

## **Schooling and subject disengagement in Year 10 Science in four maintained schools in Northern England.**

### **Introduction**

Osterman (2000) argues that many of the cultural norms, values and practices of schooling undermine pupil commitment and engagement, while Little (2002) refers to schooling's dominant interest in maintaining order against a backdrop of sterile pedagogy. In England concerns are expressed that developments in the 14 – 19 curriculum (DfES 2006b) may not be sufficient to prevent the disengagement of pupils (NFER 2006). Meanwhile, teachers leave teaching (TES 2003b) and disengaged pupils play truant (TES 2003a). This paper, reporting on a small scale research project using semi structured interviews and lesson observation in four publicly maintained schools in northern England, explores the nature of disengagement in Year 10 Science lessons.

Pupil disengagement from Science lessons has been a focus of concern in England (Monk 2006; BBC 2005; James 1998), leading to significant changes in the content and skills requirements for the subject at Key Stage 4 (DfES 2006a). The new orders have been reduced in content. The 'Programme of study' and 'Breadth of study' for Key Stage 4 have been reduced to 2 pages. This light touch has encouraged a range of approaches by the exam boards to their specifications. For example, EDEXCEL see the changes as an opportunity to make 'science accessible to all students, from those who just want to understand the world around them to those who want to progress onto further study. ... 360Science is a comprehensive and flexible curriculum. It gives you the freedom to tailor your teaching approach and use your professional judgement.' (EDEXCEL 2006)

The introduction of the new orders has been controversial, being criticised as a ‘more suitable for the pub than the school room’ (Warnock 2006). Through the perspective of pupil and teacher values this paper explores the nature of pupil engagement with Science and raises important questions regarding the purpose of school Science and the influence of Schooling on subject study.

It is useful to begin with a brief explanation of key terminology. The National Curriculum determines the content to be taught in schools and is divided into four Key Stages. During Key Stage 4 pupils are in Years 10 and 11. These pupils are 15 and 16 years old and are normally entered for the General Certificate of Secondary Education (GCSE) in each subject studied. This is graded A\* to G. There is also a U grade (unclassified). Success in this examination is interpreted in the ‘League Tables’ of schools – published annually – as achievement in the range of A\* to C. Prior to curriculum change in 2006 Single Science was the separate study of the three disciplines of Science. This was thought of as more academic and suitable for ‘top ability’ sets, whilst Double Science combined the study of Physics, Biology and Chemistry into time allocated for two subjects, so that the award of two GCSE’s could be achieved. This option was widely considered more suitable for ‘middle ability’ students.

Secondly, it is useful to clarify some of the key concepts used in this paper. Capitalised ‘Science’ refers to the school subject. Values are something to prize, to esteem and often coincide with educational aims (Dewey 1966). Dewey also makes a distinction between

types of values. Instrumental values are a means to a further end, whilst intrinsic values have worth in themselves. Mortification strips pupils and teachers of certain parts of their selves (Woods 1979) and pupils counteract this with the development of alternative systems of value and status. Mortification attacks the substantial self (Nias 1989) and can result in a loss of dignity leading to alienation. Schooling (Giroux 1983) is distinct from education and takes place within institutions regulated through funding or qualifications by the state, whilst the practice of Schooling is referred to as the hidden curriculum: ‘those un-stated norms, values, and beliefs embedded in and transmitted to students through the underlying rules that structure the routines and social relationships in school and classroom life.’

Osborne (2000) provides a useful perspective on the purposes of school Science. Utilitarian arguments about the usefulness of Science in everyday life, and Science as training for future employment are, Osborne argues, undermined by scientific and technological advances that, in emphasising the intuitive nature of operating technology, reduces the need to develop scientific knowledge or ability for employment. Osborne sees greater justification for Science for all in a focus upon the development of greater understanding of scientific issues, and Science citizenship, which uses scientific analysis to make sense of contemporary life and to ‘resolve uncertainty’.

## **Methodology**

Case studies (Appendix 1) were developed from seven Science classes. Data was collected through lesson observation, pre and post lesson observation interviews, and post

lesson observation and interviews with class teachers and pupil focus group interviews. In addition the dissemination of findings to teacher informants allowed for further refinement by those teachers. All four research schools were publicly funded urban schools in post industrial communities in the North of England. None of the schools selected pupils on the basis of ability. The data was collected between 1999 and 2002. Italicised profiles of the schools are sourced from their Ofsted reports.

