PHYSICS IN SCHOOLS
III. Bucking the Trend

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Executive Summary

Bucking the Trend is the third in a series of reports commissioned by the Gatsby Charitable Foundation from the Centre for Education and Employment Research on the current state of physics education in England. The first two studies (Smithers and Robinson 2005 and 2006) found that participation in the subject in schools and universities has been declining for the past two decades. But amongst the general downward trend there were schools running thriving physics sixth forms. Most were grammar and independent schools, but up there with them were some comprehensives. This study sets out to identify what these comprehensives are doing that others are not and to suggest ways to reverse the seemingly inexorable decline in physics education.

Key Findings

The main ways in which the successful physics schools differed from the schools with few A-level physics students and were similar to each other were:

- strong leadership in physics;
- core of well-qualified and enthusiastic physics teachers teaching the subject at KS3 and KS4 as well as A-level;
- culture of science success in school in which good physics results are obtained and the subject is not seen as difficult;
- way the subject is taught with a balance between a well-structured curriculum and a sense of fun;
- teaching physics as physics in KS4 either within the framework of GCSE science or as the physics GCSE;
- critical mass of able and interested pupils.

Other features such as the state of the laboratories and the extent of science enhancement activities seemed to be less important, but there was general concern about the low levels of technician support and the difficulty of recruiting to these posts.

Methods

The ten per cent representative sample of schools taking part in the 2005 survey, described fully in the first report, were ranked according to the percentage of Yr 13 who took the A-level physics examination in 2004. The original intention was to compare each of the top eight comprehensive schools (leaving aside the grammar and independent schools) with a school from low down the order which matched it, as far as possible, for region, overall GCSE performance and eligibility for free school meals. In the event, while all top eight schools agreed to participate, those with few A-level physics students were much more reluctant. In fact, only three were brave enough to open up to us. These three comparisons between what we have designated high-physics schools and low-physics schools form a key part of this report. In the case of one of the low-physics schools which is a girls' Catholic school there are two high-physics comparators, one a Catholic school and the other a girls' school.

In addition to these seven schools, nine other high-physics schools plus another successful girls' school have been studied in detail, making 17 case studies in all. Each school was visited and the head(s) of the science/physics department(s) consulted for about two hours. We also asked to see the labs and other science facilities, collected documentary evidence on the way science is taught in the school, and assembled information about the school from the Ofsted and DfES websites, as well as the school's own.

Reversing the Decline

The key features of successful physics schools are inter-connected and bound up with a school's location, history and tradition, and cannot be simply transposed to transform a school with few physics students into one with many. But there were examples in our study of schools which had done just that. However, any school wishing to change may have relatively little room for manoeuvre. To do so it needs to be able to recruit good specialist physics teachers and it is the government's responsibility to secure that supply.

Most of the attempts at increasing the numbers of physics teachers have been directed towards increasing the pool from which they are drawn. But the heads of department in the present study, when asked what they would do, suggested that it was at least as important to reduce the loss of those physics graduates who had opted to train as teachers. The second report showed that those graduates tend to be lost at three points: over a fifth train as maths teachers; only just over half of the physics teacher trainees take up posts in state schools; and about six per cent a year leave during each of the first three years.

Proposals to Government

The heads of science put forward four ideas for stemming these losses, which we commend to government.

- Involve schools with thriving physics departments to ease the path of the newly trained into the classroom. At present they can find themselves the only physics specialist in a science department, with the entire burden of curriculum and assessment falling on their shoulders. The heads of science suggested that it would be better to 'grow' physics teachers by supporting them during the initial stages in successful physics schools where they could develop their classroom skills. We recommend that the government or a charitable foundation should consider funding a study to assess the feasibility of establishing **centres of excellence in physics teaching**.
- Devise a **more focused PGCE**. Some heads of department favoured teacher training courses in physics and maths as a more natural combination than the three sciences, but there were fears that this would open the way to more losses to maths as well as going against the grain of school organisation. They were agreed, however, that it would be a good idea to separate off biology, which they felt that most physicists would not want to teach.
- Better provision of **technician back-up,** the lack of which the heads of science felt was a factor in the loss of physics graduates to maths teaching.
- An additional point made by several heads of science was that fear of losing touch with their subjects was a concern for scientists entering teaching. It was, therefore, suggested that every teacher should have **regular opportunities for learning about developments in their subjects**. Although referred to as sabbaticals, what they had in mind were intensive courses of a week or two.

Proposals to Schools

Any school wanting to increase its physics participation is operating within a number of constraints and may not find it easy to change, but the school at the top of our ranking had greatly increased its A-level physics take-up. It had achieved this in three ways:

- It recruited a **strong and clear-sighted head of physics** who in turn brought together a **team of well-qualified and enthusiastic physics teachers.**
- **The head of physics devised a well-structured curriculum** with the emphasis on student success.
- **Physics is taught as physics** in this case within the framework of the dual science, with the A-level teachers teaching from at least Yr 9 so the pupils can develop confidence in themselves and in their physics teachers.

Conclusion

Not everyone has the interest or ability to study physics to a high level, but since the proportion of the age group taking an A-level in the subject has dropped between 1990 and 2005 from 5.9 per cent to 3.9 per cent it is reasonable to infer that there are people out there who could do it if they wanted and had the opportunity.

The crucial feature of the successful physics schools in this study was a team of expert teachers. Physics and teaching can provide very different satisfactions so it may not be easy to attract physics graduates to teaching. But too many of those who have shown an interest are being lost.

The idea which has emerged in this study that has appealed to us most is to harness the experience of successful schools. In particular, they could play a part in easing the transition of the newly-trained into the classroom so that at this critical stage in their careers they do not find themselves as the only physicist in a school. We recommend a feasibility study leading, in the event of a favourable report, to the funding of a pilot scheme in several successful physics schools.

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1. Introduction

1.1 This is the third in a trilogy of reports on the current state of physics education in England funded by the Gatsby Charitable Foundation. The first two (Smithers and Robinson, 2005 and 2006) set out the situation starkly. Participation in physics at school and university has been declining for the past two decades. The overall picture was depressing. But standing out from the general drift downwards were schools bucking the trend with physics numbers holding up at more than twice the national average. Most were grammar schools and independent schools, with selected intakes and advantages in attracting teachers, but among them were comprehensives. *Bucking the Trend* reports on visits to these comprehensives to try to unearth what it is that they are doing right, and what other schools and policy makers can learn from them. The report, therefore, has a practical aim: to suggest what might be done to reverse the continuing swing away from physics in schools.

The First Two Studies

Survey

1.2 In 2005 the Centre for Education and Employment Research (CEER) conducted a survey of physics in schools and colleges (Smithers and Robinson, 2005). It found that physics take-up was very uneven across schools and in some areas the opportunity to take A-level physics was very limited. Chart 1.1 shows that 8.7 per cent of comprehensive schools and 50.0 per cent of secondary modern schools with sixth forms did not offer physics or there were no takers. At the other end of the scale, 7.4 per cent of the comprehensives and none of the secondary modern schools had at least 15 per cent of Yr 13 taking A-level physics. In contrast, 37.6 per cent of the grammar schools and 40.8 per cent of the independents had physics groups of this size.

Chart 1.1: A-Level Physics Entries by Institution

% Yr 13	Comp	Sec Mod	Gram	Ind	SFC	FE	Total
25.0+	0.7	0.0	6.3	8.2	0.0	0.0	2.3
20.0-24.9	2.0	0.0	6.3	10.2	0.0	0.0	3.5
15.0-19.9	4.7	0.0	25.0	22.4	0.0	0.0	8.6
10.0-14.9	22.1	0.0	37.5	32.7	0.9	0.0	21.9
5.0-9.9	43.6	0.0	12.5	22.4	54.5	0.0	32.8
0.0-4.9	18.1	50.0	12.5	2.0	36.4	30.4	17.6
None	8.7	50.0	0.0	2.0	0.0	69.6	13.3
Number	149	8	16	49	11	23	256

1.3 Smithers and Robinson (2005) showed that these differences were closely related to the qualifications in physics of science teachers in the school. This was second only to pupil ability as a predictor of a school's physics results. The best-qualified teachers in physics were to be found in the grammar and independent schools, but the sixth-form colleges and some FE colleges were also well staffed. However, a number of the colleges were finding it difficult to fill their physics places, largely because of an inadequate ladder below them. Almost half of maintained secondary schools lack sixth forms and those without find it particularly difficult to recruit teachers with good qualifications in physics. Nearly a quarter had no teacher who

had studied the subject to any level at university. Without the opportunity to experience physics taught by physics specialists up to the age of 16 it is perhaps not surprising that many pupils should shy away from taking what they have heard is a hard subject at A-level.

1.4 In addition to showing that there were not enough physics teachers to go round, the 2005 survey found that the stock of teachers expert in physics is diminishing. Their age profile is skewed, with almost double over fifty as are thirty and under. Fewer of the newly appointed teachers than the leavers in 2005 were qualified in physics. More of the teachers of physics aged 21-30 held a degree in biology than in physics. This imbalance in the science background of teachers has been confirmed by the National Foundation for Educational Research (NFER, 2006).

Numerical Picture

1.5 The second study aimed to set the survey results in context by examining the trends in the study of physics in schools and universities. It found that between 1982 and 2005 entries to A-level physics declined from 55,728 to 28,119 (by 49.5 per cent). Only 3.9 per cent of 16-year-olds took A-level physics in 2004 compared with 5.9 per cent in 1990. The decline in A-level physics has occurred across all school and college types, but with the sharpest falls in further education colleges and the smallest in independent and grammar schools.

1.6 The drop in A-level physics entries has impacted on the subject at university. More than a quarter of universities that had sizable physics departments have stopped teaching the subject since 1994, while the number of home students on first-degree physics courses has gone down by more than 28 per cent. Forty-two UK universities in 2004 had ten or more home students on full-time first-degree physics courses compared with 57 in 1994. Even in the 26 elite universities with the highest ratings for research the trend in student numbers has been downwards. The report also showed that fewer graduates in physics than in the other sciences are training to be teachers, and a fifth of those who do, train not to be physics teachers but to be maths teachers.

1.7 The numbers of students obtaining A-levels in physics have dropped despite changes to GCSE courses in 1988, which mean that more pupils study some physics up to the age of 16 as part of GCSE science. Efforts to persuade more girls to study physics have also stalled. A-level entries in physics from girls have fallen at the same rate as those from boys to remain at about 22 per cent of the total. Even though girls, on average, get better A-level grades, the proportion at university reduces to 18.5 per cent. Male and female students with A-level physics tend to read different subjects in higher education with the former going mainly into engineering, computing, and the latter into medicine and the biological sciences.

The Present Study

1.8 As part of the analysis of the 2005 survey, schools in the sample were ranked according to the proportion of their Yr 13 in 2004 entered for A-level physics. As we have seen in Chart 1.1, grammar and independent schools took most of the top positions, but eleven comprehensives were up amongst them. The original intention was to match, as far as possible, the top eight with similar seeming schools at the bottom of the list. Matching was attempted in terms of region, the percentage of

pupils eligible for free school meals, and overall GCSE performance. Other variables taken into account were gender, number on roll, size of sixth form, funding category and religious affiliation. It was a difficult process, but from across the sample we were able to arrive at eight pairs to compare and contrast. But while the schools at the head of the list were only too happy to see us - and the present report includes nine of the top ten – those with only a few physics students were much more reluctant. Only three were brave enough to submit to scrutiny. These three schools are compared with their nearest equivalents among the top performers in the next chapter, 'Contrasting Fortunes'. A Catholic girls' school is compared with both a Catholic school and a girls' school, so this part of the analysis is based on seven case studies.

1.9 The direction of the research, therefore, changed somewhat to concentrate on the successful schools and in some ways this is better since we were essentially concerned to find out what is it that enables some schools to have thriving physics departments when most struggle. As well as the seven schools involved in the high/low physics comparisons, nine other comprehensive schools with thriving physics sixth forms and another successful girls' school were studied. These ten case studies are discussed in Chapter 3 which examines the reasons for the schools' success and asks what can be learned from them.

1.10 All 17 case studies are presented in the Appendix. This makes for a long report and we would not recommend that these individual accounts be read through one after the other unless the reader is especially interested. Rather they are the source of the evidence on which Chapters 2 and 3 are based, and are cross-referenced to the charts and quotations in them. It is open, therefore, for the reader to check the evidence and set it in context. The final section in each case study, 'What Can Be Done?' would, however, repay reading since it contains a number of interesting ideas from the heads of physics/science besides those taken up in the main body of the report.

1.11 Chapters 2 and 3 contain the substance of the findings which Chapter 4 draws together. Two key questions are addressed: first, what makes a successful physics school successful and, secondly, what can be learned from such schools that would increase participation in physics.

2. Contrasting Fortunes

2.1 In this chapter we compare three schools with very low physics uptake with similar-seeming schools with high physics uptake to see what distinguishes them. As shorthand, we have designated the schools low-physics and high-physics, respectively.

Comparison A

2.2 School 1, the school with very low physics uptake in Comparison A, summarized in Chart 2.1, is in no sense a deprived school. It is in a very pleasant town, its GCSE performance in terms of five good grades was in the four years prior our visit 23 percentage points above the national average. Its pupils' eligibility for free schools meals at three per cent is way below the national average for secondary schools of 14.3 per cent. But only 2.5 per cent of Yr 13 were taking A-level physics. In contrast, in School 2, the high-physics school, which in fact came top of all the comprehensive schools in our sample, 27.0 per cent were entered. Like School 1, School 2 is in the North West region, it is voluntary aided, Catholic, it is a specialist Arts college, its GCSE performance is similar but somewhat lower, and its eligibility for free school meals is similar but somewhat higher. One major difference, however, is that while School 2 is coeducational, School 1 is for girls only. In order to assess the likely impact of gender we have added another girls-only school to the comparison. Like the other two schools, School 3 is in the North West region, is voluntary aided, is a specialist Arts college and has similar eligibility for free school meals. It differs in selecting a proportion of its intake, reflected in its higher GCSE performance. Chart 2.1 tabulates these details and also shows that all three schools have enjoyed the recent refurbishment or rebuilding of their science labs.

2.3 If on the surface the schools look to be very similar why should they be so different with regard to physics? Five main factors suggest themselves: the calibre of the teaching; the importance attached to physics in the school; whether physics is regarded as a subject or just part of science; the way physics is taught; and the gender of the pupils.

Calibre of Teaching

2.4 Consistent with the quantitative analysis in *Physics in Schools and Colleges* (Smithers and Robinson, 2005), teacher quality emerges as the most important of these factors. The head of science in School 1 identified this as the main reason why the numbers taking physics at A-level were much lower than might have been expected. He had come into the school the previous year as head of science and head of physics in a department of nine with only two physics teachers including himself, neither of whom is a physics specialist. His degree is in chemistry and his colleague is a temporary overseas-trained teacher whose degree again is not in physics:

> Between the two of us, we are just about able to cover the physics at KS4 and KS5. The shortfall is in Yr 9...If it is good and enjoyable at KS4 the girls are more likely to go on to KS5. For instance the school did a survey of the girls and this showed up, like 'we always learn in this lesson', that is, a physics lesson with me teaching it. Gradually I am getting a stronger physics team in place. My temporary overseas teacher is leaving and I have a dynamic NQT coming. I need well-qualified and good teachers to help counteract the perceived difficulty of physics.

Chart 2.1: Contrasting Schools in North West

	1. Low Physics	2.Top Physics School	3. Girls' School
%A2 Physics	2.5	27.0	9.1
Funding	Voluntary Aided	Voluntary Aided	Voluntary Aided
Gender	Girls	Coeducational	Girls
Religious Affiliation	Catholic	Catholic	None
Specialism	Arts	Arts	Arts
Admissions	Not oversubscribed	Hugely Oversubscribed	Selects 35%
GCSEs (FSM)	77% (3%)	72% (4 %)	97% (3%)
Physics Teachers	2, neither a physics specialist	4, all with physics degrees, 3 male, 1 female	4, all with physics degrees, 2 male, 2 female
GCSEs Offered	Triple, Dual, Single	Dual, Single	Dual
A-level Course	Edexcel	AQA syllabus A	Salters
Resources	Labs recently refurbished. 1 FT 2 PT technicians	Labs recently built in new block	4 refurbished labs on one floor of science block. 3FT and 1 PT technicians
Factors Affecting Physics Tale-up	**Take-up is affected by the calibre of the teaching**. It's all about the quality of teaching. If it is good and enjoyable at KS4 the girls are more likely to go on to KS5. I need well-qualified and good teachers to help counteract the **perceived difficulty of physics.** Science has **low status** in the school. Girls are allowed to leave lessons to go to drama/music rehearsals. We have a constant stream of girls leaving lessons. Another factor which affects us here is that **the brightest girls are creamed off at sixteen** by other schools. So we are in this vicious circle, the brightest girls leave so this means our results at AS/A2 are lower and in turn this means that more continue to leave.	When I came there was high turnover of staff and results were poor. I had a say in recruitment and by working at it I have put together **a well-qualified team of physics teachers with degrees in physics.** I take control right from Yr 7. We teach by topic and **they know what is physics**. We have filing cabinets full of **work sheets**. **Homework** is important also. We fo**cus on attainment**. Coursework for GCSE is done in Yr 10 and then revisited in Yr 11. More generally, we have a very good, **supportive head**. Discipline is good in the school and **bad behaviour is not tolerated**.	We have **highly qualified and highly motivated teachers**. We teach the sciences separately from Yr 9 upwards - so basically **'identity'** and possibly the layout of the labs helps. Physics is a **high status subject**. There is a buzz about physics. **The choice of A-level** was very important. Numbers have been building ever since we started Salters. The subject is **fun** to people who feel they can do it. We have addressed this at GCSE as well with fun through **practical work**. We are behind boys' schools in our numbers, but we haven't experienced a 'drift from science'. We have to **go with the grain of girls' natural way of doing things**.
What Can Be Done?	It's all down to the **staff you can recruit**. It's all about the quality of teaching.	The key is a **well-structured curriculum**. The pupils need to have **confidence** in both their own ability and the teacher's ability.	It's essential to have a **core of well-qualified** staff in the school. . It is much harder to instil love of subject when it is not the teacher's specialism.

2.5 In contrast, the other two schools had much stronger physics departments with in each case four specialist physics teachers all with degrees in physics. The highest performing school (School 2) has not always been at the top. "*When I came there was high turnover of staff and results were poor. I had a say in recruitment and by working at it I have put together a well-qualified team of physics teachers with degrees in physics*."

2.6 The high-physics girls' school (School 3) also emphasized the importance of a core of well-qualified physics teachers:

> Physics is a demanding subject. It is much harder to instil love of subject when it is not the teacher's specialism. If you ask the girls they would say 'he loves physics'. The girls know that their teachers are very much into the subject they are teaching. If I am teaching say a biology topic to a Yr 7 group I know I can't put as much into it as a biologist would – it's the same for physics.

Importance Attached to Physics in School

2.7 School 1 was finding it especially difficult to recruit physics specialists and this is not unconnected with the importance attached to physics in the school. Physics was evidently not a priority. The head of science told us, "*Girls are allowed to leave lessons to go to drama/music rehearsals. We have a constant stream of girls leaving lessons. In science we believe it is detrimental in terms of learning*." "*The education in this school can be disrupted by religious activities and sometimes I might not see a pupil for a month if she missed two consecutive sessions on a fortnightly timetable*." Not surprisingly perhaps those with a keen interest in science look elsewhere, "*Physics suffers at A-level here because we lose some of our brightest girls to other local schools*." In contrast, the head of science in School 3, also a girls' school told us, "*Physics is a high status subject and we have a sufficient nucleus for there to be a lively interest in the subject. There is a buzz about physics*."

Physics Identity

2.8 It might be thought from the GCSEs offered that physics would have a stronger identity in the low-physics school than in the other two schools, since it was the only one of the three to offer the physics GCSE. But the issue of identity runs deeper than this. It seems to turn on whether physics is taught as physics from at least Yr 9 by physics specialists some of whom will also be the A-level teachers. As the head of science in School 2 says, "*The pupils need to have confidence in both their own ability and the teacher's ability*." The point is made at greater length by the head of science in School 3:

> We have properly qualified physics staff. We teach the sciences separately from Yr 9 upwards even though we do co-ordinated science. The different subjects are taught separately by specialists. Only in Yrs 7 and 8 is it 'science' as such. Even in the textbook the three sciences are identifiable because they are colour-coded. The layout of the labs also helps. There are three floors of labs each for a separate science with the relevant staff. Although everyone chips in, in Yrs 7 and 8 only very rarely do people teach outside their specialism. It hasn't happened for several years. The quality of

the staff means you get the enthusiasm as well and the ability to explain things.

2.9 School 1 was, in fact, under its new head of science in the process of dropping the physics GCSE:

> We decided to stop offering the separate sciences to concentrate on a well-taught dual award, which, we believe, will provide sufficient preparation for progression to AS/A2 physics…The rationale for this change of policy arose from the fact that for historical reasons we weren't getting the best students opting for the separate sciences. We had a significant number opting to do the course from Set 3 and they were struggling. They had to cope with triple science in the same time allocation as for the dual award…Although we have lost triple science, the dual award is divided very clearly between the three subject areas and I want to keep it that way. In my previous school, an 11-16 school, we were deemed to be 'scientists'. So everybody taught everything.

Way Physics Is Taught

2.10 The nature of the curriculum was stressed by both successful physics schools in this comparison, but from different points of view. School 2, the school with the highest take-up of A-level physics in our original sample, was very instrumental, that is, geared to achieving the best possible examination results for its students. Like School 1 it had given up the separate sciences - against the wishes of some parents - but for a different reason, "*Our data showed that they (the top set) were not getting the run of A* that the dual award sets were getting*." The head of science explained why she thought the school was doing so well in physics:

> We focus on attainment. When I first came here I couldn't understand why we had so few Level 7s at KS3, and the GCSE results were so poor. I look for weaknesses and target them aiming for constant improvement. I would like to do 'cover' lessons for KS4 on the same model as in KS3. There we bullet point what the children need to get down and then set questions on these facts, so any teacher can come in and carry through the lesson. Coursework for GCSE is done in Yr 10 and then revisited in Yr 11. In November, after they've done their modules, everything has improved – their English skills, their numeracy and they can see more clearly what they want to do…The key is a well-structured curriculum that provides clear pathways and builds confidence…The problem is our success at GCSE. We have got pupils doing AS and A-level physics who really shouldn't.

2.11 In School 3 the curriculum has been chosen with the emphasis on the enjoyment of physics:

> We try to get the message across that physics is fun. We are happy if at the end of the sixth form they say it's been 'tough' but they have enjoyed it. Learning and finding out, combined with things that are fun to play with, for instance, toys, remote control cars etc. makes a difference to their perception of physics. We did a survey with Yr 11 at the end of the course. One of the things that came out was their enjoyment of practical work. If you talk to the sixth form in any of the sciences they will tell you how much they like the practical aspect…The choice of A-level is very important. Numbers have been building ever since we started Salters. I remember at the end of the first

cohort in the last term one of the girls turned to me and said 'you know we've learnt an incredible amount but it has been such fun'.

Gender

2.12 Schools 1 and 2 are very similar in many ways. They are voluntary aided, Catholic schools with specialist Arts status with intakes of similar ability and eligibility for free school meals, but crucially they differ in the one being girls-only and the other coeducational. In order to gauge the impact of gender we have included in the comparison a high-performing girls' school. Like School 2 this has four specialist physics teachers, all with degrees in physics. Its general ability level as judged by overall GCSE results is higher reflecting a partly selected intake, but its A-level physics uptake is markedly lower. At just over nine per cent it is only about one third of that in the coeducational school. This bears out the analysis of the second report of this series, *Physics in Schools and Colleges: Patterns and Policies* (Smithers and Robinson, 2006), which showed that less than a quarter of A-level physics students were female and even fewer went on to study physics at university. Physics as a subject seems to hold much less appeal for girls.

Overview

2.13 Thus the gender composition of the intake will have contributed to the big difference in A-level physics take-up between Schools 1 and 2, since even a successful girls' physics school, School 3, mustered less than 10 per cent of Yr 13 in physics. But of more general significance were such features as the calibre of the teaching, the importance attached to science in the school, the teaching of physics as a subject in its own right and a good curriculum. This is borne out by our second comparison.

Comparison B

2.14 The second comparison, set out in Chart 2.2, is between two coeducational, foundation schools in the West Midlands. School 4, the low-physics school, is one of only two schools in a small prosperous town and School 5, the high-physics school, is the only school in another small industrial town. Both have eligibility for free school meals well below the national average, but the high-physics school, although taking the complete spectrum of pupils, has an appreciably higher proportion achieving five good GCSEs. Interestingly, it is the low-physics school that has recently been awarded specialist science status. "*With the new specialism it was either music or science and maths. Science and maths impacts on the whole cohort of pupils with potentially a big boost to GCSE results…so we went for science and maths*."

Ability

2.15 School 5 (high physics) acknowledges that the ability of the intake is a factor in the popularity there of physics. "*The school does appeal to the more academically aware pupils, and physics is seen as the most challenging A-level which attracts the cream of the students along with further maths and chemistry*." Its low physics comparator (School 4) also recognises the importance of ability, but as an explanation of its relatively low A-level numbers. Students do get to take physics in the sixth form, but "*there is quite a high failure rate at AS – up to about half are graded 'U'. They may get on to it because their highest grade is in dual science, say two 'Bs', with everything else 'Cs' or below, but they don't really have what it takes*."

Chart 2.2: Contrasting Schools in West Midlands

	4. Low Physics	5. High Physics (Ranked Sixth)
%A2 Physics	4.2	18.6
Funding	Foundation	Foundation
Gender	Coeducational	Coeducational
Religious Affiliation	None	None
Specialism	Languages (+Science)	Technology
Admissions	Slightly undersubscribed	Only Secondary in Town
GCSEs (FSM)	58% (4 %)	83% (2%)
Physics Teachers	4 teachers including two SMT, 3 female, 3 with physics degrees	4 teachers, 2 PT. FT teachers, male, degrees in mech eng and biology, PT teachers female both physics degrees
GCSEs Offered	Triple (in dual time), Dual	Dual, Single
A-level Course	Salters	AQA syllabus B
Resources	Science block twelve years old, ten labs, two preps, two FT and 1 PT technician	Physics labs mainly mid-50s and short of apparatus. 1 FT and 2 PT techs.
Factors Affecting Physics Tale-up	At present there is precious little specialist physics at KS3 which leaves Yr 10 with the mindset that they can't do physics. Only about half progress from AS to A2. With the new specialist status in science, we are trying to increase our numbers by **enthusing the children**, **making it clear they can succeed** and having **specialist teachers** at KS 4.	I'd like to think that the kids see the **physics staff as enthusiastic, interested in their subject**, **and approachable**. I'd like them to come into the lab **laughing and smiling**, not thinking 'oh, awful, we've now got an hour of physics'. The school does appeal to the more **academically aware pupils** and physics is seen as the most challenging A-level and attracts **the cream of the students**. Parents of pupils coming to the school have **high expectations** and there is high achievement. There is traditionally **strong management** and very **few problems with discipline**. Lower down we've purposely made KS3 very **practical** so the kids get to perceive science as a practical subject. The **science faculty is seen as strong in the school, with stable staff and good results**.
What Can Be Done?	We need more **quality teachers**. I wouldn't pay more, they might be attracted for the wrong reasons. Physicists are not always user-friendly. I would prefer to employ a good teacher who was a biologist rather than a poor teacher who was a physicist	Every teacher should have the opportunity every year or two of **learning about developments in the subject**. I am talking about something different to the five INSET days which in my experience are mainly just about filling the right boxes. Also, give **more recognition to scientists and engineers**.

