) or link new and prior knowledge. Probing questions induce the clarification or development of a given answer (King, 1997, 1999).

2. General discussion

The general aim of the dissertation was to solve a complex educational problem and to advance our knowledge about interventions that take into consideration teacher cognitions and the process to design them. Given that Chapters 1 to 4 already discuss our results
regarding the lack of inquiry in science teaching, the General Discussion focuses on the design of the intervention.

In regards to the general research question, the findings indicate that considering teacher cognitions in teacher professional development has –indeed- an influence on teachers’ and pupils’ inquiry behaviour during science lessons in the context of Ecuadorian primary public schools. This statement will be discussed in two parts: first of all, we look at the integrated contribution of the research results in relation to teacher cognitions; secondly, we look at the influence of the results regarding teacher cognitions in the design process.

### 2.1. Contribution of the studies to develop a comprehensive understanding of teacher cognitions regarding inquiry-based science teaching in public primary schools in Ecuador

The general research question implies, in the first place, studying the personal understandings, perspectives, or frame of reference in terms of which teachers inspect their science teaching practices (Borg, 1999; Hennissen, Crasborn, Brouwer, Korthagen, & Bergen, 2010; Wyer & Albarracín, 2005; Zwart et al., 2007). As explained in the General Introduction (see section 1.1), the study of teacher cognitions was organized according to the levels of change in the onion model (Korthagen, 2004).

To answer the first part of the general research question, Studies 1 to 3 explored teachers’ perspectives regarding:

a) their own capability to perform effectively (levels of beliefs and behaviour),

b) the possibility of achieving something given the circumstances and the people around (levels of beliefs, environment, and behaviour),

c) the activities they implement in the classroom (level of behaviour),
d) the environmental factors that influence their lessons (levels of environment and behaviour)

e) their position in the teacher-pupil interaction (levels of competencies and behaviour)

f) what is important in a good teacher (levels of mission, identity, and behaviour)

The results have already been presented in section 1. Here the emphasis is on the interconnections between the consecutive studies and how the results of one study have contributed to a better interpretation of results from other studies in the dissertation.

The observation of teachers’ behaviour in Study 2, for example, was useful for understanding the perspective from which teachers answered the self-report questionnaire, i.e., teachers’ cognitions (or perspectives) of their own behaviour (Study 1). During the observed lessons, teachers performed activities they also declared to perform in the self-report, but these activities were not inquiry-oriented. For instance, when teachers declared “I require students to present their results orally, in writing, and/or through graphical presentations”, what they actually meant was that they required students to search for content regarding a topic, to memorize and recite such content in front of the class. Similarly, when teachers declared, “I present previous or new material and review content understanding by drawing together with the children a concept map”, what they actually meant was that they required students to fill-in the branches of the concept map instead of asking them to differentiate between main and secondary ideas; teachers used concept maps to recall content and not to review the pupils’ understanding.

As illustrated in the examples presented above, the classroom observations from Study 2 revealed that teachers concentrated on memorization rather than on understanding. Interestingly, the activities teachers declared to perform the most were precisely those “to understand” the content/material (Study 1). This apparently shows that teachers’ cognitions

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1 More precisely: attitudes. In the onion model, attitudes belong to the level of competencies (Korthagen, 2004)
regarding their own behaviour are incongruent with their actual behaviour. The accuracy of teacher reports on their classroom behaviour has provoked discussion in the teacher research literature (e.g., Lawrenz, Huffman, & Robey, 2003; Raviv & Reisel, 1990). From the perspective of the teachers in Study 1, the activities they perform more frequently –among the options given in the self-report- are those aiming at understanding previous or new material. However, from the perspective of the observer in Study 2, teachers do not develop pupils’ understanding and clearly confuse recalling with understanding. Interestingly, in Study 2, the mismatch between teachers’ behaviour and teachers’ perspectives on their behaviour could be clarified by their lack of knowledge of Bloom’s taxonomy, which distinguishes between recall and understand (as depicted in Bloom, 1966).

Moderately high self-efficacy beliefs and high to moderately high context beliefs were findings common to the large and the small-scale studies 1 and 3, respectively. The interpretation of these results was elucidated by Study 2 in the following ways. Teachers’ answers to the questionnaires on self-efficacy and context beliefs depend on their understanding of “effective science teaching” which, according to the interviews, observations, and inquiry-test, is mistaken. For these teachers, teaching efficacy is about keeping the pupils actively involved in a fast questioning-answering interaction where the teacher asks and the pupils answer. As long as teachers see this movement, they are satisfied with the lesson because –from their point of view- the more the pupils answer, the more they are “learning”. In conclusion, teachers consider pupils’ actively answering questions as the parameter of a good lesson.

The absence of probing, hint, and metacognitive questions in Study 3 was consistent with the absence of following up pupils’ answers observed in Study 2. When the answer to a previous question is incomplete, the teacher may use probing and hint questions to help the pupil “fill in gaps in knowledge, correct misunderstandings, and clarify material” (King,
This requires listening carefully to the pupils and building on what they say. The same applies to metacognitive questions, which help the pupil to reflect on the thinking process that brings him/her to a certain answer. Given the fast questioning-answering interaction and the lack of feedback from the teachers on the pupils’ answers (Study 2), the absence of these types of questions is not surprising (Study 3).

There is a feature that appears consistently in all the studies: teachers’ controlling orientation or attitude as revealed in their behaviour. Study 1 concluded that teachers adopt rather a strictly guided approach in contrast to giving autonomy to pupils to work on their own. Results from Study 1 suggest that it is difficult for teachers to give up control. This can be linked to the teachers’ overwhelming questioning behaviour observed in Study 2. When compared to the absence of pupils’ questions, the excess of teacher questions can be interpreted as the result of their controlling orientation (Williams & Deci, 1996).

Results from Study 3 on the types of questions teachers use complement the discussion above. A controlling orientation implies asymmetry in the teacher-pupil relationship and, according to Oliveira (2010), an asymmetric relationship is nourished by the types of questions teachers ask. Likewise, the types of questions teachers ask position him/her in a more symmetric relationship.

The interpretation of teachers’ cognitions regarding their mission and identity in Study 3 was heightened by the self-reported and observed behaviour in Studies 1 to 3. Findings of these studies suggest that teachers’ behaviour (i.e., keeping control, dominating the questioning-answering interaction, and not building on the pupils’ answers) may be rooted in the teacher-pupil relationship, which was a major concern for the teachers when reflecting on their mission and identity.
Finally, the comprehensive understanding of the nature of teacher cognitions developed throughout Studies 1 to 3 substantiates the teacher professional development intervention in Study 4, which is discussed in the next section below.

2.2. Design decisions for a teacher professional development intervention that consider teacher cognitions

The aim of the present section is to discuss and highlight the influence of our findings regarding teachers’ cognitions on a couple of design decisions.

As explained in the General Introduction, the four studies were linked to each other according to the three phases of the instructional design model: analysis, strategy, and evaluation (Smith & Ragan, 2005). Therefore, results from every study contributed to instructional design decisions. Thus, for example, Study 1 suggested a controlling tendency in the teachers which was further explored in the next studies. It was not difficult to infer a controlling orientation from certain teacher behaviours given that Ecuadorian public primary schools hold traditional teacher practices (Ministerio de Educación & VVOB, 2008). Several manifestations of a pupil control ideology can be found in traditional schools (Woolfolk & Hoy, 1990). Our concern regarding the controlling orientation of the teachers was supported by Smithenry (2010), who observed the relationship between progressively giving autonomy to the students and progressively moving towards more advanced inquiry skills. This –in conjunction to other findings- indicated that the behaviour we wanted to influence had an affective component. Implementing inquiry was not only a matter of knowing, but also wanting; wanting, for example, to transfer to the pupils some control of the classroom. Consequently, the design decision was to set up learning goals in the what, the how, and the why. This can be better explained with the following example extracted from the Trainer’s Guide (see more in Appendix B):
At the end of the first session, teachers will know what wait times concern, why other teachers use wait times, and how to use wait times. During the week, they will practice with wait times and -via reflection- they will discover the advantages of using wait times. At the end of the week, they will know why they use wait times. Finally, at the end of the intervention, teachers will choose to use wait times.

