The dissonance between scientific evidence, diversity and dialogic pedagogy in the science classroom

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Abstract

The literature displays several related tendencies that seem to draw together into two main positions: one focused on the identities/subjectivities of those learning science, that is, the culturally and linguistically diverse students themselves; and the second, on considerations of science as culturally located, Western and non-Western knowledge. This study adopts a sociocultural view of science that views science as a cultural way of knowing, and acknowledges that it is laden with cultural understandings, interpretations, and a language of its own. This study explored the interplay between science teachers' pedagogical beliefs, scientific evidence, and diversity. This paper reports findings derived from qualitative data including interviews and journal field notes observations. The interview sample comprised seven primary school science teachers and nine secondary science teachers. The findings indicated that there was a reliance on dialogic teaching strategies to teach for the school science agenda, but not for the diversity agenda. The findings show that teachers used evidence pedagogy through using their dialogic pedagogy which act as mechanisms to avoid confronting and dealing with diversity, or with the diverse students' concerns. Teachers use these dialogic pedagogies as a 'teacher-led dialogues' tool. Conclusions from the study argue that science teachers need a clear sense of their own views of science in their cultural context in order to be able to understand those of their students and to engage with these views and enhance the use of the dialogic pedagogy by integrating these cultural beliefs into the science discourse.

Introduction

Our schools in the UK and schools all over the world are filled with a wide range of learners: linguistic, cultural, racial and ethnic, socio-economic differences, different experiential backgrounds, special needs, gifted, heritage language learners, students who learn differently, and those with different cognitive abilities; in addition to the wide range of views of and attitudes towards science and science education. With an increasing number of minority students from different racial and ethnic populations, teachers are increasingly finding themselves in classrooms with children from cultural backgrounds much different from their own (Author, 2011, Brand & Glasson, 2004). This requires a fundamental change in the science teacher's role and the need for teachers to change their conceptions and practices concerning the teaching of science in a diverse classroom (Biesta, Priestley, & Robinson, 2015; Karousiou, Hajisoteriou, & Angelides, 2019; Gutentag, Horenczyk, Tatar, 2018; Hachfeld, Hahn, Schroeder, Anders, Kunter, 2015; Sanchez & Valcarcel, 1999). How can science teachers accommodate this wide array of learners, and meet the demands of teaching science for all? (Shah, 2019; Sjøberg & Schreiner, 2005van Griethuijsen, et al., 2015;).

So, what is actually meant by 'science for all'? The National Science Education Standards (NRC, 1996) provides part of this definition in the first principle that underpins that document: All students, regardless of age, sex, cultural or ethnic background, disabilities, aspirations, or interest and motivation in science, should have the opportunity to attain high levels of scientific literacy (NRC, 1996). Responding to this broad goal for science education, Southerland and Gess-Newsome (1999) argue that science for all refers to a broad spectrum of individuals and that science education should be inclusive:

> that is, accessible to all individuals regardless of gender, ethnicity, culture, economic circumstance, background, primary language, disability, future aspirations, or current motivations. This goal becomes particularly important as we see increasing diversity in the students in our classrooms, caused, in part, by changing demographics and efforts toward mainstreaming students. (p. 131)

Only by conducting a study to explore science teachers' beliefs of and experiences with diversity can insights be offered into how science teachers respond to issues of diversity and of practice in the science classroom. Atwater (1996) identified teacher beliefs related to ethnicity and culture as key constructs for gaining insight into teacher perceptions of the role of diversity in science teaching and learning. A study by (Author, 2015) stressed the importance of understanding teachers' epistemological and ontological beliefs alongside cultural and religious beliefs of science and scientific discoveries when teaching science to diverse students (Author, 2008, 2010). In this sense, Garibaldi (1992) suggested that teachers' beliefs about diversity will have been influenced by information that reinforces stereotypes of minorities and students from subcultures that are not part of the mainstream culture. As asserted by many studies, more research is needed to understand the conceptions teachers have of inclusive teaching, how these conceptions are formed, and how they act to shape instruction (Forlin, 2010; Gavish, 2017; Jane Essex, Alexiadou, & Zwozdiak-Myers, 2019; Mensah, et. al., 2018).

Considering the cultural diversity in classrooms that can represent different views of the nature of science and the goals of learning science, science educators ask key questions that everyone interested in science education should consider when planning or developing curricula for teaching science: whose culture are we teaching when we teach science? What are appropriate criteria to use as we decide what counts and what does not count as science? (Lynch, 2001; Pomeroy, 1994; Krajcik & Delen, 2017; Meyer & Crawford, 2015; Roblin, Schunn, McKenney, 2018). These questions are calling for a critical view of the universalist views of Western science about what science we teach and the approach we take to teach this science (Stanley & Brickhouse, 1994, 2001). In this sense, teachers' views of science are to be challenged. Also, teachers' understanding of scientific inquiry and how and why the inquiry approach is used in the classroom is questionable too (Author, 2015; Cigdemoglu & Köseoğlu, 2019; Vhurumuku, 2015; Wahbeh & Abd-El-Khalick, 2014). Answering these questions may explain why students are engaged in the science classrooms or why they decide not to continue studying science in the future.

An unresolved issue is how teachers work from their own cultures, experiences, specialism and background and are not considering students' diversities. Bennett (1986) warns that ignoring the effects of culture and learning style affects all students:

> If classroom expectations are limited by our own cultural orientations, we impede successful learners guided by another cultural orientation. If we only teach according to the ways we ourselves learn best, we are also likely to thwart successful learners who may share our cultural background but whose learning styles deviate from our own. (p. 116)

This quote by Bennett raises important questions that are considered in this study: in an individual teaching and learning situation, does the teacher adapt to the student, or the student to the teacher? Does the teacher have to adapt to scientific epistemology and ontology? Should science education aim at promoting students' cultural beliefs in or understanding of scientific theories and models? And what is the role of the science teacher's own education regarding these complicated issues? Should science teacher training aim at changing teachers' beliefs to match the curricula that they are teaching or to comply with the educational policy?

A proper goal for science education is that learning should not entail students' change of beliefs, but rather students' understanding of scientific ideas (El-Hani & Mortimer, 2007, Khishfe, Alshaya, BouJaoude, Mansour et al., 2017). Smith and Siegel (2004) argue that science education needs to stimulate students to recognise the scientific status of the theories they are being taught). Also, science education should make students aware of how these theories have been developed and the limitations of these theories. In this case, teaching the nature of science is necessary (Abd-El-Khalick & Lederman, 2000; Akerson, Carter, Pongsanon, & Nargund-Joshi, 2019; Duschl, & Grandy, 2013). When doing so, we should consider how students make sense of the natural world. Carter (2008) argues that we can know nature only through culturally constituted conceptual or epistemological frameworks, enabled and limited by local cultural features such as discursive practices, institutional structures, interests, values, cultural norms, and so on. In this respect, Longino (1993) extended Kuhn's notion of science as a communal activity to call for inclusion of multiple voices and diverse perspectives in deciding the legitimacy of scientific claims. She began by arguing that scientific knowledge should be understood not as the product of individuals applying a method, but as the outcome of members of a community engaged in critical dialogue with one another.

