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 centres 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 Science Teaching

Current studies on science teaching emphasize the importance of inquiry-based methods (e.g., 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 definition of inquiry (Bloom, 2006). In our study we adopt the following descriptive definitions: ‘Inquiry in education is also sometimes called “research”, “investigation”, or “guided discovery”.

\(^1\) 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.
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 Enochs 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; Enochs & Riggs, 1990; Gibson & Dembo, 1984). Riggs and Enochs (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 external 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 unidocentes’ (schools where only one teacher teaches all the groups); 17% worked in ‘escuelas pluridocentes’ (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 percent of the teachers were teaching one group, 14% was teaching two, three, four, five, or even

\(^2\) Second and seventh years correspond to first and sixth grades in the US educational system.
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, 2000; 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 (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. The content validity of the self-report questionnaire is supported by the fact that these activities cover all the steps of the inquiry process discussed in the scientific literature; the self-report instrument is based on a robust theoretical background.

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 (α = 0.77), medium support (α = 0.75), and high support (α = 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, 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 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

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3 Both teachers from Arenillas and Huaquillas protested against and did not attend mandatory workshops on Saturdays.
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: \(r = Z / \sqrt{N}\). 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 consulta⁴, 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.

[Insert Table 2 about here]

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

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.
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.

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 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 ($n = 52$, $Mdn = 1.36$, $U = 1355$, $p = 0.50$). 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 most, correspond to the first step in the inquiry cycle (Understand) and the results further suggest stagnation in the way the further 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 effective performance is possible in
the pupils. 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.

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.

5. References


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, 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.) and data-gathering instruments (e.g. 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>
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>
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>U</th>
<th>p</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.