The learning goals of the intervention and the instructional strategies to reach them were supported on the –usually- neglected claim that every behaviour has an affective component (Martin & Briggs, 1986; Smith & Ragan, 2005).

In Study 2, results regarding teachers’ perceptions of their environment signified an opportunity to the implementation of inquiry. Teachers perceived a sense of freedom to plan their lessons and this would encourage them to experiment with new practices in their classroom. Teachers’ perceptions of their workplace conditions are often as important as the workplace conditions themselves (Weiss, 1999). The design decision was, consequently, to emphasize during the intervention the regular practice in the classroom of what was discussed in the training sessions.

The findings of Study 3 were crucial in view of the design of a teacher professional development intervention. Teachers unanimously recognized that they needed interpersonal skills. Interestingly, these skills would enable them to put in practice a new questioning behaviour (Artzt & Armour-Thomas, 1998; Carlsen, 1991; Oliveira, 2010). The adoption of wait times, for example, involves patience, and the use of challenging questions requires an environment of trust: the teachers should trust the pupil (“He/she can do it”) and the pupil should trust the teacher (“He/she wants to help”). Likewise, breaking down the typical questioning pattern (i.e., inviting pupils to evaluate answers and make questions) requires confidence in the pupils’ capabilities and undoubtedly, patience. The design decision was, therefore, that the first four sessions of the intervention would focus on wait times, verbal moves, and types of questions and the last three sessions would focus on the teacher-pupil

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2 Teachers do not have to ask permission to school authorities to change their teaching practice.
relationship, including role-play and other exercises inviting the teachers to put themselves in the place of the pupils.

3. General conclusion

In conclusion, albeit certain limitations to be discussed in the next section, the present dissertation has made a contribution to enhancing our understanding of the role of teacher cognitions in the process of designing in-service teacher training. It also has helped to advance teacher training approaches by proving that considering teacher cognitions in the design of teacher training does have an impact on teachers’ behaviour.

As suggested by Plomp (2009), research on the design of educational interventions produce knowledge about whether and why an intervention works in a certain context; this output could be expressed in the following format:

If you want to design intervention X for the purpose/function Y in context Z, then you are best advised to give that intervention the characteristics A, B, and C [substantive emphasis], and to do that via procedures K, L, and M [procedural emphasis], because of arguments P, Q, and R. (van den Akker, 1999, p. 9)

To synthesise the main conclusions of the present dissertation, we rephrase the format above as follows:

If you want to design a teacher professional development intervention for the purpose of influencing the classroom inquiry behaviour in Ecuadorian primary public schools, then you are best advised to consider teacher cognitions throughout the design process, and to do that via procedures P1 to P9, because of theoretical arguments T1 to T13 and empirical arguments E1 to E9, as shown on Table 1.
Table 1: Design procedures based on theory and validated by empirical arguments derived from the dissertation.

<table>
<thead>
<tr>
<th>Design procedures</th>
<th>Theoretical arguments</th>
<th>Empirical arguments extracted from the dissertation</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1. Identify the level of support (low, medium, or high) teachers provide to pupils when implementing inquiry activities and the type of inquiry they implement (structured, guided, or open).</td>
<td>T1. A controlling orientation in the teachers can be inferred from their behaviour (Woolfolk &amp; Hoy, 1990).&lt;br&gt;T2. Open inquiry is real inquiry (Molebash et al., 2002).&lt;br&gt;T3. Moving from one to another type of inquiry requires progressively transferring control of the classroom to the pupils (Smithenry, 2010).</td>
<td>E1. Apparently, it is difficult for teachers to give up control. They prefer to adopt inquiry activities set up in collaboration between themselves and the pupils, instead of giving autonomy to the learners and showing them exactly how to carry out the activities.&lt;br&gt;E2. Teachers do not ask pupils to formulate their own research question and define, by themselves, the research procedure. Accordingly, our teachers are far removed from implementing real inquiry.</td>
</tr>
<tr>
<td>P2. Explore teachers’ context beliefs: beliefs in the possibility of achieving effective science teaching given the circumstances and the people around.</td>
<td>T4. Teachers act in line with what they think is possible given the circumstances and the people around (Ford, 1992; Haney, Lumpe, Czerniak, &amp; Egan, 2002; Lumpe, et al., 2000).&lt;br&gt;T5. Teachers who believe in the impact of the school (contextual factors) on effective teaching are less custodial with the pupils (Woolfolk &amp; Hoy, 1990)</td>
<td>E3. Teachers with higher context beliefs adopt lower support levels as compared to teachers reflecting lower context beliefs. This suggests that teachers who believe that effective science teaching is possible in their schools also believe that pupils are able to perform effectively without much support from the teacher.</td>
</tr>
<tr>
<td>P3. Conduct a needs assessment where teachers’ self-reports are contrasted with classroom observations.</td>
<td>T6. The frame of reference against which teachers inspect the activities they implement in the classroom may differ from the frame of reference they would be expected to have (Lawrenz et al., 2003; Raviv &amp; Reisel, 1990).&lt;br&gt;T7. Observation is the most accurate way to evaluate attitudes (Smith &amp; Ragan, 2005)</td>
<td>E4. Classroom observations –as part of the needs assessment– revealed a controlling orientation underlining discrepancies between actual and desired behaviours.</td>
</tr>
<tr>
<td>P4. Explore teachers’ perceptions of environmental factors that inhibit or facilitate their daily teaching practice.</td>
<td>T8. Teachers’ perceptions of their workplace conditions is often as important as the workplace conditions themselves (Weiss, 1999).</td>
<td>E5. Daily practice in the real setting (the classroom) took place during the intervention because teachers felt free to do it: they perceived freedom to adopt new teaching practices without having to ask permission to school authorities.</td>
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<tr>
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<tr>
<td>P6. Conduct an in-depth reflection exercise where teachers identify what is important to them and what they need to develop in themselves when confronted with their image of a good teacher.</td>
<td>T11. Interventions should take into account what teachers personally desire instead of unilaterally deciding what is good for them (Beijaard, Meijer, &amp; Verloop, 2004; Grion &amp; Varisco, 2007; Korthagen, 2004).</td>
<td>E7. Through personal reflections, teachers are able to identify by themselves what is important and what they need to work on to fulfil their image of a good teacher.</td>
</tr>
<tr>
<td>P7. Find in the literature a link that connects what is externally expected from the teachers with what they personally desire. P8. Decide on learning goals that attend these two aspects.</td>
<td>T12. In general, projects fail because they are externally imposed and neglect the particular aspirations and experiences of the target group (UNDP, 2001)</td>
<td>E8. What is relevant to the profession does not conflict with what teachers personally desire. Interpersonal skills and patience, which are relevant for the teachers, are also necessary to improve the questioning behaviour in the classroom.</td>
</tr>
<tr>
<td>P9. Attend the affective component of behaviour</td>
<td>T13. Behaving in a certain way is not only about knowing how to do it and doing it but also about wanting to do it (Martin &amp; Briggs, 1986; Smith &amp; Ragan, 2005)</td>
<td>E9. Our intervention, which succeeded in influencing the classroom inquiry behaviour, included learning objectives with a focus on the what, the how, and the why.</td>
</tr>
</tbody>
</table>
4. Limitations and directions for future research

It could be argued that the small number of participants in Studies 2 and 3 might limit the generalization of our research results regarding teacher cognitions. This statement invokes a debate. Teacher cognitions depend on the context where they develop (Correa, Perry, Sims, Miller, & Fang, 2008). Our results were specific to our study context and, consequently, they were not intended to lead to broad generalization. Yet, they might inspire future research that has similar interest in using qualitative research methods, such as classroom observation. As Wiersma (2000) explains, in qualitative research “external validity is [rather] more concerned with the comparability and the translatability of the research” (pp. 211-212). To ensure external validity, our studies were well documented with a complete description of the theoretical background, context, participants, and procedures so that the reader can understand the results and might be inspired to develop applications in other situations or contexts.