A particularly important case arises when a student rejects scientific claims because they subscribe to religious ideas in a fundamentalist manner (El-Hani & Mortimer, 2007). Southerland (2000), for instance, argues that in this case the teacher should help the student understand the religious grounds on which the belief is based, and point out which kinds of questions religious views answer and which they do not. In this approach the teacher is stimulating the student's understanding of the domains of application of different ways of knowing (Author, 2015; Newton, Driver, & Osborne, 1999). The teacher is trying to teach the students to argue from different perspectives or angles. The student is coming from a religious angle and the teacher's role is to help the student to consider the domain of science and scientific enquiry as a way of knowing, so that students also understand what kinds of questions scientific knowledge cannot address (Driver, Newton, & Osborne, 2000; Jiménez-Aleixandre & Erduran, 2007' McNeill & Knight, 2013; Newton, Driver, & Osborne, 1999; Walker & Sampson, 2013). The student may never accept or believe in scientific explanations or evidence, but the science teacher would have played their role in an appropriate manner, promoting understanding of scientific explanations, the reasons for them, the process of their construction, and the demarcation of the domains in which they are adequate. In this case, we should consider that science involves a way of knowing that is different from other ways of knowing (AAAS, 1993; NRC, 1996). The scientific world view is based on the Western tradition of seeking to understand how the world works (i.e., to describe, explain, predict and control natural phenomena), which differs from other ways of knowing based on personal beliefs, experience and/or traditional cultural knowledge systems (which may or may not include myths, religious values and supernatural forces) (Abd-El-Khalick & Lederman, 2000; Akerson, Carter, Pongsanon, & Nargund-Joshi, 2019; Deng, Chen, Tsai, & Chai, 2011; Duschl, & Grandy, 2013; Olson, 2018). In this case, teachers' own attitudes and beliefs about diversity and educational equity are important. Even the best multicultural teaching materials are ineffective when the teacher ignores students' diversity (Banks & Banks, 1995).

Although teachers may assume the culture and values of familiar subcultures in which they grow up, they must often cross cultural borders to understand new subcultures as they strive to relate to students from different cultural backgrounds (Aikenhead, 1996, 1997; Asante, 2018; Bang & Medlin, 2010; Gondwe & Longnecker 2015; Vera Cruz, Madden, Parsons & Carlone, 2013). According to Aikenhead (1996, 1997), crossing cultural borders requires renegotiations of beliefs and ideas as teachers understand and assimilate the values of students, families, community, and the school subcultures in which they work. It is imperative to focus on understanding the ideas and attitudes of teachers toward diversity as a means of identifying mis/preconceptions and prejudices (see Garcia & Lopez, 2005). As Korthagen, Kessels, Koster, Lagerwerf and Wubbels (2001) argue, it is only possible to work with teachers' ideas and realistically move them forward once they are known. Therefore the current study attempted to identify teachers' concerns to categorise their positions with regard to diversity, science and teaching practices, in order to provide a meaningful way of analysing teachers' positions and the shifts within these.

A sociocultural view of science and research questions

This study adopted a sociocultural view of science that views science as a cultural way of knowing that acknowledges it as laden with cultural understandings, interpretations, and a language of its own (Kaya, Erduran, Birdthistle, & McCormack, 2018; Author, 2011; Meyer & Crawford, 2011). From this sociocultural perspective of science education, scientific knowledge can be seen as a meaning system in which scientific words have meaning not in themselves but in relation to social settings in science as a whole (Halliday & Martin, 1993; Lemke, 2001). A growing number of educators have argued that such sociocultural perspectives must inform descriptions of science if teachers are to interest and engage students from underrepresented ethnic groups usually positioned on the margins of the science classroom (Bianchini & Solomon, 2002; Author, 2015; Stanley & Brickhouse, 1994, 2001). Considering this sociocultural view of science, students' engagement in the science classroom and their understanding of science depends on the degree of cultural differences that they perceive between their life-worlds and their science classroom; how effectively students move between their life-world culture and the culture of science; and the assistance they receive in making these border-crossing transitions between cultures easier (Aikenhead, 1996, 1997; Jegede & Aikenhead, 1999).

One tension that this study sought to explore and understand was teachers' views of diversity and their pedagogical responses to cultural groupings and individual differences when teaching science (Grant, 2006; Grotzer, 1996; Sharma, 2019) argues that while paying attention to culture is important, students need to be first treated as individuals who are influenced by the contributions of their culture, before treating them as part of a larger stereotyped cultural group. In this sense, Carter (2004) claims that the literature displays a number of related tendencies that seem to draw together into two main positions: one focused on the identities/subjectivities of those learning science, that is, the culturally and linguistically diverse students themselves, and the second, on considerations of science as culturally located, Western and non-Western knowledge, frequently identified as multicultural approaches to science (Candela, & Rey, 2019; Lewis & Aikenhead, 2000). In the context of this argument, the sociocultural turn in science education raises the question of how we understand science: whether we accept its ideology of decontextualised knowledge, or locate knowledge in the context of cultural practices and interests (Carter, 2008). This turns out to be a key question for diversity in the science education context since it is the authoritarian voice of science as decontextualised truth which many authors claim is alienating students from different backgrounds. This argument informs the research focus of this study which aimed to explore the pedagogies that science teachers use in the classroom to mediate their views about science and diversity. The study explored the extent to which teachers implement a culturally responsible teaching approach in their classrooms, and the interplay between science teachers' pedagogical beliefs, scientific evidence, and diversity:

1. What are science teachers' epistemological and ontological views of constructing science?
2. What is the relationship between teachers' views of the 'evidence' in scientific inquiry and diversity?
3. How does teachers' understanding of scientific inquiry shape their pedagogical beliefs and practices about teaching science for all?

Methodology and research methods

This paper reports findings derived from qualitative interviews concerning teachers' perceptions of science education in relation to diversity in primary and secondary schools in England. This data represents a sub-set of data derived from a large-scale EU-funded international project entitled [deleted for the review]. For the purposes of this paper, out of the total UK data, a set of four secondary schools was selected, two in Greater London and two in the South West region of England (specifically, one located in the city of Exeter and one in the Cornish market town of Bodmin). The qualitative data was collected during a subsequent period of intensive questionnaire research. The interview sample comprised seven primary science teachers and nine secondary science teachers. The sample included 11 men and five women, aged from their mid-30s to early 50s; the number of years' teaching experience varied from five to 25 years. Because the sample was drawn from primary and secondary schools the teachers had experience of teaching different age groups and different subjects within science education.

The decision to focus attention on two regions of England, Greater London and the South West, was based partly on logistical grounds and partly on the specific requirements of the [deleted for the review] project. Given that the University of [deleted for the review] is the UK partner in the project, it made sense to work with relatively local schools to facilitate collaboration and to take advantage of existing links between [deleted for the review] Consequently, schools were approached via the university's [deleted for the review] 'partnership office', the administrative group responsible for liaisons between the Graduate School of Education GSE and its partnership schools. Additionally, the project team, comprising science education academics involved in both teacher training and research over an extensive period in the region were able to make recommendations as to suitable schools to work with based on criteria devised by the team (see below).

However, given that the focus of the research is on diversity, it was deemed highly desirable to work with schools exhibiting a significant degree of diversity based on traditional markers such as gender, ability, socio-economic status and ethnicity. The latter dimension is a shortcoming of schools in the South West region generally which are predominantly characterised by white-British ethnicity. Consequently, it was considered desirable, if not essential, to work with schools exhibiting a much broader ethnic diversity than is available in the South West. Given the characteristic distribution of ethnic minority populations in the UK, this meant seeking to work with schools in the large metropolitan areas, such as London. Fortunately, one of the project team had worked in London for ten years in two Higher Education Institutions and had developed strong links with potential schools, and these links were used as the basis for approaching a range of London schools. Specifically, the criteria for recruitment were: strong research potential, enthusiastic staff, diversity represented in at least significant ethnic diversity.

