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The association of classroom interactions, year group and social class

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We investigate differences in the teacher–learner interactions in Reception, Year 2 and Year 4 science and literacy classrooms through three measures: (i) the proportion of open questions asked by the teacher, (ii) the rate of successful responses, and (iii) wait-times. A regression analysis of data from 20 schools and 102 lessons suggests that classrooms in socio-economically disadvantaged areas offer distinctive patterns of interaction, i.e., typically associated with those approximately two years younger in the more affluent school districts. We then closely examine the quality of two contrasting dialogues from reception science classes of schools in poor and affluent areas. We see how teachers' questions can work or fail to work to achieve the expected quality in scientific dialogue, and thus how effective use of open questioning might be indicative of quality. In conclusion, we discuss quality of talk as an explanation of class differences in learning outcomes of schooling.

Introduction

This paper explores the variation in teacher–learner interactions in classrooms in 'poor' and 'affluent' schools as determined by pupils' eligibility to free school meals. The hypothesis backgrounding this exploration is that well known social class differences in learning outcomes (Ball, 1993; Gewirtz *et al.*, 1995; Bourdieu, 1998; Black, 2004; Mongon & Chapman, 2008) might in part be explained by differences in the quality of classroom talk offered in schools in poorer and more affluent areas. This study addresses a key link involved in such a hypothesis, namely the classed variation in the patterns of classroom discourse interaction in primary classrooms.

The research draws on systematic observations of teachers' questioning, wait-times and pupils' responses in 102 classrooms (51 science and 51 literacy) in a diverse sample of 20 schools. Alongside collection of these data, there were interviews and less formal conversations with teaching staff both before and after the lessons to gather their views on what they hoped to achieve and how well this was realised

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during the course of the lesson. This work was inspired by the first author's experiences of engaging with learners in a nursery over a period of four months, when she discovered that very young children do not respond to open questions in the 'rich' way that orthodoxy in science education led her to expect.

We have hitherto shown that 'open' and 'closed' are not always sufficient concepts since they focus rather too much on the internal grammar of the utterance itself, rather than its relation to the previous and other texts (Harris & Williams, 2007). In particular, we showed how an open or a closed question can sometimes be satisfactory and at other times unsatisfactory depending on its 'cohesion' with the preceding discourse, or the phenomenon at hand (Halliday & Hasan, 1976). More importantly, we also found that open questioning can 'work well' from the teacher's perspective with older pupils because the children have the required cultural resources, but we suspected that social class was relevant to this.

In this paper, we address the relationship between age, class and learner-teacher interactions by comparing measures of classroom interaction in schools situated in poorer and more affluent areas. We are, however, aware that classroom interactions are extremely complex phenomena, and that reducing the 'quality of interaction' to a few measures carries risks. There is, however, an (almost) consensual view in the neo-Vygotskian science education literature that teacher-learner interactions can only provide a zone of proximal development for the learner by ensuring the learner's ideas are voiced as well as the science conceptions being taught. Mercer (1995) and Rojas-Drummond (2000) suggest that children's success or failure in the classroom can be explained in part by the quality of these teacher-pupil interactions and also by the artefacts that mediate them. Therefore the significant feature of 'quality of interaction' in the context of whole class science teaching is that the discussion or dialogue should engage: (i) the learners' ideas and concepts relevant to the phenomenon being explained/studied; and (ii) the new ideas/concepts to be learnt. In practice, in group discussions, teachers attempt to achieve this by asking questions: our three measures of classroom interaction for this construct 'quality of interaction' in teacher-learner interactions focus on the strategic qualities of these questions, and the degree to which these questions are regarded as 'successful' from the teachers' point of view.

Theoretical framework

Classroom talk is considered essential in engaging pupils in meaning-making and in developing pupil understandings (Goodman *et al.*, 2003; Mercer & Littleton, 2007). It is also essential for teachers to determine what learners understand, what they misunderstand and what they are actually learning (Barnes, 1976).

Teacher questioning

Teachers use questions for many purposes, in particular we believe that teachers ask open questions either because: (i) they are applying a method they have been told is good; or (ii) they do genuinely want to know what children think about a certain issue,

sometimes because they really think it is important for science teaching to engage with children's everyday conceptions and discourse. Teachers' use of open questioning may therefore seem a crude measure of classroom interaction for meaningful whole class dialogue. However, in a study of pedagogy in English preschools (i.e., for children at least a year younger than those involved in our research), Siraj-Blatchford and Sylva (2004, p. 725) found:

The quality of adult/child interactions in the most effective (excellent) settings in terms of the cognitive outcomes was particularly striking... The adult interventions were most often in the form of open-ended questions that provoke speculation and extend the imagination.

Open questions, however, often hand over a certain amount of 'power' to the learners in that the pupils are invited to influence the subsequent course of the lesson by the responses they provide. This closely relates to Bernstein's (1997) notion of 'strong/weak framing' in his description of pedagogical discourses. According to Bernstein (1997), framing refers in part to the degree of control the teacher and learner each possess over what occurs as part of the pedagogic relationship in the classroom. Therefore, closed questions (and funnelling, see later) that maintain teachers' control may be regarded as indicative of 'strong framing' of interactions because the teacher uses his or her questioning to determine what knowledge will be introduced, in what way and when. Conversely, open questions may indicate 'weak framing'; temporarily handing over responsibility to the pupils for the way their learning unfolds.

In addition, open questioning can also be interpreted as an indication of teachers' *expectations* that their learners can and will engage productively in dialogue, which is arguably an important measure of classroom interaction for meaningful science learning. But then, the capacity of children to respond to open questions is equally as important as their teachers' disposition to allow wait-time since teachers' expectations are emergent phenomena in practice. Previous research by Rowe (1974) and Good and Brophy (1994) reports that wait-time is strongly related to both quality teacher-learner interactions in the classroom and also to teacher expectations.