2.16 Although the percentage achieving five good GCSEs is lower in the low-physics school than in its more physics-oriented comparator, it is still four percentage points above the national average. But its high failure rate at AS reminds us that not everyone has the ability to engage in physics at a high level even if they have shown an interest.

Calibre of Teaching

2.17 As in Comparison A there were differences between the schools in the teaching they were able to provide. Superficially School 4, the low-physics school, may appear to be the better off. Both schools have four teachers including two who are part-time, but whereas three of those in the low-physics school have physics degrees only two in the high-physics school have, and they are the part-timers. However, in the low-physics school two of the well-qualified physics teachers are members of the senior management team with important responsibilities elsewhere. In the high-physics school the mechanical engineer and the biologist have both been teaching physics for a long time and there were two part-timers at the time of the visit only because one retiring teacher with a physics degree was handing over to a newly appointed physicist.

2.18 In the high-physics school, therefore, "*the science faculty is seen as strong in the school, with stable staff and good results. The kids have respect that you know what you are talking about and appreciate a directness in the physics staff who will come clean if they don't know and tell them where to find it*." While in the low-physics school, *"there is precious little specialist physics at KS3 which leaves Yr 10 with the mindset that they can't do physics." "It's a nightmare trying to appoint physical scientists. Our best source is from the trainees. Our last appointment had been a trainee with us and he was one of only two applicants."*

Identity as Subject

2.19 This comment from the School 4 (low-physics school) about the importance of good staff bears out Comparison A. Having become a specialist science school, School 4 is hoping to boost participation in physics by "*enthusing the children, making it clear they can succeed and having specialist teachers at KS4*." Physics will be distinguished as a subject:

> At KS 4 the three top sets and separate sciences have been taught by subject specialists. But from September KS4 down to Set 6 will be taught by specialists. It is to boost A-level take-up. When a physicist says to a student, 'you are good at this, you are capable of doing physics A-level' the student will believe them. They have confidence in our comments when they might not have if they were coming from a non-specialist.

2.20 However, the low-physics school through not having enough physics staff will have to continue teaching across the board at KS3, whereas the high-physics school has specialist teachers from Yr 9:

> We teach the sciences as separate subjects in the dual award. We've always made sure that from Yr 9 onwards they have specialist teachers. In Yrs 7 and 8 there is just the one teacher though we try to change the teacher's specialism from one year to the next. In Yr 9 there are three periods, one

specifically for each of the three sciences. In Yrs 10 and 11 they have five hours per week split into the subjects so we rotate.

Way Physics Is Taught

2.21 As with School 3 in the first comparison, the curriculum in the high-physics school is designed so as to be fun and to involve lots of practical work:

> Lower down we've purposely made KS3 very practical so the kids get to perceive science as a practical subject. They like that. Generally I think the practical content in Yrs 10 and 11 is less than we would like it to be, but we have still got the hard core of believers from Yrs 7, 8, and 9, and still available at A-level…I'd like to think that when kids make choices after GCSE they see the physics staff as enthusiastic, interested in their subject, and approachable. I'd like them to come into the lab laughing and smiling, not thinking 'oh, awful, we've now got an hour of physics'.

2.22 The low-physics school, School 4, offers the modular science GCSE which it sees as improving the motivation of the pupils:

> We have problems with pupils' confidence. I have one girl in Yr 13 who told me in Yr 10 she couldn't do it, but she got a double A at GCSE. Going modular has helped. They get their first results in March of Yr 10 and if they are getting good grades, it makes an amazing difference.

Other Factors

2.23 Comparison B reinforces the picture that has already emerged. The main differences between schools with high and low physics take-up are the teachers and teaching physics as physics. It also brings out the importance of pupil ability. In addition, School 5 recognised that some general features of the school contributed to its physics success:

> Parents of the pupils coming to the school have high expectations and there is high achievement. There is traditionally strong management. Teachers have been aware of the fact that there is the support up there and that has an effect on pupils and they behave accordingly, so there are very few problems with discipline. For somebody in my subject that is ideal – you don't want to get the kids to sit on stools, you want to teach your subject.

2.24 This echoes a point made by School 2, the high-physics school in Comparison A, *"More generally, we have a very good, supportive head. Discipline is good in the school and bad behaviour not tolerated*."

Comparison C

2.25 The third comparison is between two schools in the East Midlands, School 6 (low physics) and School 7 (high physics), both community, coeducational, and popular, with concerns about the science laboratories. Eligibility for free school meals is similar and although below the national average, less so than in the other two comparisons. The low-physics school was slightly below the national average for five good GCSEs and lower than the high-physics school. But there are no striking

differences in background characteristics as listed in Chart 2.3. The contrast was in who was doing the teaching.

Calibre of Teaching

2.26 School 6, the low-physics school, reported, "*Only one of the science staff is capable of teaching physics to A-level. He has a degree in physics. We are also training up an applied scientist, who was an NQT last year, to do more physics. She is finding it very demanding. But she's got the physicist always in an adjacent lab, so there is somebody for her to refer to*." The experience and opportunities in physics of the children at that school are markedly different from those in the comparator where the head of science enthused, "*How many other schools have five specialist physics teachers?…Four of us teach A-level, three with physics degrees and the other with a degree in electrical engineering. The fifth does KS4 only. She prefers this and doesn't want to do A-level and she has an HNC in electronics and physics*." Ironically, the low-physics school recruited a physics graduate but after a year she transferred to the maths department. "*I can teach maths, they're seated, they're not walking around. I don't have to worry about health and safety all the time and the content is not so great or diverse.*"

2.27 So why is School 7 able to attract specialist physics teachers when School 6 is not? It is accepted that currently there are not enough well-qualified physics teachers to go round (Smithers and Robinson, 2006). Those that there are, tend to gravitate to the best opportunities. As the head of science at the high-physics school explained, "*It's a bit of a vicious circle. A nice school can draw them in. I wouldn't apply to a school where I had to teach all sciences. I am a physicist and I want to teach physics*." Science is recognised as a strength of the high-physics school, "*but not overwhelmingly so."* It probably became a strength because the school is in a very pleasant town with a number of science industries, so science is held in high esteem. It has a stable staff and the head of science, himself a physicist, has been in the school a number of years having taken a pay cut to join the school as a main scale teacher to avoid travelling. In contrast, the low-physics school has high turnover and the head of science, a chemist, our source, was herself about to leave. Although popular for the area - "*There is a local saying, 'if you can't teach here, you can't teach anywhere"*" – the school lacks the appeal of the high-physics school.

Physics Identity

2.28 Both schools are keen to teach physics as physics and both at the time of the visits offered the separate physics GCSE. But the low-physics school has been unable to sustain it. The head of physics fell sick and left, and it proved impossible to find a physicist to replace him. A biologist was appointed to a temporary post, which was not extended, and she was followed by a chemical engineer who "*had problems with classroom control*" and who left within the year. Numbers taking the physics GCSE fell from nearly 30 to under 10 in two years, and "*the senior management team decided to pull the plug*." In consequence, the physics post has been lost.

Chart 2.3: Contrasting Schools in East Midlands

	6. Low Physics	7. High Physics (Ranked Eighth)
%A2 Physics	3.8%	16.9 %
Funding	Community	Community
Gender	Coeducational	Coeducational
Religious Affiliation	None	None
Specialism	Arts	Technology
Admissions	Oversubscribed	Popular, but not oversubscribed
GCSEs (FSM)	50% (8%)	63% (7%)
Teachers	One real physicist and one applied scientist we are training up	5 specialists, 4 teaching A-level, 3 with degrees in physics, 1 in engineering and 1 with HNC in electronics
GCSEs Offered	Triple, Dual, Single	Triple, Dual
A-level Course	AQA	OCR 'Advancing Physics'
Resources	Labs dire. 3 technicians, 1 male	Not enough labs, max of 17 classes, but only 12 labs. 3FT technicians
Factors Affecting Physics Tale-up	The **most important resource is the teacher**. There is only one specialist physics teacher and additionally one being trained up to teach physics to GCSE. The physics specialist shoulders the burden of all the A-level work. There is little variety of approach at A-level and practical work is limited. I disagree with those who say all science teachers should be able to teach up to GCSE level. That's rubbish. Problems with staffing just exacerbate the fact that A-level physics is **seen as jolly hard** – 'that's my weakest subject', especially by the girls here. Students can do an A-level in say psychology or geography and probably get an 'A' grade. My students doing physics and chemistry would probably come out with 'Cs' and 'Ds'. The role models are **predominantly male**. That doesn't help either.	The pupils **enjoy** it, they have good teachers, and science and its **separate subjects are clearly identifiable**. How many other schools have **five specialist physics teachers**? A number of the parents work in science industries. It may account for the **prestige science** has. We also get very **good results**. One of the most important things is that the pupils know they will be successful. From quite an early age they are made aware that people succeed at physics. Lots of grade 'A'. Some of that is down to the teaching and the **organisation of the course**. We make sure that parents know they will be **successful** when they come round to open evenings and things. Physics has an aura of being difficult, but actually it isn't. It used to be much more difficult than it is. People think you are cleverer than you are if you have an A-level in physics.
What Can Be Done?	The answer is to **increase the numbers of specialist physics teachers**. If I were in their (the pupils') shoes it would be the teacher who was the key rather than smart labs. **I would put the emphasis on specialist training in ITT** rather than the broad balanced approach. As a chemist doing a PGCE my biology was up to scratch because of my lab experience but not so my physics. I would also like to see **the profile of physics raised** (along with chemistry) and clearly identified **as a subject in its own right** in schools**.**	You need to get in **more and better and dedicated teachers**. It's a bit of a vicious circle. A nice school can draw them in. It is hard at the start so some kind of support mechanism would be helpful, specific to physics. Perhaps starting in a school which has got a good track record in teaching the subject. Or funding some schools to provide first year training for NQTs perhaps **Centres of Excellence for Physics Teaching**.

2.29 It is evident that decisions about the teaching of physics as physics cannot be divorced from the availability of teachers. The head of science at the low-physics school was keen for the sciences to be separately identified from KS3 upwards. But, "*there is only one specialist physics teacher so non-specialists cover the physics parts of the syllabus at GCSE for all but the top sets. At KS3 pupils may never experience a specialist physics teacher*." The head of science, herself, has had to take over some of the physics teaching:

> I haven't enjoyed doing the physics part of dual award. I have had to do a lot of mugging up on it at home. I have put in the effort but there is not the spark. I disagree with those who say all science teachers should be able to teach up to GCSE level. That's rubbish. Student numbers have gone up in chemistry since I came here and the reason they enjoy chemistry is because I can bring it alive.

2.30 The high-physics school offers the triple sciences, but does not feel it is crucial to its success at A-level:

> Doing the triple sciences alongside the dual award means a lot of extra work and there is no real value for the sixth form – the only thing they do extra of use in the sixth form is 'momentum'. But parents like the separate sciences and it is often the reason why they come to the school. So it's got strategic value. We get some coming in Yr 10 from private schools. We get letters from parents asking why their child is not in the separate sciences group.

2.31 But what is important to the high-physics school is that it has the teachers to teach physics as a subject in its own right from an early age:

> From Yr 9 pupils have separate physics, chemistry and biology teachers and separate lessons and tests. Only one teacher at GCSE teaches two subjects – chemistry and biology - and she's qualified to do so. Even in Yrs 7 and 8 the teachers will identify the sciences separately.

Difficulty of Physics

2.32 The availability and quality of teachers also impinges on the way physics is perceived and the results obtained. In the low-physics school, with its staffing difficulties, "*A-level physics is seen as jolly hard – 'that's my weakest subject' - especially by the girls here. Students can do an A-level in, say, psychology or geography and probably get an 'A' grade. My students doing physics and chemistry would probably come out with 'Cs' and 'Ds'*".

2.33 In contrast, in the high-physics school the results are seen as an incentive:

> We also get very good results. One of the most important things is that the pupils know they will be successful. From quite an early age they are made aware that people succeed at physics. Lots of grade 'As'. Some of that is down to the teaching and the organisation of the course. We make sure that parents know they will be successful when they come round to open evenings and things. Physics has an aura of being difficult, but actually it isn't. It used to be much more difficult than it is. People think you are cleverer than you are if you have an A-level in physics.

Résumé

2.34 The three comparisons between schools with similar characteristics, but differing markedly in physics take-up, revealed a number of common distinguishing features. The key points were: the calibre of the teaching; the importance attached to physics in the school including treating it as a subject in its own right; and the way it is taught. In some of the high-physics schools the emphasis was on the fun of the subject, but in others it was on doing what is necessary to obtain good results.

3. Successful Physics Comprehensives

3.1 In this chapter we begin by comparing the five schools with the highest percentages of A-level physics students in Yr 13 in our 2005 sample of comprehensive schools, other than those already considered in Chapter 2. They are labelled Schools 8-12 and they occupied positions 2,3,4,5 and 7 in the ranking. Each of the schools had more than twice the average of their upper sixth taking physics, and that average of 7.9 per cent is for all schools not just the comprehensives. Chart 3.1 sets out the comparison schematically.

Top Ranked Schools for Physics

3.2 The circumstances of the top-ranked schools were very varied. They were found across the regions, in different funding categories, with or without a religious affiliation, and although they were all specialist in only one was the specialism science. But there were also some interesting, and perhaps decisive, similarities. They all had a critical mass of able students either because they were heavily over-subscribed (Schools 8 and 11), or because they were the only school in the town or their part of town, receiving the whole ability range including the brightest (Schools 9, 10 and 12). Four of the high-physics schools had better than average overall performance at GCSE, but School 9 was average. The two oversubscribed schools achieved 27 and 28 percentage points above the average of 54 per cent for five good passes. All the schools were also well below the average of 14.3 per cent eligibility for free schools meals. Interestingly, three of the schools (9, 10 and 12) were 13-18 schools. These were, as we have noted, the sole schools in their catchment areas, but the need to devise a curriculum from Yr 9 may have made it more likely that physics would have been distinguished as a subject from that age. All the schools had at least three specialist physics teachers, but the state of their labs and technician back-up was typical rather than lavish.

3.3 Looking across the columns of Chart 3.1, a pattern emerges which reinforces the distinctive features of high-physics schools identified in Chapter 2. The schools had in common these inter-related characteristics:

- critical mass of able pupils;
- core of well-qualified and enthusiastic specialist physics teachers;
- culture of success in science in the school;
- physics is well taught;
- physics is taught as physics from at least Yr 9.

Critical Mass of Able Pupils

3.4 In the first report of this series, *Physics in Schools and Colleges: Teacher Deployment and Student Outcomes* (Smithers and Robinson, 2005) pupil ability and teacher expertise were identified as the key factors in participation and performance in physics, and they also come through very strongly in the present case studies. They were prominent in the comparisons of high- and low-physics schools in Chapter 2, and they are recurrent themes in the successful physics schools of this chapter:

> I have got to say a lot of it is down to catchment. There are a lot of good feeder schools, a lot of the parents are professionals including in higher education, a lot of them have scientific backgrounds themselves, they value science, and therefore the kids value science. We have a very diverse intake but there is a critical mass of able pupils. (School 8, ranked second)

3.5 Schools 10 and 11 also referred to their intakes. "*This has always been a school where a lot of able children do choose the sciences…There's a group of boys and girls altogether and they talk about science a lot. They come to help at the science clubs and a project we have. They are a bright group and GCSE doesn't stretch them."* (School 10, ranked fourth). "*We have a high ability intake so catchment area does influence numbers in physics*." (School 11, ranked fifth). But both make it clear that this is a necessary, not a sufficient condition, and both go on to emphasize the importance of good teaching.

Core of Well-Qualified and Enthusiastic Specialist Physics Teachers

3.6 School 11 is in no doubt, "*Physics is successful in this school because of the people who teach physics, first and foremost."* School 10, having drawn attention to its bright students and the GCSE's failure to stretch them, goes on:

> You have to be careful they don't get bored. With physics if you just taught them the syllabus at GCSE they wouldn't go on to do it at A-level. We have four extremely good and well-qualified physics teachers. There is a buzz and enthusiasm in the department, we talk to each other a lot, ideas about practicals and so on. I would charge anybody to find any aspect of physics that is boring – there isn't one. We as a department talk about the subject morning, noon and night. We are often here until 6 o'clock. This carries through to the students.

3.7 School 8 again attributes its success in physics to the teachers:

> We have also got some good, experienced teachers who run a tight ship and I think the pupils feel they can trust them, and that they'll do their best for them. It's a subject they feel stimulated and challenged by. What I can do in physics is give them an insight into a problem. You have just got to have a high level of knowledge. I can teach, say, a perfectly respectable chemistry lesson but I can't give them the inspiration and level of detail in examples that a true chemist could. My experience in industry has been a tremendous help in giving authentic information. Kids know the difference between something you have been told about and something you have actually experienced.

3.8 School 9 (ranked third) is equally emphatic:

> One of the good things is we've had stable well-qualified staff in physics for the last three years and good technical support. We've had a lot of fun in making the A-levels, the GCSE, and KS3 happen. We enjoy it. We are around here after school discussing things. The kids come and find us. The kids pick that up and I think that's one of the reasons why we are successful.

Chart 3.1: High-Physics Comprehensives

	School 8 (Second)	School 9 (Third)
%A2 Physics	21.9%	21.1 %
Region	Yorkshire & Humberside	East
Type	Community 11-18	Community 13-18
Gender	Coeducational	Coeducational
Religious Affiliation	None	None
Specialism	Languages	Arts
Admissions	Oversubscribed	Only school in one half of market town
GCSEs (FSM)	82% (4%)	54% (8%)
Teachers	3 specialist physics teachers with degrees in material science, metallurgy and chemistry, all male	4 specialists, 3 teaching A-level, 3 with physics degrees and 1 agriculture, all male
GCSEs Offered	Dual	Dual
Resources	Labs are poor and old-fashioned but school is due to be rebuilt	Three science labs refurbished out of 11. 3 technicians, 1FT and 2PT
Factors Affecting Physics Tale-up	I have got to say a lot of it is down to **catchment**. We have a very diverse intake, but there is a critical mass of able pupils. There has always been a **strong tradition** in the sciences at the school and we've always got good results. **Success breeds success**. Then we have also got some **good, experienced teachers** who run a tight ship and I think the pupils feel they can trust them, and that they'll do their best for them. We only teach outside our subjects in Yrs 7 and 8 so another factor in uptake at A-level is that **right from Yr 9 the physics component is taught by physics teachers**. The **way we teach** is also important. Our style of teaching is probably quite traditional. But the kids love stories. So if you know your historical physics well and you can put it over in an interesting way that hooks them in. In short: we have a **good reputation**, **very good capable teachers** for a long period of time, good catchment, and **ambitious, aspirational pupils**.	There is a **culture of success in science** in the school. We have consistently done well at KS3 and science is one of the highest achieving subjects at GCSE – 7-10 per cent above the school. For the kids it is a **success story begetting success**. One of the good things is we've had **stable well-qualified staff** in physics for the last three years and **good technical support**. We enjoy our work and the kids do too. We also **distinguish the sciences** so the kids can see which they like and are good at. We are experimenting with using ICT resources a lot so even with a supply teacher the kids can still access the work even though they are not getting the input from the teacher. The other thing is we make it fun. We've revised the schemes of work, tried to bring in lots of **practical activities**.
What Can Be Done?	It's about getting the **teachers**. My personal opinion is that it is 80% of the battle. It is also important that **physics is taught as physics**. The new GCSEs seem to have been designed for schools that haven't got specialist physicists. It's all chemistry and biology.	It's very important to get and keep the teachers. The **newly trained teachers must have a chance to find their feet**. **University courses** could also be made more effective and exciting.

Chart 3.1 (cont): High-physics Comprehensives

School 10 (Fourth)	School 11 (Fifth)	School 12 (Seventh)
19.5%	19.1%	18.0 %
North East	West Midlands	East
Voluntary Controlled 13-18	Voluntary Aided 11-18	Community 13-18
Coeducational	Coeducational	Coeducational
None	Church of England	None
Art (plus Technology)	Technology	Science
Only school in market town	Massively oversubscribed	Only school in market town
74% (6%)	81% (2%)	57% (8%)
4 specialist teachers, 3 with higher degrees and one with hons in physics, 3 male, all teach A/AS	3 specialist physics teachers with degrees in mech eng, physics and biology, 2 male	3 specialists, two teaching A-level, all with physics degrees, all male
Dual, Single	Triple, Dual, Applied	Triple, Dual
13 labs for science some very old-fashioned. Four technicians, FT, female	Three physics labs, not very impressive. 4 technicians, 3 FT but none is physicist	12 science labs renewed as necessary. Just 2 FT technicians (should be 4) plus intern
This has always been a school where **a lot of able children do choose the sciences**. On the one hand, they realise the **kudos**, they know it's a gold standard A-level and there are **tremendous job opportunities**. On the other, there is a lot of **passion and fun** from KS3 and upwards. With physics if you just taught them the syllabus at GCSE they wouldn't go on to do it at A-level. We have four extremely **good and well-qualified physics teachers**. There is a buzz and enthusiasm in the department, we talk to each other a lot, ideas about **practicals** and so on. **Expectations** are high and there is good **parental support**, including pressure to do well.	We have a high ability intake so **catchment area** does influence numbers in physics. But physics is successful in this school because of the people **who teach physics, first and foremost**. Physics also has a **clear identity** from Yr 9. The **science ethos** in the school is huge. Over half of the sixth form take the sciences. One of the things I have done to improve physics numbers is to **work closely with the maths department**. We actually **target pupils in Yr 11** – tell them they are capable of doing sciences at A-level. We get lots of A-level students because they have seen their predecessors going on to do interesting things.	I think the biggest factor is to have a **nucleus of physics teachers**. A lot of new physics teachers find that very, very difficult, the entire burden of curriculum and assessment lands on this one person. Then **leadership and management** as with any subject is critical. Another key factor is that we try to establish **a separate flavour to the different sciences** very early on. We don't see science as one homogeneous 'blob'. There are skills that are covered in each, that are clearly transferable skills, but we organise for progression in particular directions in which the pupil has interest.
We need more **good and enthusiastic teachers**. A problem in many schools is that trainees are traumatised by their first placements. We have a really **good induction system**. We have fabulous **staff development opportunities** which other schools should too.	We'd love to provide a **'specialist training centre' for the newly-qualified**. I'd also like to bring **maths and physics closer** - science and maths are separate departments who barely talk to each other in many schools.	I would like a way to be found of having **NQTs in successful departments for at least a year**. Perhaps the 'Beacon Schools' idea where you would 'grow' physics teachers. Another thing I would like to see is **PGCEs with a focus on physics**.

3.9 School 12 (ranked seventh) completes the set. It brings out the difficulties newly qualified teachers may have if they are not recruited to a department with an established core of good physics teachers:

> I think the biggest one is to have a nucleus of physics teachers…Talking to other heads of science some will get a physicist, maybe an NQT, who will come in and its 'hey we've got a physics teacher'. Suddenly the entire burden of curriculum and assessment lands on this one person…A lot of new physics teachers find that very, very difficult. We are very lucky here and when I joined four years ago there was a tradition of at least three physics teachers. I think it becomes extremely difficult in schools, given the number of physicists out there, to establish a core physics group. With such a low base of physics teachers, there often isn't a critical friend they can turn to in their own science department. What they are having to do relatively early on is work with staff whose subject is not physics or having to support a member of staff. Without being derogatory they are fire fighters, supporting the poor biologist who, say, has to teach forces.

Culture of Success in Science in School

3.10 Three of the schools refer to a culture of success in science in the school. School 9 (third) with over a fifth of Yr 13 taking A-level physics from an intake judged in GCSE terms of about the national average, put it this way:

> We have a successful physics department within a successful science faculty. Next year it is projected that in a larger sixth form about 30 per cent will be doing A-level physics and half doing biology. It's pretty staggering - a template of how to 'breed' scientists. There is a culture of success in science in the school. We have consistently done well at KS3 and science is one of the highest achieving subjects at GCSE – 7-10 per cent above the school. This carries on into the sixth form. We have had, for example, one of the top students in the national results for Advancing Physics in each of the last three years. For the kids it is a success story begetting success.

3.11 School 8 (second) also speaks of 'success breeding success':

> There has there always been a strong tradition in sciences at the school? We have always had good numbers doing science and physics and we've always got good results. So when parents come to open evenings, they go round the subjects, look at what the results have been and what the prospects are and physics comes out well. It is a self-perpetuating thing to some extent - 'success breeds success'.

3.12 And School 11 (fifth) makes essentially the same point: "*The science ethos in the school is huge. Pupils at this school love science. Over half of the sixth form take the sciences. It is something in the core of the school*."

Way Physics Is Taught

3.13 Although knowing the subject is a necessary condition, good physics qualifications are not sufficient in themselves to make a good teacher. All of the five successful schools compared in Chart 3.1 drew attention to the way they taught the subject, but each had its own preferred approach. School 8, the school with the second highest

proportion of A-level physics students, leavened its traditional teaching with the history of physics:

> The way we teach is also important. Our style of teaching is probably quite traditional. But the kids love stories, eg Newton arguing with Hook, the first atomic bomb going off. It gives them a look into it. So if you know your historical physics well and you can put it over in an interesting way that hooks them in. That can be missing in a lot of schools these days where its 'go to this website and find this information'. Kids want to be empowered and to find things out for themselves, but for kids who are intelligent and can sit and listen, and can take information in visually and orally, it's attractive. There is an element in the pupils who come to our school that is quite arrogant and if they detect any lack of knowledge or weakness in you they don't respect you.

3.14 School 9 (third) attempts to blend systematic coverage with enjoyment:

> All our schemes of work and materials are digitized which has been a major development in last four years or so. We are experimenting with using ICT resources a lot. We are trying to get every single work sheet digitized so you can just click and have a look at it. This has been a major thing. The other thing is we make it fun. We've revised the schemes of work, tried to bring in lots of practical activities, brought in activities, like the air rocket and so on. The kids love it.

3.15 School 10 (fourth) works hard at a good teaching style and a good atmosphere in class:

> So the kids get very involved in the lessons. We use a system of trying to encourage students to give answers and they are not frightened because there is no put down. For the weakest kids there are systems in place to help them. In my Yr 10 class this morning there were three members of staff - a learning assistant, a part-timer and me - all helping the kids because they have their exam in single award science in two weeks time.

3.16 School 11 (fifth) attaches importance to collaborating with the maths department, "*One of the things I have done to improve physics numbers is to work closely with the maths department. We tell students if they are doing physics they should do maths and vice-versa. It does make a difference to the grades."*

3.17 School 12 (seventh) says it's important to differentiate:

> We prepare pupils ranging from those who can just about pass the GCSE to those very clever, hardworking pupils who get loads of 'As' at A-level and go off to do Natural Sciences at Cambridge. But the whole way through we do see the sciences as separate and we want pupils to get the best possible experience in the classroom. The way to do that is not to spread the talent evenly, but ensure that those people who have got the interest in astrophysics do it and those that do an equally good job with covalent bonding or biotechnology issues go there.

Teaching Physics as Physics

3.18 Differentiation leads naturally to the fifth feature the successful physics schools have in common and that is teaching physics as a subject in its own right, certainly at KS4, but usually from at least Yr 9 onwards. However, this does not necessarily mean teaching the triple sciences. Two of the schools (11,12) offered the physics GCSE to some students, but the other three taught the sciences separately within the framework of the dual award. School 12 (seventh) which does offer the separate sciences, put it this way, "*Another key factor is that we try to establish a separate flavour to the different sciences very early on. Even in Yr 9 they are taught separate sciences so they can see that these three subjects have different strengths and characteristics. We completely reject the notion that 'science is science"*".

3.19 School 8 (second) takes the same view, "*so another factor in uptake at A-level is that right from Yr 9 the physics component is taught by physics teachers. This engenders identification of subject specialisms*." School 9 (third): "*Because we are organised into biology, chemistry and physics departments in the school with separate prep rooms and big A-level numbers we have tended to teach KS3 and KS4 science as three subjects. The kids get science on the timetable but they have three different teachers."* School 11 (fifth): "*physics also has a clear identity from Yr 9*."