The sample of schools used in the project can be judged to be neither randomly selected nor representative of the wider school-community in the UK or, indeed, the regions from within which they were recruited. Consequently, this study adopted a qualitative approach and makes no strong claims to generalisability. However, observations based on themes emerging from the data will be discussed as potentially informative in a more general sense.

Data for this study consisted of audiotaped interviews and journal field notes of observations. The taped interviews consisted of open-ended questions in an attempt to promote an open discussion of experiences and beliefs. Examples of the interview questions are presented in

Table 1:
Examples of the interview questions

Interview questions	Propping questions
Do you think it is useful to bring discussions of ethical issues around science into your teaching?	[If no] Why not? [If yes] Why, and how do you do this?
Do you think it is useful to bring social issues around science, such as sustainability, into your science teaching	[If no] Why not? [If yes] Why, and how do you do this?
Do you try to get pupils to have some understanding of the history of science?	If not, why not?
There are several ways that a teacher can deal with history. One way is to give pupils a sense of 'great moments of discovery'. Another is to make them aware that scientists have thought very differently about scientific phenomena at different times and in different places.	What do you think about each of these goals? Do you try to achieve either of them?
If a pupil said to you that what you taught in your science class was contradictory to what their religious leaders taught them, how would you respond?	Why would you deal with it in this way?

An interviewer's notebook of memos was kept throughout this study, documenting descriptions of occurrences as observed by the researchers. Such descriptions included participants' lesson activities, resources, expressions and gestures while being interviewed or observed in the classroom, and for recall of other information discussed informally by the participants at other times when they were not being interviewed or they were in the class teaching. This log helped the researcher to contextualise the interviews with the teachers and to create meanings as the data were collected and initially analysed. The information in these memos was also used to construct future questions to the same interviewee or another interviewee and identify areas requiring additional information. The researcher offered feedback to participants by sharing information and observations from the study (Brand & Glasson, 2004).

To ensure that the research was fairly conducted and that the conclusions closely resembled participants' experiences, strategies substantiating trustworthiness were used. Among these strategies, data were triangulated from different sources including the audiotaped interviews, informal discussions, and field notes from classroom observations. Teachers were provided with frequent opportunities to clarify and elaborate on information provided. Data were also periodically shared and discussed with a peer debriefer to identify and question conflicting evidence and opinions. In addition, the transcripts and data analysis were reviewed several times for inconsistencies in the findings. Credibility of the data analysis was produced by outlining narratives and reflective notes representative of the participants' accounts that address the research questions.

Data analysis:

The interviews were transcribed and then studied for patterns. Data were analysed to provide meaning and interpretation of science teachers' views of scientific enquiry and their responses to the students' diversity. Interview data were coded and organised into categories to develop emerging themes. Categories were taken mainly from the transcribed interviews. Links were identified between the categories and used to establish themes. Nvivo was used to code the data. Codes emerged from a first reading of the interviews, and they were then compared across interviews, with similarities and differences noted. Pattern coding (Miles & Huberman, 1984) was used to identify emergent themes. Data were taken through a second reading, and from this reading, a scheme for coding the data was developed, beginning with the first interview. For example, M's (a secondary teacher) discussion of exploring the students' belief and views was coded as an example of 'explanatory mechanism''. All other accounts of early experiences with diversity that were shared by participants were coded accordingly. Table 2 exemplifies the first stage of the analysis and outlines how the theoretical coding of 'teachers' views of scientific enquiry, scientific evidence, diversity and dialogic pedagogy' emerged from the data. The initial process of data analysis was done inductively by using an incident-to-incident coding technique (Charmaz, 2006). (See some examples of the open coding in Table 2).

The second process of the data analysis was building categorical structures (an axial coding), in which categories were combined into theoretical statements. In this stage, a 'cross-case analysis' using the constant comparative technique (Miles & Huberman, 1994) of each participant's interviews was used to identify characteristics of teachers' views of scientific enquiry and diversity in relation to their pedagogical practices. In this stage, the data analysis focused on understanding how the categories related to each other, as well as on defining the direction of the relationship from one category to other. In comparing and linking the categories with one another, the researcher was guided by what Glaser called 'the Six Cs: Causes, Contexts, Contingencies, Consequences, Covariances, and Conditions' (1978: 74). For example, what are teachers' views and understanding of the 'evidence' in scientific enquiry? What are the relationships between teachers' views of diversity and views of scientific enquiry in relation to the dialogic pedagogy? What are the contexts of these relationships? To explain the contextual settings of teacher beliefs and practices, a socio-pragmatic approach was adopted, based on the 'action paradigm model' defined by Strauss and Corbin (1998). They used several generic notions related to action explanations, such as causal and intervening conditions, context, action/interactional strategies, and consequences. Pettigrew (1989) claimed that this approach provides an opportunity for examining continuous processes in context, in order to draw out the significance of various levels of analysis and thereby reveal the multiple sources of loops of causation and connectivity; crucial to identifying and explaining patterns in the process of change. The coding revealed that teachers' views and practices about diversity were influenced by their views of scientific enquiry, scientific evidence, the science curricula, their roles in the science classroom, and teaching and learning science (see 'building categorical structures' in Table 2).

Table 2
Examples of the codes and themes

Inductive coding 'Open coding'	**Conceptual refinement**	**Building categorical structures 'Axial coding'**	**Theoretical Themes**
science-based evidence	Teachers' understanding of how science is constructed	Epistemological views of science	**Theme one: Teachers' views of constructing science**
Process of science "western approach to science"	Science is looking for evidence		
Changeable science	Scientific evidence and scientific facts are not fixed	Ontological views of science	
What is science?	Science is not about truth, it's about questing for the truth		
Ontological view of evidence	Evidence is open to interpretation and challenge and thus hypothesis change		
Science in the text book	Teachers reflect on the science curriculum		
key concepts of science	Teachers reflect that science should be taught in the classroom regardless the students' background or diversity.	Teaching science regardless the cultural differences	**Theme two: Teachers' views of diversity and cultural beliefs**
a range of backgrounds and religious	Teacher emphasis that students should achieve high knowledge and skills regardless of their backgrounds or diversity		
Dismissing the differences	Teacher reflect that science should not be taught in a rigid way and it needs to be flexible to accommodate all the learning styles, but that's got nothing to do with their backgrounds		
	Diversity wouldn't change the lesson plans depending on the ethnic mix		
learning outcomes of the science	Teaching plans are to achieve these aims but not to accommodate or consider the diversity of students		
science is looking for evidence	using dialogic pedagogical techniques that allow students to express their views but without engaging with students in a dialogue about their personal-cultural views	Teachers' roles in teaching socioscientific issues	
socioscientific issues	Topics like genetics, stem cell research and cloning		
EAL in the classroom	language can be a barrier for accessing science	Language diversity	
	Teachers reflect that no change for the lessons at all depending on the ethnic mix		
Gender	they should be equally valid to both sexes	Gender differences	
the science content	science content that they need to teach act as constraints to cater for diversity	Curriculum as a container school science but not for the diversity	**Theme three: Curriculum as a container for school science but not for the diversity**