One school was approached where the Science department declined to take part citing teacher workload as one reason, and an absence of values from the National Curriculum as the other. Subsequently, *Scigirl*, with a similar school profile was approached and agreed to take part in the research project.

Transcript and observation data was analysed after Spradley (1979) using Tripp's (1993) concept of critical incidents to identify underlying tensions that were explored adapting Winter's (1982) dilemma analysis. Respondent validity was addressed through feedback of early findings to individual teacher informants and a group dissemination day.

## **Findings and discussion**

### **Co-edcomp**

*Co-edcomp was an 11-16 comprehensive. co-educational, county school. Roll 1297. Free School meals 11% Statemeted pupils 2% Special Needs register 9% English as an additional Language N/A Exclusions 1% A – C at GCSE (1998) 61% KS3 level five or above: Science 70*

### **- Dennis: Single subject Chemistry**

Dennis taught Chemistry and Physics. He had always thought that he would 'give the job five years', and if he liked it he would stay with it and if he didn't he would seek other work. He enjoyed a lot of his teaching but he felt that the syllabus had not moved on since the 1930's and that paper work had increased. He cited the dissatisfaction of other teachers as one reason why he wanted to leave. This was his fifth year and he left teaching at the end of the academic year, but returned to participate in the dissemination day

Dennis stood at the front of this 'top ability' class which had three parallel benches facing the front. He remained there for the larger part of the lesson advising pupils while they conducted practical experiments to investigate energy changes in chemical reactions. Although, he acknowledged that it was 'not their curiosity as such. I suppose it is me telling them how to find something out.'

Dennis, was ill at ease with being a teacher, feeling that there was a certain 'busyness' (Woods 1979) about teaching that was non-productive. Dennis felt that teaching could be lonely, and that teachers were 'moaners'. He had gone into science because he was curious, but the Science curriculum was 'stuck in the mud'. He ended up explaining to pupils rather than letting them follow their curiosity because of the time constraints created by a crowded curriculum, and class sizes up to thirty-four. Dennis' pupils shared this frustration with the curriculum.

*How could lessons be improved? P1* He can't unless he changed the syllabus. More trips.*P3* And different kinds of experiments so that it isn't always heating up a substance over a Bunsen burner

or something. P2 Something that has got the element of surprise. *What can you remember about ammonia?* P2 We didn't do anything about ammonia..P1 Yes, we did. P4 Only for about a week. P1 It was one experiment. We learnt the number formula for it. *He talked about gas in the 1st World War.* P1 Oh, yes.P3 It's coming back. P2 We didn't do a lesson on it, he just like mentioned it. P1 I want to do about genetics.. P2 Psychology P4 Physiotherapy. *Why psychology?* P2 Because it is interesting.

They shared his belief that the syllabus was out of date, predictable and boring. Dennis had talked in his interviews about the role that the discovery of ammonia played in prolonging the First World War, and in providing fertiliser that helped to feed the world. Dennis thought that this was one of the few occasions when he was able to relate Chemistry to values. Dennis thought that this was significant, but the pupils barely noticed as he 'just like mentioned it.'

In their interview these 'top ability' pupils (like their 'middle' and 'mixed ability' counterparts as we shall see later) expressed a desire for controversy, difference and variety. Unlike their counterparts in other Science classes, these pupils had a generally positive attitude to schooling and their subject. They wanted greater relevance in Science, but wished to be 'successful', in other words to achieve an A – C. Even though they would rather have studied genetics, psychology and physiotherapy they were not negative about Science. Instrumental values, particularly in the form of qualifications, were important to these academically successful pupils. School, although not intrinsically satisfying, was useful to them.

### **- Betty: Chemistry in Double Science**

Betty had been teaching for 15 years. She felt apprehensive as she was a Biology specialist and had been asked to take on more Chemistry. She still enjoyed teenagers as

she found them fun and refreshing. During the course of the research she accepted a part time contract in order to 'get a dog' and to devote more time to 'her son and the cats.'

Betty taught her 'mixed ability' pupils in a 'long thin' classroom with five parallel benches. Betty conducted her exposition on blast furnaces from the front of the class. After seeing a video of blast furnaces the pupils answered written questions and Betty moved around the class helping them.