In order to explore these aspects of classroom interaction, it was deemed necessary to capture the types of teacher questioning, respective children's response types and wait-times of relevant, unanswered questions. In addition, these observations were carried out in both science and literacy lessons, comparing the use of questions in the 'elicitation phase' of the science activity and the 'shared text' element of literacy. This was achieved by using both qualitative and quantitative approaches to the problem. Thus we sought to discover whether open questions were in some sense privileged in the science classroom, as suggested by the UK science education literature (Science Process and Concept Exploration (SPACE) Project, 1990–1998; Newton, 2000; Harlen & Qualter, 2004; Chin, 2006).

Earlier work by Edwards and Mercer (1987) challenges the superiority of open questioning since they believe that recalled factual information gathered from closed questioning may be just as useful in the teaching/learning process. In addition, a 'snappy factual question' maintains pace whereas an open question can

prove to be inappropriately time-consuming for children to answer (Myhill *et al.*, 2005, p. 71).

An enduring feature of the question-and-answer sessions that take place in the primary classroom is that the children may be trying to guess what their teacher is thinking rather than sharing their own ideas with the rest of the class (Holt, 1970). Given the low ratio of teachers to children in many classrooms, Alexander (2008) believes that this game may become quite competitive amongst the children. Nevertheless, far from engaging the children, this process can develop into an ‘uninspiring quiz’ called ‘guess what’s in the teacher’s mind’ (Rojas-Drummond & Mercer, 2003, p. 101).

Enculturation into science

Our perspective on learning is one of ‘enculturation’ into academic practices—this came especially from the literature in science education (see Lemke, 1990; Roth, 2001). We assume a child brings life experiences and practices—from their home and community—into school (Bennett *et al.*, 2002; Myhill *et al.*, 2005); these may be more or less different from those of the school (Sharp *et al.*, 2009); and teachers’ questioning plays a prominent role in gaining access to the children’s perspectives, what they already know, and therefore what they can learn (Ausubel, 1968). This process needs skilled teachers as Barnes *et al.* (1990) explain, ‘the pedagogical problem in a room full of pupils is how to enable all of them to bring to mind relevant knowledge and understanding and to “recode” it in terms of the new framework offered by the teacher’ (1986, p. 26).

As Vygotsky pointed out, there are conflicts between the scientific conceptions taught in school and the everyday or common sense conceptions of the learner and so, through their schooling, children need to be inducted into ‘playing the game’ of school, e.g., doing and talking science. Since the older children have had more experience of ‘the game’, they may be better equipped to engage in the way teachers prefer, and these engagements may in turn encourage the teacher to ask open questions. Enculturation can therefore be considered the socio-cultural perspective of induction into a community of scientific discourse or, more colloquially, learning to ‘talk science’ (Lemke, 1990; Roth, 2005).

This explanation, however, may be rather simplistic because, as our earlier work revealed, it is not necessarily always the case that younger children are unable to answer teachers’ questions or indeed that older children are able to answer them (Harris & Williams, 2007). We suspected that some of the young children from middle class homes and communities in affluent areas were more enculturated into schooling than some of their older peers in disadvantaged areas. Halliday (1978) discussed a similar phenomenon when he wrote of ‘mismatches’ between the school and the community it serves. From a sociological perspective, teachers might therefore have lower expectations of the children who come to school in poorer areas (Bernstein, 1996) although these preconceptions may prove to be unjustified. Hasan (2000) even asks whether school is actually the best place for some children to appropriate elaborated codes or, as she describes it, ‘decontextualised talk’.

Socio-economic status and cultural capital

Lubienski (2002) found that generally the pedagogy and curriculum of the classroom rewarded the beliefs and discursive skills of the pupils from higher socio-economic status backgrounds. Although Lubienski's (2002) research was into mathematical problem-solving and consequently may not seem to be applicable here, she reported that the pupils from lower socio-economic backgrounds engaged with many of the problems but they 'tended to consider a complex variety of real-world variables in solving the problems' (p. 116). This meant that these pupils sometimes missed the point of the exercise and its more generalised mathematical implications. The pupils from more affluent backgrounds were found to approach each problem from a less individualised viewpoint where mathematical concepts could be used in more widespread contexts.

Bourdieu and Passeron's (1990) perspective on cultural capital may be relevant when examining such learners' disadvantages in school. Bourdieu (1977) offers socio-cultural explanations clarifying why certain groups may be excluded by the educational process: cultural capital may take many forms and can be reflected in knowledge, behaviour and disposition to academic learning generally. All this explains why more privileged groups may be able to utilise the educational system more effectively (Ball, 1993; Gewirtz *et al.*, 1995; Hart & Risley, 1995; Bourdieu, 1998; Lareau, 2003). Looking at this from the perspective of teachers and schools, children from poorer backgrounds may be perceived as a liability as compared with their more affluent peers (Reay & Ball, 1997). This attitude towards family income and status is consistent with Mongon and Chapman's (2008) view that these attributes are 'by far the most significant correlates of success in the school system' (2008, p. 4). This idea is developed further by Black (2004) who explores the communicative exchanges that take place in the classroom between teacher and pupils. She identifies the cultural capital that the children bring with them into school linked with the respective teachers' expectations of their pupils as being responsible for the differences that are evident in the teacher–pupil interactions.

Given this background, our study can be understood as testing the hypothesis that the teacher–learner interaction *itself* may provide a medium of exclusion from enculturation into science in school, and that this may be more acute for children from less affluent backgrounds.