Purpose of science education	Teachers reflect on the purpose of science education driven by the science curricula and school science		
size of the syllabi			
Science education to help exams			
Teacher's role in learning			
Science education is to get information			
Exams are drivers for success			
Teaching how science works	National curricula is to definitely cater for academic to be specialised on science	Curriculum as a diver or a context for the dialogic pedagogy and evidence pedagogy	
teacher is to communicate the information	Understanding that the way that evidence		
Teacher's role in argument	Science curriculum as a driver for pedagogy		
Dismiss diversity	Pedagogy is not to orientate it to cater for one specific cultural and religious	Dialogic mechanisms to avoid conflicts with cultural beliefs	**Theme four: Dialogic mechanisms to avoid conflicts with cultural beliefs**
Students' voice	Teachers use dialogic approaches when teaching socioscientific issues to help the students voicing their own opinions	Scaffolding-Dialogic mechanism for a student voice	
Awareness	Mechanism to help them knowing their students' background and reveal their personal or cultural underpinning	Exploratory-dialogic mechanism	
Students' cultural beliefs	Teachers' exploration of the students' beliefs and ideas		
Students' personal ideas	Teachers to communicate the scientists ideas		
	Teachers are to avoid contradiction with the students' cultural-religious beliefs	No judgmental dialogic mechanism	
inquiry-based learning	Inquiry-based learning in the classroom to help students looking for the scientific evidence regardless the personal feelings	Scientific-evidence based mechanism as an authoritative-dialogic tool	
scientifically found evidence	Teachers view the inquiry-based learning and scientific evidence together as an agent to handle the cultural diversity among the students		
Authoritative dialogue	Evidence to come to these type of conclusions		

Theory diagrams were used to present the relationship between the main themes and sub-themes (see Figure 2). These diagrams can be seen as models of the focused issue and its action context (Axelsson & Goldkuhl, 2004). In the theory diagrams, different labels indicate the role of each category within the action chain, such as 'precondition' or 'action'. These labels were derived from the action-oriented model. In this way, the theory diagram gives a more distinctive picture of the preconditions, actions, results and effects associated with its action focus (Axelsson & Goldkuhl, 2004).

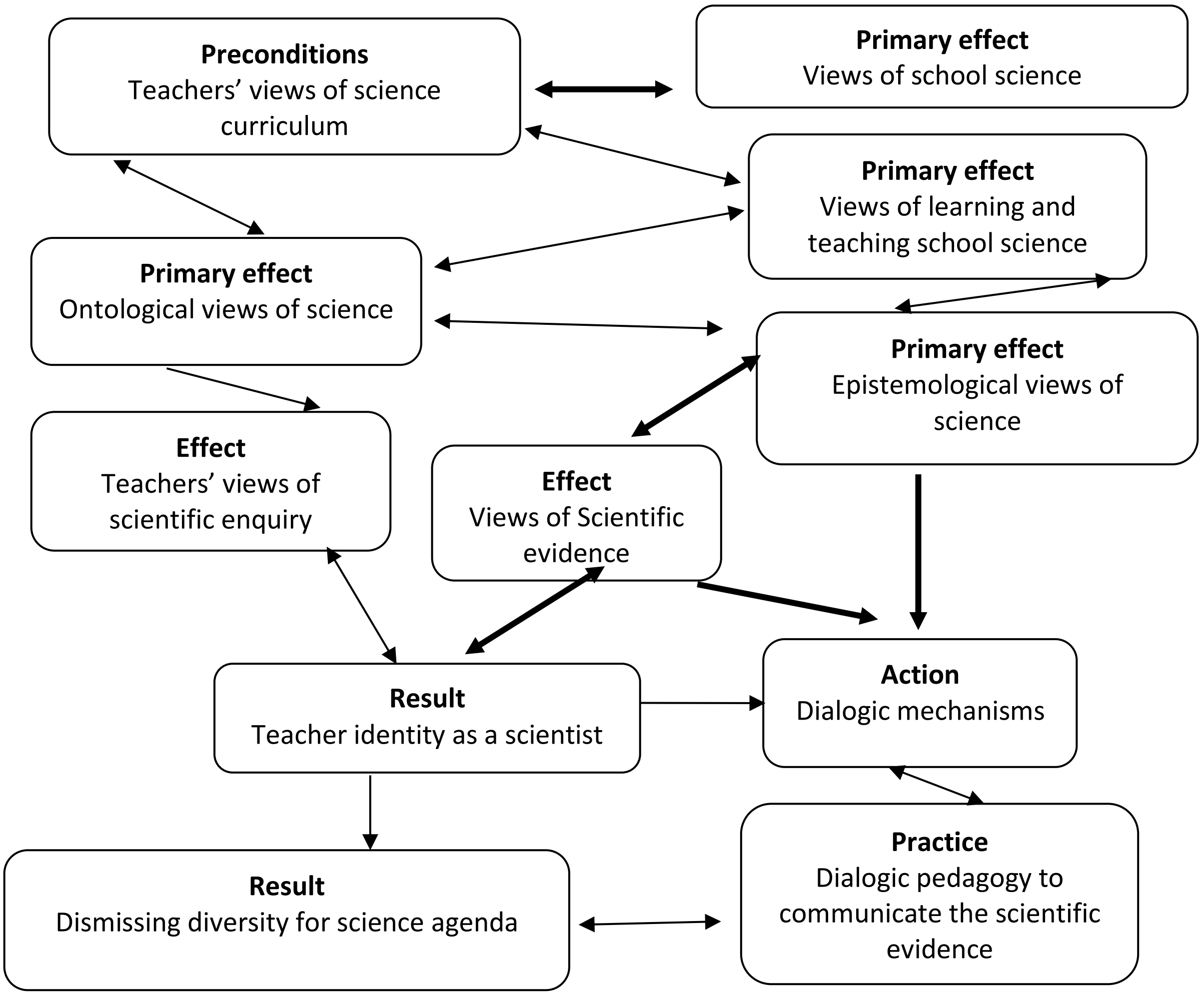

Figure 1. ***A 'Theory diagram' illustrating the sequence of the categories that emerged in the study***

Findings:

As shown in Figure 2 and Table 2, analysis of the teachers' interviews indicated that four main themes emerged from the data. These were: teachers' views of constructing science; teachers' views of diversity; curriculum as a driver or a context for the dialogic pedagogy and evidence pedagogy; and dialogic mechanisms to avoid conflicts with cultural beliefs.

The analysis also showed that on the whole, teachers' use of dialogic pedagogy was manipulated by their use of the evidence pedagogy to teach school science through enquiry.

The themes show how the teachers' views and practices of dialogic pedagogy were influenced by their views of scientific evidence and school science. Figure 2 shows the inter-relationships between the four main themes of the study. It explains that the key teachers' role in the classroom as science teachers is to teach science through 'evidence pedagogy' or scientific inquiry as it is required in the national curricula or school science and as the students will examine it. When teachers in this study teach socio-scientific issues such as evolution, they manage the students' cultural diversity through using dialogic pedagogical techniques/mechanisms that allow students to speak up and express their views, but without engaging with students in a dialogue about the personal-cultural views: mainly they use the dialogic pedagogy and evidence pedagogy to communicate what they want students to know, and for them to consider and discuss the evidence introduced by the curriculum.

The evidence for the four main themes, as presented in Figure 2, are illustrated by examples of the verbatim quotations from the transcripts which are set out below. Mainly, the selected quotations are representative of the teachers' responses for each particular theme or sub-theme.