Beety's pupils had a similar perspective to Dennis' pupils.

P2. They could involve you more in what they do. Have more discussions. P1. Up to date video's!  
P3. Like '70's! *Do you want to hear more about the teacher's personal opinions?* P1. Yeah, then we could have a discussion about it...she talks about steel and why we need it. *Is Chemistry useful to you?* P4. I don't know really. Because we are doing like tests on making iron and stuff, but we are not exactly going to be making iron in that industry.

Betty reinforced Dennis' point about their inability to allow pupils to pursue their curiosity because of 'time constraints', and class sizes that mean 'you don't have the time to devote to pupils on an individual basis that is necessitated if you are going to follow curiosity when it crops up'.

For Dennis' 'top' group instrumental value was achievable in terms of successful certification (at 'C' or above), but they found little use in studying the subject. Intrinsic value, in terms of pleasure, or the satisfaction of curiosity was not an attribute of Science that was recognised by either class.

### **Churchcomp**

*Churchcomp was an 11 - 18 voluntary aided Catholic school which drew on pupils from across the town. Roll 950 Free School meals 14% Special Needs register 17% English as an additional Language 3% Exclusions 16% A – C at GCSE (1998) 45.2% KS3 level five or above: Science 57*

– **Keith: Physics in Double Science**

Keith was head of Biology and had been teaching for 22 years. Sometimes he regretted not having had another career, particularly when he was ‘going through the motions’. He said this happened when he was getting no feedback from pupils, some of whom he said didn’t want to be there and hated Science. Other times, when he as ‘fired up’ and they were ‘eating out of your hand’ he had no regrets.

The class was arranged with a mix of circular work benches and rectangular work benches. This meant that at times pupils would not be facing the front – Keith’s favoured classroom position – an arrangement Keith had not been consulted about and was not entirely happy with. There were twenty four pupils in this mixed ability set. Prior to the pupil interviews they were involved in a practical investigation of the reflection of light followed by writing up of the experiment.

Keith hoped that pupils would take ownership of their work even though setting, which he thought de-motivated some pupils, was imposed in the Science department. He argued that Science gave reason and explanation but was also required for employment. Keith accommodated the constraints of the syllabus – which he talked of as a ‘straight jacket’ -



and the de-motivation of setting through a belief that he was able to do something about these matters through his pedagogy.

Pupils were discouraged from collaborating through signing a ‘disclaimer’ for the exam board, asserting that it is all their own work. Keith’s classroom activity was driven by an examination imperative that gave rise to a limited notion of instrumental value: Science for examination success. Pupils thought that they had to be passive receivers in the classroom. They felt that they could not tell some teachers what they thought, and were wary of asking for explanations. Keith wanted closer relationships between teacher and pupil. However, relations were not what Keith himself would describe as ‘friendly’ in the classroom, but rather formal. His pupils gave an explanation as to why this may be the case.

P2. this schools skint...P3. If they haven’t got what they need to teach they get agitated and have to use rubbish stuff, like balloons in Science instead of proper apparatus...we would learn better. *Do you think it affects (Keith)?* P2. Yeah. P3. He gets frustrated. Like not enough water baths. P3. Not enough starch. P1. That experiment, there were too many people in the classroom, and everyone was too close to the tables, and I couldn’t learn at all.

P1 We always get shouted at. ...*When a teacher shouts at you what sort of effect does it have on you?* P1. I think it’s funny. *Why?* P1 I don’t know it’s just funny when you see them lose their rag, and see them get right mad and up tight when it’s over little things and you should have a laugh about it. But they get really mad and upset, and we don’t understand why.... we are only kids. When they were little they would have messed about as well, but they take it right serious if someone throws a rubber across classroom or something like that. Just laugh....

Keith’s *Churchcomp* pupils enjoyed making the teachers lose their tempers. They considered the things that teachers get angry about to be small things, of little significance. They get pleasure from the displeasure of the teachers. They showed strong feelings of resentment. In *Churchcomp* data although they show some understanding of why teachers may get frustrated they do not recognise it as a frustration common to them as pupils. They express a heavy sense of oppression, a stifling of their spirit. They don’t understand why teachers should demand such absolute control over the pupils’ behaviour.

They think that they are only acting like children have always done, and see nothing wrong in it. They think that teachers are to blame for failing to understand this.