The Bourdieu-sian conceptual framework unifies the two parts of the paper by postulating that 'practice' (classroom practice, especially teacher–learner interactions conditioned by teacher values and expectations) produces and is produced by the structure of the habitus and field, i.e., the distribution and class-related differences in cultural capital (i.e., socio-economic differences in cultural capital/cultural resources) and indeed including misrecognition of these same. This frame leads to quantitative hypotheses (e.g., that teachers are more likely to 'recognise' and encourage through interaction/questioning pupils with the habitus/capital associated with affluence/middle class families and school districts) and to qualitative explorations of interactions which look to cultural resources and capital 'recognised' as valuable by the teacher.

Research questions

In this paper, therefore, we explore the relationship between age, class and learner–teacher interactions by investigating two key research questions:

- (a) What is the relation between teachers' use of, and children's responses to, open questioning in the classroom, and how do the patterns vary (quantitatively) with (i) the year group, (ii) the subject (science or literacy), and (iii) the socio-economic status of the school community (using statistical analysis)?
- (b) How can the cultural capital of the children mediate dialogue and hence help explain the (qualitative) patterns of classroom interaction?

The first question is explored through a quantitative investigation of a survey of classroom interactions which reveals a classed pattern of development of interactions. The second question is explored through the analysis of two contrasting dialogues which offer some insights into how questioning sometimes seems to succeed and sometimes not (from the teachers' perspective) and the significance of children's cultural resources in this.

Quantitative study design

A structured observational record sheet was designed to gather data from whole class observations with six- and seven-year-olds (Year 2) and eight- and nine-year-olds (Year 4) and smaller group observations with three- to five-year-old children (Reception). It should be noted that our aim was to observe the individual teachers teach the two subject areas and not to limit or constrain what they perceived to be best practice by restricting the number of pupils being taught, etc.

The survey was carried out in 20 primary schools in the north west of England and involved 51 teachers during 102 lesson observations, 'paired' for science and literacy activities. These observations generated almost 5000 question-responses categorised according to: 'open'/'closed', 'correctly answered'/'incorrectly answered'/'unanswered'. The questions were classified initially on strictly traditional grammatical grounds. In practice, however, we were aware that an open question might well be interpreted as closed in certain contexts and vice versa. Consequently each question was categorised according to its role in the surrounding discourse. Using digital recordings, inter-rater reliability for the categorisation of the type of question used was 92%; for the children's responses it was 100%.

This survey merely recorded the type of question asked, whether a response was elicited and whether the teacher accepted it as correct or not. 'Unanswered' questions were recorded as such and in this case the 'wait-time', i.e., the time allowed for the child to respond to the question was noted (Rowe, 1974). No wait-times were recorded for answered questions since the lengths of these wait-times were determined by the children rather than by the teacher. Rhetorical questions were ignored.

We operationalised the quantitative study in the following research question:

What is the relationship between (i) the percentage of open questions used by the teacher, (ii) the percentage of acceptable children's responses to such open questions, (iii) the wait-times offered by teachers in appropriate questions, and (a) the year group (Reception, Year 2, and Year 4), (b) the subject taught (science and literacy) and (c) the school's percentage of FSM?

We address these questions by presenting four graphs which use the data collected using the structured observational record sheet during science and literacy lessons in the 20 north west primary schools. These data comprise the percentage of open questions asked and the percentage of open questions answered appropriately. These graphs show values for these 'measures of classroom interaction' as outcome variables versus 'measure for social class' (FSM), for each of science and literacy and for each of the three age groups (Reception, Years 2 and 4).

Findings

We use the proportion of children in the school who are eligible for free school meals (hereafter FSM) as the indicator for the socio-economic status of the school community. This has become the proxy measure of convenience in much school effectiveness and other educational research in the UK because these details are usually easy to find in administrative datasets and are therefore relatively accessible to researchers (Neighbourhood Statistics, Pupil Level Annual School Census, School Census; we used Ofsted, The Poverty Site, The Joseph Rowntree Foundation and data direct from the schools). Although Hobbs and Vignoles (2010) questioned its validity as a proxy for low family income, it is generally considered fit for purpose and remains a widely accepted indicator at this time. The percentage of children eligible for free school meals in our 20 north west schools ranged from 9% to 30% with an overall average of 19%. The average percentage of free school meal eligibility for pupils taking Key Stage 1 SATs in the north west as a whole was 20%, but we are aware the range of FSM over the whole region is much greater.

(i) Open questions asked by the teachers

Figure 1 (below) shows one point for each science class observed, representing the percentage of open questions used (on the vertical axis) plotted against the schools percentage of FSM on the horizontal axis. Note that in several cases the schools have the same FSM value, and there is some missing data in three cases. It also shows the regression lines of the percentage of open questions on the percentage of FSM, for each of the three year groups (hence three regression lines and equations, one per year group; the dotted line showing the confidence interval for the regression for Reception only, the dotted lines for Year 2 and Year 4 are similar in width).

Figure 2 shows the corresponding regressions for literacy. As can be seen, there are two bands in both graphs. The lower band comprises open questions used in the reception classes which shows that open questioning by the teacher is significantly lower than in Years 2 and 4.

Figure 1. Percentage of open questions asked against free school meal eligibility for Reception, Year 2 and Year 4 in science lessons (the dotted lines indicate a 95% confidence interval for Reception)

Figure 2. Graph of 'proportion of open questions asked' versus FSM for Reception, Year 2 and Year 4 in literacy lessons (the dotted lines indicate a 95% confidence interval for the Reception model)

Thus, the difference in percentage eligibility between the highest 'FSM' school and the lowest was 21%. Figure 1 compares the magnitudes of the effect of free school meal differences from the sample with the differences between the average use of open questions in Reception, Year 2 and Year 4. Thus the percentage use of open questions decreases by 18% (from 32% to 14%) in Reception; by 26% (from 60% to 34%) in Year 2; and by 26% (from 67% to 41%) in Year 4 for this 21% increase in eligibility for FSM.