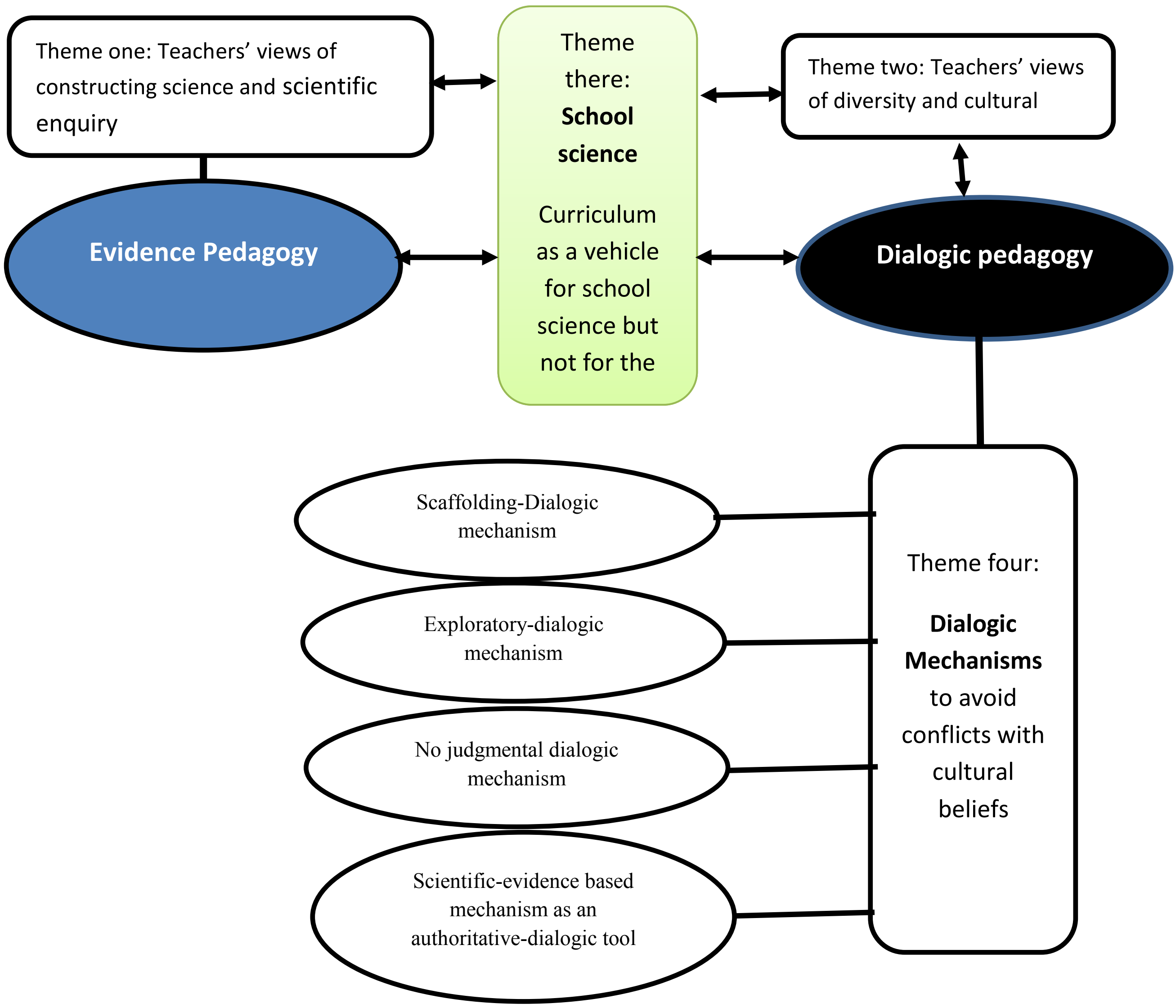

Figure 2: Interplay between teachers' views of the scientific evidence, diversity and dialogic pedagogy

Theme one: Teachers' views of constructing science

All the teachers in this study stressed through the interviews the importance of scientific evidence, to help students understand science or construct scientific knowledge. They explained how scientific inquiry is used in the classroom to support students' science learning. This theme looks at teachers' views of constructing science from the epistemological and ontological perspectives.

Epistemological views of scientific enquiry: 'scientific evidence'. From an epistemological perspective, all primary and secondary teachers in this study argued that science is predominantly what could be perceived as being a Western approach to science. It is simply about gathering data, assessing data, making sure that the data can be corroborated, and then drawing conclusions. They argue that the conclusions they teach their students are the conclusions that scientists have drawn through scientific experiments, and that any other alternative conclusions are less scientifically valid. For example, Teacher D's views of the relationship between scientific inquiry and collecting acceptable evidence is similar to the other 16 teachers' arguments. He used the phrase 'god of the gaps' to refer to the other knowledge and beliefs that are not explained by science but that students may bring to the classroom. He is presenting and arguing that scientific inquiry within the context of pedagogical discourse can become a persuasive communicative tool designed to guide these students to understand scientific phenomena, and that the scientific-based approach is the only acceptable way to gain knowledge. His quote is representative of the other 16 teachers' views:

Science is looking for evidence so that you can see something that is repeatable. And particularly the way that I would often put it would be that if you don't know something and if science doesn't know something then not just to fill in the gaps: that is essentially make-believe. You know, that's not to belittle people's beliefs, I suppose it's the 'god of the gaps' theory that they talk about, isn't it? But just that a scientific way of looking at things is to accept that we don't know everything, and even the things that we do know may change in the future, but don't just make up random ideas. (Teacher D)

Teacher S agrees with Teacher D and also represents the other teachers' responses about the importance of the science-based evidence but argues that the scientific inquiry within the context of pedagogical discourse can make use of other non-scientific theories which have enough evidence and can match the scientific evidence.

I am happy to say, for example, creationist views to be expressed, in fact I would express them myself, however what we are teaching is the theory [of evolution]and that theory is always taught, and then you have to accommodate other ideas around it. As long as you are always accessing the evidence and it's evidence-based then you are OK. (Teacher S)

Ontological views of scientific evidence.

From an ontological perspective, all teachers in the study argued that scientific evidence and scientific facts are not fixed, but are something that is as true as it can be understood now through evidence-based techniques. They expressed their awareness of their students' ontological views of science: that students tend to think that science is about facts which are known and, in some way, have always been known and always will be known and are absolutely known. Teachers expressed how they push the notion that science is not about truths, but is about questing for the truth, and what they do to challenge students' ideas and misconceptions. Teacher E expresses the 16 teachers' responses and practices:

We get them to understand that there is not truth, there is just our best understanding based on the evidence we have, and then that evidence is open to interpretation and challenge, and thus hypotheses change, etc. That way would always be my preferred approach. Then I would like to think it fleshes it out and makes it more human; whether it does I don't know. (Teacher E)

All teachers expressed that one of their significant roles when teaching science is to teach the student that the evidence is unbiased and unprejudiced. They teach the students how to collect scientific evidence and work as scientists. Teachers emphasised that students could have quite a lot more confidence in what they're told from scientists, compared with many other people who are pushing ideas in their direction or trying to sell them things or telling them a certain way that reality is. One of the representative quotes for teachers' views and practices about scientific evidence is teacher F's quote:

I would hope that a child would understand first of all that science is always about looking at evidence, and also have an understanding that the way that evidence is collected cannot always be impartial, but people do make their best effort to make sure it is, and the results, when they're collected, are judged by other scientists, by what we call peer review. (Teacher F).