Regarding the validity of the intervention study, we acknowledge that the absence of random selection of participants might represent a limitation in quasi-experimental research. It should, however, be noted that, since educational research commonly draws on naturally-formed intact groups of individuals, randomization is often impossible (Hartas, 2010; Wiersma, 2000). In our case, we did work with naturally-formed groups of teachers: in every participating school there were normally three teachers in the seventh year; because of a strong school spirit, all the seventh-year teachers in the participating school requested to participate on the basis of their rule “all of us or none of us”. Moreover, assigning teachers from the same school to different conditions would have “contaminated” the results. We preferred that teachers in the control condition were not biased by hearing from their colleagues about the content of the professional development course. Whether the school would participate in the control or the experimental condition was decided during a meeting.
with the principals and the general supervisor; not by the teachers. This implies that the teachers were not self-selected. Moreover, we used a pretest-posttest non-equivalent control group design. A critical pre-test guaranteed the equivalence between the control and the experimental condition at the level of dependent variables.

In the intervention study, a change in teachers’ attitudes was measured via observation of their behaviour. Among the methods generally used to assess attitudes, observation is the most accurate one (Smith & Ragan, 2005). Smith and Ragan maintain that other common methods, including direct self-report and indirect self-report, can be influenced by what the respondents perceive to be socially acceptable. It could be interesting, however, to set up an additional study on teachers’ reflections before and after the intervention. We present some ideas currently being developed: in view of a fifth study, data from 22 pre- and post-intervention interviews were collected and analysed\(^3\). In the experimental condition, we observe changes in the discourse of teachers when reflecting on their environment, behaviour, competencies, beliefs, mission, and identity in relation to a specific event occurred during the lesson. Moreover, these were video-stimulated reflections and the novelty use of this method has opened up the opportunity for even a sixth study. Furthermore, it would be interesting to see the line of progress regarding teachers’ reactions to the intervention, particularly, how their fears in the beginning may grow into concerns in the way and satisfaction in the end.

Even though a seven-week intervention proved to be effective, we could always aspire to a longer term of interventions. What has been learnt from this short-intervention is that teachers know there is another way of behaving in the lesson, as they have experienced themselves. They also deepen their understanding of what to do, how to do it, and why to do

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\(^3\) Manuscript is in progress.
Future research could adopt the holistic approach promoted in the present dissertation and develop a longitudinal perspective.

5. Implications for policy and practice

This section centres on the question, “So, what do we do with the results now?” The implications of the results for the design of teacher education programs have already been discussed. The following paragraphs present a “fresh look”: the implications from the point of view of policy makers and practitioners themselves. In departing from their viewpoints, more future research directions can be identified.

It is expected that this dissertation could promote discussion among policy makers and assist in the daily practice of teachers and teacher educators. Some steps have already been taken in view of its dissemination beyond the academic field. Recently, the results of the studies were presented to three groups of stakeholders: a) teachers at a public primary school, b) teacher educators at a public university, and c) policy makers at the Ministry of Education in Ecuador.

Building on our presentation involving an audience composed of the teachers that participated in the intervention study (control and experimental conditions) and all the teachers from one of the participating schools, concrete ideas can be derived. The teachers recognize in the studies a value for their daily practice. They also believe that training in questioning behaviour applies not only to the teaching of science but also to the other school subjects. They add that inquiry should be implemented from the first to the last year of primary education and that training should be extended to teachers in all the years.

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4 The results of the intervention where presented to the participating teachers two years later. From their comments during the presentation, it can be concluded that they still believe they have learnt something useful and important.

5 Or “grade”
Teacher educators and educational authorities at a public Ecuadorian university admit that the behaviour of the teachers, as reported in the studies, is common to in-service primary school teachers, including their own student teachers. They affirm that the research results have important implications for policy-related and practice-oriented decisions regarding three specific problems:

Firstly, teacher educators provide student teachers with inadequate feedback or no feedback at all. The introduction of new concepts, such as core reflection (Korthagen & Vasalos, 2005, 2010), as proposed in the dissertation, could arouse interest in improving the feedback competencies of the teacher educators, including their attitude.

Secondly, when teacher educators supervise student practices, they write down their observations on a record that goes to a file, resulting in the fact that the files are hardly read, let alone put into use. In this dissertation, it has been shown that behaviour observation can be a powerful instrument that has been traditionally wasted but should now be fully exploited in the supervision of students’ practice.

Thirdly, teacher educators and university authorities showed interest in exploring the potential for expanding the approach to the professional development of mentor teachers. Mentor teachers are regular in-service teachers that welcome student teachers in their classrooms. Apparently, the way in which mentor teachers relate to student teachers resembles that in which in-service teachers relate to the pupils, as described in the results of the dissertation. Finally, the teacher educators proposed that new research projects be set up in order to better address and deal with the changes proposed above.

After the research results were presented, staff in charge of the national in-service teacher training program from the Ministry of Education expressed an interest in the potential for expanding to a large scale the proposed teacher professional development approach. The current compulsory program, which has already reached more than 350 000 public primary
school teachers (Ministerio de Educación, 2012), focuses mostly on content and pedagogical knowledge. Policy makers acknowledge that the program must be improved but do not know where to start. They call it “a monster difficult to defeat”. We believe that the small number of participants in our studies could be considered as strength. The small-scale makes it easier for the trainers to establish personal contact with the teachers, visit the schools, observe the teachers’ behaviour, conduct in-depth interviews, provide regular follow-up, and implement any other kind of activities that secure trust and collaboration. If the approach discussed in the dissertation is to be extended to the large scale, it is suggested that more facilitators\(^6\) be involved to match up with the population of trainees so that the size of every group remains small. In this regard, these facilitators should be trained first to be familiar with the theoretical conceptions that underlie the dissertation. Most importantly, facilitators should experience themselves how it is to receive feedback in a positive way, and how is it to feel respect, acceptance, and empathy from the trainer. Adding to Korthagen (2001), who postulates that teachers should be treated the same way they are expected to treat the pupils, we propose that facilitators should also be treated the same they are expected to treat the teachers. This opens up an alley for future research.

The underlying message of the dissertation could be summarized in the spontaneous reaction of a teacher when the present research project was introduced to him: ‘Finally, somebody wants to listen to us instead of just coming here to tell us what to do.” We hope that this message reaches an audience as wide as possible with amplified effects as time goes by.

\(^6\) A teacher trainer or educator is, or should be, a facilitator of personal and professional growth.
References


Appendix A:
Measurement instruments
Appendix A ~ Measurement instruments

1. SELF-REPORT ON INQUIRY ACTIVITIES

**Directions:** Below you will find a list of activities that could or could not take place in the teaching of science. Due to their similarity, we have arranged these activities in groups of three. We would like to know which, from the three activities, you perform more frequently than others, which one you do not perform so often, and which one you perform less frequently than the others; it could also be that some activities do not apply to the reality of your class, and therefore, you never perform them. In case of indecision or not understanding the statement, you have the option of answering "I hesitate".

1st = **First place in frequency:** I perform this activity more often than the other three
2nd = **Second place in frequency:** I perform this activity but not as often as the first.
3rd = **Third place in frequency:** This is the activity than I do less frequently from the three.
N = **Never:** I do not do it; this activity does not apply to the reality of my class.
UN= **Undecided:** I hesitate or I do not I understand well what this activity is about.

Please, before answering, read the three activities and then specify how often you perform each activity in your class. Enclose your answer in a circle.

Attention: Only one activity can be chosen for the first place, only one in the second place and only one in the third place. No match is possible. You cannot assign two or three activities in the same place.