P2 you've got to be bad now and again. *Why?* P3 To let it out of your system so that it dunn't build ...P1 If you keep it in in school then you go home and take it out on your mum and dad. I'd rather take it out on my teachers than on my mum and dad. Cos if it is boring you think, 'this is crap, I'm going to do something enjoyable, and mess about'. But if it is fun to start with it's all right then and hour goes dead quick and you just go home. P1 Because you are looking at the clock all the time and thinking what shall I do next? P3 Yeah. P4 Just cause trouble. P1 Pass time. Just cause trouble.

The pupils justify what many teachers would view as disruptive behaviour in a number of different ways. It is possible to understand, in cramped Science labs with large numbers of pupils to control, why Keith would find it inadvisable to ignore such behaviour, but the pupils do not identify with the teacher's point of view. They see that they are asked to emulate behaviour that they equate with the removal of 'risk'. They do not wish to become people who just 'do as they are told'. They want to be able to 'let it out' of their 'system', and they would rather do that at school, with teachers, than save it up for their parents when they go home. They see 'causing trouble' as a way of passing the time in boring lessons, and as a way of maintaining a natural equilibrium within themselves. We see echoes of an alternative pupil culture (Woods 1979), where self-entertainment is central to the schooling experiences of some pupils as they struggle to combat the monotony and boredom of the school day. Keith's pupils are disrespectful, and take pleasure in the way this upsets the teachers, although they see it as a simple expression of spirit.

Keith wanted to treat people as 'human', possibly as 'friends' but he was unsure whether friendship was a proper relationship for pupils and teachers to have, but left the researcher with the impression that he wished things could be different.

### **- Susan: Physics in Double Science**

Susan's specialism was Physics and she had been teaching for 3 years, all of them at *Churchcomp*. She was promoted to second in the department during the research, and at the end she moved to a sixth form centre because she felt that there the paperwork would be to a 'purpose' and she wouldn't have to spend her time talking about 'chewing gum or tucking shirts in.'

The class was taught in the same room as Keith taught his Science. There were 20 mixed ability pupils and the lesson was a demonstration of the reflection of light by the teacher followed by pupil duplication of the experiment.

Susan thought that the syllabus not only prevented the exploration of curiosity in Science, but disrupted it. This was at odds with her hope that every lesson would foster curiosity.

*Do you get chance to explore and say, 'Oh look, I've got a different answer?' P1 No. P4 Not really, no. But then you hardly ever do anything different to how she demonstrated it. Why? Because she shows you step by step how to do it, so it is basically you are doing the same experiment and so it is usually the same results...(experiments) are exciting when you do the things yourself, but when the teacher does it, it is not exciting. You are just sat there watching, real bored. Does anybody think that they would like to hear what her opinions are? If it is like to talk about space and how she thinks that the world began and all that, or how she thinks that most of the scientists think that. And does she ever tell you about those things? P2 Not usually, no.*

Susan's pupils wanted to explore for themselves. Their experience of school Science was not helping them to satisfy their curiosity. Their attitude to schooling in general was not a positive one. They kept referring to 'the school' and how things were only done for show and not for the pupils. Their exclusion from parts of the building at break time, their denial of the opportunity to leave the premises at lunch time, the disrepair of aspects of

the building, and lack of facilities for relaxation at break times were all cited as examples of how the school showed them disrespect.

In *Churchcomp* Keith and Susan used what they perceived to be a 'safe' pedagogy, not only because of class size and time constraints, but because of their pupils' negative attitude towards school, and the potential for disruptive behaviour that this offered. Values such as excitement and curiosity are not so much shared as removed. Pupils and teacher are captives of a regime that has a tendency to lead to the mortification of those who are trapped by it. Both pursue a form of instrumental value, often defined for 'middle' and 'lower ability' pupils by an elusive search for examination success. How elusive this can be is illustrated in *Boyscomp*.

### **Boyscomp**

*Boyscomp was an 11 -18 county boys school: Roll 514 Free School meals 60% Special Needs 20% English additional Language n/a ('a very high percentage') Exclusions 6% A – C at GCSE (1995) 11.2% KS3 test percentage at level five or above: Science 15*

### **Derek: Physics in Double Science**

Derek had been teaching for thirteen years and was head of the Science department. He had a career break of three years when he ran his own electrical installation business. He felt he was doing a much better job 'this time around' because he was more 'mature' in his attitudes. Derek said that he had been a pupil at a school that had been labelled the 'worst in the country' and he wanted to use these experiences to help the pupils at *Boyscomp*.