Theme two: Teachers' views of diversity and cultural beliefs

This theme explains how teachers view and respond to the students' cultural diversity and how they view their own roles when they teach students different in such as gender, religion and language. Primary and secondary teachers emphasise that students should achieve broad knowledge and skills regardless of their backgrounds or cultural diversity. This theme discusses mainly teachers' views of students' cultural diversity through four sub-themes: teaching science regardless of the cultural differences, gender differences and language diversity; and teachers' roles in teaching socio-scientific issues.

Teaching science with regard to, or regardless of, the cultural differences. Four of the seven primary teachers and six of the nine secondary teachers said that science should be taught in the classroom with regard to the students' cultural background or diversity. These teachers believe that science should be taught using different strategies to accommodate the differences among the students to teach them the key concepts of science. Teacher B is one of the secondary teachers who represents this view of teaching science with regard to the cultural differences among the students:

When provided with a very diverse range of backgrounds and religious views and beliefs to teach to, then I would have to be a bit more flexible and accommodate that, of course. But essentially I tend to believe that science should be taught in a, not in a rigid way; it needs to be flexible to accommodate all the learning styles, but that's got nothing to do with their backgrounds. The objective for each pupil should be the same, 'cause it should be 'objective'. (Teacher B)

Teacher M is one of the primary teachers who agrees with teacher B on the importance of helping the students to achieve the learning outcomes of the science curriculum and adjusts their teaching plans to achieve these aims, but does not accommodate or consider the diversity of students. Teacher M says:

I actually don't see any particular differences there at all. I wouldn't adjust my teaching on the basis at all of ethnic background, you adjust your teaching on the basis of understanding, performance and so on. I wouldn't change my lesson at all depending on the ethnic mix… whoever you are teaching just make it fun, make it interesting, make it alive. I don't think it matters what background they are from, if it's boring they get turned off. (Teacher M)

Gender differences. All primary and secondary teachers in this study believe that there are differences in boys' and girls' preferences of science learning and science disciplines. Teacher H believes that girls and boys have different preferences in science:

I think with girls they seem to connect with Biology a lot more because it's sort of like how things work and they can see when things are happening, whereas with boys they tend to prefer the Chemistry and the Physics, and it just seems to me that they find the Biology boring, and maybe it could be that Biology is not challenging enough for them. And how they process information in Physics, they might process it or enjoy it even more that girls do. (Teacher H)

But all teachers believe that both girls and boys should have the same opportunities to learn all sciences. One teacher says:

I try and link what we're learning to experiences that differentiate that link for boys and girls, but in terms of the activities and the objectives, I tend to think that they should be equally valid to both sexes; I don't think science should be discriminatory. (B).

But all the teachers agree that there is no need to make changes to the teaching method based on gender. An example of these views is expressed by teacher B. She said:

I don't see that there are necessarily differences in my teaching or why I should differentiate my teaching for girls and boys. Maybe the only topic that I would maybe, maybe do differently for girls and boys might be if it was to do with reproductive physiology. Obviously girls are probably going to be slightly more interested in female and male – male, things like that, or if I'm teaching sexual reproduction maybe I will approach it in different ways depending on the maturity of some of the individuals in the group. That's probably the only thing I would really change for girls and boys. (Teacher B)

Language diversity. Two of the seven primary teachers and four of the nine secondary teachers expressed that student diversity is mainly about English as an additional Language EAL. For example, Teacher A had experience working in a school located in an Asian community and found that language could be a barrier for accessing science.

I worked in [name of the school was deleted] which is a very different place to where we are now and it's a large Asian community there, and we're talking Indian, Pakistani, Bangladesh, that sort of area of the world if you like. And I think within – it would be difficult to say that this particular culture fits this… I don't think that's the way it works, I think within those students there were students who found the learning first of all very, very difficult because of language barriers, but then there were also very well-motivated students who just chewed the work up and, you know, were really racing ahead and doing very, very well. (Teacher A)

Theme three: Curriculum as a vehicle for school science but not for the diversity. All the primary and secondary teachers in this study expressed that due to the nature of the science curriculum and that they are expected to deliver on results and national curriculum levels, the students have to meet the demands of the curriculum and understand the scientific phenomena as it features in the curriculum, to be able to pass the exams. One teacher says:

I respect their view-point, I would respect what their religious beliefs are, however I would encourage them to just be aware that there are scientific phenomena as well and this is something that they should know in fact, because it's in the curriculum. (Teacher T)

Five of the seven primary teachers and seven of the nine secondary teachers expressed that the size of the syllabi and the science content that they need to teach act as constraints to catering for diversity. They argued that teaching how science works from observation to conclusion does not leave space for divergent perspectives of science or different ways of developing science. One teacher said:

There is a lot of content and sometimes, particularly with the move towards how science works, sometimes it's difficult to fit [in] the sort of 'how science works' and good science practice and the relevant content that pupils need: it's difficult to get both of those in to science lessons, particularly at key stage four; there's still a little bit at key stage three. And I can see why that's not easy though because there is an awful lot of science content that is still important, and there's a certain amount that you cannot dispense with if pupils are … to understand the way key principles work. So it's trying to sort of distil and find the fundamental aspects that they need, whilst also being able to teach them about scientific process. (Teacher D)

Another teacher emphasised that a key aim of the national curricula is to definitely cater for academics to be specialised on science; but that a national curriculum-style model leads to lack of engagement with science. He said:

We have, in the science department there's the GCSE, we have the vocational OCR national, we have applied science, we have core and additional science for the more academic pupils, and we also have the choice of doing separate science. And you can't have a course for every single pupil, but I think with those range of courses we definitely cater for academics who are very keen on science, academics who have chosen not to opt for extra science, applied and vocational pupils. My concern is that the future could well see us moving back towards a national curriculum-style model with all the lack of engagement and the feelings of failure that we desperately tried to avoid. (Teacher M)

Theme four: Dialogic mechanisms to avoid conflicting with cultural beliefs

Teachers were asked in the interviews to respond to this question: If a pupil said to you that what you taught in your science class was contradictory to what their religious leaders taught them, how would you respond? Teachers expressed that they tried different mechanisms to cope with the students' diverse views. However, all the different pedagogical approaches that participants mentioned play a key role to maintain the scientific approach and marginalise the students' cultural differences and beliefs. The findings reported four teacher-led dialogic mechanisms: a scaffolding-dialogic mechanism, exploratory mechanism, non-judgmental mechanism, and scientific-based mechanism.

Scaffolding-Dialogic mechanism for a student voice. Five of the seven primary teachers and seven of the nine secondary teachers use dialogic approaches when teaching socio-scientific issues, to help the students voice their own opinions and teach them how to argue or debate. An example of the 12 teachers, teacher C elaborated that there are particular scientific issues that can inspire students to argue and create a dialogue among themselves by expressing agreement and disagreement about these issues. She said:

Topics like genetics, stem cell research and cloning are very good to stimulate the students voicing their own opinions. They quite often will voice their own opinions and say, 'I don't think that's right, Miss, that's really mean,' or, and you try and say, 'OK, look at it from this point of view,' and if they still hold that opinion then I'm not going to go 'You're wrong'. It's interesting and it's really good to get a debate going because quite often you will get two pupils, like, come together and be like, 'I don't think that's right', but also it's quite, they don't yet quite know how to argue a point, they just think they talk the other person down, so they're not quite there yet. (Teacher C)

Exploratory-dialogic mechanism. All of the teachers use this mechanism to help them know their students' background and reveal the personal or cultural underpinning of their voice or view. These mechanisms help teachers to structure the dialogic approach they use with their students. For example, Teacher G explained what kinds of cultural background he will get from his students and how he will use these details to explain how the scientific theories were developed and how scientists develop science:

I would probably ask a little bit about what their religious leaders do teach them and where they're coming from with those beliefs and those ideas, and then I'd sort of go on to discuss a little bit like what we've said before, the idea of what science theories are, how scientists and scientific communities arrive at them, and how science is a global phenomenon where information is shared across the globe and that scientists of all sorts of cultures, beliefs, backgrounds will actually agree with theories or disagree, but if they disagree then they're looking for evidence to counter or contradict those theories. (Teacher G).