3.20 But School 10 (fourth) was concerned that there was a move to submerge physics in science:

> Our children are having a bit of trouble with recognising the subjects within the schemes of work. For instance, they will say 'when is the chemistry exam on the timetable?' and of course I have to say its Science Paper 2 because its not identified as chemistry. I think there is a deliberate policy to get rid of these identities.

Other Successful Schools

3.21 Chart 3.2 tabulates five other successful physics comprehensives, labelled Schools 13-17. The first two are the schools ranked ninth and eleventh overall. School 15 had the third highest number of A-level physics students, but in a large sixth form, so it did not get into the top group in percentage terms. School 16 is the highest placed school in the South East, a region that would not otherwise have been included (grammar and independent schools are concentrated in this region and tend to cream the comprehensives). School 17 is a very successful girls' school. Chart 3.2, and the full case studies in the appendix, reinforce the message of Chart 3.1: that the successful physics schools have a core of good physics teachers.

Leadership and Teachers

3.22 Although School 13 emerges as ninth overall in our listing it is disappointed with current A-level physics numbers and it attributes this to a failure to provide specialised physics teaching in KS4. However, there is hope of recovery now that a new head of physics (poached from a nearby school) has been appointed:

> We have been to some extent the victims of our success. With just 1½ physics teachers and two classes in each of Yrs 12 and 13 our teaching was mainly confined to A-level. KS4 have been coming through without having had any physics teacher at all and this has had a knock-on at A-level. Even though the KS4 biologists and chemists doing the physics are excellent

> teachers, they don't have the same inside knowledge and anecdotes, the same kind of unconditional enthusiasm. Pupils vote with their feet. They like a certain teacher, get used to them and they stick with that subject. If you asked Yr 12 why they are doing physics they would probably say that they enjoyed Yr 11 and have confidence in the teacher. They know, therefore, they are on safe ground, which is especially important in physics where the perception is that it is a hard subject. So we have a rebuilding job to do. The key responsibility of the new head of physics will be to promote the subject.

3.23 School 14 (eleventh) also illustrates the importance of good leadership and teachers:

> When I arrived there was an understanding that physics was difficult and you would only expect a 50 per cent pass rate. I said 'no', what's the point of doing it if you don't pass, so we aim to get everybody through. If we think they can't succeed we don't take them. I take personal responsibility for their grades. I give up time for extra-revision courses. I think I'm an approachable and friendly personality. That 'openness' including the grading and marking is important. I'm very accessible. I'm your pocket teacher – you keep me in your pocket! If you're struggling and it happens to be 9 o'clock at night and I'm online you can talk to me.

3.24 School 15, with the third highest number of A-level entries, in attempting to articulate the reasons for its success, nicely encapsulated the main points to have emerged in this study:

> The sciences are taught as separate all the way through from Yr 7, so the students can recognise physics and know whether they like it. The way it works is that kids spot a teacher they have confidence in and stay with them. We have as much ambition as we can possibly have here for our students at A-level to go on to the best universities and to study physics and related subjects. The gold standard is to get them into Oxbridge, Imperial, and wherever to study physics and then we have done something. While we do show the kids how important physics is for getting a job we tell them they are going to university to study a subject not to get a job so to make sure it's a subject they enjoy. They know everybody thinks physics is difficult. Our job is to get them keyed into it and it works. Once they get into it you can't get rid of them, they come back for clubs etc.; it's about creating a 'culture' around the department and the teachers.

3.25 When the head of science and physics in School 16, the top-performer in our sample in the South East, was asked what he was doing right, he said:

> I don't know how to answer that. I have thrown it around the staff. They said 'you're enthusiastic about your subject'. I do 'talk' physics early on and I think I might sow a seed here and there. I'm always talking positively about 'when I teach you in the sixth form for physics'. It's tenuous. I can't really quantify it. I'm active at open evenings. I'm enthusiastic. We teach physics as physics from Yr 9 and the A-level teachers also teach Yrs 7-11 so the kids can see who they will be getting. A core of physics teachers is vital. We can sit down and talk about physics, the latest developments, what's in the news. In the sixth form they swap ideas and also they put pressure on you to some extent so you need the knowledge base to draw on to fuel their interest.

Chart 3.2: Other Successful Physics Comprehensives

	School 13 (Ninth)	School 14 (Eleventh)
%A2 Physics	16.0%	15.3 %
Region	South West	Outer London
Type	Foundation	Foundation
Gender	Coeducational	Boys
Religious Affiliation	None	None
Specialism	Science	Technology
Admissions	Oversubscribed	Three times oversubscribed
GCSEs (FSM)	69% (8%)	73% (6%)
Teachers	3 specialist physics teachers with degrees physics, two male	3 specialist teachers, 1 with physics degree, 1 from abroad , 1 newly appointed, 2 female
GCSEs Offered	Dual	Dual, Applied
Resources	Capital funding from specialist status has provided an extra wing with conference room and display areas etc	Labs and funding adequate, 3 FT and 1 PT technicians
Factors Affecting Physics Tale-up	In fact our numbers have been a little disappointing. We have been to some extent the victims of our success. With just 1½ physics teachers and two classes in each of Yrs 12 and 13 our specialist teaching was mainly confined to A-level. KS4 have been coming through without having had any physics teacher at all and there has had a knock-on at A-level. So we have a rebuilding job to do. The new head of physics will **promote the subject on open evenings**, there will be a much **higher profile of physics teachers at KS4** and we will continue with the **enrichment activities**.	I think a lot has to do with the **results**. We've got great **enthusiasm** and high **expectations** for A-level. We have **specialist teaching in Yrs 10 and 11** so they know they are doing physics. We do identify clearly which is physics, chemistry and biology from early on. Even in Yr 7 they have two units of each of physics, chemistry and biology. Both the pass rate and A-level take up have increased since we switched to **modular science**. We also make them aware that maths and physics can lead to the **highest paid jobs**. We put up displays of the jobs you can get. We pick up on publicity, for example, from the TV about physics and employment and incorporate it into the lessons.
What Can Be Done?	Schools need to be able to get the teachers to ensure that **physics at KS4 and earlier is taught by specialists** so the pupils know who they are and can relate to them as someone who is going to get the best out of them at A-level. **Role models** are also incredibly important. We get ex-students coming back here, who are excellent adverts, helping us to counteract the image of a dull, academic, hard subject.	Our school could be a '**Physics Centre**'. If a school had no physics teacher the pupils could come to the 'Centre' here. It could run **master classes** in the evening or **the training of teachers** who are not specialists to teach physics. There is a problem with physics teaching that if you don't love it then you are never going to be able to put across how interesting a subject it is.

Chart 3.2 (cont): Other Successful Physics Comprehensives

School 15 (High Numbers)	School 16 (Highest in SE)	School 17 (Girls')
11.6%	11.8%	5.9 %
Inner London	South East	Outer London
Foundation 11-18	Community 11-18	Foundation 11-18
Coeducational mainly Boys	Coeducational	Girls
None	None	None
Technology	Maths and ICT	Technology
Part selection	Not over-subscribed	Heavily over-subscribed
85% (11%)	75% (2%)	81% (4%)
5 FT + 1PT, 4 physics degrees, 1engineering, 1 biology. 4 teach A/AS, 5 male.	4 specialist physics teachers 3 with degrees in physics + 1 medicine, 3 male	3 physics teachers all with degrees in subject, 2 higher, all male
Triple, Dual, Single	Triple, Dual, Applied	Triple, Dual
Has benefited from specialist status with injection of £30,000	Under-resourced, desperate for white boards, 2 FT+1 PT tech	New science block, 5 technicians, 4 FT
It's a damn good school with a lot of **highly qualified and motivated teachers**. We also have a **critical mass of very able** science students. Our view is that you win if you target the top end - make sure it is being stretched. The **sciences are taught as separate** all the way through from Yr 7, so the students can recognise physics and know whether they like it. The way it works is that kids spot a teacher they have confidence in and stay with them. We have as much **ambition** as we can possibly have here for our students at A-level to go on to the best universities. It's about creating a **'culture'** around the department and the teachers.	I do **'talk' physics early on** and I think I might sow a seed here and there. We teach **physics as physics from Yr 9** and **the A-level teachers also teach Yrs 7-11** so the kids can see who they will be getting. **A core of physics teachers is vital**. We can sit down and talk about physics, the latest developments, what's in the news. I've always believed in choice and tried to give as much science choice as I'm allowed to do. So at GCSE **it's single, double or triple**. A relatively high proportion of the children who come here have the **ability** to do well in physics, but that does not necessarily mean they would take it. That they do is down to us.	**Bright girls, good labs and technicians, and the three sciences taught as themselves within a mutually supportive faculty**. It is also to do with **money and resources**. But the **teachers make a huge difference**. The two of us who **teach A-level also teach lower down the school.** I know the girls like the teachers and that influences their A-level choices. We do well in terms of girls taking physics, but for whatever reason physics **doesn't seem to appeal to girls** as much. When the girls are choosing A-level options we give presentations in the lessons on what physics means in terms of **employment**.
Other schools could try to develop that **culture**. We need to train **more specialist teachers** and teach physics rather than science, or news about science. **It is no good throwing physics teacher trainees or NQTs in at the deep end**. They need time to develop their confidence in the classroom and they need the support of other physics teachers.	There are issues affecting **retention**, for instance, a lack of control in many schools. But it is especially tough starting out. It is important to be able to feed off experienced teachers. It is essential to have **good specialists to learn from**. Just following the book would be literally a paper exercise.	**Teachers are the key**, but where are they going to come from? I wonder if something could be done to ease the induction of the NQTs. **Facilities and back-up** from technicians also make a huge difference. I can well see physics graduates opting out to teach maths if they don't get sufficient help.

3.26 There is thus remarkable consistency across our high-physics schools. It is the teachers and the leadership from the head of department; it is teaching physics as physics; it is a culture of high aspiration and success; and it is lively teaching in KS3 and KS4 by the A-level teachers. But our final school, School 17, shows that it also depends crucially on the pupils. This school has all the characteristics of a high-physics school, but only 5.9 per cent of its Yr 13 were taking the subject:

> We have bright girls, good labs and technicians, and the three sciences taught as themselves within a mutually supportive faculty. It is also to do with money and resources. But the teachers make a huge difference. We went to a conference where there were lots of other physics teachers and you could tell the ones with blossoming departments because they were the more accessible to talk to and have the ideas. We do have that critical mass of bright and enthusiastic physics specialists, but many schools don't. The two of us who teach A-level also teach down the school.

3.27 School 17 is a girls' school and, as it itself muses, "*for whatever reason physics doesn't seem to appeal to girls as much*." That has been another recurring theme of this series of reports.

Résumé

3.28 Detailed scrutiny of nine schools with high A-level physics take-up plus a successful girls' school confirms the comparisons of Chapter 2. The key features of high-physics schools emerge as: a critical mass of able pupils; a core of well-qualified and enthusiastic specialist physics teachers; good leadership in science and physics; a culture of success in science in the school; physics is taught as physics; and it is well taught by A-level teachers in KS3 and KS4 so the students know who they will be getting and physics is not perceived as difficult and a risk to grades. The relatively low take-up of physics in a girls' school with all these characteristics (except perhaps the first) also reinforces the findings of Comparison A in Chapter 2: that, even in a school with considerable advantages, girls are disinclined to study physics.

4. Reversing the Decline

4.1 Physics in schools is seemingly in free-fall. Entries at A-level have dropped sharply. Since 1990 they have gone down by over a third (35.0 per cent) while A-level entries overall have risen by 12.1 per cent. As a percentage of 18-year-olds the decrease has been from 5.9 per cent to 3.9 per cent, which suggests that there are young people with the ability to take physics to a high level who are not now doing so. The drift away from physics has occurred mainly in comprehensive schools, sixth form colleges and particularly further education colleges, with grammar schools and independent schools less affected.

4.2 But our 2005 survey revealed that there are some comprehensive schools bucking the trend. They were able to recruit more than double the national average of A-level physics entries (including independent and grammar schools). This report is a detailed study of these schools contrasted with those at the bottom of the ranking. Its main aims have been:

- to uncover what makes for a successful physics school;
- to see if what they are doing can be transposed to other schools to halt and then reverse the seemingly relentless decline in physics.

Characteristics of Successful Physics Schools

4.3 The characteristics of the high-physics schools have been discussed in detail in Chapters 2 and 3, and the individual accounts are set out as case studies in the appendix. From the wealth of information gathered it is evident that those schools share a number of important characteristics in which they differed from the low-physics schools: strong physics leadership; core of well-qualified and enthusiastic physics teachers; culture of science success; the way physics is taught; physics is treated as subject in its own right; and last but not least a critical mass of able and interested pupils.

Strong Physics Leadership

Quality of leadership was not mentioned much by the heads of physics and science themselves probably because they took it for granted or out of modesty. But it was obvious to us and it came through in many of the things they said. The head of science, a physicist, in School 2, the comprehensive school with the highest A-level physics take-up in our sample, said: "*When I came there was high turnover of staff and results were poor. I had a say in recruitment and by working at it I have put together a well-qualified team of physics teachers with degrees in physics*." School 13 (ninth) was disappointed that it had been experiencing some fall-off in interest and put this down to outgrowing the capacity of its physics specialists so they had had to concentrate on A-level at the expense of KS4. They had, however, just head-hunted a new head of physics. "*So we have a rebuilding job to do. The key responsibility of the new head of physics will be to promote the subject*." The head of physics School 14 (eleventh) explained: "*When I arrived there was an understanding that physics was difficult and you would only expect a 50 per cent pass rate. I said 'no', what's the point of doing it if you don't pass so we aim to get everybody through*."

Core of Well-Qualified and Enthusiastic Physics Teachers

From the schools' details and what the heads of departments told us it was clear that all the high-physics schools had a core of at least three well-qualified and enthusiastic physics specialists. This was the most obvious difference from the low-physics schools. Not all the physics specialists had degrees in physics, but most did. A few had been recruited from closely related subjects like materials science or engineering, and there was the occasional biologist (who had been teaching physics successfully for a long time). The case for physics expertise is made powerfully in Chapters 2 and 3, but it is worth reminding ourselves of the difficulty a very good teacher of chemistry can have with KS4 physics. The head of science in one of the low-physics schools said, "*I haven't enjoyed doing the physics part of the dual award. I have had to do a lot of mugging up on it at home. I have put in the effort, but there is not the spark. Student numbers have gone up in chemistry since I came here…because I can bring it alive."*

With their teams of physics teachers, the successful schools were not only able to have several teaching at A-level (one of the low-physics schools hinted that their problem was that the sole physics specialist was boring), but also the A-level teachers taught at KS3 and KS4. This was important in progression to A-level. As School 15 put it, "*The way it works is that kids spot a teacher they have confidence in and stay with them*." This helps to counteract the perception that physics is difficult. School 7 (eighth) made essentially the same point: "*Physics has an aura of being difficult, but actually it isn't. From quite an early age they are made aware that people succeed at physics*." In our first report (Smithers and Robinson, 2005) we found that a serious problem in physics education is that the 11-16 schools are under-provided with physics specialists. Consequently, there is no physics ladder taking pupils up to the sixth form colleges and further education colleges, which are generally well staffed in physics but find it difficult to fill their places.

Culture of Science Success

A number of the high-physics schools drew attention to the strength of science in their schools. School 8 (second): "*There has always been a strong tradition in sciences at the school and we've always got good results.*" School 9 (third): "*There is a culture of success in science in the school.*" School 10 (fourth): "*This has always been a school where a lot of able children choose the sciences*". For these schools it was "*success begetting success"*. In School 1, however, in spite of GCSE results 23 percentage points above the national average, physics participation is tiny because science is not regarded as important: "*Girls are allowed to leave lessons to go to drama/music rehearsals. We have a constant stream of girls leaving lessons*." "*The education in this school can be disrupted by religious activities and sometimes I might not see a pupil for a month if she missed two consecutive sessions on a fortnightly timetable*."

So how does a school get to be a strong science school in the first place? Two of the schools referred to the bonus of having local science-based industries giving high prestige to physics. The school that topped our ranking had got there through strong leadership. An attractive location makes it easier to recruit physics teachers. But while schools, within their limits, can be transformed, they can also wane. The head of science in School 13 (recently promoted to assistant headteacher) told us, *"Our numbers are slightly down on what we would expect. My energies up to 2000 were*

concentrated on physics, but since then I have had to take my eye off the ball with all the other responsibilities…We are back to one group each year (Yrs 12 and 13)…Physics needs someone to be constantly promoting the subject."

Way Physics Is Taught

The way the teachers taught was also very important. It is clearly not enough to have physics expertise, it must be put across effectively. There were two distinctive emphases in the way the successful schools approached the teaching of physics which we can perhaps dub the '**systematic instrumental'** and the **'intrinsically pleasurable'**. The first is best exemplified by the school that topped our rankings (School 2). Here everything is codified in a departmental handbook with very clear schemes of work backed by *'filing cabinets full of worksheets'*. The focus is on attainment with everything done to maximise the pupils' and school's performance, with triple science dropped because it was not yielding enough 'A*' and course work done twice. Its very success is causing a problem. *"We've have got pupils doing AS and A-level physics who really shouldn't*."

School 5 (sixth) attaches more importance to the fun to be had: "*I'd like them to come into the lab laughing and smiling, not thinking 'oh, awful, we've now got an hour of physics'… My observations are that kids do enjoy the GCSE science on the whole particularly the practical element. They enjoy the challenge because they have to think. The government solution seems to be 'dumbing it down', taking out what I always thought of as the core stuff in physics. I also have reservations about target setting. We used to set targets for every child in each subject. But when you ask them what their target is, they don't know, so what's the point?"*

Both approaches in the right hands can be very successful and each high-physics school struck its own balance between them. One of the great advantages of setting out the course in worksheets or on PowerPoint is that, as School 9 (third) pointed out, *"even with a supply teacher the kids can still access the work even though they are not getting the input from their regular teacher."*

Teaching Physics as Physics

All the successful physics schools had specialist physics teachers teaching the subject as physics (rather than as subsumed in science) in KS4 and in most cases from Yr 9 or earlier. They have taken the view that biology, chemistry and physics are different subjects which should be taught by specialists. School 15: "*so the students can recognise physics and know whether they like it."* Two of the low-physics schools would like to have done so, but did not have the teachers. School 6 put it this way, "*I disagree with those who say all science teachers should be able to teach up to GCSE level. That's rubbish*!"

Teaching physics as physics does not mean that it has to be offered as a separate GCSE. High-physics schools have shown that it can be taught successfully within dual science provided it is distinguished as a subject and taught by specialists. Some schools had retreated from the triple sciences because the school could only afford the time allocation of two subjects. It may be that there will be a move back with the new GCSEs since several schools were contemplating teaching the core science GCSE in Yr 9 with Yrs 10 and 11 devoted to the separate sciences or 'additional' science. Three 13-18 schools came in the top nine physics schools and a factor here

was having to plan Yrs 9-11 as a whole. School 10 (fourth) did, however, express concerns that the new scheme of work could dissipate the sense of subject identity, "*Our children, however, are having a bit of trouble with recognising the subjects within the schemes of work. For instance, they will say 'when is the chemistry exam on the timetable?' and of course I have to say its Science Paper 2 because its not identified as chemistry. I think there is a deliberate policy to get rid of these identities*."

Critical Mass of Able and Interested Pupils

The high-physics schools do recognise that they are fortunate in having a critical mass of pupils with the ability to enjoy physics. Some are in this position because they are over-subscribed and their admissions arrangements, even if they do not involve selection, tend to result in a skewing to the top end of the ability range. But, interestingly, there were also some 'true' comprehensives, catering for the whole ability range from candidates for the leading universities through to pupils who really struggle. These tended to be the sole schools in their areas. The head of science in School 9 (third) explained why he thought that comprehensives worked well in this situation: "*We prepare pupils ranging from those who can just about pass the GCSE to those very clever, hardworking pupils who get loads of 'As' at A-level and go off to do Natural Sciences at Cambridge. But the whole way through we do see the sciences as separate and we want pupils to get the best possible experience in the classroom*."

School 9 was able to achieve over a fifth of its sixth form successfully studying physics from an intake whose GCSE results overall were close to the national average. But within its mixed ability intake there was a critical mass of physics enthusiasts who it had found ways of identifying and educating to a high level. Having pupils with the ability is necessary but not sufficient. School 1, a girls' school, has a very able intake, but its priorities are elsewhere. Physics just does not seem to hold much attraction for girls and, among other things, this has implications for recruitment to teaching, which appeals more to females.

Other Features

Other aspects that might have been expected to play a part in high-physics take-up seemed less important. While some of the successful schools bubbled with enthusiasm for enhancement activities such as clubs, visits, lectures, and competitions, others were more sceptical, preferring to concentrate on the curriculum. The top-ranked school (School 2) said, "*We do not go in much for enhancement activities*." School 5 (sixth) said, "*We are not particularly strong on enhancement activities."* And School 7 (eighth) said, "*We do not do much in the way of extracurricular activities. I probably disagree with my seniors on this. One of the things we do is to focus very much on our primary aim which is to teach kids about physics*."

Neither did the state of the laboratories seem to be a determining influence. The facilities of the successful schools ranged from the sumptuous to the frankly dismal. The quality of the learning had much more to do with who was doing the teaching than where it was staged. School 6 (low physics): "*If I was in their (the pupils') shoes it would be the teacher who was the key rather than smart labs*." Technician support was probably more important but most of the schools felt they were under-

staffed in this respect and found it difficult to recruit to the posts they had. Poor back-up is probably one of the reasons for the drift from physics into maths teaching. As the head of science in School 17 said: "*Facilities and technician back-up also make a huge difference. I can well see physics graduates opting out to teach maths if they don't get sufficient help in setting up practicals*."

What Can Be Done?

4.4 Although these features have been discussed individually they are clearly inter-related. A school can only teach physics as physics if it has a sufficient core of specialist teachers. It is chicken-and-egg since a school is likely to be more attractive to teachers if it offers the prospect of specialist teaching. These interconnections have to be borne in mind if one is thinking of ways to reverse the drift from physics in schools. It is not easy to see what can be done. But who better to be able to suggest possible courses of action than the heads of physics and science running successful departments? Those consulted in the present study came up with four main ideas: use successful physics schools to help newly trained physics teachers to find their feet; more specialised teacher training; a well-structured curriculum; and sabbaticals to enable physics teachers to keep up with subject.

Centres of Excellence in Physics Teaching

4.5 The argument for centres to ease the transition from teacher training to work in the classroom was best expressed to us by the head of science at School 12 (seventh of our top schools). "*Working with physics teachers countrywide and talking to heads of science some will get a physicist, maybe an NQT, who will come in and its 'hey we've got a physics teacher'. Suddenly the entire burden of curriculum and assessment lands on this one person. They don't get two or three years to develop their own teaching and learning strategies. A lot of new physics teachers find that very, very difficult*."

4.6 He proposed an interesting solution:

> Perhaps the 'Beacon Schools' idea where you would 'grow' physics teachers. The focus would be NQTs learning to teach and be supported where there was a critical mass of good physics teachers. This would be on reduced teaching time but several NQTs in the one school would free up a senior member of staff for mentoring and other things. Then NQTs would have a grounding from which to move into departments less well off. A cohort of NQTs from say 15 schools could also meet regularly at the 'Beacon School' or a science learning centre over the course of the year to hone up their teaching, subject knowledge, examination skills and other things. Physicists from the school could also go out to help other schools to mentor their physics NQTs. I do notice as I move around that a lot of money goes into professional development, but if staff are not supported/not trained it just doesn't get going.

4.7 This idea is echoed, but not articulated as fully by a number of the other heads of successful departments. School 7 (eighth): "*It is hard at the start so some kind of support mechanism would be helpful, specific to physics. Perhaps starting in a school which has got a good track record in teaching. Or funding some schools to provide first year training for NQTs perhaps Centres of Excellence for Physics*

Teaching." School 9 (third): "*It's very important to get and keep the teachers. The newly trained teachers must have a chance to find their feet. When our NQT came four years ago, the two others and me were there with many years experience to support him. So he has been brought up in this atmosphere. He's learned loads of stuff in a place with a buzz about it. All new entrants should have that sort of chance. It must be soul destroying just to be thrown in at the deep end*." School 10 (fourth): "*We need more good and enthusiastic teachers. A problem in many schools is that trainees are traumatised by their first placements. There it's very much survival and no time to reflect on what they came into teaching for. We have a really good induction system. NQT staff get a great deal of support, around their subject and behavioural issues, and they are given a chance in the sixth form*."

4.8 School 11 (fifth): "*I bet at lot of those who train to be physics teachers fall out in their first year because there is not enough support. We'd love to provide a 'specialist training centre' for the newly-qualified. We already provide pre-training experience for those thinking of doing a PGCE*." School 14 (eleventh): "*I would love to have some kind of responsibility for physics across the borough, or with other schools, encouraging physicists. Or our school could be a 'Physics Centre'. If a school had no physics teacher the pupils could come to the 'Centre' here. It could run master classes in the evening or the training of teachers who are not specialists to teach physics*."

4.9 School 15 (100 taking AS/A physics): "*It is no good throwing physics teacher trainees or NQTs in at the deep end. They need time to develop their confidence in the classroom and they need the support of other physics teachers*." School 16 (South East): "*There are issues affecting retention, for instance, a lack of control in many schools. But it is especially tough starting out. It is important to be able to feed off experienced teachers. I've found that out with my department. It is essential to have good specialists to learn from. Just following the book would be literally a paper exercise*." School 17 (girls'): "*Teachers are the key, but where are they going to come from? Joining us here must be quite different from going into a school as the only physics specialist. I wonder if something could be done to ease the induction of the NQTs*."

More Focused PGCE

4.10 Another recurring suggestion from the heads of science was for a more focused PGCE. They seemed to favour more specialisation within the sciences rather than a more radical approach of combining physics and maths. Here they could see two difficulties. Maths and the sciences are separate in many schools and, according to the heads of science, have quite different outlooks. The organisation of schools would have to evolve to accommodate a joint teacher. Secondly, there is already a drift of physics graduates into maths teaching and a joint PGCE might exacerbate this. School 6 (low physics): "*I would put the emphasis on specialist training in ITT rather than the broad balanced approach. As a chemist doing a PGCE my biology was up to scratch because of my lab experience but not so my physics*." School 11 (fifth): "*I'd also like to bring maths and physics closer. A PGCE in physics and maths would be good, but when schools interview a physicist they expect their second subject to be a science. I also think you'd lose more to maths*." School 12 (seventh): "*Another thing I would like to see is PGCEs with a focus on physics. But I am doubtful about a physics-maths PGCE. The culture in maths is different and*

they tend work in different ways. There could also be a staff loss – I don't want to teach any biology so I'm off to teach maths." School 14 (eleventh) expressed a contrary view: "*Combining maths and physics into a PGCE might well go down well. We are thinking here of linking the maths and physics departments a lot more. Some teaching overlaps and we are not necessarily capitalising on that. It's a timetabling issue and we need a more consistent approach.*"

Well-Structured Curriculum

4.11 The comprehensive school with the highest proportion of its Yr 13 taking physics – 27 per cent – attributed it success to the way it teaches the subject. "*The key is a well-structured curriculum that provides clear pathways and builds confidence. The pupils need to have confidence in both their own ability and the teacher's ability*." Its importance was alluded to by most of the other successful schools although not stated as explicitly.