There were a number of work benches in the middle of the room where 9 ‘lower ability’ pupils sat. There were more pupils on role but a number were long term absentees and others often had Friday afternoon off (the majority of pupils were from Muslim families). Derek gave a demonstration, and then pupils worked in pairs or threes as they investigated the effects of electromagnetism. He felt that ‘some (*of his pupils*) never will appreciate any value (*in Science*). They never will appreciate that Science is impinging on their everyday life.’

At face value, Derek’s pupils did not articulate the cynicism of *Churchomp* pupils:

P2. We always do (experiments) in two’s. P1. So we can help each other... The practical work, sir. It was fun, sir. You could see all the sparks and how the electromagnet was working. P2. Then if you mess about, he stops the experiment, which is reasonable. *Why do people miss off school?* P1 Because it is useless.

These pupils are bored by school, but enjoy aspects of the practical work, almost as entertainment. Derek admits that ‘I’m not particularly sure that on that day they actually learnt any Science. I’m quite happy for them to have almost a play at the experiment.’

The instrumentality of this Science lay in the pupil’s ability to develop their skills in ‘playing’ with the equipment, in order to learn how to handle some of the more common equipment, but for what purpose? As one of them says, school is ‘useless’.

### **Gordon: Single subject Biology.**

Gordon had been teaching at *Boyscomp* for half a term. He had taught at *Boyscomp* previously for a short period of time before teaching in Botswana for six years. He entered teaching quite late, after having done a number of other jobs, including gardening

and working in a lab. He would have liked to have had a career in environmental education. Gordon left teaching to train as a paramedic shortly after the school based research was completed. He had given little indication that this change of career was imminent.

The class was seated behind parallel rectangular work benches in an old classroom. The roof was leaking on the day this top ability set was observed. The lesson was on the composition and function of blood components. Pupils were working on worksheets ‘to guide them through it...to encourage them to find out for themselves how to obtain information, how to analyse information.’ Gordon was facilitating throughout the lesson. Pupils, who should have been in another lesson, deliberately came to Gordon’s lesson instead. They made themselves known to Gordon after twenty minutes before leaving the room.

P1. In Biology we don’t talk about it (*the subject*). We want to know more about the environment, we should learn about the things about us. P2. We had to look through the book to find the information and we had the sheets as well. So, for the work we had a lot of information...P1. There wasn’t much communication between the teacher and pupils...we wanted to communicate more with the teacher.

Gordon talked about the development of self reliance and reasoning, but the evidence from pupil interviews and observation was that this was not as successful as he hoped. The pupils wanted to learn more about ‘things about us’ and they identified that one way to do this was through better communication to explore those issues. Like Derek, Gordon’s instrumentality was more concerned with classroom control, avoiding confrontation, keeping pupils focused ‘on task’ with the justification that it develops skills.

## **Scigirl**

*Scigirl was a girls' comprehensive county school. 11-18 Roll 1,245 Free School meals 38% Statemented pupils 2% Special Needs 18% English is not the 1st language 55%. A – C at GCSE (1999) 36% KS3 test percentage at level five or above: Science 31*

### **- Farouk: Physics in Double Science**

Farouk had been an assistant lecturer in Iraq before moving to England. He had worked as a research fellow at a northern university and gained a Ph.D. He had been a teacher for six years and had a responsibility point for Key Stage 3 Science. He had tried to get promotion to 'middle management' but felt that his ethnic origins had stopped him from being successful. He said that he liked teaching for the feel of authority, the stability, and the challenge.

Farouk stood behind his raised desk, in front of the three parallel benches while he demonstrated the effects of electromagnetism. The pupils in this 'mixed ability' set of 26 girls were gathered round the front two benches whilst one pupil, 'Pupil A', sat at the back of the room working through 'self-study' on the computer.

Analysis of *Scigirl* data brings into relief issues emerging from *Boyscomp*, *Churchcomp* and *Co-edcomp*. It suggests a correspondence of teacher and pupil experience. The correspondence lies in the denial of intrinsic value, the distortion of instrumental value, and the mortification of the self. We have seen that Keith's *Churchcomp* pupils justify their disruptive behaviour with an analysis of their own needs. What was remarkable

about Farouk's pupils was their analysis, based upon an understanding of needs of others.