*Non-judgmental dialogic mechanism***.** Equally, teachers emphasised the importance of avoiding contradiction with the students' cultural-religious beliefs. They use a non-judgmental approach toward all students with different religious beliefs.

Teacher (S) emphasised that she will not challenge the students' religious beliefs but she will help them considering the others' points of view. She said:

I would just say right okay fine, your religion is your religion and I am not here to impede upon it in any way, but I think on my part I would just ask them to at least just acknowledge that this idea does exist and just be aware of the idea behind it, and you may not agree with it and that is fine, that's down to you, keep it separate from that. (Teacher S)

Scientific evidence-based mechanism as an authoritative-dialogic tool. All the teachers use scientific-based evidence to avoid conflicts with cultural beliefs. They made their point clear, that diversity does not count when they teach science and all groups and beliefs need to be put aside when learning science as science does not differentiate between groups. Teachers are using inquiry-based learning in the classroom to help students look for scientific evidence, regardless of personal feelings, cultural interpretation or preconceptions. Teachers view inquiry-based learning and scientific evidence together as an agent to handle cultural diversity among the students and to mediate any cultural differences; not to respond to these cultural differences but in a way to make the science voice as a mediated agency that can be a language that all the students can use in the classroom. For example, Teacher K said:

I strongly feel that science is quite well-defined, as responding to scientifically found evidence, and therefore communicating what science is [is] just as important as answering the questions. So to take away offensiveness from a cultural background, you say, 'Well science is based on this type of evidence, therefore we come to these conclusions, and therefore as a science teacher I'm teaching you how to use this type of evidence to come to these type of conclusions. It's, you know, it doesn't step on the toes really of a conclusion you've come to in different ways, unless the two conclusions are completely contradictory, in which case you have to decide for yourself which, what evidence you're using to come to that conclusion, but this is what science is and this is what we're teaching as scientists. (Teacher K)

Discussion and implications

Interplay between teachers' epistemological view of science and diversity

All the 16 teachers in this study view science as a product of a systematic process using only evidence-based techniques (Bell & Schwartz, 2002; Lederman, Abd-El-Khalick, Osborne, 2014; Saribas, Ceyhan, & Lombardi, 2019). This process starts from a simple observation with an objective in mind, that leads to gathering data, assessing data, making sure that the data can be corroborated, and then drawing conclusions (Goldman & Dominici, 2019; Windschitl, Thompson, & Braaten, 2008). In this respect, Popper (1963) noted, 'the belief that science proceeds from observation to theory is still so widely and so firmly held that my denial of it is often met with incredulity' (p. 46). In this study, the position of teachers' views of science and the production of science can be explained by Lederman et al. (2002) as a 'naïve' view, associated with ignorance of the social and cultural embeddedness of science.

In line with teachers' views of science and the scientific evidence, all the teachers in this study believe that their role is not to challenge students' cultural diversity that conflicts with the scientific claims or evidence (Author, 2011; Levinson, 2006). They made it very clear that their responsibility as science teachers is to teach science as it is documented and required in the national curriculum and as the students will examine it (Author, 2010a; Jenkins, 2000). Teachers limited or filtered out their management of students' cultural diversity through using dialogic pedagogical techniques that allow students to express their views in a way that does not influence their learning of school science. This leads to a tendency to ignore the cultural diversity present in schools, or to manage it from an interventionist and non-preventive standpoint (Coronel, & Gómez-Hurtado, 2015; Stanley & Brickhouse, 1994, 2001). In this sense, the teachers' pedagogical beliefs and practices were managed and filtered through teachers' own views of science and diversity (Author, 2008, 2013; Bang & Medin, 2010; Biesta, Priestley, & Robinson, 2015; Hachfeld, Hahn, Schroeder, Anders, Kunter, 2015; Gutentag, Horenczyk, Tatar, 2018).

Interplay between teachers' views of the scientific evidence, diversity and dialogic pedagogy

As shown in Figure 2, the results of this study strongly argue that there is interplay between teachers' epistemological and ontological views of science and their pedagogical beliefs. In many cases of the teachers participating in this study, their epistemological and ontological views of science alongside their views of diversity influenced their teaching strategies in class (Bianchini & Solomon, 2003; Hamilton, 2018; Kang, & Wallace, 2005). As shown in the findings and in Figure Two, teachers used evidence pedagogy through the dialogic pedagogy to act as mechanisms to avoid confronting and dealing with diversity or the diverse students' concerns (Bang & Medin, 2010). They used the same approach to argue that there is one science and one way to understand this science. In this way, teachers used the scientific evidence as an authoritative tool to reach a universal truth that students should not dispute using non-science approaches (McNeill & Berland, 2017). This shows that teachers use a legitimate scientific discourse to dismiss the students' cultural discourse (McNeill & Berland, 2017; Warren, Ballenger, Ogonowski, Rosebery, & Hudicourt-Barnes, 2001).

Curriculum as a driver for school science but not for diversity

The findings show that teachers' practices in the science classroom are driven by the science curriculum (see Figure 2). Teachers expressed that some of the content is totally irrelevant to the students' future careers but they are learning it because they have been made to study it, and they must cover the content because the exam requires it (Ametller & Ryder, 2015; Osborne & Collins, 2001; Roblin, et al., 2018). In this sense, the findings of this study can be explained by Leeman and Ledoux (2005), that teachers develop intercultural practices in their classrooms to respond to the dilemmas they are confronted with. They do their work in a political context that does not celebrate multiculturality and in schools that operate in an educational marketplace where results in the basic skills count but ignore the dominant discourse of cultural difference.

Teachers in this study argue that the curriculum demands only for teaching of scientific processes, 'how science works', using 'evidence pedagogy', and how science has developed robustly through these scientific processes: observation, measurements, interoperations and conclusions (Rudolph, 2000; Ryder, Banner, & Homer, 2014; Singer, Marx, Krajcik, & Chambers, 2000). The result is often a fact-oriented science which appears decontextualised, objective, rational, and mechanistic (Singer et al., 2000, p. 875). A response to these teachers is Abd-El-Khalick's (2012) argument that the stereotype of scientific practice can be countered very effectively with a balanced selection of ideas from the sociologists and anthropologists of science and still ensure that science is recognised as a rational, robust, and extraordinarily productive enterprise.

Teachers' use of the dialogic pedagogy for the school science agenda but not for the diversity agenda

The findings indicate that there is a reliance on dialogic teaching strategies to teach for the science agenda but not for the diversity agenda (Lee, 2005). Although these models of effective instruction can contribute much to our understanding of minority students, it is not possible to create a model of the good teacher without taking issues of culture and context into account (Author, 2013; Garibaldi, 1992; Gay, 2002; Hachfeld, et al., 2015; Karousiou, et al., 2019; Zeichner, 1992;). In this sense, the study findings suggest that without directing greater attention to students' actual experiences and cultural views in school science and how science may or may not align with students' diverse racial, cultural, and linguistic backgrounds and understandings, these student groups will likely remain underrepresented in the sciences (Bianchini & Solomon, 2003; Meyer, Barbara, Crawford, 2011). As a result, students holding minority cultural views about science may be marginalised by the pedagogical practices of their classrooms (Shah, 2019; Sleeter & Grant, 1999). This may explain the great decline of science for the minority students (Brazziel & Brazziel, 2001).