Opportunities for Updating

4.12 A particular difficulty for scientists one that might deter those interested from training to be teachers is the fear of losing touch with the subject. Several of those heads of department who we consulted argued, from their own experience, for sabbaticals to enable physics teachers to keep up to date. School 5 (sixth): "*Every teacher should have that opportunity every year or two of learning about developments in the subject. I had a week on a university course which I thoroughly enjoyed. It is of immeasurable benefit to the kids since it gives you confidence in the subject and developed my professional understanding and skills. For example when I graduated quarks hadn't been understood yet I have to teach it. So unless I'd read up and gone on that course I would have had to stand up in front of 25 sixth formers without a clue. I am talking about something different to the five INSET days which in my experience are mainly just about filling the right boxes, for example, on behaviour management and preparing for Ofsted*." School 16 (South East): *There perhaps ought to be compulsory and universal sabbaticals for science teachers so that they can keep up-to-date. If I come across something new in physics I get myself onto a 2-week residential course as soon as possible*."

Policy Pointers

4.13 The main purpose of this report has been to identify from the study of successful physics schools what might be done to halt and reverse the decline in school physics. The government has already received a wide variety of proposals, for example, from The Royal Society (2006) and the House of Lords Science and Technology Committee (2006) and it has a number of incentives and initiatives in train. But the heads of department consulted here came up with a novel suggestion which we think should be explored further. Essentially, it is to involve the schools with thriving physics departments in settling newly trained teachers into the classroom.

Proposals to Government

4.14 There is general agreement that, in principle, the solution to the physics crisis is to attract more good teachers, but there is little agreement as to how it might be done. The head of science in School 7 (eighth) explained why he thought it difficult:

> A lot of the physicists I studied with not are not natural teachers. I know from my own experience quite a bit of physics is very focussed, very single-

> minded, and quite nerdy. Those who are good at it lack the social skills required to be a teacher. You don't want to set up a system that tries to attract people with first-class honours degrees and very precise research minds to become teachers because they probably won't have the characteristics to be a successful teacher. They might even reinforce the stereotype.

4.15 The satisfactions of physics and teaching are different (Smithers and Hill, 1989) and relatively few physics graduates enter teacher training. Over a fifth of those that do opt to train as maths teachers. Smithers and Robinson (2006) found that there are three times as many teacher training places in biology as there are in physics. Only about two-thirds of the teacher trainees in physics complete their training compared with over four-fifths of those in biology and chemistry, and only just over three-quarters of the completers take posts in maintained schools. The net effect is that of every 100 embarking on teacher training in physics, only just over half enter teaching and, as with all subjects, the highest wastage is in the first three years of teaching.

4.16 Most proposals for improving physics teacher supply home in on increasing the pool of trainees through, for example, the governments's 'golden hellos', higher rates of pay (House of Lords, 2006) or training up non-specialists (The Royal Society, 2006). But the focus of the heads of science in the present study is on reducing the loss of those physics graduates who are attracted to teaching. Three suggestions were made which we commend to the government:

- Centres of Excellence in Physics Teaching based on schools where there is a core of well-qualified and enthusiastic physics teachers to ease the transition from teacher training and to classroom teacher (see paragraphs 4.5-4.9);
- More focused PGCEs so potential physics teachers are not put off by the thought of having to teach biology (see para 4.10);
- More technician support (this is also recommended by the House of Lords, 2006) to make it easier to put on practicals, the effort of which is thought to be a major reason for physics graduates switching to maths teaching.

Proposals to Schools

4.17 Any school wishing to improve physics take-up has relatively little room for manoeuvre. It is dependent on the government and the Teacher Development Agency for Schools to secure a supply of good teachers. Catchment and competition from other schools will determine whether it can attract a critical mass of able and physics-interested pupils. Parental support may or may not be forthcoming. But there are two actions open to such a school.

- Appoint a strong and clear-sighted head of physics and provide him/her with the support to recruit a team of well-qualified and enthusiastic physics teachers. As we have seen, the comprehensive topping our ranking (School 2) was turned round in just such a fashion.
- Teach physics as physics. Recognise that biology, chemistry and physics are different subjects attracting different talents and temperaments and don't be taken in by the comfortable argument that says science is science and any

science teacher can teach any science. Physics, chemistry and biology can be taught within a science GCSE, but the teaching should be by specialists, including the A-level teachers. Good teaching not only counteracts the impression that physics is a hard subject (it is very easy for some students), but it also gives the students confidence in the people who would be taking them in the sixth form. The new suite of GCSEs is a framework which allows the science core to be taught in Yr 9 with opportunities for specialisation in Yrs 10 and 11, either as separate sciences or as 'additional' or 'applied' science.

Conclusion

4.18 Not everyone has the ability or interest to study physics to a high level, but since 1990 the proportion of the age group taking A-level physics has fallen from 5.9 per cent to 3.9 per cent in 2005. Thus it is clear that there are young people with the ability who at present have either not developed the interest or lack the opportunity. What can we learn from comprehensive schools in which physics is thriving that would encourage more young people into this fundamental branch of human knowledge? What emerges is that, crucially, there must be expert and enthusiastic teachers to awaken interest and develop talent. It is not easy to recruit physicists to teaching, but too many of those who do show an interest are lost without making careers in the classroom.

4.19 The idea emerging in this study that appeals to us most is that of harnessing the experience of the top physics comprehensives to ease the path of teacher trainees into the profession. One approach would be to fund some as centres of excellence where the newly-qualified could learn from experienced and successful colleagues before taking on the responsibilities of a post where they could be the only physics teacher in a science department. It would be well worth commissioning a feasibility study to see how this might work in practice, and in the event of a favourable report, to run a trial.

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Appendix: Case Studies

A.1 Case studies of the schools are set out on the following pages in the order they are summarized in the text. They are included mainly for reference rather than as a continuous read. We begin with the schools in Comparison A (Chart 2.1) with the low-performing school first, then move on to the schools in Comparison B (Chart 2.2) and those in Comparison C (Chart 2.3). Case Studies 8-12 are the other five top performing schools in order of percentage A-level physics participation (Chart 3.1). Case Studies 13-17 are the schools summarized in Chart 3.2 and are, respectively: the next two highest performers; the third highest school on numbers but down on the percentages because of the size of its sixth form; the highest school in the South East; and a girls' school in addition to the two in Comparison A.

Methods

A.2 Initially the schools were contacted towards the end of April 2006 by letter, sent directly to the named head of physics (or science as appropriate). These details were available to us from the 2005 questionnaire survey returns. A phone call to the school office was made first to check the person was still in post. The letter, asking the school to participate, explained what the proposed study entailed, how it had arisen out of the 2005 survey, why they had been chosen and what they would be asked to do if they agreed to take part. A copy of the 2005 report was also included with the letter. The letter explained that in a few days the researchers would get in touch by telephone to follow up and to discuss the possibility of visiting the school. Two variants of the letter were prepared, one for schools at the top of the ranking and one for the others with lower take-up. The top performing schools readily agreed to take part, but it was more difficult to get the low-physics schools to participate. Three were brave enough to explore with us why their physics uptake was so low. They are compared with high-physics schools in Comparisons A (two comparators), B and C in Chapter 2. The other ten schools studied were all high performing schools, though School 17, the girls' school, was only successful compared to other girls' schools.

The Visits

A.3 The school visits took place over a period of several weeks starting in May just before the half-term break and finishing towards the end of the summer term in July. Arrangements were made to interview the head of physics, or the head of science, depending on who had provided the information on the 2005 questionnaire. In some of the schools these posts were held by the same person. The interview was semi-structured and was more in the nature of a conversation, which focused on the key issues relating to physics take-up in the school. Each interview lasted about two hours. To obtain an accurate record of the conversation the interviews were tape recorded and then transcribed.

The Interview Schedule

A.4 The interview was based on a framework common to all the case study schools but the nature of the questions were tailored to the particular circumstances, especially whether it had high or low take-up of A-level physics. The 2005 questionnaire was used as the starting point for the discussion and the opportunity was taken of

updating information already provided by the school. The interview covered the following areas:

- contextual factors including location, the abilities and social background of the pupils, admissions policy and specialism (if any);
- leadership in physics and science in relation to departmental/faculty organisational structures and responsibilities;
- staffing, including teacher qualifications and experience in physics, the match with teaching requirements, the recruitment and retention of physics and other science teachers and technicians; involvement in teacher training; and staff development and the opportunity for training and further study;
- the curriculum, organisation and delivery of science teaching in Yrs 7-11, including time allocation and features of practice, including monitoring and assessment;
- the curriculum, organisation and delivery of science teaching in the sixth form, including gender differences and destinations;
- the resources available to support the teaching of physics and science in general, such as the provision and condition of laboratory space, equipment and computing facilities and to include also the strength of teaching in IT and mathematics;
- the promotion and presentation of physics and science in school, in particular through the development of enhancement activities within school and outside;
- the school's view of why it had high/low-physics take-up;
- what the school thought might be done to increase the numbers taking A-level physics.

Other Evidence

A.5 The interviews provided the core of the information obtained, but the case studies are also derived from:

- observations made during the visit, in particular of the physics and science laboratories;
- documentation provided by the schools, including departmental reports, curriculum materials, examination results and other numerical information including the destinations of sixth form leavers;
- published information on the school including the school's website, Ofsted reports, DfES performance profiles, and any newspaper articles on the science activities of the school.

Individual Accounts

A.6 On the following pages detailed descriptions of the 17 schools visited are given. They are inevitably condensations of rich impressions and information, but for ease of access they are set out in the same way each time following the order of the

interview questions listed in paragraph A4. The full case studies are included as the evidence on which the recommendations of this report are based. Although it is not anticipated that they will be read through in turn, the 'What Can Be Done?' section at the end of each case study contains a number of interesting ideas besides those taken up in the main report. In order to protect the anonymity of the schools some peripheral details have been changed.

Case Study 1: Low-Physics School from Chart 2.1

Voluntary Aided, Roman Catholic, Girls, Comprehensive, 11-18, North West, Specialist Arts, 900-1,100 pupils, 160-180 in sixth form, 2.5% A-Level Physics. Interview with Head of Science.

Context

This is an average sized secondary school situated in a town centre. The pupils, all girls, come from about 40 feeder primary schools serving a wide catchment area which is basically the Catholic diocese. At GCSE results are way above the national average. The percentage of pupils eligible for free school meals is much lower than the national average as is the percentage of students with statements of special educational needs.

Faculty Organisation

I came to the school two years ago as head of science as well as to be in charge of physics. There are also teachers with separate responsibility for managing biology and chemistry within the science department.

Staff

There are 9 teachers in the department including a deputy head who has a limited teaching commitment. Two of us are responsible for the physics teaching through to A-level, myself and one other teacher. Neither of us is a physics specialist. My degree is in chemistry. But I am known as a physicist because I teach physics. We did have a female physics specialist but she left last year. We advertised nationally and were lucky to pick up a science teacher on a temporary basis who was keen and able to teach physics although her degree, which she obtained overseas, is not in physics. We are fully staffed in terms of the level of technical support we are allowed, with one full-time senior technician and two part-timers. Of course we would like more. We try to allocate each of them to a specific subject specialism.

Years 7-11

Until the beginning of this school year we offered triple science in addition to single and dual award. We decided to stop offering the separate sciences to concentrate on well-taught dual award, which, we believe, will provide sufficient preparation for progression to AS/A2 physics. The rationale for this change of policy arose from the fact that for historical reasons we weren't getting the best students opting for the separate sciences.

Except in Yr 7 the pupils are in groups according to subject ability through to Yr 11. There are six sets. Sets 1 to 3 were offered the possibility of doing triple award. We found that we had a significant number opting to do the course from Set 3 and they were struggling. They had to cope with triple science in the same time allocation as for the dual award. Sets 4 and 5 did the dual award exclusively. Single science was offered to a small group of about 14 to 20 students in set 6. Some of these girls are capable of doing the dual award but were under-achieving because of behavioural problems.

The other reason for dropping triple science, bearing in mind the time allocation for it, was practical. The education in this school can be disrupted by religious activities and sometimes I might not see a pupil for a month if she missed two consecutive sessions on a fortnightly timetable.

A small minority of parents were quite vocal but the head was fully behind the change. Although we have lost triple science the dual award is divided very clearly between the three subject areas and I want to keep it that way. In my previous school, an 11-16 school, we were deemed to be 'scientists'. So everybody taught everything.

Between the two of us, we are just about able to cover the physics at KS4 and KS5. The shortfall is in Yr 9. In that year I allocate two teachers to each group who teach in rotation. I try to make sure that each biologist is teamed with a physical scientist. In Yrs 7 and 8 each group is taught by one teacher, who may not have any physics background at all. At KS3 we follow a scheme of work based on the Hodder 'Starting Science' scheme. Since 2002 we have also participated in the CASE programme. Traditionally we have followed the AQA syllabus. We haven't come to a decision yet about the new GCSEs.

We are very keen on monitoring. All the test and modular results are made very clear to each group, displayed as a wall chart, so each girl can track her own progress. It's transparent and it allows moves across the ability range and in that sense we don't have to justify the moves.

Sixth Form and Beyond

The sixth form is available to all existing pupils who can fulfil the requirements of individual subjects. For AS physics we advise pupils should have 'B' grades in GCSE science but we don't demand this. We have taken those with 'Cs'. Again in maths we prefer a 'B' but we don't insist. This year we have 7 in Yr 12 and 2 in Yr 13. In Yr 11 we possibly have 11 wanting to go on to AS, but this could drop to five or six by Yr 13. AS filters out about 50 per cent. Physics suffers at A-level here because we lose some of our brightest girls to other local schools, particularly the grammar school. For historical reasons, we follow the Edexcel course at AS and A2 levels. We haven't looked at more innovative courses like 'Advancing Physics'.

Resources and Funding

All seven of our labs have been fully refurbished in the last five years and we are well equipped. Three have excellent computing facilities. Being relatively new to the school it is difficult to comment about the impact of specialist status, which was operational before I came here. As far as I can comment I see the impact more indirectly. Girls are allowed to leave lessons to go to drama/music rehearsals. We have a constant stream of girls leaving lessons. In science we believe it is detrimental in terms of learning. I'm not sure whether we would be supported in that belief or not.

Extra-Curricular Activities

So far I have not yet had much chance to develop this area. Our activities are still rather limited. Our Yrs 12 and 13 have attended out of school master classes and they also go to the Philip Allen lectures. The school runs curriculum extension days for each curriculum subject. Science gets one day and this is a great boost at KS4 for getting course work done.

Physics Take-Up?

On the face of it the numbers should be much higher at A-level. Even though the three sciences have a clear identity there are several reasons why they are not. I believe, although it is a bit early for me to be sure, that **take-up is affected by the calibre of** the **teaching**.

Before last year we had half the numbers opting for AS that we have now. It's all down to the staff you can recruit. It's all about the quality of teaching. If it is good and enjoyable at KS4 the girls are more likely to go on to KS5. For instance the school did a survey of the girls and this showed up, like 'we always learn in this lesson', that is, a physics lesson with me teaching it. Gradually I am getting a stronger physics team in place. My temporary overseas teacher is leaving and I have a dynamic NQT coming. I need well-qualified and good teachers to help counteract the **perceived difficulty of physics.** This is a big problem with the girls. I think there is also a more general issue relating to **the way students learn, especially in girls' schools,** for example, in physics they like to be given very clear information, logically sequenced, with explicit instructions.

The perception of physics as difficult is made worse by the negative impact that the maths department has. Some concepts are wrongly understood or not at all. Admittedly we have **to raise the profile of physics** in the school, which I am trying to do, it's not very good. But there are other issues, which could help, like **more co-operation with** maths**.**

Another factor which affects us here is that **the brightest girls are creamed off at sixteen** by other schools. So we are in this vicious circle, as I have said, the brightest girls leave so this means our results at AS/A2 are lower and in turn this means that more continue to leave to go to other local, higher performing schools.

Case Study 2: High-Physics School from Chart 2.1 (Ranked First)

Voluntary Aided, Roman Catholic, Coeducational, Comprehensive 11-18, North West, Specialism Arts, 1,200-1,300 students, 200-220 in sixth form, 27.0% A-Level Physics. Interview with Head of Science Faculty, a physicist.

Context

The school is hugely over-subscribed with a very large catchment area. When I first came we were not so over-subscribed and about 10 per cent of the intake were non-Catholic but now there are very few. When we took in 10 per cent non-Catholics a lot of them were very bright, now we have lost that group.

Faculty Organisation

We are organised as a faculty with three heads of subject. The separate science subject heads take responsibility for A-level and schemes of work all the way through. They decide the exam boards. For the new GCSE I, as head of science, did the research and gave them a presentation on the options, and unanimously they wanted to stick with the most traditional one.

Staff

Fourteen members of staff are assigned to the faculty including two of the deputies. This doesn't help at all – they are always so busy doing other things. Although I have some say, each year I have to put in a bid to the curriculum manager for teachers to be allocated to levels. When I know who I have got teaching at which level I can organise the teams for each group. I have two teams of three teaching across the ability range. I have no control over which teacher has sets 7 and 8 but for the others I can work out who I want teaching which set and what topics. I do a rota with Yrs 7-11 colour-coded to see who is doing what including the reports, the parents' evenings and the like. So I organise it all to make it fair.

It is difficult to get well-qualified staff, but I have a network. We had two retirements in the summer and we had two very good candidates for the first post we advertised. We decided to appoint both, one a chemist and the other a physicist, and the chemist can also teach physics so we didn't advertise the second post. One of the appointments is someone who came to us for PGCE training. Outside the faculty the head of maths has a joint maths with physics degree. He keeps saying he would like to come across to do some physics.

I'm very hot on professional development and I make sure the staff are looked after. It is very important. We had to have temporary cover last year. He came from abroad and struggled because he had a very heavy accent. He went home for Christmas and just did not come back. We managed to fill in but the pupils will have had three different and not very good teachers, so I'm sure the results will suffer.

Years 7-11

We offer the dual and single award science, but not the separate sciences. We used to but then gave it up. Only the top set did the separate sciences. Our data showed that they were not getting the run of A* that the dual award sets were getting. Also we could only spare five periods per week. Staff, too, were wanting to opt out of teaching it because of the coursework.

We only ran it for a couple of years allocating by set. The second set were miffed they couldn't do it, so it also led to bad feeling. In physics we found we were repeating quite a lot of the electronics at AS so that was another reason for dropping the physics GCSE. The parents were quite keen for us to keep the triple, but they have been very supportive since our numbers have increased so the parents' attitude was not a big factor. When I came here there were just 11 doing chemistry. We now have 65 doing chemistry still less than physics and biology, but its still not low is it?

We are, of course, facing new schemes of work now. We will keep it simple; it has to be simple. I wrote the current scheme of work fifteen or so years ago. We have sat down with it and all I have done is swap it around a bit. I didn't change it much at all. We just carved up what would have been Yr 10 and Yr 11. We found that chunks had been missed out – decent stuff – all the induction has gone, momentum is back in. I have opted for the SEG syllabus. We do that now, so the new GCSE syllabus from September is closest to what we do now. I will not water down if I can possibly help it. Except Sets 7 and 8 all will do the core and additional. They will not have a choice. Sets 7 and 8 will just do the core. I am not doing applied. Just the core over two years like a single award. The rest will do core and additional very similar to the dual more or less as they do now. We will do the modules early and that will be like the core in Yr 10.

We are traditional in our approach, but I am also very keen to use ICT in the classroom. I talk to them a lot; I explain a lot. I don't depend on the projector. I set very clear goals. When I see a weak area we target it. Two years ago I realised it was KS4, so I said 'let's target that'. We have a huge effect on the schools results – we provide two of the 5 A*-Cs. They only have to get three more. I feel the pressure of that. If I am above the school in grades A*-C then I know I am doing my job. Our results went up by 13 percentage points when we went modular. Basically we had by Yr 11 six modules in the bag so they knew exactly what they had to do in the last two papers. All the time 'it's you can do it; you will do it'.

Sixth Form and Beyond

They have to get six A*-C GCSEs to get into the sixth form. We lose about two or three per year from physics at AS, but they are the ones who shouldn't be doing it anyway. The problem is our success at GCSE. We have got pupils doing AS and A-level physics who really shouldn't. A lot of the successful A-level candidates go on to do degrees in science or engineering afterwards, and we also have a fair few medics. A small group – six last year - of the less able did do the advanced science GNVQ and they were successful and went off to university. I rather suspect the applied science route, which has just started as double AVCE Science, will be the same.

Resources and Funding

Funding has gone up a bit this year because we now have specialist status. We also have small bits of sponsorship from local companies. The specialism is Arts because the head did not want to specialise in a core subject. He felt this would put pressure on that subject and he wanted to raise the profile of other subjects. Languages, like ourselves, is quite strong and that was a possibility, but much smaller numbers of course in terms of A-levels. Eventually it was decided to go for music, drama, arts which between them can generate more pupils.

I am not too worried about science not being chosen. I would have had to have a member of staff allocated to just dealing with the links. That would have been away from the teaching, and I am very much the sort of person who wants them in the classroom.

Extra-Curricular Activities

We do not go in much for enhancement activities. There are two main reasons. We bus a lot of children out at 3.10. Then there is the problem of lunchtime. We used to have a science club. But this year we changed the school day. The head felt that a lot was going bad at lunchtimes – 1300 children in an over-crowded building. He has devised a 1½-hour lunch cycle with lesson 4 incorporated into that, so the years are rotated through a 30 min break. This means that only a third of the school is wandering around at any one time. The knock-on effect, however, is you can't have clubs at lunchtime. Last night I went out with my Yr 13 physics group (to see the Da Vinci Code). But we don't do much. I encourage them to read things. We did some master classes at Cambridge in particle physics and astronomy. In fact, we have three, what you would call 'social events' for Yr 13 during the year, one in each of the main sciences. Yr 12 haven't so far had anything.

Why Good Physics Take-Up?

I take control right from Yr 7. We teach by topic and **they know what is physics**, what is chemistry and what is biology. I organise the syllabus so that they continually revisit topics like electricity. All they learn about electricity in Yr 7 is current and we make sure that they know all about it and different circuits. In Yr 8 they start to think about voltage, which is quite a hard concept, and then electro-magnetism in Yr 9. At each stage we revisit what they have learnt before and that helps, it builds on their knowledge. Especially in physics we work in a very logical manner up through the levels of difficulty. I spent a lot of time devising this strategy.

We have filing cabinets full of **work sheets**, so when a new teacher arrives and says 'how can I do this' they are there for them. I've been teaching 30 years so I have loads, which are really helpful to a new teacher. **Homework** is important also. It is essential to learning. There is no point in giving them homework if they don't get instant feedback. We do a lot of marking in science – more than in other subjects - and write really thorough comments.

We focus **on attainment**. When I first came here I couldn't understand why we had so few level 7s at KS3, and the GCSE results were so poor. I look for weaknesses and target them aiming for constant improvement. I would like to do 'cover' lessons for KS4 on the same model as in KS3. There we bullet point what the children need to get down and then set questions on these facts, so any teacher can come in and carry through the lesson.

Coursework for GCSE is done in Yr 10 and then revisited in Yr 11. In November, after they've done their modules, everything has improved – their English skills, their numeracy and they can see more clearly what they want to do. New course work rules will affect this. We give advice, for example, labelling axes on graphs. We don't actually help them just make useful comments.

More generally, we have a very good, supportive head. Discipline is good in the school and **bad behaviour not tolerated**.

What Can Be Done?

The key is a **well-structured curriculum** that provides clear pathways and **builds confidence**. The pupils need to have confidence in both their own ability and the teacher's ability.

When I came there was high turnover of staff and results were poor. I had a say in recruitment and by working at it I have put together a **well-qualified team of physics teachers** with degrees in physics.

Case Study 3: High-Physics Girls-Only School from Chart 2.1

Voluntary Aided, Girls, Comprehensive 11-18, North West, Specialist Arts, 1,200-1,400 pupils, 330-350 in sixth form, 9.1% A-Level Physics. Interview with Head of Science and Head of Physics.

Context

Although designated a comprehensive school it is a former grammar school which has remained partly selective. Currently we admit 35 per cent by academic ability. The school is heavily oversubscribed and the other 65 per cent of places are allocated according to several criteria. We have, for example, a high proportion of siblings and that is what produces the tail. The school has a wide ethnic mix. As well as admitting at age 11 it also has an intake into the sixth form. Quite a lot of girls who come into the sixth form are from non-English homes, parents wishing them to be in an all-girls school rather than a mixed sixth form or sixth form college. The girls that come in are high flyers, they have to be very good to get a place, and so they do well. Not many of the pupils are eligible for free school meals or have special needs other than physical or visual difficulties. Although there is a range of social backgrounds they tend to come from more prosperous homes. Some parents definitely have high expectations for their daughters and this can be a pressure; pressure to do medicine or veterinary science that may be totally unrealistic. For example, someone in year 10 at foundation level and the parents say she has got to take the higher level because she wants to be a vet. The school has Beacon Status, a Charter mark and has received School Achievement Awards.

Faculty Organisation

The three sciences have individual heads of department who have autonomy for day-to-day running and organisation. The head of science oversees and co-ordinates through a meeting every week. In terms of appointments, the head of the particular science department and the headteacher are on the interviewing panel, and in addition the head of science and a deputy headteacher help draw up the short-list.

Staff

Science is a big department with 18 teachers, but only four (including one who was full-time but is now 0.7) of us are physicists. We all hold single honours degrees in physics. Two of us are female and two male. Although it is a very attractive school with opportunities to specialise in teaching physics to very able girls, it is not easy to recruit suitably qualified physics teachers. When we wanted a physicist two years ago we were exceedingly lucky in finding someone through a network of contacts. The downside to recruiting staff is the house prices. Two of us are nearing retirement and that is going to a real problem for the school.

We are very keen on training teachers. We have loads of GTPs and PGCEs in the school. We have them in science and it is unusual not to have at least one. Last year we had a GTP in physics. The trainees provide a 'pool' of potential staff. We are also keen on staff development though money is always tight. We've all been on IoP updating courses. There has been a tremendous input this year from the new GCSE. I've just spent three days at the science learning centre on particle physics and astrophysics courses. It is very, very important that people go and go regularly. You need the chance to talk to other physics teachers.

We are stretched for technicians. Three are almost full-time and one is part-time. Really we need at least another full-time one. It can be very difficult. Only in last three years have we had had the part-time one. Every year we put in a bid for another.

Years 7-11

In science the girls are setted from Yr 9 in which there are two parallel bands of upper and lower sets. In Yrs 10 and 11 it is a bit more complicated. In past the girls in the top sets did the dual award and the less able girls did modular science of which about a quarter do, about 10-12 girls each year, were entered at the foundation level. There has been a lot of opposition to the modular course from the parents, and the girls were not keen on it. This year everybody will do co-ordinated science with one group at the foundation level. Most of the A-level physics students come from the top set with may be one or two from the next one down. Once we had a girl from the modular course who actually did quite well.

We've spent a long time deliberating over what to do with the new GCSE and we all decided we liked AQA the best. OCR's 21st Century Science was a step too far for some people and we weren't too keen on the way it is examined. We are not going for AQA multiple choice either. We can see no point in multiple choice for one year and then swapping to another sort of assessment in Yr 11. We find girls are not so good at multiple choice. They are better at the more discursive type of question.

We declared before the government announced in its 7 March 2006 document that we would teach separate sciences to every girl who achieved a level 7 in the KS3 SATs and core and additional to everyone else. We're a bit unsure about the bottom dozen girls (ours aren't like other schools). We won't try Applied Science yet. That would be too many changes at once, so we'll give them core and additional. If doesn't work we'll try again. Yesterday we had our SATs results and nearly two-thirds of the year group achieved level 7. So we will have rather a large separate science group. We haven't done the separate sciences hitherto, because of the sheer content of them. The School didn't want to crowd out opportunities for music, art and other options. You could get into A-level anyway with the Dual Award. So there was no point. The physics, chemistry and biology content of the new courses is less than the current separate GCSEs so we can deliver them in the same time as the dual award. At the moment only the very bright would have coped with separate sciences as they currently are and we would have needed four instead of three periods per week.