Confidence intervals of 95% have been used to indicate the reliability of the regression model (shown with dotted lines) for Reception. The confidence intervals are relatively small compared with the differences between Reception and Year 2 or Year 4 which suggests that we can have confidence that the gap is significant. The confidence intervals for Years 2 and 4 are of a similar size to those for Reception but have not been included on the graphs for ease of interpretation (the same will apply to each graph).

A similar pattern emerged in literacy although the slopes of the regression lines are more severe in science. Note that the percentage use of open questions here decreases by 15% (from 26% to 11%) in Reception; by 29% (from 66% to 37%) in Year 2; and 18% (from 71% to 53%) in Year 4 for this 21% increase in eligibility for FSM. As with science, the confidence intervals are relatively small compared with the differences in Reception, Year 2 and Year 4, suggesting significance of effects.

In addition, a multiple linear regression model was calculated which imposes a single slope for the three year groups and both subjects of -1.02 , whereas the six models in Figures 1 and 2 allow variations in slope for each year group and subject (actually varying from -0.6 to -1.3).

The multiple linear regression model takes the form:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3}, \text{ where } i = 1 \text{ to } 3.$$

Where Y_i is the dependent variable 'percentage of open questions asked' and X_{i1} to X_{i3} are the independent variables: age (Reception, Year 2 and Year 4), subject (science and literacy) and percentage of free school meals.

This model gives standard error statistics of the order of 0.9% to 1.8% and so differences of 20% (due to FSM), 27% (Reception and Year 2), 6% (Year 2 and Year 4) and even 3.2% (due to science over literacy) are all significant, having reasonable to large effect sizes as well as being statistically significant. Comparing the multiple linear regression model with the previous separate regression analyses (shown in Figures 1 and 2) reveals that it is consistent except that the slopes in the multiple linear regression model are forced to be equal. The diagnostics are also good for this model ($R^2 = 0.9282$).

The effect of the slope (-1.0) of the regression over the range 10% to 30% (for which the model is valid) is therefore to decrease by approximately 20% the proportion of open questions asked, which is comparable in order of magnitude with the difference between Reception and Year 2 (27%) or half the difference Reception and Year 4 (half of 33%, or 16.5%). Thus we conclude that the difference between the most affluent and the least affluent classes in our sample is of the same order as two years' difference in the year group taught.

(ii) Open questions answered appropriately by pupils

Our second measure of classroom interaction is the children’s proportion of acceptable answers to open questions, by which we mean acceptable to the teacher, i.e., no indication (either facial expression or comment from the teacher) that the children’s response is incorrect/inappropriate in any way. Therefore, the next two graphs show regression models of children’s ability to answer open questions successfully on FSM eligibility for each of the three age groups in science (Figure 3) and literacy (Figure 4).

Figure 3 compares the magnitudes of the effect of FSM differences from the sample with the differences between the average for appropriately answered open questions in Reception, Year 2 and Year 4. Thus the average successful response to open questions decreases by 26% (from 69% to 43%) in Reception; by 43% (from 81% to 38%) in Year 2; and 19% (from 84% to 65%) in Year 4 for this 21% increase in eligibility for FSM.

Confidence intervals of 95% have been used again for Reception but those for Years 2 and 4 have not been included on the graphs for clarity.

A similar pattern emerged in literacy but this time the slopes for literacy are higher than in science in Year 2 and Year 4, suggesting an interaction effect of age and subject. In the survey, the difference in percentage eligibility between the highest ‘FSM’ school and the lowest was 21%. Therefore, using Figure 4 to compare the

Figure 3. Percentage of appropriately answered open questions versus percentage of FSM for Reception, Year 2 and Year 4 in science lessons (the dotted lines indicate a 95% confidence interval for Reception)

Figure 4. Percentage of appropriately answered open questions versus percentage of FSM for Reception, Year 2 and Year 4 in literacy lessons (the dotted lines indicate a 95% confidence interval for Reception)

magnitudes of the effect of FSM differences from the sample with the differences between the average use of open questions in Reception, Year 2 and Year 4 gives: the percentage use of open questions decreases by 42% (from 75% to 33%) in Reception; by 37% (from 79% to 42%) in Year 2; and 36% (from 92% to 56%) in Year 4 for this 21% increase in eligibility for FSM.

As with science, confidence intervals of 95% were calculated for all three age groups but, as before, the confidence intervals for Years 2 and 4 have not been included on the graphs for clarity.

Also, as for the percentage of open questions asked by the teachers, a multiple linear regression model was generated. The standard error statistics are slightly larger than for the open questions asked and of the order of 1.8% to 3.5% and so differences of 20% (due to FSM), 5% (Reception and Year 2) and 13% (Year 2 and Year 4) all have large effect sizes as well as being statistically significant. However, the effect of subject 0.9% (science and literacy) does not appear to be statistically significant in children's ability to answer open questions. The diagnostics are also good for this model ($R^2 = 0.6765$).

As previously stated, the effect of subject (science or literacy) in the multiple linear regression model is not statistically significant when considering children's ability to respond appropriately to open questions. That said, for the Year 2 children, the 0.9% effect of subject may be more educationally significant because there is only 5%

difference between Reception and Year 2 children's ability to answer open questions, i.e., the effect of subject means that there is a 20% improvement in children's ability to answer open questions in science than in literacy.