The findings show that teachers used different dialogic mechanisms (see Figure 2) to avoid confronting students' cultural views of science. They use these mechanisms to teach the Western-science culture regardless of the students' cultural views or voices (Aikenhead, 2001; Cobern, 1996; Fleer, Adams, & Gunstone, 2019). Teachers argue that they use these approaches to help the students understanding science as it is represented and required in the national curriculum (Jenkins, 2000; Ryder et al., 2014). As shown by the quotes and findings, in many cases, the intent seems to be using the scaffolds to help students eventually give up the culture of the home for the dominant culture of the school and of Western-science culture (Baker & Taylor, 1995; Cobern, 1996; Gaskell, 2003). Cummins (1986) refers to this as the 'subtractive approach', where teachers become biased in favour of the school science culture. Cummins argues that the successful integration of students' cultural views and in turn students' academic success is associated with teachers' enactment of a genuine dialogue between the teacher and students. In this sense, it seems that the teachers, by using dialogic approaches to mediate the communication about the students' cultural beliefs in relation to science, have followed an epistemological rather than an ontological approach to dialogue. Epistemological approaches focus on the dialogue as a medium through which legitimate knowledge that is known, defined, pre-contested, and finalised by the authoritative word is presented to the students (Matusov, 2011; Mercer, Dawes, & Kleine Staarman, 2009). Teachers saw the cultural diversity of students as a condition to be fixed and managed rather than something to be celebrated or be used to inform responsive pedagogies. Teachers' key agenda was to help students to learn the school science and achieve the expected grades (Philip et al., 2006; Shah, 2019; Walker, & Sampson, 2013). They do not have a problem with using dialogic teaching to help students' understand the curriculum and use its content to mediate their thinking and dialogue, but the study results indicate that teachers and pedagogy need to genuinely consider students' voices and agency, and work in its favour rather than ignoring it; otherwise students' engagement in the classroom or in continuing to learn science will be negatively impacted (Gutentag, et al., 2018, Brown, Boda, Lemmi, & Monroe, 2018).

Teachers in this study used dialogic pedagogies to help them understand their students' cultural background of science, which in turn helped them to know how to manage and respond to the students' voices in a way to make the students focus on learning the school science and achieve their learning targets (Meyer & Crawford, 2011, 2015). In this sense, teachers use these dialogic pedagogies as a 'bridge' tool or 'scaffold' tool, also called 'teacher-led dialogues' (Abd Elkader, 2014; Scott, Aguiar, Mortimer, 2006; Skidmore, 2006), to find a sensible way to avoid confronting the students' cultural diversity but get them focus on school science. This view of school science, science teaching and science learning constrains the effectiveness these dialogic pedagogies can offer to respond to the students' cultural diversity and use these cultural differences as part of the pedagogy that can help students learn about the nature of science (Alexander, 2004; Brown, Boda, Lemmi, & Monroe, 2018; Richards, 2019). When this incoming cultural view of knowledge and learning is taken into account, the methods the participating teachers used were not limited, but rather their dialogic epistemology minimised their effects by their naïve views of science, dialogue and diversity, which in turn attempted to minimise the effects of student diversity. In this sense, DePalma (2010) argues that when dialogue is used merely as an instrument of instruction rather than an authentic project that seeks students' voices as a legitimate source of knowledge, students' performance falls, in comparison with more teacher-centred practices.

Conclusion

This study brings some clarity to the literature regarding why teachers adopt and implement a particular pedagogy in relation to diversity in their classroom and their views of the science education agenda. The study shows that teachers' views of science and scientific inquiry ('scientific evidence') work as a guide for their use of dialogic pedagogy in the classroom to communicate the science evidence and override the students' cultural differences that may agree or disagree with this evidence (Fleer, Adams, & Gunstone, 2019; McNeill & Berland 2017). Therefore, science teachers need a clear sense of their own views of science and cultural views in order to be able to understand those of their students and to engage with these views and enhance the use of the dialogic pedagogy by integrating these cultural beliefs into the science discourse (Atwater, 1996; Brand & Glasson, 2004; Author, 2013; Sanchez & Valcarcel, 1999; Tobin, et al., 1999).

The study illustrates the importance of taking seriously the ideas and different perspectives that children from diverse communities bring to science and the science classroom (Author, 2013). These different perspectives can be dealt with in the classroom as a creative critical process (Bakhtin, 1981) which can lead to a pedagogy that considers and engages all the students (Darling-Hammond, Flook, Cook-Harvey, Barron, & Osher, 2019). In this sense, the study urges for teacher professional development and pedagogy that considers an inclusive view of science which is tentative, empirically based, subjective (in the sense of being theory-driven), socio-culturally embedded, and dependent on human imagination and creativity (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002; Bianchini, et al., 2002; Cigdemoglu, et al., 2019; Forlin, 2010; Garibaldi, 1992, Gay, 2002, 2010, 2015; Gutentag, et al., 2018).

This study shows that the science curriculum content and pedagogical action are developed considering the ‘uniformity’ of the student body (Banks, 2015; Kaya, Cetin, Yıldırım, 2012). The teachers made their point clear, that cultural beliefs are of no account when these beliefs conflict with the scientific evidence. The educational practice of teachers in the classroom, therefore, consists of adapting their pedagogies using scientific-based evidence as a mediating tool to avoid conflicts with cultural beliefs. Teachers’ involvement in cultural diversity management is far from a reality in the schools taking part in this study; it is not part of their ‘agenda’ (Coronel & Gómez-Hurtado, 2015; McNeill & Berland, 2017; Saribas, Ceyhan, & Lombardi, 2019).

In brief, the issue of diversity is not about groups, but is mainly about the voices of individuals within these groups. One of the most needed items of knowledge and skill seems to be the desire and ability of teachers to learn about their students’ cultural views of science and their interpretations of the science culture, and the ability and motivation to take this knowledge about students into account in their pedagogical practices (Brand & Glasson, 2004; Author, 2010; Karousiou, et al. 2019; Sleeter, 2001; Zeichner, 1992). Understanding the beliefs and views about diversity and science together with teachers’ own cultural beliefs is critical if those in science teacher education are going to develop programmes that have a lasting impact on teachers and the student learning in a diverse classroom (Castro, 2010; Civitillo, Juang, & Schachner, 2018, Gay, 2010, 2015; Santoro, 2015). Ultimately, this could result in a different configuration of Continuing Professional Development CPD programme or different processes that can be drawn upon during the professional development experience (Coronel & Gómez-Hurtado, 2015; Luft & Roehrig, 2007; Sleeter, 2001). This way of thinking about science education and science teacher education leads to a situation in which science knowledge is contextualised and perceived as connected to the learners' cultural beliefs and their lived experiences (Author, 2010, 2011, 2013, 2015; Tobin, Seiler & Smith, 1999) but most importantly, students will become culturally engaged with school science and develop an interest in science (van Griethuijsen, et al.,2015; Roblin, et al., 2018; Sjøberg, & Schreiner, 2005).

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