We are doing separate sciences for two reasons. Ease of moving on to A-levels is one though A-levels will be changing. Then over years there has been a lot of pressure from parents for separate sciences and here is the opportunity to do it but in exactly the same amount of time that everybody else has for the double award. We envisage some of them moving down to double at the end of the first year. We plan to teach the core and the additional in parallel because there isn't a lot of meaty content in the core. We think they will find it boring so we are going to teach Yr 11 material as well and are not going to do any exams until the end of two years except for internal ones.

The big question is will this produce more girls wanting to do physics at A-level or not. I am not sure. At the moment when they get their dual award result they just get the grade, but we know the numbers for the three sections and we can see that they get less high marks in the physics than the chemistry and biology sections.

If this happens with the separate sciences it could put the girls off and that worries me. We have found internally that physics is their best or second best paper. So I'm not sure whether the separate science will end up being a real incentive or not.

Sixth Form and Beyond

To take any of the sciences in the sixth form the girls must have at least a double B at GCSE. We also in physics like them to have an 'A' in maths. If they do not have an 'A' we discuss at length with the head of maths whether they will survive. Most of the girls stay on into the sixth form. In each of Yrs 7-11 we have about 180 girls, and our sixth form averages 160 per year, of which about 20 have come in from outside. Some girls leave because they don't achieve the grade, some because they want to do subjects we don't do or particular option combinations, or just to go somewhere different. The cohort coming in tends to be from outside the local authority, where single-sex education in the sixth form is not available or because there are sixth form colleges and they would prefer to be in a school. In physics and the sciences generally do get incomers about 3 or 4 out of the 25 or so at AS.

We drop to around 15 at A2, because the school insists that other than in very exceptional circumstances students only take 3 A-levels, so by the law of averages you are bound to lose a third, so we lose just a bit more than that. Physics is no longer necessary for medicine. Our numbers changed dramatically when this happened. All the medical schools insist on chemistry and you have to have a really good reason not to do biology. So if you can only do 3 A-levels physics sometimes falls by the wayside. Physics is also perceived as slightly harder so if they have to get AS for the course of their choice and they think it's a bit dodgy they will drop the physics.

We try to get the message across that physics is fun. We are happy if at the end of the sixth form they say it's been 'tough' but they have enjoyed it. Learning and finding out combined with things that are fun to play with for instance, toys, remote control cars etc makes a difference to their perception of physics. We did a survey with Yr 11 at the end of the course. One of the things that came out was their enjoyment of practical work. If you talk to the sixth form in any of the sciences they will tell you how much they like the practical aspect. The Salters course in Yr 13 has a project as part of the syllabus, which they very much enjoy. It makes a difference that it is an all-girls school. The girls can have more ownership, particularly in practical activities. In a mixed school if there was, say, an experiment with a radio-controlled car the girls would be pushed out. The school has some joint lessons in sociology and drama with the neighbouring boys school but not in science. We very much resisted even when our numbers were much smaller.

Some of the girls do physics because they are good at it and like it and some because they are interested in engineering, astronomy and particle physics. Some of them are interested in maths, and also music. Some know they want to do science, some are thinking of medicine and are good at science and they take all three. Some are good at design and go on to do engineering or architecture. Not as many as we would like go to university to read physics. There are two this year. The others are going into medicine, radiography, engineering, maths, geophysics, and architecture.

We give a lot of careers advice through the careers service, PSE lessons and individual members of staff. They always ask about physics – 'do you think I can do it' - boys would not ask this.

Resources and Funding

We have four physics labs and 13 science labs altogether. We probably get less money than probably we would have had as a specialist science school. But the head is very good at bringing in money. We are lucky enough to have had the labs refurbished which has made a tremendous difference. Three have white boards and we are due to get another two. So we are we very lucky to have the facilities we have.

Extra-Curricular Activities

We run 'Questors' in lower school and for the sixth form we are thinking of starting an astronomy club. We do 'CREST', Young Engineer (a maths teacher leads this). We take girls to outside lectures. We keep clued up through the Salters and IoP email groups and the LEA teachers centre. We're affiliated to the IoP and ASE.

Why Good Physics Take-Up?

It is a team effort – good facilities, good specialists, and I'm sure it's the **quality of the teachers** - highly qualified and highly motivated. We have properly qualified physics staff. We teach the sciences separately from Yr 9 upwards even though we do co-ordinated science. The different subjects are taught separately by specialists. Only in Yrs 7 and 8 is it 'science' as such. Even in the textbook the three sciences are identifiable because they are colour-coded. So basically **'identity'** and possibly the layout of the labs helps. There are the three floors of labs each for a separate science with the relevant staff. Although everyone chips in Yrs 7 and 8 only very rarely do people **teach** outside their **specialism**. It hasn't happened for several years. The quality of the staff means you get the enthusiasm as well and the ability to explain things.

Physics is a **high status** subject and we have a **sufficient nucleus** for there to be a lively interest in the subject. Currently we have two AS classes which collapse into quite a large A2 class on the cusp of two. There is a buzz about physics. The **choice of A-level** was very important. We helped to pilot the Salters course and that was the most stimulating thing I ever did. For two years we had a lot of INSET. We were keen and enthusiastic, and established 'rapport' and worked with other interested physics teachers. The attitude carries through to the kids and rubs off down the school. Numbers have been building ever since we started Salters. On the whole they find the Salters course much more stimulating and enjoyable. I remember at the end of the first cohort in the last term one of the girls turned to me and said 'you know we've learnt an incredible amount but it has been such fun'. If we stayed with the old Edexcel which was so boring our numbers would be much lower.

The subject is **fun** to people who feel they can do it. We have addressed this at GCSE as well with fun through **practical work** which they enjoy. It makes it different from their other class-based subjects. I feel we can go further. We are behind boys' schools in our numbers, but we haven't experienced a 'drift from science'. We have to go with the grain of **girls' natural way of doing things**. They are very social, so we have to teach in a way that allows them to talk in group activity with group work/discussion/role play.

What Can Be Done?

It's essential to have **a core of well-qualified staff** in the school. Physics is a demanding subject. It is much harder to instil love of subject when it is not the teacher's specialism. If you ask the girls they would say 'he loves physics'. The girls know that their teachers are very much into the subject they are teaching. If I am teaching say a biology topic to a Yr 7 group I know I can't put as much into it as a biologist would – it's the same for physics.

I'm sure a lot of schools have a problem getting a physicist if there is no sixth form work. You'd have to be a very special kind of physics teacher who is not frustrated by that. Anybody who is really interested in physics will find it very hard to be in a school that doesn't go beyond sixteen.

Case Study 4: Low-Physics School from Chart 2.2

Foundation, Coeducational, Comprehensive 11-18, West Midlands, Specialist Languages, 1,200-1,400 pupils, 190-210 in sixth form, 4.2% A-Level Physics. Interview with former Head of Science (now Assistant Head) together with Assistant Head of Science (Physics).

Context

We are one of two schools in this small town close to the city, and the pupils come from the immediate vicinity and outlying villages. We are a languages school and have recently become also a science school. The other school is nearby and specialises in performing arts. We are seen as a more 'traditional' school, students who come here I suspect know we expect slightly more from them and the behaviour is stricter. There is also different emphasis on uniform. We are blazer and tie, down the road it's polo neck and sweatshirts. We have a joint sixth form with the other school but the A-level physics students come mainly from within our own school.

Our intake is comprehensive but we lose the top end to selective schools, including a CTC which claims to take the top two pupils from every primary school. We can select a handful in languages. We actually have language lessons that go on after school for primary school pupils. We use these as a guide, but in fairness we've never actually used it – but it is there. We are not over-subscribed. This year it's exactly right. Last year we were slightly under for the first time in five years. We have been getting more boys than girls in last couple of years. We are not sure why, perhaps it is a local population trend or more girls are going to the other school because it is a performing arts college. The proportion claiming free school meals is only about a third of the national average though we have the children of agricultural labourers as well as the well-to-do from the villages. For the great majority English is the mother tongue though with some from Eastern Europe and Asia.

Faculty Organisation

We have a head of science (who is also head of biology) and two assistant heads of science who are the subject heads of physics and chemistry. The head of department in on four points, assistant heads on two and the KS3 co-ordinator on 1 - an old system. It is policy now, that other than heads of department everybody has a badge which just has their name on and their subject in this case science. KS3 would know us as scientists, but KS4 should know you're a physicist if you teach them, but I am not sure they would if you didn't.

Staff

In the science department there are 15 of us, four physics teachers, five chemists (some part time) and the rest biologists. (There are also two other teachers with degrees in physics in the school one of whom teaches PE and the other business studies). As assistant head I am only part-time and a deputy head also teaches AS physics. Three of us have single honours degrees in physics. Three of us are female and the other was a student here so we signed him up quick. In the past two or three years we've appointed three or four new science staff, including 12 months ago the ITT student as a physics teacher. So we are fully staffed at the moment, but there is precious little specialist physics at KS3 which leaves Yr 10 with the mindset that they can't do physics.

It's a nightmare trying to appoint physical scientists. Our best source is from the trainees. Our last appointment had been a trainee with us and he was one of only two applicants. We will only accept two trainees in science if one is a physicist. I'm lucky in that I have good relations with the unis and will squeeze people in at the last minute, so if there is a physicist going they will send them here. But they are few and far between. We do also have a chemist GTP. We cherish our links with ITT so we then get to know what they are like. But the county is too remote for many. Our NQT was attracted to stay here after PGCE because his girlfriend is at a nearby university otherwise I don't think he would be here. Previous NQTs have hated the area and have gone. Our youngest members of staff happen to live at home. In other words a domestic tie. Housing is cheaper but it's a huge disadvantage because once you are here you can't leave.

We have three technicians, one part-time, and all female. We poached our chief technician from another school. She had worked here voluntarily ten years ago. We are lucky. We are now fully staffed when a little while ago we were mega-under.

Years 7-11

At GCSE we offer triple science and dual award. We have never offered single science. We've been doing triple science for five years. The aim was to increase A-level numbers. There was a big push in the first year but since then the group has dwindled to about 20. It has created some issues. People doing physics and say no chemistry – for example we have an A2 student who has actually done no chemistry since Yr 9. It was also felt if a child disliked one of the sciences it would lead to lower marks than in the dual award.

At the top end we mainly have specialists. At KS3 we teach across the board. At KS 4 the three top sets and separate sciences have been taught by subject specialists. But from September, KS4 down to Set 6 will be taught by specialists. It is to boost A-level take-up. When a physicist says to a student, 'you are good at this, you are capable of doing physics A-level' the student will believe them. They have confidence in our comments when they might not have if they were coming from a non-specialist.

We have problems with pupils' confidence. I have one girl in Yr 13 who told me in Yr 10 she couldn't do it, but she got a double A at GCSE. Going modular has helped. They get their first results in March of Yr 10 and if they are getting good grades, it makes an amazing difference.

With the new GCSEs we're sticking with Edexcel, except for our weaker end who are probably going to do applied science in Yr 11. Edexcel don't do this, so we are going to use AQA. Everything else including BTEC (first cert + diploma in applied science) is with Edexcel. We didn't like the specifications that labelled themselves '21st Century Science'. We will be selecting the top set and offering them triple science in dual award time.

Sixth Form and Beyond

Students can take physics AS if they have at least two Bs in science. They can only come in with less if the teacher recommends it. We don't insist that they also take A-level maths, but we recommend they do. They can struggle. At AS there is a particular difficulty with students who have taken intermediate level maths at GCSE.

There is quite a high failure rate at AS – up to about half are graded 'U'. They may get on to it because their highest grade is in dual science, say two Bs with everything else 'Cs' or below, but they don't really have what it takes. Our A-level syllabus is Salters. We rejected the IoP's 'Advancing Physics' because we thought it too hard, too mathematical. We never have had half girls though we have got towards 40 per cent, perhaps because with a preponderance of female physics teachers they have positive role models. One of the girls in the present Yr 13 is going to read physics at university. The other students are going on to engineering, maths, chemistry and languages (she took Russian, music + physics A-levels).

Resources and Funding

We have pretty good facilities. The science block was opened about twelve years ago. The rooms were built to the minimum size to maximize the number. It can cause problems occasionally. There are ten labs with prep rooms upstairs and downstairs, and a staffroom.

We are hoping for a lot from our newly won science specialist status. There has been a big impact on the number of languages we have offered over the last five years. Science will be getting £60-70,000 per year for next four years. Some of it is for community work, 'gifted and talented' for science and maths for local primaries, and providing CPD opportunities for local schools especially if they've got non-scientists teaching science and maths. That's where we will focus our initial efforts. In school we are improving ICT in all the science rooms and putting projectors in five of the 10 labs. We are a bit lacking over here in laptops. Until recently over here we weren't on the network we could only have stand alones, so it was very unsatisfactory. There is though a real advantage to being in a separate block. Specialist status means extra staffing including a technician. With the new specialism it was either music or science and maths. Science and maths impacts on the whole cohort of pupils with potentially a big boost to GCSE results. And of course nearby is the performing arts college. So we went for science and maths.

Extra-Curricular Activities

We do the 'Physics Olympiad' for the best ones. This year we will also be doing the Advanced Extension Award for the first time.

Physics Take-Up?

Our projected numbers for AS in Sept are 37 – 29 from this school and only one on teacher recommendation. The rest are predicted double 'B's or better. About five are girls. Top of year is 'boy-heavy' as is the cohort itself. They are clever enough to realise getting a 'C' in physics A-level is better than an 'A' in some other subjects.

What Can Be Done?

We raised our numbers by **enthusing the children**, **making it clear they can succeed** and having **specialist teachers** at KS 4. We need more quality teachers. I wouldn't pay more, they might be attracted for the wrong reasons. Physicists are not always user-friendly. I would prefer to employ a good teacher who was a biologist rather than a poor teacher who was a physicist.

Case Study 5: High-Physics School from Chart 2.2 (Ranked Sixth)

Foundation, Coeducational, Comprehensive 11-18, West Midlands, Specialist Technology, 1,200-1,400 pupils, 280-300 in sixth form, 18.6% A-Level Physics. Interview with Head of Physics.

Context

This is the only secondary school in a small industrial town on the outskirts of a city. It is a prosperous area, partly because of the school which has an excellent reputation (it used to be a grammar school) that has attracted in middle class parents and they can afford more costly housing. So there is low eligibility for free school meals and most pupils are from white British backgrounds excepting for a few Chinese and Indian professionals. We do not select though we could do so for up to 10 per cent on aptitude. We lose a few to prestigious independent schools although we rival them in league-table terms. We also lose a few at 16 to a college in the city that offers A-levels we don't.

Faculty Organisation

There is a head of department for each subject, one of whom, the head of biology, is the head of faculty. As head of department I am responsible for day-to-day subject management. I have a say in the appointment of physics teachers and for the last appointment was on the interviewing panel along with head of science and deputy head.

Staff

There are 13 or 14 teaching staff in the science faculty and four in physics, two of whom this year are part-time. I have a degree in mechanical engineering and teach both the dual award and A-level. The other full-time physics teacher has a degree in biology but has been teaching physics for many years. He mainly does the dual award, but has a few AS lessons. One of the part-time staff has retired from a full-time post with us, going part-time for a year. She has a degree in physics and is taking A2 classes. The other part-time teacher will be full-time next year. She too has a physics degree.

It was difficult to get a replacement for the lady who has retired. We advertised the post as a physics job. We had about 8-10 applicants, took details of 5-6, and short-listed three. One didn't last the morning of the interview, there were issues with the other, so we agreed we'd appoint the part-time teacher who was already with us teaching the dual award science. We agreed that she would do Yr 10 physics last year to bed herself in before taking Yr 11 and another set of Yr 10s this year. Next year she will be sharing in the A-level teaching. We have always split the A-level groups between teachers. It takes the pressure off the teacher and from the pupils point of view they see different methods of explanation and experience different approaches.

In the science faculty we take on one PGCE student a year, largely biologists. I was offered a physicist this year but he wasn't terribly well informed and I had doubts about both his skills and knowledge. We've had another who had the knowledge but his competence in the classroom was a little bit uncertain shall we say? The school has GTP trainees, but not in science.

There are three technicians, one full-time and two part-time both on two-thirds time. They tend to have a sort of specialism for each subject. I think we should have more even though they are very good. We really need three full-time.

Years 7-11

We offer the dual and single science GCSE. We did experiment in the late Nineties with the triple award. It was popular with parents, but the results dropped right off. Normally we would expect 50-60 A*, but that year it dropped to a handful. So are we actually doing the kids a favour? Some kids would sooner have the double A* rather than the 3 As they ended up getting. We had many, many discussions but, on balance, we felt that triple science wasn't giving us anything. We also thought that as we were squeezing three GCSEs into the time for two we weren't doing the subjects any favours either. We thought our results dropped in triple science so much because there we were being compared with the grammar and independent schools, which select the more able.

But we do teach the sciences as separate subjects in the dual award – the AQA co-ordinated. We've always made sure that from Yr 9 onwards they have specialist teachers. In Yrs 7 and 8 there is just the one teacher though we try to swap the teacher's specialism from 7 to 8. In Yr 9 there are three periods one specifically for each of the three sciences. In Yrs 10 and 11 they have 5 hours per week split into the subjects so we rotate.

There is setting on the basis of teacher assessment at the end of Yr 9 and the option block the children choose. We don't pay much attention to the SATs results. There are two blocks. In one double science is offered along with the single, which frees up time for other subjects, but in the other it is purely the double. In this block there are four sets, two upper and two lower. Throughout Yrs 10 and 11 they are tested and with the agreement of the three teachers they can be moved lower to upper or vice-versa. All the upper sets take the higher tier papers, and of the lower, about two-thirds do. The Yr 12/13 scientists come almost exclusively from those taking the higher tier. The single science group is a mixture of the very intelligent with no desire to do science and those with very limited ability and interest in science.

We shall be doing AQA's new GCSE. Myself and the heads of biology and chemistry went to presentations by the OCR, Edexcel and AQA Boards. We presented our findings to the rest of the faculty and overwhelmingly we went for AQA. We chose AQA syllabus A, the online multiple choice option, which is not necessarily the best from the point of view of the children's understanding of science, but likely to lead best outcome for the children in terms of grades. I fundamentally dislike Edexcel which is totally incompetent and OCR's 21st Century Gateway seems just fancy stuff not really science and we didn't feel comfortable with it.

Our intention is to do the core in Yr 10, with the exception of those we would label as single scientists and they would do it in Yrs 10 and 11. The rest in Yr 11 would do 'additional'. The headteacher has agreed to give us an extra period a week in Yr 11 - from 5 to 6 hours – so we can offer separate sciences with two hours for each. Some would do 'applied'. So far about 9 pupils have said they are interested, which is borderline but enough to enable us to develop it.

We will then be doing four courses. Some would do single, those in the upper sets would do separate and those in the lower sets would do 'additional', with 'applied' for a handful. They will probably take the 'core' exam at end of Yr 10. The way this is set up we might have more success with the separate sciences this time round and there seems to be more 'push' behind it than say five years ago. If you look at the content it is much, much reduced with the emphasis more on skills so if we are going to have six hours a week we feel confident we can get through the content.

Even so, I am not won over by the arguments for bringing in the new arrangements. The government and other people say that science does not appeal to the 16-18 year old age group and therefore not enough are going to university to study subjects like physics. So we need to make it more interesting and hence the new course. That may or may not be right but as a cynic I see it the other way. My observations are that kids do enjoy the GCSE science on the whole particularly the practical element. They enjoy the challenge because they have to think. The government solution seems to be 'dumbing it down', taking out what I always thought of as the core stuff in physics. The content has been vastly reduced and we will end up with kids who might be able to say why something has gone from red to green, but not explain what happens in an experiment or is shown in a diagram. With the new stuff they won't be able to reason the 'mechanics', the electrical stuff behind it to explain why, because they won't have the basic understanding of basic physics. Similarly A-levels will be 'dumbed down' in two years time to accommodate the fact that GCSEs have been 'dumbed down' and there will be a 'knock-on' effect in the universities. I do have major misgivings about it. It may work some for some, but I don't think they have thought it through.

I also have reservations about target setting. We used to set targets for every child in each subject. But when you ask them what their target is, they don't know, so what's the point? Hopefully we might be setting one target per pupil for the year across the subjects. In each subject there is an internal module test each term which is used to rank the pupils against the age group. This is then discussed with the pupil.

Sixth Form and Beyond

For entry into the school sixth form there is a requirement for at least a 'C' in English and maths. About a fifth of our Yr 12/13 physics students come from outside. Overall about four-fifths are male. For physics we ask from both our own students and those from outside a minimum of 'B' in double science. If they only get a 'C' we say don't rule it out, we'll talk it through. Similarly, with maths. We should be looking at a 'B' in higher tier maths. We also recommend that they should do AS maths but there is always a handful who don't. I don't like to turn people away. I say if you have a genuine desire to do physics I will support you. When the results come in we have to go and discuss how kids have performed with the headteacher. For several years I have said my major concern is the maths abilities of the pupils. Even those getting A* in maths tend not to be able to manipulate formulae and data and that hinders their ability to understand physics. The head suggested putting a slot of 1 hour on the timetable of 'maths for science' for kids doing chemistry, physics and biology. It almost worked out but it hasn't proved possible to put on.

In A-level physics we do the practical exam. There are several reasons for this. It is partly the constraints on the timetable and the support staff. If all three science A-levels involved course work we simply wouldn't be able to prepare for it. Biology and chemistry do course work and physics the practical. We've actually got very limited apparatus in physics and if it were course work based there would be more demand for equipment and that would be costly. Also there would be more marking and I have a fundamental dislike of course work. We do the AQA physics B syllabus. But in terms of practical content throughout the syllabus I think in the last ten years it has dropped and the focus has changed. The instrumentation side now tends to be more observation not analysis. There are benefits. The kids are possibly stronger at seeing patterns in results, but in terms of ability to confidently handle apparatus I think it's much worse. There are no serious, challenging practicals any more. They tend to be 10 mins observe this, do this in another 10 mins etc.

The great majority of the A-level physics students go to university. In fact, I am not aware of any that haven't. Up to about a fifth read physics or astrophysics. There is a big variety of other subjects. There is usually handful of medics, very, very occasionally someone for veterinary science and quite a few this year for engineering, and increasingly computing and control technology. They are drawn into physics mainly for career purposes - doctor, engineer, especially as they see it as a key part of the technology/engineering side. It has become less important for medicine. Quite a few potential medics do not seem to do physics anymore. Twenty years physics was the number one science and now I reckon it's down at number three. About 15- 20 per cent drop physics after AS mainly because their grades are too low and they have a better chance of a good grade in another subject. At the end of the day it's points for university.

Resources and Funding

Historically we have been short of apparatus and it has not got any better. With the big expensive stuff we often have only one of each but with 60-70 taking AS/A-level you would expect more than that. The physics labs also are not much cop. There are ten science labs, three of each and a general one. The physics labs are still mostly mid-50s though one was refurbished about five years ago. The biology labs are the most up-to-date with two new last year and the chemistry labs are not far behind. In terms of physical appeal, physics is probably at the bottom of the pile. Specialist status as a technology college has probably brought science an increase in funds as one of the faculties where an increase in uptake was promised in the bid.

Extra-Curricular Activities

We are not particularly strong on enhancement activities. Very occasionally we have outside speakers. We are not close to any large industry. We do have a three-day physics field trip taking in a nuclear power station, aluminium smelting works and Jodrell Bank. I also usually take a small group – not the whole year group – to participate in the Physics Olympics. We have had projects with industry, for example on the rocking mechanism of train doors in which kids go to the plant and people come in. It can work very well but more often they don't because of the pressures in industry. Students seem attracted to physics more as a professional thing than by what extra activities are attached.

Why Good Physics Take-Up?

I am not aware that we are doing anything special. I honestly don't know. I'd like to think that when kids made choices after GCSE they see the **physics staff as enthusiastic, interested in their subject**, **and approachable**. I'd like them to come into the lab **laughing and smiling**, not thinking 'oh, awful, we've now got an hour of physics'.

The school does appeal to the more **academically aware pupils** and physics is seen as the most challenging A-level and attracts **the cream of the students**, the most intellectually able, along with further maths and chemistry. Parents of the pupils coming to the school have **high expectations** and there is high achievement. There is traditionally **strong management**. Teachers have been aware of the fact that there is the support up there and that has an effect on pupils and they behave accordingly, so there are very **few problems with discipline**. For somebody in my subject that is ideal – you don't want to be spending all your time getting the kids to sit on stools, you want to teach your subject.

Lower down we've purposely made KS3 very **practical** so the kids get to perceive science as practical subject. They like that. Generally I think the practical content in Yrs 10 and 11 is less than we would like it to be, but we have still got the hard core of believers from Yrs 7, 8, 9 and still available at A-level. The **science faculty is seen as strong in the school, with stable staff and good results**. The kids respect that you know what you are talking about and appreciate a directness in the physics staff who will come clean if they don't know and tell them where to find it. We don't 'coach' for course work. Within the rules you can 'direct' comments onto the work. This favours the least able and disadvantages the most able. I'm not playing that game.

What Can Be Done?

Every teacher should have that opportunity every year or two of **learning about developments in the subject**. I had a week on a university course which I thoroughly enjoyed. It is of immeasurable benefit to the kids since it gives you confidence in the subject and developed my professional understanding and skills. For example when I graduated quarks hadn't been understood yet I have to teach it. So unless I'd read up and gone on that course I would have had to stand up in front of 25 sixth formers without a clue. I am talking about something different to the five INSET days which in my experience are mainly just about filling the right boxes, for example, on behaviour management and preparing for Ofsted.

Give **more recognition to scientists and engineers**. Those choosing A-levels in science/maths have to work hard go to university do the sciences and technologies and once there have 20 hours a week of lectures and practicals instead of the few hours in other subjects. They get a degree, get a job in something that doesn't have a high profile, work damned hard for many years and don't get recognised at the end of it.

Case Study 6: Low Physics School from Chart 2.3

Community, Coeducational, Comprehensive 11-18, East Midlands, Specialist Arts, 1,000-1,200 pupils, 160-180 in sixth form, 3.8% A-Level Physics. Interview with Head of Science.

Context

We are basically an urban, community comprehensive. Although I would say the school is average regarding ability we are still oversubscribed. Last year 20 cases went to appeal and only three were successful. We do tend to draw in some pupils who live further a field on the inner margins of the LEA, closer to the city, where I would describe the children as more challenging. So the parents try to get their children in here. There are only a handful of difficult children. There is a local saying 'if you can't teach here you can't teach anywhere'. We are well below the national average on the take up of free school meals. They are eligible but proud. Because of our location we are not really adversely affected by independents creaming off the brightest. At sixth form level the school is part of a local consortium of schools and colleges.

Faculty Organisation

There is a head of department for each subject. I came here several years ago as head of chemistry and for the last two years have been head of science as well, but I am moving to a new post in a science specialist school. As head of science I am responsible for the strategic development of the faculty and with my chemist's hat on the day-to-day management of that department as well. When I am given the subject groups it is my task to allocate the teacher to the class. Because of financial constraints, I also have to carry responsibility for KS4.

Staff

There are 10 or 11 teaching staff in the science faculty. We have one real physicist, one we are training up to GCSE level, two chemists and five biologists. Only one of the science staff is capable of teaching physics to A-level. He has a degree in physics. Two other teachers one with a degree in applied science and one with a degree in chemical engineering covered the physics in dual and single award for some of the classes. Now we are down to one since the chemical engineer has left and has not been replaced. We are training up the applied scientist, who was an NQT last year, to do more physics. She is finding it very demanding. But she's got the physicist always in an adjacent lab, so there is somebody for her to refer to. She's taking this current cohort through the dual award course. So, fingers crossed, hopefully she's done a good job. She couldn't do A-level though.