<table>
<thead>
<tr>
<th>Activities that could occur when teaching science</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>N</th>
<th>UN</th>
</tr>
</thead>
<tbody>
<tr>
<td>A I present previous or new material and model for the children how to identify the main ideas. I think aloud. I provide a step-by-step example.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I present previous or new material and identify the main ideas in interaction with the children.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I present previous or new material and review content understanding by asking the children to identify the main ideas</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>B I present previous or new material. I identify, by myself, the difficult words and show where to find the meaning (encyclopedia, dictionary, text, etc). I think aloud; that is, I say what I do meanwhile I do it. I provide a step-by-step example.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I present previous or new material and ask the children to identify difficult words and to look for the meaning by themselves</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I present previous or new material and review content understanding by asking the meaning of some words. Both the children and me look together for the meaning of some words.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>C I present previous or new material and review content understanding by asking the children to draw a concept map.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I present previous or new material and model for the children how to draw a concept map. I think aloud. I provide a step-by-step example.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I present previous or new material and review content understanding by drawing together with the children a concept map.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>D We, the children and me, relate information from one source to information from another source.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
</tbody>
</table>

1 Version previous to the final modifications in Spanish.
<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>I ask the children to relate information from one source to information from another source.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I model for the children how to relate information from one source to information from another source. I think aloud. I provide a step-by-step example.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>E I encourage children to ask questions related to a science topic.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>Based on a science topic, I model for the children how to make questions or hypothesis that could initiate a research project or “consulta””.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I encourage the children to make, with me, a list of questions based on a science topic.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>F I indicate the research question or hypothesis and let the students define their own research procedure.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I provide the students with a general topic and ask them to formulate their own research question or hypothesis and to define, by themselves, the research procedure.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I indicate the research question or hypothesis and the procedure that children will follow to solve the question or confirm the hypothesis.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>G I show (model) how to use information resources (newspaper, magazines, books, etc.) or how to create data-gathering instruments (surveys, interviews, etc.). I provide a step-by-step example.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I ask the children to use, by themselves, information resources or data-gathering instruments.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>Together, the children and me, use information resources and create data-gathering instruments.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>H The children and me, we use together tools to manipulate data.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I explain (model) the use of tools to manipulate data (e.g. calculator, Excel, principles in Statistics, etc.).</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I require students to manipulate data using the tools that they find most appropriate.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I In a research project or “consulta”, I require the students to draw their own conclusions and to support these conclusions with data.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I model for the children how to draw conclusions in a research project or “consulta” and how to support these conclusions with data. I think aloud while I model. I provide a step-by-step example.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I guide the students in drawing conclusions and in supporting these conclusions with data. We do it together.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>J I show how to prepare the presentation of research results orally, in writing, and/or through graphical presentations. I provide a step-by-step example.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I guide students in presenting their results orally, in writing, and/or through graphical presentations. We do it together.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I require students to present their results orally, in writing, and/or through graphical presentations.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>K Together with the students, we reflect on the process that occur along the research.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I ask the students to reflect on the process they followed along their research.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
<tr>
<td>I teach the students, via modeling and thinking aloud, to reflect on the process they followed along the research.</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>N</td>
<td>UN</td>
</tr>
</tbody>
</table>

2 Consulta: Information easy to get. Something simpler and shorter than a research project. Homework that can be done from one day to another.
### 2. CBATS³

**Directions:** Suppose your goal is to be the most effective science teacher possible during the next school year. Listed below are a number of school environmental support factors that may have an impact on this goal. In the first column, please indicate the degree to which you believe each factor will enable you to be an effective science teacher. In the second column, indicate the likelihood that these factors will occur (or be available to you) during the next school year.

Choose one answer from column 1 and one answer from column 2. Verify that everything is completed.

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>The following factors would enable me to be an effective science teacher&lt;br&gt;SA= STRONGLY AGREE&lt;br&gt;A= AGREE&lt;br&gt;UN= UNDECIDED&lt;br&gt;D= DISAGREE&lt;br&gt;SD= STRONGLY DISAGREE</td>
<td>How likely is it that these factors will occur in your school?&lt;br&gt;VL=VERY LIKELY&lt;br&gt;SL=SOMETHING LIKELY&lt;br&gt;N=NEITHER&lt;br&gt;SU=SOMETHING UNLIKELY&lt;br&gt;VU=VERY UNLIKELY</td>
</tr>
<tr>
<td>1. Professional staff development on teaching (workshops, conferences, etc.)&lt;br&gt;SA A UN S SD</td>
<td>VL SL N SU VU</td>
</tr>
<tr>
<td>2. National guidelines for science education (standards and goals)&lt;br&gt;SA A UN S SD</td>
<td>VL SL N SU VU</td>
</tr>
<tr>
<td>3. Support from other teachers (coaching, advice, mentoring, modeling, informal discussions, etc.)&lt;br&gt;SA A UN S SD</td>
<td>VL SL N SU VU</td>
</tr>
<tr>
<td>4. Team planning time with other teachers.&lt;br&gt;SA A UN S SD</td>
<td>VL SL N SU VU</td>
</tr>
<tr>
<td>5. Community involvement (civic, business, etc.).&lt;br&gt;SA A UN S SD</td>
<td>VL SL N SU VU</td>
</tr>
<tr>
<td>6. Increased funding.&lt;br&gt;SA A UN S SD</td>
<td>VL SL N SU VU</td>
</tr>
<tr>
<td>7. Extended class period length.&lt;br&gt;SA A UN S SD</td>
<td>VL SL N SU VU</td>
</tr>
<tr>
<td>8. Planning time.&lt;br&gt;SA A UN S SD</td>
<td>VL SL N SU VU</td>
</tr>
<tr>
<td>9. Permanent science equipment (microscopes, glassware, etc.).&lt;br&gt;SA A UN S SD</td>
<td>VL SL N SU VU</td>
</tr>
</tbody>
</table>

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|10. | Classroom physical environment (room size, proper furniture, sinks, etc.). | SA | A | UN | S | SD | VL | SL | N | SU | VU |
|11. | Adoption of an official school science curriculum (goals, objectives, topics, etc.). | SA | A | UN | S | SD | VL | SL | N | SU | VU |
|12. | Expendable science suppliers (paper, chemicals). | SA | A | UN | S | SD | VL | SL | N | SU | VU |
|13. | Support from the principal. | SA | A | UN | S | SD | VL | SL | N | SU | VU |
|14. | Science curriculum materials (textbooks, lab manuals, activity books, etc.). | SA | A | UN | S | SD | VL | SL | N | SU | VU |
|15. | Technology (computers, software, Internet). | SA | A | UN | S | SD | VL | SL | N | SU | VU |
|16. | Parental involvement in science teaching. | SA | A | UN | S | SD | VL | SL | N | SU | VU |
|17. | An increase in students’ academic abilities. | SA | A | UN | S | SD | VL | SL | N | SU | VU |
|18. | Involvement of the supervisor from the Ministry of Education. | SA | A | UN | S | SD | VL | SL | N | SU | VU |
|19. | A decrease in my course teaching load. | SA | A | UN | S | SD | VL | SL | N | SU | VU |
|20. | A reduction in the amount of content I am required to teach. | SA | A | UN | S | SD | VL | SL | N | SU | VU |
|21. | Reduced class size (number of pupils). | SA | A | UN | S | SD | VL | SL | N | SU | VU |
|22. | Classroom assessment strategies. | SA | A | UN | S | SD | VL | SL | N | SU | VU |
|23. | Teacher input and decision making. | SA | A | UN | S | SD | VL | SL | N | SU | VU |

If you think it is important to include one more factor, besides the ones already listed, please mention it here: Which other factor would enable you to be an effective science teacher? How likely is it that this will occur?
### 3. STSE\(^4\)