Considering open questions asked by the teacher, the effect of the slope of the regression over the range 10% to 30% is approximately 40% in the proportion of open questions answered in a way that was acceptable to the teacher. This is comparable with twice the difference between Reception and Year 4 (18%). Therefore the difference between the most affluent and the least affluent communities in our sample may also be of the order of more than four years' difference in the year taught when considering children's ability to respond appropriately to an open question. It seems then that this effect is even more marked than the use of open questions: the successful responses to open questions being even more affected by FSM than the teachers' practice of asking them. The statistics do not necessarily reveal a causative relation between these two, of course; but the significance of these statistics does raise the question of causality, whether it be teacher expectations, enculturation into a middle class encoding, learners' habitus, or emergent from a vicious cycle of all these.

The fact that the social class differences between 'teacher questioning' (approximately two years) is significantly less than that for 'successful responses' (approximately four years) is disturbing, as it may be consistent with a vicious circle of inequality. Differences between science and literacy too suggest that slightly more open questions (3%) in science are associated with slightly more successful responses than in literacy (1%) albeit these are barely significant.

(iii) Wait-time

Our third measure of classroom interaction is 'wait-time' which is widely believed to be strongly related to quality interactions and also to teacher expectations (Rowe, 1974; Good & Brophy, 1994). We report the findings for the unanswered questions only, in the same science and literacy classes, across the three age groups (see Table 1). (N.B. these data were extracted post hoc from lesson recordings, and were not collected on the original observation schedule, allowing for reliable times accurate to approx 0.5 seconds.) The purpose of this part of the study was to ascertain whether teachers would wait longer for a pupil to respond to an open question than a closed question. It was therefore necessary to work with only the wait-times for unanswered questions, i.e., the wait-time before the teacher moved on to someone else, rephrased the question or answered it himself/herself.

In both science and literacy and across the three age groups, the teachers in the schools with fewer children eligible for FSM were prepared to wait longer for responses to open questions from their pupils. We interpret this as informing the link between teacher expectation and quality of interaction which was identified by Thrupp (1998). He reported that the 'social-mix' effect in a school is very closely related to its culture of success or failure and also that the socio-economic status of the pupils influences teacher expectations, pedagogical practices and ultimately the quality of teacher-pupil interactions.

Table 1. Unanswered open and closed questions in science and literacy

Subject (task)	Year group (total number of questions asked)	Open questions			Closed questions		
		Number of questions asked	Number of unanswered questions	Percentage unanswered	Number of questions asked	Number of unanswered questions	Percentage unanswered
Science (<i>elicitation</i>)	Reception (N = 822)	197	49	25	625	33	<1
	Year 2 (N = 905)	462	87	19	443	8	<1
	Year 4 (N = 886)	496	78	16	390	17	<1
Literacy (<i>shared text</i>)	Reception (N = 674)	121	36	30	553	30	<1
	Year 2 (N = 835)	401	89	22	434	4	<1
	Year 4 (N = 769)	423	60	14	346	22	<1

Thus, it is clear that the variation due to affluence is particularly significant relative to both year level and subject: a possibly even more disturbing result than those found above in that this measure of classroom interaction is widely thought to reflect teacher beliefs as well as classroom cultures.

Discussion of the findings from the three measures of classroom interaction

To sum up the analysis so far: we have used three measures of classroom interaction to evaluate the quality of classroom interaction. The results provide models which seem to be consistent: the quality of interaction offered is related to the affluence of the school community in ways that might disadvantage learners from poorer communities. For our first two measures of classroom interaction, learners in poorer classrooms are offered a quality of questioning that is typical of classes of the order of two years younger than in the affluent classrooms, and arguably the situation with wait-times is even worse. Concurrently (we do not claim causality) the success rate for such questions in poorer classrooms is even more strongly associated with affluence, suggesting that inequality may actually be growing.

In the next section we look more closely at some interactions in the reception science classrooms, where we feel confident we can interpret the science learning and assess the scientific quality of the dialogues. Our purpose is to deepen our understanding of how questioning might work to provoke quality dialogue, why the apparent 'richness' of children's contributions might vary according to the affluence of their community, and so how the children's responses might be critical in validating the teacher's expectations.

Qualitative study design

In this section we report the findings of our qualitative analyses in which we explore how the cultural capital of the children can mediate dialogue and hence help explain the patterns of classroom interaction.

We achieve this by focusing attention on two dialogues from an affluent and less affluent school reception class; we feel more confident that children's participation in Reception will be less attributable to the schools' history of enculturation than the older classes. We also are able to choose these two dialogues for analysis as extreme cases of class work on a similar topic, viz. metamorphosis, being taught with the aid of books that are both marketed as an introduction to this area of science for young children. The two dialogues seem to us to illustrate: (i) how open and closed questions can apparently function—or malfunction—in science contexts; (ii) how questioning—even closed questioning—may malfunction (less affluent group); and (iii) how open questioning can be successful when the children appear to have the 'matching' cultural capital that the teacher deems appropriate (more affluent group).

The two transcripts reveal the cultural resources that are brought to bear in making interactions more or less successful. These particular lessons have been chosen because

the activity is almost identical—finding out what the children know by discussing the cover of a book about butterflies. Our hypothesis was that children in disadvantaged areas are likely to produce discourses that the teacher finds less helpful, and in our second extract, ‘The art critics’, the teacher is actually ‘thrown’ by the unexpected nature of the children’s responses to her questions, even though these are mostly closed. Finally, in ‘Crystals and chrysalises’, we have a case where children from a more affluent area respond to open questions by producing the desired cultural knowledge.

The choice of these two ‘science’ reading books is in itself interesting. Dowling (1998) carried out extensive analyses of mathematics textbooks in which he found that texts assigned to ‘lower ability’ pupils related to everyday problems whereas their more able peers were given texts that had a higher percentage of esoteric references. This differentiation enabled the ‘higher ability’ pupils to get to grips with the underlying mathematical principles whereas these were denied to their less able classmates. This selection process is evident in our teachers’ choice of books for the pupils from the two different communities suggesting the teachers’ expectations of their children’s abilities.