About five or six years ago we had a female physicist who transferred after one year to our maths department. She said 'I can teach maths, they're seated, they're not walking around. I don't have to worry about health and safety all the time and the content is not so great or diverse'. We haven't appointed a physicist for the last four years even though we advertise nationally. Last year we advertised for one to start in September. By July we still hadn't had any applications so as an interim measure we appointed a biologist, who was replaced eventually by the teacher with the degree in chemical engineering. Although his physics was sound he had problems with classroom control and left before the end of his first year.

We had to cover his lessons between us. Since then our time allocation for physics has been reduced (single subject physics no longer offered as part of triple science) so this post has not been filled. When our head of physics was off sick for an extended period of time we were fortunate in getting the former head of science, a physicist, who had retired, to come in and teach the A-level group. H now does three days a week in an independent school - small classes, well-behaved students and just teaches physics.

When I leave, my post is being taken by another chemist. I meet with the other local heads of science regularly and at one point over a four-month period five of us were trying to recruit a physics teacher. The situation is no better in the school I am moving to and it's a specialist science school. We are trying to appoint a physicist because the current one is moving out of the area. The post was advertised with a £5,500 carrot on top of the main scale with some management responsibility. I said to the deputy head 'we should be fine with that salary – no problem'. We had one applicant who wasn't suitable. We have now just got an NQT, a late entrant and a qualified engineer. I know him personally and I know he will do a good job for me.

Over the years I have built up a very good relationship with our local HE institution. They make sure I get good PGCE or GTP students in science. This year they have over 20 biologists and one physicist on the PGCE course, so I rarely get a physicist. The last physicist I had was over fifty and had been made redundant. He was unable to get a job so thought he would try teaching. In the end he hated it and went back to his old job part-time because they wanted his ICT skills.

There are three technicians, one male and two female. Our chief technician (male) is physics-trained, but he is coming up to retirement and could be difficult to replace.

Years 7-11

We offer dual and single award science GCSE. Until this last year we also offered the triple award but recently numbers have fallen (down form 28 to 11 over the last two years). The senior management team decided to pull the plug said the numbers weren't viable. I was asked if the dual award candidates did any worse at A-level then the triple. I had to be honest and said they didn't, so I shot myself in the foot. If the student is academically bright they will succeed coming from the dual award. It is harder work. They have to learn more. But if they want to do it they will do it anyway. Some of the parents wrote in to complain about it being withdrawn.

The pupils are setted from Yr 7 based on the SATs results and then twice per year for fine-tuning. The top three groups at KS4, where I am hoping to get my A-level scientists from, have specialist teaching, although we are very tight on the physics side with only one real physicist who has to do all the A-level as well. The other groups at KS4 have two teachers but not necessarily a physicist. This is the same in Yr 9, two teachers rotating but usually these are biologists and chemists. In Yrs 7 and 8 there is one science teacher per group. We don't have the facility for specialist teaching of the separate sciences other than the top groups at KS4. I would like to, but within the curriculum I do identify the topics as chemistry, biology and physics. I make a point with all my staff that they have to identify clearly the separate sciences. They have a separate chemistry, biology and physics book and I try to keep it as separate as possible. We used to colour code the worksheets but that has gone by the by now.

When I first started teaching I didn't think it was necessary to identify the three sciences separately. I joined the profession when the dual award was new with the 17 attainment targets. But now I think it is increasingly important to do so. I do a lot of tracking of pupil attainment and performance.

We are going to do Edexcel for the new GCSE. Sadly for one reason only. It is the best opportunity we have of getting the highest per cent A-C. We used to do AQA, it is the hardest. When I took over I researched it. I've got close links with another school in the Local Authority which has a very good reputation in science and high take-up at A-level. They said 'your results will go up 5 per cent straight away if you do Edexcel'.

It's going to be easy to get a qualification with the new GCSE. The students are going to believe they are better than they are. There are six modular exams. Each exam covers 2 units all multiple choice questions, no extended answers required at all. We will do the core and additional but not the applied. That's the trouble with Edexcel. They have core and additional both taught as concept or context but no additional applied in Yr 11. At present in Yr 10 I allocate two three-week lesson slots for GCSE course work. So they have two goes at it, all done in the classroom. But a lot of schools play the system. They are allowed to redraft it, given post-it aide-memoirs, but I won't go along with this. Fortunately from 2006 this will be replaced by classroom-based tasks. In my opinion with the new GCSEs it's a case of 'if you haven't got the physics teachers you just water down the physics content'.

Sixth Form and Beyond

Beside ourselves, AS/A2 physics is offered at three other centres in the sixth form consortium. The school has a large and expanding sixth form and offers a wide range of courses including vocational, but numbers for AS/A2 physics are small and declining. All the centres are struggling. To get on to the AS/A2 physics course we expect double 'C' in dual award and a minimum of 'C' in maths. Whereas entry to the sixth form is open to all students who are prepared to work hard and for whom an appropriate course can be structured. For an A-level course the requirement is 5 A*-C.

This year we have 4 students doing AS and 3 A2. The previous year it was more than double this but still on the low side compared to chemistry and biology. I suspect only one of the 4 in Yr 12 is going to go through to A2. In fact senior management considered removing A2 physics this year because it was not cost effective to run. I was asked to find out if the students could have finished the course at one of the other centres but this plan had to be shelved because they were all doing different exam boards. I can see A-level physics being removed from the curriculum here in the next year or so. We have never recruited any physics students through the consortium. We compare very unfavourably with another LEA comprehensive in a different consortium where the numbers are very buoyant. It has three really strong physics teachers, although two of them are nearing retirement. They also attract a good inflow from the rest of their consortium.

There has been a significant drop off in numbers since our previous head of science and physics retired two years ago. The current cohort was asked in an LEA survey what they most disliked about the course and the answers they gave are revealing. They said they 'would like more than one teacher to get a variety of teaching styles' and also they wanted 'different approaches/explanations to help with understanding'.

Another comment was 'there were not enough practicals so we don't always understand the concepts'. I think they find some things could be rather dry. The feedback from the science adviser was that there should be more structure/focus to the lessons and that the students needed more guidance then just 'research this'. It was also suggested that the students needed guidance about what to revise and to see exemplar exam papers.

When a student is accepted on to a course I usually put them on a three-month trial to put pressure on them. Some of them can be very lazy. In dual award now it is quite easy to get a 'C' and they have to prove to me they want to do it. My successor has a different philosophy 'if they want to do the course and might just get an 'E' take them on'. I would prefer them to take a course to which they are academically suited. We do the AQA syllabus. We have stayed with AQA after mulling it over. We have all the textbooks and know the course inside out but the current Yr 12 are significantly weaker and they are struggling. We haven't considered 'Advancing Physics'. We prefer students to do A-level maths as well but we don't insist. AS filters out more than half the students either because they are struggling or physics has been a fourth choice. A popular A-level combination is chemistry, biology and psychology. Psychology is the most popular A-level here, over 60 students. It is a very strong department led by a widely experienced and very effective teacher.

Our A-level physicists going on to HE tend to opt to do related science subjects, like mechanical engineering. But two years ago, two very bright boys did go on to do straight physics

Resources and Funding

Getting specialist status has brought more money into the school. They have to show the majority of the money has gone into the specialism, so we have a new performing arts area. Bu the knock-on effect is more money to other departments. We can do all the practical work we want to, so in that sense we are not under-resourced. But our labs are in a dire state - I've got rotting wood, can't open windows and don't possess a fume cupboard. Surroundings are not the be all and end all but in my new school with science specialist status all seven labs have been totally refurbished.

Extra-Curricular Activities

We try to arrange a variety of activities with outside speakers as much as we can and visits. For example the A-level students go on a physics enrichment day at a nearby university. And in Yr 9 a group of 20-25 pupils, mainly form the top sets, go on a science enrichment day. We have a lower school science club. For Yrs 10 and 11 we run a science clinic for one period every week, but uptake is low.

Physics Take-Up?

The school has had a tradition of offering triple science at GCSE although this is no longer the case. As head of science I am keen for the sciences to be separately identified from KS3 upwards. But there is only one specialist physics teacher and additionally one being trained up to teach physics to GCSE. The physics specialist shoulders the burden of all the A-level work so there is little variety of approach at A-level and practical work is limited. Non-specialists cover the physics parts of the syllabus at GCSE for all but the top sets. At KS3 pupils may never experience a specialist physics teacher.

I'm convinced a key factor influencing take-up is whether the school has **a core of enthusiastic, specialist teachers**. I want inspirational teachers. I can teach physics. I'll do the best I can but it won't be inspirational. But put me in front of a class to teach chemistry and that will be a different matter because I am totally confident. Since the head of faculty retired two years ago and we were left with one physicist I haven't enjoyed doing the physics part of dual award. I have had to do a lot of mugging up on it at home. I have put in the effort but there is not the spark. I disagree with those who say all science teachers should be able to teach up to GCSE level. That's rubbish.

Student numbers have gone up in chemistry since I came here and the reason they enjoy chemistry is because I can bring it alive. Having spent some years in the chemical industry helps. I've got so many tales I can tell them. If I have to teach physics they get it by the book – a sound education in physics, but they don't get those little asides and then the comments come 'oh that's interesting, I'd really like to study that'. I also try to do as many practicals as possible. I love practical chemistry.

Problems with staffing just exacerbate the fact that **A-level physics is seen as jolly hard** – 'that's my weakest subject', especially by the girls here. Students can do an A-level in say psychology or geography and probably get an 'A' grade. My students doing physics and chemistry would probably come out with 'Cs' and 'Ds'. **The role models are predominantly male**. That doesn't help either.

What Can Be Done?

The answer is to **increase the numbers of specialist physics teachers**. If I was in their (the pupils') shoes it would be the teacher who was the key rather than smart labs. **I would put the emphasis on specialist training in ITT** rather than the broad balanced approach. As a chemist doing a PGCE my biology was up to scratch because of my lab experience but not so my physics. I would also like to see **the profile of physics raised** (along with chemistry) and in schools clearly identified **as a subject in its own right.**

Case Study 7: High-Physics School from Chart 2.3 (Ranked Eighth)

Community, Coeducational, Comprehensive 11-18, East Midlands, Specialist Technology, 1,600-1,800 pupils, 320-340 in sixth form, 16.9% A-Level Physics. Interview with Head of Science (until recently Head of Physics) joined later by new Head of Physics (internal appointment).

Context

It's a small, attractive town and the parents have only two choices, or go independent. We are the more popular but we aren't always oversubscribed. We get a typical cross-section coming in, with a fair number on free school meals. I came because I wanted to work in a proper school, a proper comprehensive mix with a sixth form. This is ideal – you need the variety of students to challenge you, you need the full age range and teachers need sixth formers to keep them professionally on their toes.

Faculty Organisation

I have just been appointed Head of Science. I'm in my seventh year. I came as a main scale teacher taking a salary cut to avoid travelling. I'm lucky I have somebody in charge of biology (and KS5 issues), a colleague recently made up to head of physics (and KS4 issues) and new head of chemistry (KS3 issues). In other schools I've known it has been head of faculty and a deputy and that's it.

Staff

There are 18 staff in science and five in physics. Four of us in physics teach A-level, three with physics degrees and the other with a degree in electrical engineering. The fifth does KS4 only. She prefers this and doesn't want to do A-level. She has an HNC in electronics and physics. When a new member of staff arrives they don't have to do some kind of apprenticeship before they are allowed in front of a sixth form class. We want to get the benefit of their expertise, with support, if necessary, from somebody who has taught that class.

It's an attractive location and we have a stable staff. We last recruited two years ago, but there was a term where we had to make do before she was appointed and her predecessor left (at the last minute). We were very lucky – we interviewed four people but we could only have appointed one of them. We have two retirements looming in the next two years one female, one male. To be honest we've had more trouble with getting chemists, especially head of chemistry. We had three attempts and in the end appointed but he was the only suitable one – none of the others were worth interviewing. We also tried to appoint a main scale chemist but he didn't want the job – must be a seller's market.

Generally we are very supportive – welcome people who want a 'taster', or returners who want to see what it is like now before they commit. We do take PGCE students. Last year we had a very good one in physics. But we would be very wary of GTPs in science. We are also not keen on science CPD. I see myself first as a teacher then as a physicist. I think I'm average at physics but a good teacher. I don't want a month out of the classroom because the kids would be getting a less good deal. I'm not sure what say a month in industry either would do to help to deliver the content of the curriculum and how to teach it.

We have three full-time technicians, one in each 'subject' area. Its adequate for what we need. My perception is the most important thing is their attitude – willing to do what needs to be done and they are a positive influence on the department. They also do research for us eg website, try out experiments, but not averse to doing some photocopying or cleaning up. Our chief technician who has an engineering background came new last year. Before that we had trouble with getting the right sort of person.

Years 7-11

From Yr 9 pupils have separate physics, chemistry and biology teachers and separate lessons and tests. Only one teacher at GCSE teaches 2 subjects – chemistry and biology - and she's qualified to do so. Even in Yrs 7 and 8 the teachers will identify the sciences separately. There are six sets in each year and the top two do triple science in the same curriculum time. We select and rank on results with teachers drawing on their professional judgements of the pupils for any amendments. There is regular testing in Yrs 7/8 during the year and an end of year exam (end of topic tests means some teachers teach to the test so an exam is a fairer assessment).

Triple award pupils tend to do better in physics than in the other sciences. Partly I think this is because we are better at assessing coursework in physics. Physics lends itself well to doing the kind of coursework the current GCSE demands – repeated measurements and looking for scientific explanations for things. We set them things they can do and we make sure they are very clear what they need to do to get the grade. Quite a number will get full marks, but even a few marks extra could make the difference.

Doing the triple sciences alongside the dual award means a lot of extra work and there is no real value for the sixth form – the only thing they do extra of use in the sixth form is 'momentum'. But parents like the separate sciences and it is often the reason why they come to the school. So it's got strategic value. We get some coming in Yr 10 from private schools. We get letters from parents asking why their child is not in the separate sciences group.

Looking towards the new GCSE we went to all the presentations and got all the literature. This allowed us to immediately write off Edexcel because their system for assessing practical work seemed to be really crap. It was a choice between pretty traditional AQA and OCR's 21st Century which is the opposite. We were all a bit unsure but agreed on OCR since it is supposed to be about changing science at GCSE and AQA isn't much of a change. I hope it will result in more of our pupils liking science even if they don't choose to study it.

As we go into the new GCSE the difference between separate sciences and the dual award is much more significant. We are planning that the current Yr 7s finish KS3 at end of Yr 8. We'll then start the separate science GCSEs in Yr 9 and have three years in which to do it them. Of course, selecting so early on we'll miss some and include some we shouldn't. Whether we'll do it lineally with the content of single award in Yr 9, double in Yr 10 and separate in Yr 11, or whether bits are fed into different topics, we're not sure. We might run the applied route, but the students will be told very clearly that the only science A-level they will be able to do is the applied. We are also looking at the Entry Level Certificate in Yr 10 for less able pupils.

Sixth Form and Beyond

Last year we had more doing physics than chemistry or biology – but these things tend to go in cycles. Next year chemistry will be the biggest and that is not normally the case, and this year of course there's been no head of chemistry. One very bright girl, who had done her research on the internet had decided chemistry was more of a key subject for a career than physics, so this may have something to do with it – others may have listened to her. The physics students are predominantly male, say six girls in current Yr 12 out of 35, but the top performer last year was a girl doing medicine.

Science is recognised as a strength in the school, but not overwhelmingly so. Humanities, especially history, are very popular and the school is also strong in vocational areas like health and social care. If we get two classes of physics in Yr 12 I'm quite pleased with that. In physics we don't generally take kids unless they have at least a 'B' in GCSE physics or the dual award. We also advise them that they need to be competent in maths (at least a 'B' at GCSE), but we do not insist on them taking the A-level. Occasionally, if they've done the dual award (where you can see the breakdown of the marks) and it's a B in physics but they end up with a C because of chemistry and biology we might give it a try. But this can be 'unkind' to them because they tend to get to end of their first module exam and they don't pass. Those who only get an E in AS go back and sit the whole year again or go and do something else. In past you wouldn't get kids doing physics in the sixth form who were not bright, not good at it. Now they'll try it and for some 'D' is a successful outcome, it's a real achievement for them and may be their best grade.

At A-level we do 'Advancing Physics'. It was chosen by our previous head of physics and thought to be a bit of a gamble. But it is more interesting to teach physics that doesn't stop in 1930. It contains for example a big section on imaging and how images are transmitted. I had to find out how this was done in order to teach it. It's also more relevant. But they are not necessarily turned on by what is more relevant. There are also popular topics like astrophysics and quantum physics done in a more fun way. There is still the classical physics you'd expect but also these interesting topics

We get very good results because we are very focused on what we want the outcome to be. We test them as soon as we can. They do their first module in January in Yr 12 and we try and build them up for that. They resist but we say why not take it and get it out the way. More often than not it gives them a real boost because they have found it hard. We do quite a few unfamiliar things at the beginning. The dual award students are less sure they can do them than those from the physics GCSE but then again the separate lot were selected. We are also very professional about dealing with coursework. Two of us have been involved as examiners. At specific times in the year – for example the sensor project built into the first year – we have a day off timetable with all four physics A-level teachers in attendance and we blitz the thing that day. We also give them past papers with mark schemes to practice on. Our general approach is you are going to do well at this, almost whether you like it or not. Most who get A-levels go to unis, though a fair number do a gap year. Last year was very good we had eight going to unis to study physics whereas it is normally two or three at most.

Resources and Funding
We are relatively well funded compared to where else I've worked when it was a red-letter day when I could afford a new set of textbooks. Having big sixth form sets is of course a help. Specialist status has been an excuse to get some more money and it didn't particularly focus on technology. It has improved ICT/Science not in any precise way but there has been a knock-on effect. But I wouldn't say the average pupil notices much difference.

Labs have been a problem. The school has 12 proper labs and 1 small one, really more a seminar room with some possibility for practicals. In the present timetable the max number of science classes at one time is 17, so there are never enough rooms ie labs available.

With lots of pushing from senior management and governors the LEA has agreed a new build. Partly because we are a successful school there has been less incentive to do anything. The new build will free up space where there is overcrowding so for the school it is very important strategically, for example technology and English and Drama will get there own areas. With the new build we will have 14 labs and two seminar rooms for main school and sixth form. We wanted 15 labs but this was not possible, but it will centralise the science faculty which at the moment it is very strung out and makes communication a bit difficult. Even with 14+2 a couple of classes per week will still be taught out of area.

Extra-Curricular Activities
We do not do much in the way of extracurricular activities. I probably disagree with my seniors on this. One of the things we do is to focus very much on our primary aim which is to teach kids about physics. There have things like the Engineering Science Scheme where you team up with a local company and do a project. This takes pupils and teachers out just before Christmas when they are preparing for their modular exam. So I didn't want to be involved with this. It would have been counterproductive to have say six kids plus one teacher out for a week. So we are very focussed on our core activity. Other departments are very different.

We do have some lectures here and we do take students to things that are inspiring in physics like the Philip Allen lectures. We also take younger children to Faraday lectures. I'm not sure showing people 'industry at work' is very effective. I went on a chemistry trip to a plastics factory. It was very boring and would have put people off doing chemistry. I had two weeks work experience before starting my NQT year and came away with little other than how miserable the workforce were and wished they didn't work there!

Why Good Physics Take-Up?
It's a good question. The pupils **enjoy** it, they have **good teachers**, and science and its separate subjects are **clearly identifiable**. They are well taught by teachers who know their subject, enjoy it and can put it across. It wouldn't be the same if I were trying to teach biology. How many other schools have five specialist physics teachers? We are helped by the town being a **science town**. A number of the parents work in science industries. It may account for the **prestige science** has.

We also get **very good results**. One of the most important things is that the pupils know they will be successful. From quite an early age they are made aware that people succeed at physics. Lots of grade 'A'. Some of that is down to the teaching and the organisation of the course. We make sure that parents know they will be successful when they come round to open evenings and things. Physics has an aura of being difficult, but actually it isn't. It used to be much more difficult than it is. People think you are cleverer than you are if you have an A-level in physics.

What Can Be Done?

You need to get in more and better and **dedicated teachers**. It's a bit of a vicious circle. A nice school can draw them in. I wouldn't apply to a school where I had to teach all sciences. I am a physicist and I want to **teach physics**.

A lot of the physicists I studied with not are not natural teachers. I know from my own experience quite a bit of physics is very focussed, very single-minded, and quite nerdy. Those who are good at it lack the social skills required to be a teacher. You don't want to set up a system that tries to attract people with first-class honours degrees and very precise research minds to become teachers because they probably won't have the characteristics to be a successful teacher. They might even reinforce the stereotype.

It is hard at the start so some kind of support mechanism would be helpful, specific to physics. Perhaps starting in a school which has got good track record in teaching. Or funding some schools to provide first year training for NQTs perhaps **Centres of Excellence for Physics Teaching**.

I went to another school the other day where there were very basic things they didn't do. There might be other schools like this. They didn't have past papers to prepare for exams. We offer a huge amount of support. They had not set about getting the teachers **examining expertise**. Maybe there should be some additional incentive for this.

Case Study 8: High Physics from Chart 3.1 (Ranked Second)

Community, Coeducational, Comprehensive 11-18, Yorkshire and Humberside, Specialist Languages, 1,200 -1,300 pupils, 320-330 in sixth form, 21.9% A-Level Physics. Interview with Head of Physics..

Context

We are and always have been a comprehensive. The catchment area goes into the city centre in a sort of U-shape. It has not always been the comprehensive to go to in this area, but the nature of the intake changed rather dramatically and suddenly at the favoured school and a lot of the aspirational parents moved their children here. The intake is changing again now. We have always been a fairly ethnically diverse school and the performance of the ethnic minorities has always been very good. Recently there has been quite a Somali intake which has presented its own challenges. The school takes a great pride in its ethnic diversity. Some of the ethnic minority pupils are feeding through into the A-level group. The nature of intake will be less skewed to white pupils over the coming years since white, middle-class parents tend to have fewer offspring. The school is oversubscribed. Parents tend to go to appeal so we have some classes of 33/34 in Yrs 7 and 8 and the labs can't cope. It's a good job they are well-behaved. In Yr 9 I have a top set of 32which is not safe given our labs.

Faculty Organisation

The Head of Biology is the Head of Science. She is +4 pts, myself and the head of chemistry are on +2. This is my first year as Head of Physics. The Head of Science looks after the interaction with senior management, looks ahead and plans strategically, and a lot of the things going on in the science department. I basically assist her and look after the A-level physics.

Staff

There are 14 staff in science including four part-timers. In physics there are three of us, two of us with materials science and the other with a chemistry degree, plus some help from two biologists. My background was physics dominated. My biggest challenge was bringing myself down to the level of the pupils – the crux is can you put things across well? I'd like to think we do a pretty good job. Two of us have been teaching physics for more than 20 years. One went part-time last year prior to retirement, so when a biologist was recruited it was made clear at the interview that some physics teaching in Yrs 9 and 10 was involved. The person appointed has done quite a good job though she has needed support for certain topics. The person who went part-time finishes this year and we have appointed a NQT in his place. She has a very good, mechanical engineering degree and has worked a couple of years in an engineering company. What we really wanted was someone with a couple of years of A-level experience. What we got was a very good NQT. She was clearly the best of the four that we interviewed. We had about twelve applications, but when you rule out the bizarre ones, there were four possible candidates. Another physics post will be falling vacant at the end of this year and then we will really need an A-level specialist because our NQT will have had only one year's experience.

Years 7-11

In science we set from Yr 9, but not all subjects do, English for example. We don't teach triple science - just the dual award. There's been a lot of soul searching about that. When I first came here five years ago we were still doing separate sciences, but it was mucking up the timetable. If we received our full percentage of the timetable we would have ten one-hour periods per fortnight, but in fact we only get nine. We achieve as well as any other department in the school, but with less time than we should have. We found that the separate sciences did not give better results than the dual award. There was also some anecdotal evidence that the ones who had done separate sciences were a bit bored in the first few months. The AS had been brought down to a level that the dual award fed into it very well. So we decided to get rid of separate sciences. But there was a lot of resistance from parents. Once they were convinced that it would not be detrimental to A-level results they went along with it. We have had a few years without it now and A-level results have not suffered at all. The local independent schools still offer separate sciences.

It has been difficult to decide what to do about the new GCSEs because all options are on the table again. We have decided to stick with AQA, because we feel they have a huge amount of data that can support the quality of their awards and I think there is a great danger at the moment that you could go with a board with a new GCSE and then find that in a couple of years time there was a debate about its value and that's the last thing we want here. But because we feel that there is a small amount of the harder content missing yet again, we were worried that it wouldn't lead as well to A-level. So we've tried to pick a syllabus that feeds into A-level but we do have to bear in mind that not all will do A-level science (about half of the year group of 180 will), so the courses we are offering must be interesting and useful to them also. The new GCSE is split into two awards – so in Yr 10 all will do core science and they will have an award for that. Our current thinking is Sets 1, 2, and 3 will do 'additional', which is the A-level feeder. Then Set 4 (the lowest set) will do applied. This involves more portfolio work and projects which may be will equip them for aspects of science that they will come across in their daily lives, like health and safety and debates on mobile phones etc. This year one of us has an extra free period a week and is going to research and resource the applied.

I understand the nature of A-levels is going to change again, but it will have to. At the moment, the way the course work is done at A-level isn't going to fit with the new GCSE. In five years it has been all change. Since I came I have taught separate science, dual award co-ordinated, dual award modular, now a new GCSE with additional + applied. It is ridiculous. We never have a system that is fully operational and working efficiently.

Sixth Form and Beyond

To take any science A-level we require a 'B' at GCSE. We have debated this in the department. We want to be inclusive, but you have to be realistic and honest with pupils and if they don't get a 'B' our experience tells us they will really, really struggle. In Yr 12 we usually say at least a 'D' in AS –it is so much easier than A2. If they can't get a 'D' at AS they are probably going to fail at A2. There are exceptions, one boy got an 'E' and still managed to pass A-level.

Over last five years our numbers have gone up and down a bit. They are still mainly male. In Yr 13 out of 25 we have five girls. In Yr12 we have 33 students and there are ten girls. The numbers doing A-level chemistry and biology are more than that, but physics still holds its own. Biology has seen a major spurt. In biology they have a young team, all female. We have no male biology teachers at all in school. They do quite a lot of field trips, so a lot of female pupils are attracted to that. Chemistry benefits because quite a lot want to do medicine and you need chemistry for that. In Yr 13 we do the medical physics option because of the interest in medicine and its not so intensive on the maths side. Quite a few pupils find the maths tricky because they are not doing A-level, so an option like astronomy would be too demanding. It's compulsory because it's quite an investment in materials and staff training and we couldn't timetable alternatives. We have been looking at how we can reinforce the areas that are common to maths and physics. The physics mechanics module, for example, is very similar to the maths module. But our A-level physics students do very well without A-level maths though they must have a B in maths at GCSE.

The school has got a very good reputation, so it has a significant post-16 intake. But in physics we don't have room for many, perhaps three or four a year. With an A-level group of 20+ you don't want anyone from outside. Some of entrants are from independent schools. Our results are as good, so why pay if you are the parents. Most of our A-level students go on to higher education reflecting their aspirational background. We did a survey the other day. They take things like engineering, sports studies, physics itself, medicine and some have a year out to travel.

Resources and Funding

We don't have problem now with money. My impression is that if we need it we can have it. We have got most of what we need. The money I have this year, I will have to think hard about how to spend. We are okay for equipment. We don't have any outside sponsorship. Being a language college hasn't had an impact on us in science. Our facilities are not very good, but the school is due to be rebuilt.