*Directions*: Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

- **SA**: STRONGLY AGREE
- **A**: AGREE
- **UN**: UNCERTAIN
- **D**: DISAGREE
- **SD**: STRONGLY DISAGREE

<table>
<thead>
<tr>
<th></th>
<th>Statement</th>
<th>SA</th>
<th>A</th>
<th>UN</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Even though I try very hard, I do not teach science as well as I do most subjects.</td>
<td>SA</td>
<td>A</td>
<td>UN</td>
<td>D</td>
<td>SD</td>
</tr>
<tr>
<td>2</td>
<td>When doing a research project, I am not very effective in supervising experiments.</td>
<td>SA</td>
<td>A</td>
<td>UN</td>
<td>D</td>
<td>SD</td>
</tr>
<tr>
<td>3</td>
<td>I generally teach science ineffectively.</td>
<td>SA</td>
<td>A</td>
<td>UN</td>
<td>D</td>
<td>SD</td>
</tr>
<tr>
<td>4</td>
<td>When doing a research project, I find it difficult to explain to students why an experiment works.</td>
<td>SA</td>
<td>A</td>
<td>UN</td>
<td>D</td>
<td>SD</td>
</tr>
<tr>
<td>5</td>
<td>I am typically able to answer students’ science questions.</td>
<td>SA</td>
<td>A</td>
<td>UN</td>
<td>D</td>
<td>SD</td>
</tr>
<tr>
<td>6</td>
<td>Given a choice, I would not invite the principal to evaluate my science teaching.</td>
<td>SA</td>
<td>A</td>
<td>UN</td>
<td>D</td>
<td>SD</td>
</tr>
<tr>
<td>7</td>
<td>When a student has difficulty understanding research conclusions, I usually do not know how to help the student to understand them better.</td>
<td>SA</td>
<td>A</td>
<td>UN</td>
<td>D</td>
<td>SD</td>
</tr>
<tr>
<td>8</td>
<td>When teaching science, I usually welcome student questions.</td>
<td>SA</td>
<td>A</td>
<td>UN</td>
<td>D</td>
<td>SD</td>
</tr>
<tr>
<td>9</td>
<td>I do not know what to do to turn students on to science research projects.</td>
<td>SA</td>
<td>A</td>
<td>UN</td>
<td>D</td>
<td>SD</td>
</tr>
</tbody>
</table>

4. EJERCICIO DE CONTRASTE

Este ejercicio consiste en traer a la memoria una experiencia pedagógica de la cual usted se haya sentido muy satisfecho y otra experiencia que no le inspire ningún sentimiento positivo.

Se trata de ir de la experiencia hacia uno mismo.

Vamos a compartir en parejas. Uno será quien “contribuya” y otro será quien “ayude” y viceversa. Contribuir quiere decir identificar, descubrir, revelar lo que para usted es esencial cuando usted enseña. Eso lo va a lograr al comparar una experiencia positiva con una negativa. El ayudante escucha atenta y activamente, pide que se le clarifique algún punto importante, hace preguntas, resume los pensamientos y sentimientos del otro para confirmar si está entendiendo bien.

Ejercicio A: Experiencia positiva

1. Regrese en el tiempo a aquella situación positiva, tan positiva que cuando usted la recuerda se dice a sí mismo “Lo haría nuevamente! Esto es algo que siempre quisiera conseguir.”
2. Si vienen a su memoria más de una situación, escoja solo una.
3. Cierre los ojos y observe con la mente. Permita que la imagen se vuelva más clara.
4. ¿Dónde está Ud.? ¿Cómo se ve esto o aquello? ¿Quiénes o quién está ahí además de Ud.?
5. Escuche lo que se dice, lo que se hace. ¿Cuál es su rol en esta situación?
6. ¿Qué piensa Ud.? ¿Qué siente Ud.? ¿Qué quiere Ud.?
7. Deje que esta imagen y este sentimiento entren completamente en Ud. Tome una foto mental y luego, póngala aparte por un momento. Mire la imagen desde afuera.
8. Abra los ojos y cuéntele a su colega.

Ejercicio B: Experiencia negativa

9. Regrese ahora en el tiempo a una situación negativa; tan negativa que usted se diga a sí mismo “Entonces no me sentí nada bien.” O tal vez, “Eso… nunca más!”
10. Repita los pasos anteriores (del 2 al 8)

Ejercicio C: Contraste

11. En su cabeza coloque ambas situaciones una junto a la otra. ¿Qué es lo que le hace falta en aquella situación negativa y qué es lo acertado de la situación positiva? ¿Qué hace diferente a una experiencia de la otra? No es necesario ir a los detalles. Se puede caer en la trampa de extenderse en la conversación con su colega. Tanto la experiencia positiva como la negativa podrían llevarnos a otras experiencias; por eso, hay que identificar y mantenerse en el núcleo central de la experiencia y no distraerse con los detalles. ¿Cuál es la característica que hace diferente a una experiencia tan positiva de una tan negativa?
12. Cuéntele a su colega
13. Resuma su respuesta en máximo tres líneas:

……………………………………………………………………………………

---

Ejercicio D: ¿Qué es lo esencial para mí?

14. Use el ejercicio anterior (la reflexión anterior) para llegar a la respuesta de la siguiente pregunta: ¿Qué es lo obviamente esencial en la educación para mí?
   Escriba su respuesta:
   …………………………………………………………………………………………………………………
   …………………………………………………………………………………………………………………
   …………………………………………………………………………………………………………………

15. Complete las siguientes oraciones:

Soy alguien para quien ……………………………………………………………es importante.

Soy alguien que necesita …………………………………………………

Soy alguien que lucha por ………………………………………

Cambie de roles. Empiece desde el Ejercicio 1.
Appendix B:
Trainer’s guide

1 Sample of the first three lessons
“Let’s build on what you know.” A course for primary school teachers
Designed by Maria Lucero, Ghent University

General Introduction

“Let’s work on what you know” is a short course designed for in-service teachers in primary schools. It proposes a series of practical exercises accompanied by individual and group reflections to secure the transfer of what is learnt in the training setting to what is done in the classroom.

The title of the course, “Let’s work on what you know”, is a phrase we expect teachers to keep in mind during their interaction with the pupils. The phrase by itself entails the attitude of paying attention to what the pupil has said and helping the pupil develop his/her thinking. We call this pupil-centered questioning.

The general objective of this course is that teachers use wait times, a varied questioning pattern, and King’s types of questions (King, 1997, 1999) during regular science lessons. Specifically, we expect a change in teachers’ behavior to be measured in the following terms:

a) An increment in the use of wait times.
b) A reduction of teacher questions and an increment of pupil questions.
c) An improvement in the types of questions teachers and pupils formulate.

The course consists of seven weeks of training and two weeks for initial and final assessment. For the assessment, teachers will be observed during a regular science lesson. Teachers will also be observed in follow-up meetings every week.

Follow-up meetings consist on observing the actual implementation of an exercise in the classroom and facilitating the teacher’s reflection on the exercise. Immediately after the exercise, the trainer will make some questions suggested in the core reflection model and the onion model (Korthagen, 2004; Korthagen & Vasalos, 2005, 2010; Meijer, Korthagen, & Vasalos, 2009). For example, the teacher will be invited to describe his/her intentions, acts, thoughts, and feelings and to compare them with those of the pupils during the exercise. We propose that teachers look at situations not only from their own but also from the pupils’ perspective. Moreover, the trainer will ask the teacher to describe the internal and external factors surrounding his/her behavior. We intend that teachers observe their behavior in an integral way.

Every training week includes a session with the group (2-3 hours) and individual follow-up meetings (1 hour per teacher). The present document is a guide for the trainer to organize the weekly sessions and exercises.

Maria Lucero
Ghent University
March, 2011
**Week 1**

*Topic of the week*: WAIT TIMES I & II

**Group session goals:**
- Teachers will know what wait times I & II are about.
- Teachers will know why other teachers use wait times I & II.
- Teachers will know how to use wait times I & II in practical exercises.

**Week goals:**
- Teachers will use wait times I & II in practical exercises.
- Teachers will know why they use wait times I & II in practical exercises.

**Seven-week training goal:**
- In the classroom, teachers will choose to use wait times I & II more often in the last than in the first observed lesson.

**Objectives:**
At the conclusion of the session, teachers should be able to...
1) Describe wait times I & II in their own words.
2) List 3 advantages of using wait times I & II according to the literature.
3) Set up an exercise to practice wait times I & II.

At the end of the week, teachers should be able to...
4) Use wait times in practical exercises.
5) List 3 advantages of using wait times I & II according to their own experience.

At the end of the seven-week training, teachers should be able to...
6) Use wait times more frequently in the last than in the first observed science lesson.