Here, the pupils discussed why some pupils were disruptive in class.

P1. Even though they have the ability, they just haven't bothered. *Why do they not?* P1 It's because they don't understand it, they might know the answer, but they won't say anything in case they get it wrong and look stupid. P4 They probably have low self esteem. So they start putting this act on just to show off to all their mates. It's not always their fault though.

Farouk's pupils offer a view of pupil values that is positive and principled. Farouk's pupils express sympathy and understanding. They do not attribute blame to their peers, but talk about their behaviour in the context of a possible teacher response to wrong answers and the pupils' own previously poor socialisation. This is how one pupil explained the behaviour of the class's most disruptive pupil, 'Pupil A'.

Well, there is one girl, right, and I'm not going to say her name, but you know who she is, right. Well, she used to be in another school, this is what I've heard from everybody, and she used to get bullied didn't she? And she used to be called names and everything and so she moved here, and I suppose because she wanted everyone to like her she started to act around. I don't blame her all the time, because it is other people, but you know, past behaviour or whatever. *Could 'Farouk' do anything do you think?* P2 Perhaps he ought to try and understand more.

Pupil understanding could be misinterpreted as complicity in disruption and disrespectful behaviour. They did not demand that 'Pupil A' 'shut up' so that they could get on with the work. In Farouk's class they tolerated disruptive behaviour. From Farouk's point of view this meant that the class failed to reach that critical mass of pupils who demand that the rest of the class respect the teacher exchange: dependent upon an ordered environment, where the teacher carries authority.

Pupils also had to wear a school uniform and were subjected to bans on certain items such as jewellery. Whilst teachers wore the same banned items this smacked of double standards to pupils. The reasons that teachers give for this did not, in the pupils' view, legitimise the rules on uniform.



P4 It is supposed to be for safety. But how is it going to be for safety? 'Cos no one is going to go around pulling your ears and pulling your earrings off. P1 You are not allowed nail varnish on, and make up. P4 No one is going to go around scraping it off. P3 They are silly. P2 Teachers wear all this jewellery, and then they say we can't wear it for safety. But it is them that is doing all the stuff isn't it? P1 They are no different just because they have got qualifications.

There was the inference from one pupil that teachers have a superior attitude to them that cannot be justified by the fact that teachers had qualifications and they didn't. Farouk's pupils thought that schooling was unfair and failed to respond to their needs, and this pre-occupied them. The implications for Farouk are considerable. Farouk takes Schooling and its benefits as a given and wants pupils to comply with the norms and expectations as implied by his reference to teachers as 'academic' and 'social' role models. Pupil pre-occupation, with their own and other pupils' needs, leads them to reject, or at least ignore these norms. This leads Farouk to distrust his pupils, preventing him from risking a more creative pedagogy.

P3 We need more excitement. P2 Not that we are being sexist, but Physics isn't really a woman's thing is it? Well it's not mine. I'm not into weighing copper bits and blowing things up and that. That's not me. P4 Yeah, but you don't blow things up. That's what's so boring about it. P3 Yeah, all we do is watch. P4 Sometimes when you do the experiments it gets so boring. You think, why bother, people have done this so many times. You don't learn anything new. It is like a right and a wrong. You can memorise all these answers. If you don't get the answers then you have failed basically. *Do you like Physics?* P1 No, because it is boring. It needs to be more uplifting for us.

Susan's pupils in *Churchcomp* shared this disappointment with demonstrations by the teacher in comparison with the anticipated excitement of genuine experiments. However, Farouk was fearful of making Science more interesting through experiments outside in the school grounds, or through pupils conducting their own experiments, because he was worried about losing control of their behaviour. He talked about the importance of an investigative and discovery approach in Science but argued that this wasn't possible because of a lack of resources, a necessarily full syllabus and 'silly' behaviour by pupils who did not appreciate the importance of education. This failure to share his values

forced him to try to maintain control through pedagogy heavily dependent on demonstration.