Extra-Curricular Activities

We have speakers coming in, eg from Bristol University on cosmic ray detection. In terms of trips – not much. We have links with local universities and those with courses in medical physics. We take the physics students to the materials department at a nearby university. Kids haven't come across it before – a new topic in A-level. Very useful to see the equipment we couldn't possibly have. We've considered competitions. Lower down the school there are science days/projects but not particularly physics. We are affiliated to the Institute of Physics. I must admit a lot of this peripheral activity gets lost in the day-to-day madness of teaching, covering the syllabus, keeping classes on track, with large A-level classes, and it's the marking.

Why Good Physics Take-Up?

I have got to say a lot of it is down to **catchment**. There are a lot of good feeder schools, a lot of the parents are professionals including in higher education, a lot of them have scientific backgrounds themselves, they value science, and therefore the kids value science. We have a very diverse intake but there is a critical mass of able pupils.

There has there always been a **strong tradition** in sciences at the school? We have always had good numbers doing science and physics and we've always got good results. So when parents come to open evening, they go round the subjects, look at what the results have been and what the prospects are and physics comes out well. It is a self-perpetuating thing to some extent -'success breeds success'.

Then we have also got some **good, experienced teachers** who run a tight ship and I think the pupils feel they can trust them, and that they'll do their best for them. It's a subject they feel stimulated and challenged by. What I can do in physics is give them an insight into a problem. You have just got to have high level of knowledge. I can teach, say, a perfectly respectable chemistry lesson but I can't give them the inspiration and level of detail in examples that a true chemist could. My experience in industry has been a tremendous help in giving authentic information. Kids know the difference between something you have been told about and something you have actually experienced.

We only teach outside our subjects in Yrs 7 and 8 so another factor in uptake at A-level is that right from Yr 9 the physics component is taught by physics teachers. This engenders **identification of subject specialisms**. We think we can sustain this specificity with the new GCSE. We did a lot of research and it was very, very clear that the exam boards had specifically designed specifications for schools that haven't got specialist physicists. Its all chemistry and biology. We have chosen a syllabus very similar to what we are doing but in different chunks. The more discussion type topics, eg renewable energy, have been shifted into Yr 10. The more mathematical 'proper' physics is all shoved into Yr 11. So the weaker ones will do three 3 units with just a little –very little –physics spread across them.

The way we teach is also important. Our style of teaching is probably quite traditional. But the kids love stories – eg Newton arguing with Hook, the first atomic bomb going off. It gives them a hook into it. So if you know your historical physics well and you can put it over in an interesting way that hooks them in. That can be missing in a lot of schools these days where its 'go to this website and find this information'. Kids want to be empowered and find things out for themselves, but for kids who are intelligent and can sit and listen, and can take information in visually and orally, it's attractive. There is quite an element in the pupils that come to our school that is quite arrogant and if they detect any lack of knowledge or weakness in you they don't respect you.

In physics there is a **homework club** everyday. Some GCSE students come as well as those doing A-level. We have to do it so they can get the grades. It's a balancing act between helping them and independent learning – so on occasions we set them stuff they can't do.

In short: we have a good reputation, very good capable teachers for a long period of time, good catchment, and ambitious, aspirational pupils.

What Can Be Done?

It's about getting the teachers. My personal opinion is that it is 80% of the battle. **People who are good at putting knowledge across**.

Case Study 9: High-Physics School from Chart 3.1 (Ranked Third)

Community, Coeducational, Comprehensive 13-18, East, Specialist Arts, 1,000-1,200 pupils, 200-220 in sixth form, 21.1% A-Level Physics. Interview with Head of Science, a physicist.

Context

We are one of two schools in a small market town. We do the western half and the villages on this side of town. The catchment area is large and a lot of the kids do a lot of travelling. Our intake reflects the locality and overall we are about average for ability, free schools meals and special needs. Nearly all the children are white with very few immigrants, though there are some travellers' children. Our GCSE pass rate varies quite a bit. The current Yr 11 is very good, with 75 per cent getting C and above in science in the Yr 10 exams, so the dual award should be well into the 60s. But for the current Yrs 9 and 10 the benchmarks on entry are much lower. I don't know the reasons. Our sixth form is mainly home grown, perhaps just two or three a year from other schools.

Faculty Organisation

Until recently we had a head of science and heads of the individual sciences. But like all schools we have had to look at the Teaching and Learning Responsibility payments. Now we have heads of biology and chemistry, but not physics. I look after that and am also head of science. The subject heads deal with day-to-day management, data collection and curriculum development in their subject. I take the overview and the lead on any strategy that affects us all.

Staff

There were four of us teaching physics, three with physics degrees and one with a degree in agricultural science, but one has left to become a head of department elsewhere and we are down to three. We had a dip in numbers last year (it affected chemistry and biology as well) and so have not been able to replace him, but we are above 40 again for AS and need another teacher. Two of us teach A-level and the third just does dual award and also environmental science at GCSE which we have introduced this year. So there is less specialist physics input into Yr 9. The head is a physicist, and he is taking some lessons and there is also ICT person who is pretty versatile in physics and chemistry. I'm upset that I have not been able to do a Yr 9 class this year as I really enjoy it. We do a lot of post-SATs activity, which is great fun.

It is difficult to recruit physics and chemistry teachers in this part of the world. My young colleague came here on teaching practice and basically he was head-hunted. The head was pretty pro-active in going for him. I'm concerned. When he goes as he's bound to in the next few years, I'll only be able to replace him with an NQT and that will put an enormous strain on me. This year a chemist is leaving and we have advertised for a biologist or a chemist and we've ended up with a biologist, so we are going to be short in chemistry. Yet we are one of the most successful science schools in the county. I have a mate who is one of the LEA strategy advisors in the region and he said most of the time its just getting somebody to put in front of the class. This means the continuity and curriculum development to put in and take things forward, which makes it more exciting, is just not there.

We do in science take one or two PGCE students for their placements but in the four years I have been here we've only had one who could be regarded as a physicist. But next year it is rumoured we are getting one.

We have three technicians, which is our full complement. We have a full-time chief technician who is also the physics one, but in addition he supports ordering, repairing and so on. Then there are two others, one each for chemistry and biology, who work from 9.00 am till 2.30 pm approx each day. Our chief technician has been here nearly thirty years and he has a lot of high-level repair skills and also building skills. He is due to retire in a couple of years so I do not know what we will do then. We trained up the chemistry technician ourselves. Two of our former technicians are now in the financial team.

Years 9-11

We run dual science for everyone, with no single and no triple. A lot of people try to cram triple into dual award time. We feel that has a negative impact so all that happens is they just sit there learning by rote and science isn't fun and doing things - its basically just something they have to do. Yrs 10 and 11 are divided into three blocks, each of about 100 students, depending on their GCSE options in other subjects. We have one express and three standard groups for each block. All classes access all grades but the express group spends more time on higher-tier material. It seems to work – many of the standard group pupils go on to AS/A2.

Because we are organised into biology, chemistry and physics departments in the school with separate prep rooms and big A-level numbers we have tended to teach KS3 and KS4 science as three subjects. The kids get science on the timetable but they have three different teachers. We do OCR staged assessment, so they have a biology module, a physics module and a chemistry module. We have somehow managed to have a clear identity in each subject but at the same time the kids sense we are working together. Obviously, the coursework is inter-linked, and the three teachers in each group are constantly talking and working together and feeding back to one another. The kids can see that and so on, but they are also able to identify in a sense what they particularly like about physics, or the other two sciences.

We have very strong links with our feeder schools. There is co-operation over what is taught in Yrs 7 and 8. We do a transfer test and we use this score to help them in Yr 9. We go to the schools, they come up here, so there is a lot of liaison. Because it is a 13-18 school the kids tend to get a fillip in Yr 9. They are coming from middle schools that haven't got good resources, so they have a whale of a time just before the SATs. We monitor the children very closely. In Yr 9 we're looking at regular testing. We know what the benchmarks are, we give them mock SATs in February and we monitor all the way. This gives us a benchmark for Yr 10, so we know what we are expecting. There they do staged assessment tests which are graded. The results are put into the database so we can compare them with the benchmarks to see what they are achieving. We add up their course work marks on a regular basis to see how they are doing. They find it quite motivating. We begin the dual science GCSE assessment in Yr 10. It's the only one so they tend to put a lot of effort in. They know their grade on one half of the course and if its good that gives them a fillip to carry on.

The school has an excellent database. I have access to an assessment record for every class and every pupil in the school for Yrs 9-11. Any teacher can click on to see what the pupil's KS3 score was, the value-added score, Yr 10 scores, grade, averages in biology, chemistry, physics.

With the new GCSEs we felt Gateway OCR offered the best balance of material, the way it was structured and assessed, and it is offered also as a continuum so it seemed to be right for us. All pupils will do the core in Yr 10 and then the additional in Yr 11. This is going to be a big strain on teachers bearing in mind we will be getting used to a new working day. So we will not be looking till next year at whether we might offer the applied science option.

Sixth Form and Beyond

We generally look for a 'B' for admission to A-level physics, but we do allow someone through on a 'C' who is particularly good at physics but has not got on well, say, in biology. We actually get a breakdown of the results at GCSE so we can see what the individual science grades are like. But there are not many of those. We also like them to have a 'C' in maths. We lose some at AS who do poorly in the January exams. They generally pass their re-sits and do okay in the AS module.

For A-level we do 'Advancing Physics'. I introduced it at my previous school and brought it across with me. We'd been doing the Nuffield course for 15 years and we liked its open-endedness more than the traditional approach. Some of the ideas of Nuffield were incorporated into 'Advancing Physics' so it seemed a natural one for us to look at along with the Salters' Project. At the time what appealed was the amount of electronic support it offered – CD-ROMs with animations, pictures, software programs, questions, answers, teachers' guides. This was fantastic as a starting point. We'd all been re-inventing the wheel for years. Also it brought physics up-to-date. It was fun, exciting, up-to-date and the impact on the kids in my previous school was very positive.

What may put some off it is that you've got to be prepared to put a bit of work in. It's not laid on a plate, here's lesson 1, 2 etc. You've got to be prepared to trawl through the sources and work it all out. Once you've done that its very exciting. The kids say the course work is harder but much more fun. They like the personalised choice. For example, a student who wants to be a vet gave a fantastic talk on sutures for her course work in Yr 12 so she was able to bring all her interests in that. For her research essay she did something linking physics with animals. She is also interested in gliding and was able do some research on flight. About a quarter of the A-level students are female, but it's growing.

We don't insist on A-level maths and about half don't take it. We just teach it in the lessons. I find, particularly at AS level, the maths isn't demanding at all. Our students take a wide mixture of A-levels. A lot of people do three sciences, but quite a few do physics with design, geography etc. Subjects like psychology are getting more pupils perhaps because we are a performing arts college. Last year it affected our numbers. But a lot of the current Yr 11 are going for three sciences and maths. Of the 24 taking A-level this year, three are doing straight physics at university, several something physics-related and others medicine and architecture and so on.

Resources and Funding

One of the things we do get here is a generous capitation. As head of physics and science over the last four years I have been able to repair, maintain and also develop each year. In my previous experience it was not so. This is across the board. I know we have equipment that other schools have not been able to buy. We have very good technical support as well.

This lab was refurbished last year. Before that it was very dilapidated. I was actively involved in its design. We are lucky enough to have had three labs redone out of the 11. The other labs are a bit more old fashioned and in need of attention. The school has benefited from being a specialist school. The facilities generally improved with more computers and so on. The school has also acquired a new block. We are a performing arts college, one of the original options, because science wasn't a choice at the time.

Extra-Curricular Activities

We do our best. Again we are lucky. Cambridge offers quite a few things. The annual 'Physics at Work Exhibition' – three days at the Cavendish labs. We take a coach load of kids and it has a very positive effect on their feelings towards physics in Yr 11. We also go to the BT Ad Astra Park in Ipswich for lectures. We host an IoP lecture. We get an astronomy road show with a mobile planetarium in every year for Yr 9, which we subsidise out of the Performing Arts money. I am also looking at getting in a couple of physics theatre groups. Generally the sixth form go to 'physics days' at the Institute of Education and that's gone down a bomb. We take a mixture of Yrs 12 and 13, and go to the science museum also. We have a science club and I would like to build it up. But we are tight on staff time at the moment. Everybody is under a lot of pressure.

Why Good Physics Take-Up?

We have a successful physics department within a successful science faculty. Next year it is projected that in a larger sixth form about 30 per cent will be doing A-level physics and half doing biology. Its pretty staggering. A template of how to 'breed' scientists. There is a **culture of success in science** in the school. We have consistently done well at KS3 and science is one of the highest achieving subjects at GCSE – 7-10 per cent above the school. This carries on into the sixth form. We have had, for example, one of the top students in the national results for Advancing Physics in each of the last three years. For the kids it is a success story begetting success.

One of the good things is we've had **stable well-qualified staff** in physics for the last three years and **good technical** support. We've had a lot of **fun** in making the A-levels, the GCSE, and KS3 happen. We enjoy it. We are around here after school discussing things. The kids come and find us. The kids pick that up and I think that's one of the reasons why we are successful. We also distinguish the sciences so the kids can **see which they like and are good at.**

My motto all the way through has been to try to create a **team ethos**. We all share the resources in physics and right across the science department. It is not like what I've seen in some schools where each teacher jealously guards their own individual worksheets. That is a major strength. The staff understand that the system is there to **support**; you can add to it and improve it but there is already a good foundation.

We have the presentations in the evenings not in lesson time. We all sit round and have some biscuits or something. We all see the presentations and how things can be done. The Institute of Physics has a very good KS3 resource pack with animations in physics so you see how something works.

We can set up some of our lessons in PowerPoint so even with a supply teacher the kids can still access the work even though they are not getting the input from the teacher. All our schemes of work and materials are digitized which has been a major development in last four years or so. We are experimenting with using ICT resources a lot. We are trying to get every single work sheet digitized so you can just click and have a look at it. This has been a major thing. The other thing is we make it fun. We've revised the schemes of work, tried to bring in lots of practical activities, brought in activities, like the air rocket and so on. The kids love it

What Can Be Done?

It's very important to get and keep the teachers. The **newly trained teachers must have a chance to find their feet**. When our NQT came four years ago, the two others and me were there with many years experience to support him. So he has been brought up in this atmosphere. He's learned loads of stuff in a place with a buzz about it. All new entrants should have that sort of chance. It must be soul destroying just to be thrown in at the deep end.

University courses could also be made more effective and exciting. We don't get large numbers going on to do physics at university. But I do think some **universities need to look at the courses they are offering**. Some have made massive strides in teaching and curriculum, but with what we are doing with ICT quite a few are in the dark ages.

Case Study 10: High-Physics School from Chart 3.1 (Ranked Fourth)

Voluntary Controlled, Coeducational, Comprehensive 13-18, North East, Specialist Arts and Technology, 1,300-1,500 pupils, 400-420 in sixth form, 19.5% A-Level Physics. Interview with Head of Physics and others including the headteacher and students.

Context

We're a 13-18 school truly comprehensive serving the whole community, in fact the only maintained school with a sixth form in this small market town. We draw most of our intake from three middle schools (about 90 per cent), but the catchment area is huge with some children coming from 40 miles away and we are over-subscribed. Nearly all the parents in the town send their children here. It is a prosperous area so many of the parents are middle class, but there are also some rural poor and disadvantaged 'inner-city types'. Take-up of free schools meals is below average. The ability of the intake is somewhat skewed to the upper end, but we do have a tail as in other small market towns of families with no tradition of academic success and they tend to be low-achieving, with low self-esteem, and not liking school.

Faculty Organisation

Up to last year we had a head of science. This post has gone. Now we just liaise as three separate departments. We co-operate and it works just fine. It depends, of course, on the personalities. The headteacher takes the lead on appointments with advice from the subject head. I've been head of physics for about ten years and have no interest in headship.

Staff

In physics we have four physics teachers, one with a PhD, two with masters' degrees and one with single honours BSc physics, all of whom teach dual award and AS/A2 physics. One is a fast-track teacher selected for the programme before his PGCE. We have a good age range, evenly spread from young to very experienced. It's an ideal first appointment because there are so many avenues you can explore, so many research opportunities. It's a walk-in state of the art school with lots of innovative teaching and learning taking place and as a physicist you largely teach physics. So we do not have too much difficulty in making very good appointments. We had a very good response two years ago. We had a large number of applicants, about 20 which is unusual, and interviewed five between whom it was very difficult to choose. But it isn't always like that. We look for a sense of humour in the candidates. They don't do a specimen lesson, it's such a big school, but I like to see how the candidates interact with the kids. Turnover is generally low. Staff move for promotion and personal reasons rather than disillusionment. In physics there was one retirement last year. Another left the previous year to go to in an international school in Germany.

We have some non-physicists teaching physics in Yr 9 because of timetable constraints. We have a chemist, biologist and a technology teacher each doing a little bit. In the middle schools I would guess the science teaching is done mainly by biologists. We play our part in teacher training by taking PGCE students. We do the 'short practice' sessions, not the long. One year we had three students for the long practice, one each in physics, chemistry and biology, and some of the parents complained. We have had two students this year both physicists.

We are a very good school and word gets around, so we get applicants from ITT students, and we sometimes recruit from among them, but it goes to open advert. We don't have any GTP or SCITT students.

We have 4 technicians. The chief technician is also our physics technician. I interviewed her four years ago when she had absolutely no experience. But she's got logical skills plus multi-tasking skills. She's absolutely marvellous and will advise me on things like the Yr 12 practical exam, which is a big job. All our technicians are female. They work pro-rata contracts. The pay is derisory, so because of the convenient hours it tends to attract married women with children.

Years 9-11

We have approx 320 students per year group in Yrs 9,10 and 11. We have got good liaison with the middle schools. We work hard at it. We don't want to be prescriptive. We try and complement one another. In Yrs 10 and 11 we have 15 sets in each year for science. There are three bands of equal ability dependent on their GCSE options and five sets per band, three higher and two lower. Then there are 2 groups in Yr 11 who do single science because they have timetable commitments for other subjects like two languages. In Yr 9 we did try mixed ability in tutor groups but this didn't go down so well. This year we have gone back to a previous system which is very broadly banded 5-7 and 3-6 according to their tier setting for the KS3 SATs and that works quite well. Then we use the KS3 SATs data to set for Yr 10.

I think the three science subjects have got quite strong identities in the school because we have separate subject departments. We don't offer triple science at GCSE. There are particular curricular pressures elsewhere and I think if we did offer it, it would be popular and other parts of the school would suffer. Taking an holistic view it wouldn't be good for the school and we are part of the school. Our children, however, are having a bit of trouble with recognising the subjects within the schemes of work. For instance, they will say 'when is the chemistry exam on the timetable?' and of course I have to say its Science Paper 2 because its not identified as chemistry. I think there is a deliberate policy to get rid of these identities.

For the new GCSE we are doing OCR 'Science for the 21st Century'. We are very well-equipped with OHPs and computers, all the labs have them. So we don't have the infrastructure problems that some schools would have and it's ideally suited as a course. In Yr 10 we will do the core. There is a big jump to the 'additional' in Yr 11 and the brightest will have the option of three sciences without any extra-curricular time. It's very experimental at this stage. We are not planning for applied science this year, maybe next. There is an element of work-related learning in it so there will be that constraint in the system, though they already all go out on work experience.

Sixth Form and Beyond

We have open entry to the sixth form. About 10 per cent of the sixth-form are incomers from other schools. If a student gets double 'C' in dual award science, even if it's at foundation level, then he or she can go into sixth form to do physics. We have several who came from foundation sets, but to be honest they do struggle and possibly fail at the end.

There is no requirement for them to get anything higher than a grade C in maths. Neither do we require them to do A-level maths. We give work to do in maths with a test in the September of Yr 13. They are made aware they need some maths, several hours worth through self-supported study sessions.

As far as possible we have open access. We don't want to engender in the entire school the belief that you have got to be an 'A' student to do physics. One who was dyslexic and predicted to fail got a grade D and went to uni to do engineering. We have had a SEN student doing A-level with a minder with him and he got a grade D. This year I've a boy who wants to do physics. He is doing the single science modular because we thought he wouldn't get a 'C' for dual award science. He is C/D borderline for the single award. Someone said he shouldn't be on my list for next year, but this lad has just passed for his private pilot's licence at the age of 16. He wants to be a pilot and has tremendous drive. Though he is weak academically we will give him a chance. He's a lovely lad. I've given him an A-level physics book 'Advanced Physics for You' with lots of pictures in it and said to him 'take it away and see what you think of it'.

We use Durham's ALIS data internally to identify the very weak students and we do a novel module on particle physics which doesn't have a large mathematical content so if the weak students are keen they can get Cs and Ds. A consequence of taking all comers who are prepared to work hard is that the A-level results show a wide spread. We have tried the Applied Science AS which we thought would appeal to those that liked science with an occupational slant. But only seven wanted to take it so it is not viable.

We currently do AQA specification A. We did change from linear to modular about three years ago. I think the specification is fairly transparent and it's certainly demanding. Our most able students are being challenged by it and we do have some extremely able ones and never have to worry about them getting bored. I had a look at the 'Advancing Physics' syllabus, but I didn't like it that much. We have students who benefit from a more logical, structured syllabus rather than the 'scenario', approach that it adopts.

Our sixth-formers take physics in a wide variety of combinations. A girl in Yr 12 said the other day she wanted to do physics and German at university. She's a linguist who was turned on to physics in Yr 11; she is very able and loves physics. We do, in fact, have quite a number of girls studying physics, about a third of the Yr 13 group. They tend to do options like medical physics and astrophysics. There is absolutely no gender bias in the subject throughout the school – no perception at all that it is a boys' subject, not even in jest. We work to show female involvement that you do not get in the textbooks. Some of the girls come through because they have got to know the A-level physics teacher through the dual award.

We enter the students for the practical exam at A-level. We used to do the coursework but found that the kids were getting marked down. We played by the rules but so many others were cheating and getting high marks for mediocre students. This way its fairer - the medium students get a good deal with it, they can score highly, and the weaker ones struggle as they would with course work. Assessing by exam also frees up a lot more time for curriculum work and allows for real rigour in physics.

A lot of our middle class parents have got the careers for their children mapped out. They are very well informed and know what is required to get into a particular subject at university. They do not reckon physics is important for getting into medicine, so those students tend to do biology, chemistry and something else. Most of our A-level students go on to university with a fair number, especially the boys, doing physics, maths or engineering.

Resources and Funding

Our allocation is fair, but we would like more. We have 13 labs. A couple are good but a few are very 1950s. This was built as a girls' grammar school for half the number of pupils. We have a lot of our equipment stored at the back of one of the labs. On one open evening for Yr 8, a boy came in and said, 'Oh I like your museum!' When we became a technology college we got all these projectors. All the IT equipment which is 3 years old is being replaced. My lab has been completely refurbished. It was re-energising to put the bid in for specialist technology status. This has brought in extra capital funding and an extra teacher in technology. Now we have got arts status as well.

Extra-Curricular Activities

We spend a lot of our time as a department outside of lessons. We have school events like 'student catch-up' where the whole library is set aside for themes like 'physics'. There are a lot of enrichment activities going on. There is an enrichment co-ordinator which I don't think many schools would have. We also have in physics an annual 'master class' at a local university and a one-week, residential course at Cambridge for the high flyers in maths and physics interested in engineering. We went to a local IoP seminar on sharing good practice and half the attenders were from this school. Our school is a 'leading edge' school and we have student researchers. We have a project trying to recreate the experiments of Lord Armstrong. High voltage stuff – bangs and crackles – the kids are very enthusiastic. We also run science clubs and participate in 'paperclip science'. We do 'science clinics' on an ad hoc basis and a physics café sort of thing where we do remedial work and for the very bright ones group meetings on for instance quantum thermodynamics.

Why Good Physics Take-Up?

This has always been a school where a **lot of able children do choose the sciences**. On the one hand, they realise the **kudos**, they know it's a gold standard A-level and there are **tremendous job opportunities**. They do have careers education which stresses the versatility of maths/physics education. On the other, there is a lot of **passion and fun** from KS3 and upwards. There's a group of boys and girls altogether and they talk about science a lot. They come to help at the science clubs and a project we have. They are a bright group and GCSE doesn't stretch them. You have to be careful they don't get bored. With physics if you just taught them the syllabus at GCSE they wouldn't go on to do it at A-level.

We have **four extremely good and well-qualified physics teachers**. There is a buzz and enthusiasm in the department, we talk to each other a lot, ideas about practicals and so on. I would charge anybody to find any aspect of physics that is boring – there isn't one. We, as a department, talk about the subject morning, noon and night. We are often here until 6 o'clock. This carries through to the students.

It's also about confidence. We as a staff are not threatened or frightened about approaching anything which is difficult to answer. If we don't know, we'll try to find out. As a non-specialist you don't have that confidence. I am thinking of myself teaching a bit of biology here. Staff being confident, give time and effort to the students, explain things after school if necessary, all the extra-curricular stuff. Even so our numbers in physics have dropped a bit over the last few years, mainly due to massive competition from new subjects, like psychology which now has over 100 students in the sixth-form.

Expectations are high and there is **good parental support**, including pressure to do well. There is a **good teaching style** and a **good atmosphere in class**, so the kids get very involved in the lessons. We use a system of trying to encourage students to give answers and they are not frightened because there is no put down. For the weakest kids there are systems in place to help them. In my Yr 10 class this morning there three members of staff, a learning assistant, a part-timer and me all helping the kids because they have their exam in single award science in two weeks time.

What Can Be Done?

We need more good and enthusiastic teachers. A problem in many schools is that trainees are traumatised by their first placements. There it's very much survival and no time to reflect on what they came into teaching for. We have a really **good induction system**. NQT staff get a great deal of support, around their subject and behavioural issues, and they are given a chance with the sixth form. There are fabulous **staff development opportunities** at the school. All staff are encouraged to join a working party, there are lots of research opportunities, and well-established CPD programmes. Staff are encouraged to give seminars to share best practice, for example, in a workshop on misconceptions in the physical sciences. For this a training allowance is payable.

Case Study 11: High-Physics School from Chart 3.1 (Ranked Fifth)

Voluntary Aided, Church of England, Coeducational, Comprehensive 11-18, West Midlands, Specialist Technology, 1,000-1,200 pupils, 200-220 in sixth form, 19.1% A-Level Physics, 3 Physics Teachers. Interview with Head of Physics/Head of Science.

Context

Parents fight to get children in so we are massively oversubscribed. There is no selection on ability whatsoever. We have a very complicated formula – 60 per cent on religious grounds, 20 per cent locally etc. Few pupils take free school meals and we do have a relatively high proportion of middle class parents, but quite of a lot of those entitled do not claim – especially the Afro-Caribbeans who regard it as a stigma. Of course this affects our funding level. A fifth of the school is of Afro-Caribbean origin, the highest in the city.

Faculty Organisation

The three subject departments are co-ordinated by the head of faculty. I have a dual role as head of science (to which I was appointed this year) and head of physics. The headteacher is not looking for a head of physics at moment – he didn't think he would get one!

Staff

There are nine full-time members of the science department altogether. In physics we are fully stretched and we can do very little Yr 7 and 8 teaching. There are three of us, two going through to A-level and the other just the dual award. I have a degree in mechanical engineering and my newly appointed A-level colleague is an NQT with a degree in physics. The dual award physics teacher has a biological sciences degree. It was very difficult to replace a superb physicist teacher with a PhD when he left two years ago. We had a very poor replacement, a geologist who we had to get rid of, and our numbers went down. When the physics post was advertised again we only got four applicants, two possible candidates, one of whom was quite weak. It's the location. It's not the first place to go to. If you are a physics graduate with a reasonable degree and a PGCE I think you can pick and choose. We've just appointed for a science post but we didn't dare ask for a physicist.

People tend to stay 3-4 years, then move on, especially the physicists who seem to get promoted quickly. We do recruit from our PGCE trainees, but we can never get physicists. Very few physicists apply to the university's PGCE science course. Two of our former ITT students are now teaching here, the biochemist doing some physics and another member of the science staff. We have not had anyone seconded in the 13 years I have been here. That's not to say it couldn't happen, but there is not much slack in the timetable. The plan for the biologists to do AS physics didn't happen.