In ‘The art critics’, the book selected by the teacher to introduce her lesson about minibeasts is called *Is that a butterfly?* by Claire Llewellyn. On each richly illustrated double page spread there is a sentence that outlines the contents of the page in 20-font and then the lifecycle of the butterfly unfolds via conversations between a snail and a bee about the caterpillar/chrysalis/butterfly in 14-font. The artwork is extremely colourful and there is a ‘lift-the-flap’ activity on every double-page spread which would seem to make it particularly appealing to young children.

Although the pupils in ‘Crystals and chrysalises’ are the same age (rising five-years-old) as those in ‘The art critics’, the book selected is more ‘grown up’ in both the way the subject is approached and the artwork. The book selected by the teacher to introduce her lesson about minibeasts is *From caterpillar to butterfly?* by Deborah Heiligman which is a ‘Let’s-Read-and-Find-Out Science Book’ written for preschool age children. It is richly illustrated on each page but with more naturalistic drawings than in Claire Llewellyn’s book. Even the front cover depicts a realistic butterfly with four wings and no cartooning. It has between 20 and 50 words in 18-font on each double page. The lifecycle of the butterfly is described through the experiences of a group of children whose teacher introduces a jar containing caterpillars into their classroom.

In the extracts, the numbers in round brackets represent the question number and type of question and the numbers in the square brackets represent the pauses or ‘wait-times’ in seconds offered to unanswered questions.

Previous research has identified a variety of teacher devices for encouraging children to arrive at the answer that is already in the teacher’s head. These include a process known as funnelling in which the teacher takes the children through the argument by asking them a series of questions designed to narrow their responses until the correct one emerges (Bauersfeld, 1980) and the most obvious way to do this is to ask closed questions (Brown & Edmonson, 1984). In Bernstein’s terms this use of closed questioning is instantiating a strongly framed discourse, which might be

weakened by open questions that authentically hand some control and agency to the learner. The first example is pertinent.

'The art critics'

This transcript derives from a science activity in the school with the greatest ratio of FSM eligibility of our survey schools (30%) where the teacher asks mainly closed questions yet, despite the fact the closed questions narrow down the options and provide clues to the answer, there are still problems with the quality of science here. The predominant use of closed questions in this extract (see Transcript 1 below) is not an anomaly. Nevertheless, the closed questions do not 'work' satisfactorily from the teacher's point of view and, it could be argued, that really there is no science talk because the children's contributions fail to meet the teacher's expectations.

For 'The art critics' the closed questions are not functioning in the way that closed questions are meant to because the teacher seems unable to 'funnel' the discussion to arrive at a scientifically meaningful conclusion. In particular, the children do not respond as the teacher wishes to the picture on the cover of the book but interpret the picture in their own way by contributing other everyday knowledge into play and the teacher is completely perturbed as a result.

Figure 5. *Is that a butterfly?* by Claire Llewellyn. Photograph by Diane Harris

Transcript 1. 'The art critics' (the question number and type of question are shown in curved brackets. Wait-time in seconds is shown in square brackets)

- Teacher So. [2.0] What's it called? *Is that a butterfly?* (Q1: closed)
 Children Question mark!
 Teacher A question mark. Well done. It's asking a question isn't it: is that a butterfly? (Q2: closed)
 Harry That's not a butterfly.
 Teacher Well it looks like a butterfly to me.
 Harry Butterflies [butterflies don't have three wings.]
 Courtney [A butterfly changes and it changes.]
 Harry But butterflies don't have three wings.
 Teacher They don't have three wings. It's probably just the way the picture's been drawn. It looks like it's three wings. [2.0]
 OK. So, what can we see in the picture looking beautiful? (Q3: open)
 Amy A flower.
 Teacher A flower? (Q4: closed)
 Josh It's a daffodil.
 Teacher It's a daffodil? (Q5: closed)
 Jake Yes, and there's a snail.
 Teacher Pardon? (Q6: closed)
 Jake A snail. Look.
 Teacher There's a snail on the cover? (Q7: closed)
 Jake Yes.
 Teacher Is it a snail or is it a caterpillar? (Q8: closed)
 Children It's a caterpillar.
 Teacher Well, I think that if we opened up the book we might find out a little bit more information.

The children were shown the front cover of the book *Is that a butterfly?* by Claire Llewellyn (refer to Figure 5). The teacher's first question to the children was 'It's asking a question isn't it: is that a butterfly?' (Q2: closed) but Harry's response of 'That's not a butterfly' was not perceived by the teacher as helpful. Undeterred, Harry substantiated his view by explaining, 'butterflies don't have three wings'. The teacher then looks more closely at the picture and acknowledges that possibly the drawing is at fault. From then on it seems every response by the children fails to help the teacher progress to her target: the flower rather than the three-winged butterfly is beautiful (from Amy) and the snail draws Jake's attention—while Courtney's potentially helpful remark is overlooked.

It might therefore be argued that these children did not yet understand the game they were expected to play in responding to their teacher's questions, particularly Harry, whose accurate observations seemed to disturb the teacher's plan. Alternatively, perhaps the children knew more than the teacher thought they would, and the questions were open enough to be interpreted in more than one way. For example, Harry knew that butterflies do not have three wings and interpreted the cartoon realistically; Courtney knew about butterflies 'changing'; Josh recognised the daffodil; all of which are correct and potentially valuable, but ignore the protocols of teacher-led discourse where children are expected to guess what is in the teacher's head, and consequently seem to trivialise the teacher's leading question asking for something

'beautiful'. Even Jake's comment about the snail may have been misrecognised: he may have already looked through the book because a snail is pictured on the majority of the pages inside. We might interpret these children's contributions as full of unrecognised wit and energy; another interpretation is that the children are less focussed on the teacher's verbalisations than the immediate qualities of the textbook.