**Participants:**
Six teachers. Trainer.

**Settings:**
Classroom

**Equipment and materials needed:**
Chairs and tables; laptop; projector. Whiteboard and board markers.

**Session outline:**

*Introduction*

1. Group discussion: What does the title of this workshop “Let’s work on what you know” tell you? 5 minutes
2. Show videos of teachers in El Oro. Ask teachers to focus their attention on teachers’ fast schedule. Do teachers ask questions to the same pupil based on the answer of that pupil? What do you observe in the questioning behavior of the teachers? How would you do it better? 15 minutes
3. Ask teachers to brainstorm about the causes and consequences of teachers not working on the answers of one pupil at a time and the causes and consequences of teachers’ fast schedule. Make a list.
   5 minutes

4. Link the teachers’ answers to the training course goals stated in the General Introduction. Show power point presentation about correct types of questions and the types of questions found in the previous study in El Oro. Contrast the ideal questioning behavior with the reality observed in the class. Group discussion.
   20 minutes

5. Introduce the goals and objectives of this session and week.
   5 minutes

   **Body**

6. Explain wait times I & II and the advantages found in the literature. Group discussion.
   15 minutes

7. Provide the following exercise instructions:
   a) Choose a science topic.
   b) Explain the exercise to the pupils.
   c) Ask the pupils to wait (at least 3 seconds) after you make a question and after somebody gives an answer.
   d) During 15 minutes, make several questions about the topic and practice wait times.
   e) At the end, ask the pupils how they felt during the exercise. Reflect about how you felt as well. What problems did you encounter? What benefits did you experience? Write it down.
   f) Repeat the exercise in another lesson.
   5 minutes

8. Make sure teachers understand and agree on the assignment. Ask a teacher to model for the others how he/she will conduct the exercise. Trainer and teachers provide feedback on the way the exercise is set up and on the use of wait times.
   15 minutes

9. Tell teachers you will observe them while doing the exercise for the third time. You will also help them to reflect about the experience. Make appointments.
   5 minutes

   **Conclusion**

10. Ask a teacher to make a summary of what we have seen today: the problem, the causes and consequences, the solution (wait times I & II), and the assignment.
    5 minutes

   **Assessment**

11. To assess teachers’ learning, transform the objectives for session 1 in questions and invite the teachers to answer them.
    20 minutes

*Total time estimated for this session: 2 hours approximately.*
Week 2

Topic of the week: A VARIANT QUESTIONING PATTERN

Group session goals:
- Teachers will know four possible moves in a questioning pattern: structuring (giving directions), soliciting (asking a question), responding, and reacting (evaluating).
- Teachers will know why teachers should use a variant questioning pattern.
- Teachers will know how to alter their questioning pattern during practical exercises.

Week goals:
- Teachers will alter their questioning pattern in practical exercises.
- Teachers will know why they alter their questioning pattern in practical exercises.

Seven-week training goal:
- In the last observed lesson, teachers will choose to reduce the number of teacher questions and increase the number of pupil questions as compared to the first observed lesson.

Objectives:
At the conclusion of the session, teachers should be able to...
1) Give examples of what teachers can say in each of the four moves.
2) Give examples of what pupils can say in each of the four moves.
3) List 3 advantages of altering questioning patterns according to the literature.
4) Set up an exercise to practice the four moves.

At the end of the week, teachers should be able to...
5) Implement the four moves in a practical exercise.
6) List 3 advantages of altering questioning patterns according to their own experience.

At the end of the seven-week training, teachers should be able to...
7) Implement a more varied questioning pattern in the last than in the first observed science lesson.

Participants:
Six teachers. Four pupils (only for a demonstration). Trainer.

Settings:
Classroom

Equipment and materials needed:
Chairs and tables; laptop; projector. Whiteboard and board markers.

Session outline:

Assessment of the previous week

1. Explain teachers that the session will begin by assessing the learning of the previous week. Ask a teacher to summarize session 1. 5 minutes
2. Ask teachers to share the reflections they made after the exercises. What were the advantages of using wait times I & II according to their own experience? What were the problems? How did the pupils feel? How did the teacher feel? Collect and post individual answers.
   15 minutes

3. Ask a teacher to model the use of wait times I & II in a practical exercise. Invite four pupils to join. At the end, ask model-teacher if he/she feels positively reinforced to behave that way. How?
   20 minutes

4. Group discussion. What gratifications did you feel during the practical exercise? What qualities do you identify in the model teacher? Would it be possible to use wait times in the classroom?
   5 minutes

**Introduction to the new session**

   15 minutes

7. Introduce the goals and objectives of this session and week
   5 minutes

**Body**

8. Explain what a questioning pattern is, the four moves, and the advantages of fostering pupil questioning (as found in the literature).
   10 minutes

9. Provide the following exercise instructions:
   a) Choose a science topic.
   b) Explain the exercise to the pupils.
   c) Ask the pupils to wait (at least 3 seconds) after you make a question and after somebody gives an answer.
   d) Provide each pupil with a set of 20 cards labeled as follows “I give directions” (5 cards), “I ask” (5 cards), “I answer” (5 cards), “I evaluate” (5 cards). Each of these cards represents a “move” the player can make in the discussion.
   e) The teacher will also have a set of cards (10 for each label).
   f) During 15 minutes, make several questions about the topic. Practice wait times and the diversified use of “moves”.
   g) At the end, count the cards used by the pupils and by the teacher. What is the difference between the moves made by the pupils and the moves made by the teacher?
   h) Reflect of the experience by asking to yourself the following questions: What did I want? What did the pupils want? What did I do? What did the pupils do? What was I thinking? What were the pupils thinking? How did I feel? How did the pupils feel? Write everything down.
   i) Repeat the exercise in another lesson.
   10 minutes

10. Model for the teachers the practical exercise with four pupils. Communicate the gratification you feel.
   20 minutes
11. Discuss with the group how to improve the exercise. Make sure teachers understand and agree on the assignment.
   5 minutes

   **Conclusion**

12. Ask a teacher to make a summary of what we have seen today: the problem, the causes and consequences, the solution (variety of questioning patterns), and the assignment.
   5 minutes

13. Group discussion: What does the title of this workshop “Let’s work on what you know” tell you? Write answers on a paper to hang on the wall.
   15 minutes

   **Assessment**

14. To assess teachers learning, transform the objectives for session 1 in questions and ask teachers to answer them.
   10 minutes

   *Total time estimated for this session: 2 ½ hours approx.*
Week 3

Topic of the week:

TYPES OF QUESTIONS

Group session goals:
- Teachers will know the importance of building on the answer of the pupil.
- Teachers will know the phases of knowledge construction: a) assessment and consolidation of prior knowledge, b) construction of knowledge, and c) monitoring of thinking process.
- Teachers will know the types of questions in each phase (King’s typology): review questions, hint questions, probing questions, connection questions and thinking-about-thinking questions.
- Teachers will be able to distinguish among questions that build on the answer of the pupil and questions that do not.
- Teachers will know how to conduct practical exercises to practice different types of questions.

Week goals:
- Teachers will build on the answer of the pupil (i.e. teachers will establish a two-way dialogue with the pupil) in practical exercises.
- Teachers will incorporate King’s type of questions in practical exercises.
- Teachers will know why they use King’s types of questions in practical exercises.

Seven-week training goal:
- In a regular science lesson, teachers will choose to build on the answers of a pupil and use King’s types of questions with that pupil.

Objectives:
At the conclusion of the session, teachers should be able to do the following:
1) Explain, in their own words, the importance of building on the answer of the pupil.
2) Name the phases of knowledge construction.
3) Name King’s types of questions and give one example for each type.
4) Given a list of questions, identify questions that lead and do not lead to knowledge construction.
5) Set up a practical exercise to practice different types of questions.

At the end of the week, teachers should be able to...
6) Build on the answer of the pupil by using King’s types of questions in a practical exercise.
7) List 3 advantages of using King’s types of questions according to their own experience.

At the end of the seven-week training, teachers should be able to...
8) Use King’s types of questions more frequently in the last than in the first observed science lesson.