## **Summary**

James (1998) talks of how Science leaves pupils disappointed. In part this can be explained by an empiricist/induction tradition in Science (Monk 2006), underpinned by a positivistic approach in the classroom (Osborne 2000; Aronowitz and Giroux 1993) that ignores ethical debates and constrains innovative teaching (Wellcome Trust 2000). This is hinted at in one Science department's decision not to participate in the research, and is strongly supported by analysis of pupil data from the Science classes in the four research schools, data that confirmed widespread pupil disengagement from Science. This disengagement was linked to a distortion of instrumental value and denial of the intrinsic.

Instrumental value was driven by the demands of Schooling: a pursuit of examination success unattainable for many, and a desire for the avoidance of pupil disruption. Intrinsic value, such as the pursuit of curiosity and pleasure was denied by constrained pedagogy and the disruption warranted by Schooling – such as large classes, poor resources, inappropriate curriculum, strained teacher-pupil relationships, discouragement of collaboration by the demands of assessment – and its rituals – such as dress codes, the denial of access to parts of the building and facilities on the basis of status, games of antagonism instigated by pupils, and the assertion of authority by teachers, all part of the roles of teacher and pupil.

In Science, pupils wanted better communication between themselves and their teachers on order to be able to explore Science and its related issues. The outdated syllabus, time constraints, large classes, poor resources, and negative attitudes to schooling, contributed to a failure to engage the intrinsic values of Science, whether they be those described by Osborne, or simply the pursuit of curiosity and pleasure. In addition these factors distorted engagement with the instrumental, as pupils disputed the practical value of the Science of their lessons, and teachers used pedagogies that were more concerned with control (including a fear of disruption) than with examination success or practical application.

The updating of Science specifications (DFES 2006a), which offers the possibility of increased intrinsic engagement, and the goodwill of Science teachers will not, in themselves, be sufficient to remedy this situation. The influence of schooling pushes deep into the classroom, despite the efforts of individual teachers to mitigate its influence. Pedagogy dominated by risk removal and the fear of disruption will not resolve a fundamental dilemma for Science: how to develop the intrinsic value of Science in a system focused on a distorted form of instrumental value. This difference is exemplified in two opposing perspectives: Warnock's perception of the new specifications as 'pub Science' (2006) and Osborne's (2000) perception of Science for citizenship and the use of scientific analysis to 'resolve uncertainty.'

Pupils are not the only ones to disengage. Analysis of data from the four schools also suggests a correspondence between the experiences of teacher and pupil. The joint denial

of intrinsic and instrumental value leads to the mortification of lively, engaged youngsters, and motivated and enthused subject specialists evident in the role-play of pupil and teacher.

Developments across the 14 -19 sector (DfES 2006b) offer the possibility of re-shaping pupil - teacher relationship and the chance to treat 14 – 16 year olds as young people with developing instrumental and intrinsic values, rather than as minds to be captured (Schostak 1984). Teachers and pupils need to free from the disruptive influences of Schooling to pursue the excitement of Science. Policy makers must think beyond the clamour for ‘clampdowns’ and the discourse of the nineteenth century prison (Garner 2005) by engaging with new models of Schooling (CERI 2003) that meet the aspirations of pupils and teachers.

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## Appendix 1

### Seven case studies

<b>Coed Comp : Comprehensive, co-educational, county school</b>
<b>Dennis</b> (5): Single subject Chemistry, top ability set. <b>20</b> ( <i>PI</i> = 4) <b>Betty</b> (15): Chemistry in Double Science, middle ability set. @ <b>20</b> ( <i>PI</i> = 4)
<b>Churchcomp: Comprehensive, voluntary aided, co-educational catholic school</b>
<b>Keith</b> (22): Physics in Double Science, middle ability set. <b>24</b> ( <i>PI</i> = 4) <b>Susan</b> (3): Physics in Double Science, middle ability set. <b>20</b> ( <i>PI</i> = 4)
<b>Boyscomp: Comprehensive, county boys school;</b>
<b>Derek</b> (13): Physics in Double Science, middle ability set. <b>11</b> ( <i>PI</i> = 3) <b>Gordon</b> (8): Single subject Biology, top ability set. <b>20</b> ( <i>PI</i> = 4)
<b>Scigirl: Comprehensive, county girls school.</b>
<b>Farouk</b> (6): Physic in Double Science, middle ability set. <b>26</b> ( <i>PI</i> = 5)

#### Notes

Figures in parenthesis represent the number of years teaching.

Figures in bold represent the number of pupils present in the observed classes.

(*PI* = *N*) = number of pupil informants in the group interview