This interpretation of Bourdieu and Passeron's concept of misrecognition is reinforced by this school's Year 4 teacher's comment during an informal conversation with the researcher: 'Open questions?... [laughs]... Look around you. Have you seen where our kids live? Do you really think their parents ask them open questions?'

'Crystals and chrysalises'

The second transcript is from a reception class in which the children appeared to respond to the teacher's open questions in the required manner. This is in a church school that provides for a community more widespread than its immediate environs, in a more affluent area than the one previously discussed, with the percentage of pupils entitled to free school meals well below average (10%).

The children here connected with the teacher's open questions and the preceding conversation. This interaction with reception class pupils is therefore unlike the previous case because the children are responding in a way that might be normally expected only from children some years older (according to our quantitative data). The children also contributed the sort of knowledge that the teacher seems to want.

This extract therefore illustrates how open questions can work for the teacher, and we believe that this is because the children 'play the game' and their contributions draw on the desired cultural resources (refer to Transcript 2 below). It should be stressed, however, that we are not arguing that the children (or their teachers) in the preceding extracts are therefore failing in some way: rather we seek to understand how schooling and pedagogy mediate success and failure in these discourses.

In many ways this activity is almost identical to the one previously described—both are about metamorphosis and both discussed the book cover before reading it, and both spent the remainder of the lessons outside looking for minibeasts in their respective school grounds. However, we note the difference between the two books, even obvious in their covers (Figures 5 and 6).

The first evidence of the children's cultural knowledge involves Alistair who, in response to the teacher's open question about why there should be a caterpillar in the picture on the cover of the book (Q1: open), replied, 'Because caterpillars go into crystals [*sic*]'. The teacher's response to Alistair's idea was to ask whether the children thought that the caterpillar would change into 'that butterfly' (Q3: closed) as she pointed to the cover of the book. Although it was a closed question and there should be little opportunity for misinterpretation, it seemed problematic for the children because they gave a variety of answers. It could be that the children thought the teacher was asking if a caterpillar could change into *that* butterfly meaning the one pictured on the book cover.

Figure 6. *From caterpillar to butterfly* by Deborah Heiligman. Photograph by Diane Harris

Charlie's next comment suggested that he had seen a caterpillar change into a butterfly and in response to the teacher's next open question, 'How does that happen?' (Q4: open), he was able to explain that he had been watching butterflies on the 'telly' with his father.

The teacher addressed her next open question to Joe (Q5: open) although he simply reiterated what had gone before: 'Caterpillars change into something and then they change into butterflies'. The teacher summarised and then Molly suggested that, 'worms change into butterflies'. When the teacher repeated her idea (Q6: closed), Charlie says, 'No' very firmly and Alison concludes, 'You have to read the book'. This final statement also suggested that these children know the game being played out and what is expected in this activity.

Transcript 2. 'Crystals and chrysalises' (the question number and type of question are shown in curved brackets)

Teacher Why do you think that there's a caterpillar here? (Q1: open) (*pointing to the caterpillar drawn on the cover of the book*)

Alistair Because...

Teacher And one here? (Q2: open) (*pointing to a different caterpillar*)

Alistair Because caterpillars go into crystals.

Teacher So you think the caterpillar would change into that butterfly? (Q3: closed)

Children NO.

Teacher Yes, the caterpillar changes into a butterfly.

- Alison Do they?
 Jason No.
 Charlie Yes. I saw one a long, long time ago.
 Teacher Well, do you know what, that must be magic. How does that happen? (Q4: open)
 Charlie Me and my daddy were watching butterflies on the telly when they were on the telly.
 Teacher They were on the telly.
 So you were watching a television programme about butterflies.
 What were you going to say, Joe? (Q5: open)
 Joe Caterpillars go into something and then they change into butterflies.
 Teacher They go into something and they change into butterflies.
 Molly And the worms change into butterflies.
 Teacher And worms change into butterflies? (Q6: closed)
 Charlie NO.
 Alison You have to read the book.

Almost every child's response implies some relevant knowledge or resource that they contribute to the dialogue, subsequently validated by the teacher. Alistair, Joe and Molly's responses suggest that they know that there is an intermediary stage between the caterpillar and the butterfly, although they all struggle to name this. Charlie has seen butterflies on the television with his father and Alison knows that you can find relevant information in books. In addition, all this information seems to be readily available to the children because, even though the majority of the teacher's questions are open, there are no unanswered questions. This suggests that the children not only have appropriate, valued knowledge but are disposed to express it in this classroom.

In conclusion, the teacher's questioning and the pupils' cultural resources were mutually enabling; even these very young children participated in a rich interaction which was 'scientifically' successful as far as the teacher was concerned.

Discussion of the qualitative analyses

We have now looked at two very different discourses with four- to five-year-old children engaged in science activities in their respective reception classes. The first shows how open and closed questions can work to funnel dialogue, but also how they may fail to work for the teacher. It demonstrates how open questions can engage children's ideas and agency in dialogue, how closed questions may enable the teacher to 'manage' the direction of the resulting discourse because closed questions can provide clues and funnel children's responses towards the teacher's objectives—but not always! This control breaks down when the children do not play the game, perhaps by exploiting the openness in even 'closed' questions to voice their ideas. Hence the teacher of the children from the poorer area—lacking control of the scientific dialogue—terminated the discussion by opening the book to read to the children. For the teacher with the children from the more affluent area, it is five-year-old Alison who suggests that the answer to the teacher's questions will be found in the book.