Participants:
Six teachers. Four pupils (for demonstration only). Trainer

Settings:
Classroom

Equipment and materials needed:
Chairs and tables, laptop, projector.
Whiteboard and board markers.
Instructions for practical exercise (Handout 3a)
Assessment 3 (Handout 3b)
Session outline:

Assessment of the previous week

1. Explain teachers that the session will begin by assessing the learning of the previous week. Ask a teacher to summarize session 2.
   5 minutes

2. Ask teachers to list 3 advantages of altering questioning patterns according to their own experience. Collect and post individual answers.
   5 minutes

3. Ask a teacher to model the use of four moves in a practical exercise. Invite four pupils to join. At the end, ask model-teacher if he/she feels positively reinforced to behave that way. How?
   20 minutes

4. Group discussion. What qualities do you identify in the model teacher? Would it be possible to alter questioning patterns in the classroom?
   5 minutes

Introduction to the new session

5. Introduce session 3: What does it mean to build on the answer of the pupil? Do you do it?
   5 minutes

6. Show videos of teachers in El Oro. Ask teachers to focus their attention on the teacher questioning: Does the teacher build on the answer of the pupil? What would you have said instead?
   20 minutes

8. Ask teachers to brainstorm about the importance of building on the answer of the pupil. Make a list.
   5 minutes

9. Introduce the goals and objectives of this session and week.
   5 minutes

Body

10. Show power point presentation and explain the phases of knowledge construction and King’s types of questions. Link this to what teachers already said about the importance of building on the answer of the pupil.
    15 minutes

11. Deliver Handout 3a and explain assignment for the week.
    5 minutes

12. Model for the teachers a practical exercise with four pupils. Communicate the gratification you feel.
    20 min

13. Discuss with the group how to improve the exercise. Make sure teachers understand and agree on the assignment.
    5 min
Conclusion

14. Ask a teacher to make a summary of what we have seen today: the problem, the causes and consequences, the solution (building on the pupil’s answers and King’s types of questions), and the assignment.
   10 minutes

15. Group discussion: What does the title of this workshop “Let’s work on what you know” tell you?
   5 minutes

Assessment

16. Deliver Handout 3b (individual assessment based on the objectives for session 3)
   10 minutes

17. How many times has the trainer use the phrase “Let’s work on what you know” today? Ask teachers if they have suggestions about how to improve this training session.
   5 minutes

Total time estimated for this session: 3 hours approx.

References mentioned in the General Introduction of the Guide:


Appendix C: Pictures
Above: Teachers in large training workshops organized by an official entity.
Below: Girls going to school in Huaquillas, El Oro
Above: Teachers engaged in a reflection exercise.

Below: Presentation of the results of the intervention to the teachers.
Nederlandstalige samenvatting
Alhoewel in de literatuur benadrukt wordt dat er voldoende aandacht moet zijn voor leerkrachtcognities bij elke poging om het lesgeven van leerkrachten te verbeteren (Meijer, Korthagen, & Vasalos, 2009; Zwart, Wubbels, Bergen, & Bolhuis, 2007), stellen we vast dat deze cognities nauwelijks worden meegenomen in het ontwerp en de implementatie van leerkrachtopleidingen (Clarke & Hollingsworth, 2002; Korthagen, 2001; Schepens, Aelterman, & Van Keer, 2007; Valcke, Sang, Rots, & Hermans, 2010). Wanneer opleidingsinterventies deze cognities negeren is er risico dat ze nauwelijks bijdragen tot de professionele ontwikkeling (Clarke & Hollingsworth, 2002; Schepens et al., 2007). Een professionele ontwikkeling van leerkrachten moet namelijk de volledige ontwikkeling van de persoon in zijn/haar professionele rol benadrukken (Beijaard, Meijer, & Verloop, 2004; Villegas-Reimers, 2003). Wanneer leerkrachtcognities en de na te streven veranderingen niet op elkaar zijn afgestemd, zullen leerkrachten een spanning ervaren tussen wat ze belangrijk vinden en wat concreet van hen wordt verlangd. Dit heeft als gevolg dat het nieuwe gedrag wordt genegeerd en leerkrachten bij het vroegere gedrag blijven steken.

Op basis van dit beperkte conceptuele raamwerk, schuiven we de volgende algemene onderzoeksvraag naar voren:

*Heeft het rekening houden met leerkrachtcognities bij de professionele ontwikkeling van leerkrachten een invloed op het onderzoekend leren (inquiry behaviour) van leerkrachten en leerlingen tijdens de lessen wetenschap in Ecuadoriaanse lagere scholen?*

Vier empirische studie werden opgezet in de context van lessen wetenschappen in Ecuadoriaanse openbare lagere scholen.
Het onderzoek naar de leerkrachtcognities werd gebaseerd op de veranderingsniveaus die door Korthagen worden onderscheiden en afgebeeld in zijn ajuinmodel (Korthagen, 2004): omgeving, gedrag, overtuigingen, missie en identiteit. Meer in concreto betekent dit dat in studie 1 tot en met 3 we leerkrachtcognities bestuderen m.b.t. de volgende vragen:

a) hun mogelijkheden om effectief te presteren (niveau van de overtuigingen en gedrag);

b) hun mogelijkheden om iets te realiseren gegeven de omstandigheden en de personen in de omgeving (niveau van de overtuigingen, de omgeving en het gedrag);

c) de instructiestrategieën die ze implementeren in hun klaspraktijk (gedragsniveau);

d) de omgevingsfactoren die de lessen van de leerkracht beïnvloeden (omgeving en gedragsniveau);

e) de interactie tussen leerkrachten en leerlingen in de klas (niveau van de competenties\(^1\) en het gedrag);

f) wat is belangrijk in een goede leerkracht (niveau missie, identiteit en gedrag).

De opzet en de bevindingen van studies 1 tot en met 3 dragen bij tot het uitwerken van de krijtlijnen voor het ontwerp van een professionaliseringsinterventie die werd geïmplementeerd en geëvalueerd in Studie 4. In deze vierde studie werd de interventie zo opgezet dat de verschillende veranderingsniveaus in een leerkracht werden beïnvloed: niveau van de omgeving, het gedrag, de competenties, de overtuigingen, de missie en de identiteit. De interventie was daarbij gericht op het optimaliseren van het onderzoekend leren (inquiry behaviour) van zowel leerkrachten als leerlingen.

De vier studies hangen onderling samen door hun focus op opeenvolgende stappen in een onderwijskundige ontwerpcyclus: analyse, strategie en evaluatie (Smith & Ragan, 2005).

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\(^1\) Meer in het bijzonder: attitudes.
1. Overzicht van de opeenvolgende studies

1.1. Studie 1: Leerkrachtovertuigingen en de implementatie van onderzoekend leren in wetenschappenonderwijs in Ecuadoriaanse openbare lagere scholen

Deze studie beschrijft Ecuadoriaanse in-service leerkrachten en hoe zij wetenschappen geven in openbare lagere scholen. De focus ligt daarbij vooral op de mate waarin deze leerkrachten onderzoekend leren (inquiry activities) implementeren in hun wetenschappenonderwijs, welke mate van ondersteuning ze geven aan hun leerlingen en welk type inquiry ze nastreven. Vier vragenlijsten werden afgenomen bij 173 leerkrachten. De resultaten wijzen uit dat de leerkrachten zeer sterke contextgerichte overtuigingen hebben en een grote mate aan self-efficacy overtuigingen. Deze leerkrachten geven aan dat ze vooral instructiestrategieën implementeren die gericht zijn op het begrijpen van de leerstof en dit in tegenstelling tot strategieën die gericht zijn op het manipuleren van data en/of het komen tot conclusies. Leerkrachten blijken een eerdere rigide geleide instructie-aanpak te volgen die in contrast staat met een aanpak waarin veel autonomie wordt gegeven aan leerlingen om zelfstandig hun werk aan te pakken. Ten laatste blijken leerkrachten het formuleren van vragen en de oplossingsprocedures sterk aan te sturen. Dit laatste remt duidelijk de ontwikkeling van onderzoekend leren af. Wat betreft leerkrachtovertuigingen, blijkt dat de sterke contextuele overtuigingen samenhangen met de mate waarin ondersteuning wordt gegeven aan leerlingen. Leerkrachten met lage contextuele verwachtingen laten in mindere mate toe dat leerlingen zelfstandig onderzoekend leren activiteiten aanpakken, in vergelijking met leerkrachten met hoge contextuele verwachtingen. Vervolgonderzoek m.b.t. onderzoekend leren zal daarom zeker rekening moeten houden met mogelijke verschillen in de contextuele overtuigingen van leerkrachten. De resultaten geven ook aan dat het in sterke of lage mate geven van ondersteuning bij onderzoekend leren onafhankelijk is van een lage of hoge mate aan self-efficacy overtuigingen.
1.2. Studie 2: Implementeren leerkrachten onderzoekend leren en zijn leerkrachten hiertoe in staat? Een behoefteanalyse in landelijke publieke lagere scholen in Ecuador

In deze studie wordt onderzocht in welke mate onderzoekend leren wordt geïmplementeerd in landelijke Ecuadoriaanse publieke lagere scholen. In de studie werd een les wetenschappen (6de leerjaar) geobserveerd van 20 verschillende leerkrachten. Ten tweede werden ook de kennis en de vaardigheden m.b.t. onderzoekend leren in kaart gebracht bij deze leerkrachten. Ten derde werd de klas als leeromgeving bestudeerd. Alle data helpen om de basis te leggen voor een behoefteanalyse; de typische eerste fase in de ontwerpcyclus van een opleidingsinterventie. De descriptieve data tonen aan dat een oriëntatie op onderzoekend leren ontbreekt; dit blijkt ook congruent te zijn met de lage test scores op een kennistest m.b.t. onderzoekend leren. Wat betreft de 20 lessen wetenschappen, leerkrachten blijken daarin in het totaal 1 600 vragen te stellen aan de leerlingen. Slechts 3 leerlingen (n = 634) stelden een vraag aan de leerkracht. De dominantie van leerkrachtgestuurde vragen remt de mogelijkheden voor onderzoekend leren af. Andere tekortkomingen zitten in de leeromgeving. Er is geen bibliotheek, geen wetenschappen labo’s en geen toegang tot het Internet. Niettegenstaande dit, zijn er ook kansen aanwezig in de leeromgeving die helaas niet benut worden door de leerkrachten om stappen te zetten in de richting van onderzoekend leren; bv. de beschikbaarheid van vrij up-to-date leermaterialen en de relatieve vrijheid die leerkrachten hebben in het plannen van hun lessen. De onderzoeksresultaten suggereren dat een eerste belangrijke stap voor het bevorderen van onderzoekend leren ligt in het verbeteren van het stellen van vragen door de leerkrachten.
1.3. Studie 3: Een holistische studie van het stellen van vragen door leerkrachten: implicaties voor het ontwerp van een leerkrachprofessionalisering

Om het gebrek aan aandacht voor onderzoekend leren te onderzoeken vanuit een holistisch perspectief, is een studie opgezet bij 19 in-service leerkrachten uit 13 openbare lagere scholen. Daarbij werd hun gedrag, overtuigingen, missie en identiteit onderzocht. Deze verschillende “levels of change” uit het ajuinmodel van Korthagen worden dikwijls gebruikt om de reflectie over de eigen onderwijspraktijk op gang te brengen. Maar de aanpak werd tot nog toe nog nauwelijks toegepast bij in-service leerkrachten. Doel van deze studie is om de aanpak op basis van het ajuinmodel toe te voegen aan de eerste fase van een ontwerpcyclus voor het ontwikkelen van een interventie gericht op het professionaliseren van leerkrachten.


De videoanalyse geeft aan dat de meerderheid van de vragen van de leerkracht de ontwikkeling van onderzoekend leren sterk inperkt. Leerkracht blijken gemiddeld vrij hoge self-efficacy en context overtuigingen te bezitten. Blijkbaar houden ze daarbij weinig rekening met de nadruk op onderzoekend leren. De persoonlijke leerkrachtrelecties tonen aan dat de leerkracht vooral bezorgd zijn over hun relatie met de leerlingen, wat – volgens de literatuur – sterk samen hangt met een zwakker “vraaggedrag”.
1.4. Studie 4: De impact van een professionaliseringsinterventie op het vragen stellen door leerkrachten en leerlingen

Een professionaliseringsinterventie van in-service leerkrachten werd geïmplementeerd in een aantal openbare lagere Ecuadoriaanse lager scholen om (1) de wachttijden te optimaliseren, (2) het alterneren in het vraag-antwoord patroon (zowel leerkracht als leerlingen stellen vragen en antwoorden) te veranderen en (3) de variatie in types vragen die gesteld worden te verbeteren. In vergelijking met leerkrachten/leerlingen in een controleconditie bleek de interventie een significante invloed te hebben: (1) een verhoging van de mate waarin leerkrachten wachten na het stellen van een vraag; (2) het verhogen van het aantal vragen die leerlingen stellen en een vermindering van de proportie leerkrachtvragen en (3) we observeren een grotere scala aan types vragen bij zowel de leerkracht als de leerlingen. In lijn met onderzoek dat het belang benadrukt van de samenhang tussen het gedrag van leerkrachten en hun kenmerken, besteedde de interventie veel aandacht aan de affectieve dimensie bij het stellen van vragen. Gegeven de bereikte resultaten is dit een beloftevolle aanpak om de toekomstige professionalisering van leerkrachten aan te pakken.

2. General conclusion

Het algemene doel van deze dissertatie benadrukt de holistische benadering van leerkrachtcognities in de ontwerpcyclus (analyse, strategie en evaluatie) voor een leerkrachtprofessionalisering. Uit de opeenvolgende studies kunnen we de volgende conclusies trekken:

b. Veel leerkrachten blijken een andere raamwerk te hanteren bij het ontwikkelen en uitvoeren van klasactiviteiten dan dat wat van hen verwacht wordt.

c. Een behoefteanalyse is zinvol om de ontwikkeling van een leerkrachtinterventie richting te geven. Van belang zijn klasobservaties die – als deel van de behoefteanalyse – kunnen helpen om in relatie tot bepaalde attitudes en leerkrachtovertuigingen, mogelijke discrepanties tussen het gewenste en actuele gedrag vast te stellen.

d. Een grondige analyse van leerkrachtcognities, die verder gaat dan een analyse van feitelijk gedrag en hun competenties, verhoogt de kans dat de concrete factor die een opleidingsbehoefte stuurt, kan onderkend worden. Het bestuderen van de verschillende leerkrachtcognities helpt hierbij een omvattend beeld te krijgen van de kloof tussen wat leerkrachten doen en verwacht worden te doen.

e. Het ajuinmodel is een nuttig raamwerk om leerkrachtcognities te onderzoeken en daarbij een omvattend beeld te krijgen van wat een “goede leerkracht” is. Bovendien kan het helpen om de concrete individuele opleidingsbehoeften in kaart te brengen die gerelateerd zijn aan de verschillende niveaus van verandering in het ajuinmodel.

f. Wat men belangrijk vindt voor het beroep van leerkracht, blijkt aan te sluiten bij wat leerkrachten zelf nastreven. Daarbij moet ene efficiënte en effectieve professionalisering van leerkrachten in lijn zijn met wat leerkrachten reeds kennen, kunnen en willen.

g. Het is mogelijk om in het ontwerpproces van een professionalisering de leerkrachtcognities te onderkennen die een invloed hebben op leerkrachtpraktijken.

Rekening houdend met enkele duidelijke tekorten in het opgezette onderzoek, kan geconcludeerd worden dat de verschillende studies hebben bijgedragen tot een beter begrip
van leerkrachtcognities bij het ontwerpen van leerkrachtprofessionalisering. Het empirische onderzoek heeft ook aangetoond dat professionaliseringen die rekening houden met specifieke leerkrachtcognities, ook effectief zijn en leiden tot significante veranderingen in leerkrachtgedrag.

Literatuurreferenties


Academic output
Output related to this dissertation

Journals (a1)


Conference contributions