The 'Art critics' in the disadvantaged area were only asked one grammatically open question which invited the children to name something 'beautiful' in the picture. We believe that the teacher was hoping they would identify the butterfly but, alas, the butterfly only had three wings. On the other hand, in the 'Crystals and chrysalises' discussion with the children from the more affluent area, there appear to be no problems for the teacher due to open questions—they are simply part of the narrative where the children are using open questions to bring in their own ideas to the discourse in ways with which the teacher felt happy.

In both discourses, the children's contributions to the conversation reveal children's available resources. But when Courtney in 'The art critics' mentions 'changes', the teacher neither picks up on it nor does she introduce it herself, perhaps because Harry and Courtney spoke almost simultaneously and Harry's comment about the picture was the more forceful. The teacher also later remarked that it was typical of the children to pick up on 'something like that'. This comment may be linked not only to the teacher's knowledge of her pupils but also to her expectations of them based upon the cultural capital that they bring with them into school (Black, 2004). In contrast, in 'Crystals and chrysalises', the teacher barely asks a question and yet there is an outpouring of what we gather were desirable contributions from the children. The open questions are therefore doing what the science educationalists would expect but this is because these children have the cultural resources that the teacher recognises, and perhaps because the children are disposed to play the teacher's game.

To summarise, from the qualitative analysis we see how socio-economic status might affect how open questioning 'works' or 'doesn't work' from the science teacher's point of view: it is mediated by the cultural capital that resources the children's 'feel for the game' and the recognition and misrecognition by the teacher of the children's cultural resources (Bourdieu & Passeron, 1990).

Conclusion

We hypothesised that socio-economically related differences in learning outcomes well known in the literature (e.g., Thrupp, 1998) can in part be explained by the variation in the quality of interactions experienced by learners in classrooms. This only makes sense if there are in fact socio-economically related differences in interactions in classrooms. This is just what we found and measured.

This was achieved by using a mixed methods approach where the qualitative analyses help us envision the ways in which the children's cultural capital can 'make a difference' (as exhibited in two classrooms) in interactions in practice, which adds meaning to what the quantitative analyses provide (i.e., mere correlations). On the other hand, the quantitative analyses create 'objectivity' of the societal relationships in similar manner to that of Bourdieu (1984) in his studies (they are not just occasional relationships but statistically aggregated/objectified over many instances) and even provide a measure of the size of the relationships.

The analyses of our quantitative data revealed similar relationships from our three measures of classroom interaction. These were that the classroom interactions in

more affluent schools normally involve more open questions, which in turn are answered more successfully and the teachers are prepared to wait longer for a response than in poorer schools. In fact the difference between our poorer and richer schools' classroom interactions was measurable and of the same order as that between classrooms several years apart. These relationships cannot be assumed to be simply causal. We have to contemplate the notion that the quality of learning in these interactions is not directly related to our measurements: for instance there might be effective non-verbal interactions that make a difference and compensate for the measured differences. However, we sought to avoid this by using three measures of classroom interaction that have their own strengths and weaknesses: thus, wait-time has been shown to relate to teachers' expectations, while the quality of learners' responses is most obviously a function of the learners engagement, dispositions and cultural resources.

What then is the source of or explanation of these relationships, which all point in the same direction? Our qualitative analyses of illustrative interactions led to insights and possible explanations of these quantitative relationships. The dialogues benefit from the ideas that children contribute to the classroom but the cultural resources the children proffer may depend in part on the socio-economic status of the community the school serves. Even with very young four- and five-year-old children, there were pronounced differences in the measures of classroom interaction for quality of interaction, i.e., the findings of our quantitative analyses as well as in the qualities of interactions in the two classes we examined, i.e., the discussion of learners' ideas relevant to the phenomenon being studied and the new concepts to be learnt. Followers of Bernstein (1996) might explain that the children from the poorer area are less practised in the school's pedagogic discourse, their conversations tending to be more focused on the immediate phenomena to hand, e.g., the artwork on the cover of the book in 'The art critics' and missing the teacher's point. Their more affluent peers, according to Hasan (2002), are more likely to be familiar with the dominant pedagogic discourse because this is practised in conversations with parents and grandparents at home even at this very young age. Thus, it may be that these children are disposed to contribute cultural resources of the type that teachers want to make scientifically meaningful interactions.

Equally, however, following Bourdieu, we might say that the teachers sometimes, or even often, misrecognise the cultural resources offered by contributions of children in poorer areas. In practice, one might argue that teacher expectations are lower because they find the children's responses difficult to interpret and make use of: they are too easily 'thrown' by the way these children neglect to play their game.

This leads us to believe that the proportion of open questions asked, the proportion of those answered appropriately, and the wait-times for those unanswered, probably do serve statistically as valid measures of classroom interaction for 'quality interactions' at least in the sense of teacher-valued interactions; and so the children from disadvantaged backgrounds may indeed be engaging in significantly poorer quality interactions, as illustrated in the science discourses analysed. Furthermore, our data only examine schools with up to 30% free school meal eligibility but work by Lauder

et al. (2002) with schools having in excess of 50% FSM eligibility, suggests that these schools may develop pedagogies which are unlike the majority of schools: i.e., they may well not fit the patterns reported here.

Therefore, the implications for children in poorer and more affluent areas should be of concern to practitioners and policymakers alike since it appears that class differences may be reproduced through these types of classroom interactions. These findings suggest that teachers may find it more difficult to handle ideas given by children from poorer backgrounds, in the same way as perhaps these children find it more difficult to handle the ideas of their teachers. It would seem, therefore, that if we seek to counteract the social class disadvantage experienced by many children in poorer areas, we may need to attend more closely to the quality of interactions in the classrooms in less affluent communities. We avoid drawing conclusions for policy that seek to short circuit the enriching of less affluent communities, except to suggest that schooling in poorer communities suffers from that poverty under the current regime.

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