We have four technicians, one part-time and she is giving up to become a teacher. Back-up is first class, but physics practicals are a real a headache because none of the technicians is a physicist.

Years 7-11

In Yrs 7 and 8 one member of staff takes the whole of science, but from Yr 9 we specialise so pupils can recognise whether they are going to biology, chemistry or physics, either as separate sciences or through the dual award.

If you get someone capable of teaching A-level teaching in Yr 9 it does make an impact. We select by inviting those whose target grades are B and above. If they don't want to do it no problem, but no one has said no. Triple science is done in the same amount of time as the dual award. Its great for senior management, three for the price of two, but it cuts both ways because we get 25 per cent curriculum time for dual award. That's probably that's why we were getting 88 per cent Cs and above against a target this year of 85 per cent. Our physics is 100 per cent pass. The dual award is so mickey mouse no wonder they struggle at AS.

We brought in the triple award three years ago because of value-added. At GCSE in this school they do really, really well in course work. I think the sciences are academically a bit more rigorous than some other subjects. Physics had one of the worst value-added post-16 here, in fact, the third worst. It was due to the ridiculous situation with the dual award where in the top set, 23 got A* and 7 A. They think they will get As at A-level and they don't. GCSE triple science is harder and their grades went down by one last year so predicted grades for AS/A2 will go down for triple award group and the value added will improve. It's just a game.

We are introducing a new AS this year in Applied Science as a 'soft option' for those getting 'C's or just scraping 'Bs' at GCSE – its not fair to take them on to AS physics or the other sciences. With the new GCSEs we are doing the OCR 'Gateway' which was considered to be the one most similar to what we are already doing. We can run the double and triple together more, so if someone doesn't like the triple we are already covering the double work. We would expect most to go on to 'additional' or triple. But we are introducing a BTEC course for 15 or so pupils (12 per cent of year group).

Sixth Form and Beyond

Our A-level numbers have gone up during the 13 years I have been here from an average of 22 per year to 35 per year, an increase of more than 50 per cent. It depends on the staff involved. The kids do physics because of the member of staff. At A-level we are part of a consortium, but in physics we make up more than 90 per cent of the cohort. We teach two of the three AS modules. The school also shares some courses with the girls' high school, but the inter-change is mainly minor subjects, eg Greek, theatre studies. We don't do A-level physics with them. It is a very high achieving school but they are reluctant to co-operate with us. They have a different A-level syllabus in physics with virtually no practical work. It's all theoretical with course-work the same year on year. Relatively few girls here take physics at A-level typically one in 7/8. It has improved since I've been here from about one in 13. There's no stigma attached to girls doing physics – that's gone.

They go on to diverse universities and diverse subjects. A reasonable proportion to engineering, electronics, maths, two or so a year specifically to physics, another two genuine candidates for medicine. The perception is that a B in A-level physics opens more doors usually for the first or second choice at university. This is their thinking more than anything the careers advisory service says, which I don't think this makes any difference to the pupil numbers in physics.

Resources and Funding

We have been a specialist technology school since 1994, but I am not sure what difference that makes to science funding. We have seven labs - 3 physics, 2 chemistry, 2 biology – plus two other rooms (including IT) in a dedicated block. Electronic suite was provided through technology money. I have to say I don't think the facilities have affected the numbers. You need a certain level of provision, so the shelves aren't filled with dusty textbooks that would put them off, but the biology labs are dire. Candidates for the recent job were very unimpressed with the facilities.

Extra-Curricular Activities

Science enhancement is very important to us. The AS group recently went to Alton Towers – lot of physics to be observed there. A whole day of timetable is devoted to problem solving activities in Yr 10. We go to local universities, for example, to a materials science day. We are affiliated to the IoP and have dormant links with ASE. We run lectures and enter competitions. We have won national finals when we've been the only comprehensive among the finalists. We offer prizes for competition. Outside speakers have to be in school time, since the students don't want to stay after school. Yr 11 triple group plus sixth form are invited to the high-level speakers. Most are very effective, but they can be rubbish. Also we do CREST, 'Science Across the World', 'Appliance of Science' and we have a whole raft of clubs – astronomy club, Yr 7 science club, and Yr 9 IoP poster competition.

Why Good Physics Take-Up?

We have a high ability intake so **catchment** area does influence numbers in physics. But physics is successful in this school because of the **people who teach physics**, first and foremost, and the **perceptions of physics** in the school – these are the main reasons. Physics also has a **clear identity** from Yr 9. The **science ethos in the school** is huge. Pupils at this school love science. Over half of the sixth form take the sciences. It is something in the core of the school. One of the things I have done to improve physics numbers is to **work closely with the maths** department. We tell students if doing physics they should do maths and vice-versa. It does make a difference to the grades. The mathematicians doing physics tend to do better in their maths AS but then, if they carry on to do maths, they do better in their physics. We actually **target pupils** in Yr 11 – tell them they are capable of doing sciences at A-level. We try and nurture them along, but is not a hard sell. We get lots of A-level students because they have seen their **predecessors** going on to do **interesting things**? We get past students back (they volunteer) to talk to pupils, to sell the subject.

What Can Be Done?

I bet at lot of those who train to be physics teachers fall out in their first year because there is not enough support. We'd love to provide a '**specialist training centre'** for the newly-qualified. We already provide pre-training experience for those thinking of doing a PGCE. I'd also like to bring **maths and physics closer**. You would need to change the way school departments work – science and maths are separate departments. We liaise on Open Evenings as a double act to boost numbers and I actually try to distance myself from biology and chemistry a bit at Open Evenings. A PGCE in physics and maths would be good, but when schools interview a physicist they expect their second subject to be science. I also think you'd lose more to maths.

Case Study 12: High-Physics School from Chart 3.1 (Ranked Seventh)

Community, Coeducational, Comprehensive 13-18, East, Specialist Science, 900 - 1,000 pupils, 200-220 in sixth form, 18.0% A-Level Physics. Interview with Director of Science, a physicist.

Context

We're the only maintained secondary with a sixth form in this rural town and the catchment area is large. We're a 13-18 school. This allows staff to concentrate on specialisms, but the downside is we seem to get a dip into GCSE rather than at KS3 as in 11-18 schools. Starting at Yr 9 however allows you to refocus the pupils. We are a specialist science school, but we accept everyone so we are a true comprehensive. I've never worked in a more 'comprehensive' comprehensive. We have pupils who come from dreadful home backgrounds through to those whose fathers will drop them off in 'ferraris'. We have a successful behaviour management programme and cater for pupils who may have proved difficult in other schools. There are transfers in from the local 11-16 schools for A-levels and from independent schools. So the Lord giveth at both ends. Some of our best pupils, however, are creamed off by neighbouring independents that offer scholarships. The school reflects the locality, which is almost entirely white Anglo-Saxon.

Faculty Organisation

As Director of Sciences, I line-manage the three departments, Physics, Chemistry and Biology each of which has its own head. Part of my responsibility is the promotion of all three, and finding funding for them. There are a number of aspects to my role. I have a two-third teaching commitment. As well as managing the Faculty, I run all the 'specialist' aspects of the school focussing on science and maths but also line-manage ICT.

Staff

There are 14 Science teachers in the Faculty, enough for us to run semi-independently of the School. We need 3½ physics teachers. Two have been here for years (one retiring this year), one for 2 years and we have a new NQT physicist;. The NQT was appointed from a short list of only two, but he was a very strong candidate. All the physics teachers have degrees in physics. We also take on recent pupils as interns – our NQT previously held the post and the present one is going up to Cambridge in the autumn. We are always looking for talent early on. One of the benefits of me working across the country for the Institute of Physics, the Specialist Schools Trust and the Association for Science Education is I'm always recruiting– are you interested etc. You have to be proactive. It is a help that we offer the separate sciences.

We have 2 FT technicians. We are woefully under strength. We should have 4 (ideally I'd like one per lab), but I do have a PA and an intern. We have been looking at the new technician structure and career programme. At the higher level there is more emphasis on working with pupils. We are developing this so both our technicians will be involved in the direct education process, but we not redefining them as Teaching Assistants.

Years 9-11

At GCSE we run triple science plus the dual award where we emphasize 'these are chemistry units, physics etc'. We do promote the sciences as separate all the way through. At options evening we have three separate stands and we make sure the staff are clearly associated with the different subjects.

When I brought in triple science I said it was there for all pupils with an interest in science – not an elitist route. We set in dual science, but have mixed ability in the separate sciences. This coming year over a third of Yr 10 is opting for the separate sciences. Our selection procedure is 'do they enjoy science, not have we got the brightest'. We still have a pretty traditional 'top set' in the dual award, but it is made clear that both routes are equally valid for A-level. We monitor very closely and in the school there is an awful lot of support available outside lessons. Pupils are very good at coming for extra help. There are two blocks of time for the dual award, but three for triple science. Those doing triple can't do two languages. We do not feel able to cram triple into two blocks. I am aware that some schools do it as part of the gifted and talented programme, but the current science curriculum is so content-led that you would have to remove the practical and the exploratory so A-level numbers would go down because they would be bored rigid.

I'm looking at a different approach with the new curriculum for GCSE. I want to start it in Yr 9, so they can do three sciences taking three years. Then the pupils can get more breadth. At the moment we find most of our triple pupils are male, with girls tending to do the dual award because they have a broader breadth of interest. But I am bothered by the way science is going. 'Science for the 21st Century' is rubbish - better to talk about science than do it. A headteacher can see this as a way out and get two GCSEs for pupils without having the right specialist scientists. More and more the gap is widening between say independents, grammars and schools like ours and then other schools where you can't get a physicist. So you timetable the dual award with virtually no physics.

Sixth Form and Beyond

We have two groups, about 30 in all, doing physics next year. Pupils do four AS usually dropping one. We get less than 25 per cent dropping out. Interestingly, we have expanded numbers in psychology without detriment to the sciences - pupils often drop a non-science for psychology. We encourage pupils to take A-level maths if they are doing physics. We benefit from a strong maths department with specialist teachers because pupils at the top end look for the whole package. If they feel one of their A-levels is in danger they will shop elsewhere.

We usually get 15-20 per cent going to unis to do straight physics, some to chemistry, engineering, ICT-based courses and a few medics. They go all over the UK with the top pupils to Oxbridge and Imperial.

Resources and Funding

Funding is very good in this LEA, especially with our large A-level numbers. I run the specialist schools budget and this allows me to enhance funding, allows the 'fun things'. We are a science college with modern, bright dynamic teaching environments.

We have twelve labs, which have emerged (as the school has grown) from four different building programmes, with the originals from the late Fifties having been thoroughly refurbished. We work hard at sponsorship. This financial year I will have brought in £8-9,000, virtually all from national project grants rather than local companies, for example, from the Rolls Royce Science Prize, the Institute of Physics and the Royal Society of Chemistry.

Extra-Curricular Activities

We try to ensure that something happens at least once a month which says 'this is physics'. We complement it in the other science subjects. This year we've done the Rolls Royce Science Prize so we've used computer-voting systems in physics, an astronomy club, we've worked with the Rambert Dance Co. We've attended the particle physics master classes, we bring in about 6-8 external speakers in during the year. We supported Einstein Year last year and run other events.

Why Good Physics Take-Up?

There are a number of key issues. I think the biggest one is to have **a nucleus of physics teachers**. Working with physics teachers countrywide and talking to heads of science some will get a physicist, maybe an NQT, who will come in and its 'hey we've got a physics teacher'. Suddenly the entire burden of curriculum and assessment lands on this one person. They don't get two or three years to develop their own teaching and learning strategies, and then a phased transition to leadership and management. A lot of new physics teachers find that very, very difficult.

We are very lucky here and when I joined four years ago there was a tradition of at least three physics teachers. I think it becomes extremely difficult in schools, given the number of physicists out there to establish a core physics group. With such a low base of physics teachers, there often isn't a critical friend they can turn to in their own science department. What they are having to do relatively early on is work with staff whose subject is not physics or having to support a member of staff. Without being derogatory they are fire fighters, supporting the poor biologist who, say, has to teach forces. Also it's very important as in all subjects to master classroom technique and make the lessons come alive – make sure the quality of what is going on in the classroom is high, enthusiastic, is relevant, and engages the pupils. New teachers really must have the chance to learn from good experienced teachers in their subject.

Then **leadership and management** as with any subject is critical. It's that whole professional development process. Another key factor is that we try to establish **a separate flavour to the different sciences** very early on. Even in Yr 9 they are taught separate sciences so they can see that these three subjects have different strengths and characteristics. We completely reject the notion that 'science is science'. We prepare pupils ranging from those who can just about pass the GCSE to those very clever, hardworking pupils who get loads of A's at A-level and go off to do Natural Sciences at Cambridge. But the whole way through we do see the sciences as separate and we want pupils to get the best possible experience in the classroom. The way to do that is not to spread the talent evenly, but ensure that those people who have got the interest in astrophysics do it and those that do an equally good job with covalent bonding or biotechnology issues go there.

We don't see science as one homogeneous 'blob'. There are skills that are covered in each, that are clearly transferable skills, but we organise for progression in particular directions in which the pupil has interest**.**

What Can Be Done?

I would like a way to be found of having NQTs in successful departments for at least a year. Perhaps the **'Beacon Schools'** idea where you would 'grow' physics teachers. The focus would be NQTs learning to teach and be supported where there was a critical mass of good physics teachers. This would be on reduced teaching time but several NQTs in the one school would free up a senior member of staff for mentoring and other things. Then NQTs would have a grounding from which to move into departments less well off.

A cohort of NQTs from say 15 schools could also meet regularly at the beacon school or a science learning centre over the course of the year to hone up their teaching, subject knowledge, organising examinations and other things. Physicists from the school could also go out to help other schools to mentor their physics NQTs. I do notice as I move around that a lot of money goes into professional development, but if staff are not supported/not trained it just doesn't get going.

Another thing I would like to see is **PGCEs with a focus on physics.** But I am doubtful about a physics-maths PGCE. The culture in maths is different and they tend work in different ways. There could also be a staff loss – I don't want to teach any biology so I'm off to teach maths.

Case Study 13: High-Physics School from Chart 3.2 (Ranked Ninth)

Foundation, Coeducational, Comprehensive 11-18, South West, Specialist Science, 1,400 -1,600 pupils, 200-220 in sixth form, 16.0% A-Level Physics. Interview with Head of Science.

Context

We have the full comprehensive range but skewed to the upper end. Our catchment in this unitary authority is the more middle class end of town and the surrounding villages; schools in the centre have the lower socio-economic intake and they struggle to get half to 5A*-C compared to our 70-75 per cent. We are over-subscribed and select by catchment and siblings.

Faculty Organisation

We have a Head of Science and a head for each of the subject areas. I was Head of Physics for eight years and have been Head of Science for four years, but I am taking on a wider school role so in science I will become just a physics teacher again. This week we appointed a new Head of Physics, someone who used to be a physics teacher here and the Head of Science post went to an internal candidate, the Head of Biology. The interviewees for the Head of Physics had to do a presentation on 'how do you raise the numbers in A-level physics?'

Staff

In science there are13 teachers, 6 biologists, 4 chemists, and 3 physicists plus 3 or 4 part-timers. About five years ago, there was me and a part-time teacher in the physics department. Now for the coming year with science specialist status and the extra funding it brings in there will be four physics teachers, one of whom is part-time. But it is very hard to recruit physics specialists. We, in effect, poached our new Head of Physics. By chance we have also picked up a female physicist who was moving back to the area. She has a degree in applied science but mostly physical science and she has taught physics A-level before. This lady was the only physicist in the four applicants for the post – it was pure luck.

Our other post was advertised as 'science' but we said we would prefer a physical scientist though really we wanted a physicist. So I didn't look at the biologists and we appointed a chemist –none of the physicists was up to it. For another science post we appointed a biologist because we knew a good biologist would be able to teach across the board, but a poor physics teacher would not. A poor physics teacher is worse than no physics teacher, because they detract from the work of the other science teachers. Biologists are usually good teachers and keen to learn physics.

We play an active part in training. We are members of the local SCITT and take PGCE trainees from several universities. Currently, there are six trainees in science though none in physics. The only SCITT physicist this year was quickly snapped up by another school. Teacher training is not part of our recruitment strategy. For the last three science appointments we did interview our trainees, but better applicants came forward. Some schools in the area have no physics teachers at all. We are paired with an 11-16 school and I teach the top group there.

Years 7-11

All KS4 do the double award science with the exception of about 5 per cent who take the single award and another 5 per cent who do an alternative curriculum which is part college-based courses and work-based-learning in English, Maths, Science. There is a common curriculum for the GCSE double award in Yr 10 but in Yr 11 about half work towards the higher tier exam and the other half the foundation papers. About 12-14 per cent get A*/A against a target of 20 per cent. There are 18 classes about 15 of which have two teachers and we try to pair a physical scientist with a biologist. The top set has a biologist and a chemist, but no physicist this year, so it does impact on physics A-level numbers. There is an effect lower down the school at KS3 when you need to enthuse them, but in the last five years there has been little input from physics teachers.

With the new GCSEs the schools in the LEA are working together collaborating over syllabuses and books. The science advisor is a very good facilitator – collective good will. We are going with OCR, 'Gateway' not 21st Century, which is not too much of a radical shift, with all the changes going on in the science department. Next year we will just be doing the 'core' – modular in January and June – so by end of Yr 10 they will qualify for a single award. Then it will be a guided choice into 'additional' or applied or to finish at that stage. We've not done separate sciences while I've been at this school. Before I came here I taught at a school where they did originally do the separate sciences alongside the double award. It switched to just the dual award because the non-triples felt they were less able and they tended not to go on to A-level. The separate science lot also covered more content so you started A-level with a two-tier entry group. We could do separate science with our top set just the same but there would be no benefit. Parents like the idea of separate sciences though. There is also so much cramming in separate science in dual award time.

Sixth Form and Beyond

We used to require a 'B' at GCSE for any A-level science, but we now decide on a case-by-case basis. We have found that if they work hard, with our monitoring, we can get them through to AS on a dual science 'C'. We've had no failures for five years. One of the reasons for the change is that if I had any doubts about whether a pupil would get a C grade I would insist that they took the foundation papers. Under our old requirement this would rule out doing A-level, but the relatively poor overall performance could be because they were good at physics but not biology or vice versa.

Even so our numbers are slightly down on what we would expect. My energies up to 2000 were concentrated on physics, but since then I have had to take my eye off the ball with all the other responsibilities. In 2000 with the new AS (Curriculum 2000) we did a big sell on 'Advancing Physics' in terms of marketing the course and raising the profile of physics at GCSE. I and my colleague were much more in evidence as teachers of physics and for several years we had two groups in Yrs 12 and 13. Since then there has been some decline and we are back to one group each year, so altogether in Yrs 12 and 13 we have 24 students, which is the lowest of the three sciences. Physics needs someone to be constantly promoting the subject. Very few of our sixth-formers do three sciences. A number opt for maths instead of physics. We get pupils with much more mixing of physics with say art or drama.

Two of the 12 students in Yr 13 have come in from other schools most of which are 11-16. There is good physics teaching in the sixth form college and at another 11-18 school. But we don't tend to lose our students except for specialisms we can't offer like music technology.

We have five students taking an AS in 'Science for Public Understanding', a superb course. Some do it as a complementary subject to A-level or because they can't cope with say A-level physics. Currently it is taught by a biologist and a chemist, but next year a physics teacher will be involved. We should like to do it as A2 but it isn't available. We have run it for two years and we will expect increased uptake when the new GCSE comes on stream. I would also like to have offered it at GCSE as well as say astronomy or environmental science for the A*/A pupils. But my department did not agree with me.

Nearly all the A-level physics students go to university. Of the twelve in yr 13 this year, three are going to read physics, three biology, one chemistry, one drama and several have offers for economics and geography, but none are aiming at medicine. The students going on to university including to Oxbridge make superb ambassadors for the subject.

Resources and Funding

The school has opted for a science specialism because it was seen as the subject with the biggest potential although it is not the highest achieving subject in school. Sponsorship was obtained from a variety of sources and there are strong local science connections. Quite a lot of parents work in science-based industries. Science status has made a huge difference – an additional pot of money, sharper focus and extra capital build. We get £150,000 per year which has to be split 2/3rds school and 1/3rd community. It directly funds five members of staff involved with science support, for example, the science community manager. In terms of other teachers you buy 'time', for example, for a person to be in charge of ICT in science. The extra money has also enabled us to go back up to 9 sets in Yrs 10 and 11 when we had had to come down to 8. The capital funding has provided for an extra wing including a conference room, display areas and an 'eco' garden.

Extra-Curricular Activities

We do lots here particularly in connection with science status. We put on physics lectures, have a science van taking equipment to primaries, teach in feeder schools, and run science festival for primary schools. We also have an astronomy project. We are affiliated to the IoP and we go to the Philip Allen lectures. But we have to be careful about which lectures we take them to because there can be a negative effect if the lecturer is poor. The best thing is to get people in and then a whole year group can attend. We hosted an IoP lecture recently.

Why Good Physics Take-Up?

In fact our numbers have been a little disappointing. We have been to some extent the victims of our success. With just 1½ physics teachers and two classes in each of Yrs 12 and 13 our teaching was mainly confined to A-level.

KS4 have been coming through without having had any physics teacher at all and there has had a knock-on at A-level. Even though the KS4 biologists and chemists doing the physics are excellent teachers, they don't have the same inside knowledge and anecdotes, the same kind of unconditional enthusiasm. Pupils vote with their feet. They like a certain teacher, get used to them and they stick with that subject. If you asked Yr 12 why they are doing physics they would probably say that they enjoyed year 11 and have confidence in the teacher. In Yr 13, nine out of the 12 came from my science set at GCSE and most were in my tutor group as well. They know therefore they are on safe ground, which is especially important in physics where the perception is that it is a hard subject.

So we have a rebuilding job to do. The key responsibility of the new head of physics will be to promote the subject. I will share the physics A-level teaching with him but I will be freed up for more KS4 work. Next year the three top sets will have a physicist teaching them so undoubtedly I can assure you our numbers at A-level will go up. We'll be pushing our exam results which are really good in physics – a 100 per cent pass rate AS for last five years, and 40 per cent A/B grades at A-level.

We will also be working hard to maintain interest lower down the school. Somewhere between Yrs 7 and 8 – where they all love 'space' – they get bogged down with content. We'll be posting puzzling and fascinating questions around the school. The big message is 'physics is simple but not obvious' – that's what makes it fun. It makes you think.

So to summarise the new head of physics will **promote the subject** on open evenings, there will be a much **higher profile of physics teachers** at KS4 and we will continue with the **enrichment activities.**

What Can Be Done?

Other schools could be doing what we are doing. If they can get the teachers they need, they should ensure that **physics specialists teach at KS4 and earlier** so the pupils know who they are and can relate to them as someone who is going to get the best out of them at A-level. Then they will take a risk with what they have heard is a difficult subject. They also need to know **which parts of GCSE science are physics** so they can work out if they like it and are any good at it. We also **drip feed in the exciting aspects** of physics before GCSE.

Role models are incredibly important. We have three going off this year to do physics at university including one to Cambridge. We provide opportunities for them to mix lower down the school where they can be ambassadors. We get also ex-students coming back here, who are excellent adverts, helping us to counteract the image of a dull, academic, hard subject.

Case Study 14: High-Physics School from Chart 3.1 (Ranked Seventh)

Foundation, Boys, Comprehensive 11-18, Outer London, Specialist Technology, 1,200-1,400 pupils, 260-280 in sixth form, 15.3% A-Level Physics. Interview with Head of Physics (Second in Science).

Context

Basically it's a comprehensive with neighbouring grammar schools. We are nevertheless three times over-subscribed. Admissions are settled on siblings and proximity. About 6 to 7 per cent of the pupils have free school meals. We are a boys' school but we do take girls and boys in the sixth form for subjects their school doesn't offer and we do get a drift because it's a good school. We have a very good reputation for performing arts, art and photography which draws girls into the sixth form. Media studies also has a good reputation which attracts girls. We had two girls come here to do physics last year but there aren't many. If girls want to study physics they do tend to stay in an all-girls environment. We lose some of our boys after Yr 11 into training/FE but most stay and go on to HE.

Faculty Organisation

There is a head of science, then me as head of physics. There are also heads of chemistry, biology and KS3. We are trying to devolve even more. KS3 is massive pressure with SATs etc so we are getting a head of Yr 7 and a head of Yr 8, then Yr 9 and overall management of KS3. I do a lot of day-to-day management of the department, even though I don't necessarily have all the information I need to do it. Communication is not as good as it should be some of the time. The head of science liaises with SMT but there is not particularly good information at that point always.

Staff

There are twelve staff in the science department equivalent to 11 full-timers. Five including the two A-level physics teachers have been teaching the dual award physics. I have a degree in physics and the second A-level teacher is from abroad. He's incredibly well qualified but it is not a degree in physics because they don't do that - they teach all the sciences so he is very well-rounded. We've been incredibly lucky, because before he came I was so worried we needed another physicist because of increasing numbers. In addition, three other staff have been teaching the dual award. One is a member of the SMT who has a BEd, the second is a palaeontologist who trained at a SCITT. She's on maternity leave. Her classes have had a difficult time. We had someone temporarily, but the kids didn't give her a chance. We got another and he's now sick. The fifth teacher taught just three periods of physics in the dual award. He is not here anymore, but has been replaced by a biologist.

I do have new physicist starting in September. It took forever. She's an NQT with a degree in physics. We don't normally get PGCE people which for me is the preferred route. I only saw her teach a sample lesson and I was very happy with that but I wasn't involved in the appointment and job spec. She is replacing the half-time teacher from the SMT (who was often delayed or not there) plus half the teacher on maternity who is coming back part-time. But we can't replace our chemist and have had one after another on temporary contracts. Now we are trying to 'grow' a lot of our own through GTP. I've been asked if I will have a GTP next year and I will. I have never had a PGCE student.

In the science department we have three full-time technicians and one part-time. The physics technician retired and I could not replace her. We did have a student who left to work in Sainsburys. I eventually convinced the head of department that we should bring him in for an interview and he's my technician now. He is a great asset to us and is on a scheme which will enable him to become a sort of glorified teaching assistant. The chief technician supervises and does the stock. At moment we have a happy little band but I don't know how long the one training will last here once he has qualified.

Years 7-11

The children are set virtually from when they arrive. We begin with mixed sets in tutor groups then they do the Cognitive Ability Test and are set after that. The year group is split into half and 4 sets are formed in each half, 8 in all. Above the two top sets we have had a class for the very brightest which is accelerated to do GCSE in Yr 10.

The other A-level teacher and I take the top sets for physics in the dual award. We don't always do that, but some of the other physics teachers don't like having the top set because they ask them difficult questions. We constantly refer to A-level in Yr 9, showing how the content develops. On the whole the A-level physicists come from the top set, but not all. They tend to come from those sets that have the A-level specialists. It's a reasonably tight correlation. Next year, for example, there will be 11 from my top set, 6 from my colleague's and two others. If the A-level teachers don't take the top sets at GCSE A-level numbers tend to be a little bit lower.

The 19 at AS is low this year because the accelerated set took GCSE in Yr 10. Then the school didn't know what to do with them. The understanding was they would go directly to A-levels, but because they had had to drop music and some other subjects they were interested in they complained so they were told they could do them in Yr 11 So we are putting on AS Science in Yr 10, two groups of 14. They should all get the top grade, but will they want to carry on with the sciences?

We also teach the applied science GCSE, but it has left us with a bit of a problem. We put into it students who were D/E material, but they are getting C's and B's. How can we tell them they can't do A-level if they get a B? But they are not up to it. We really need to do the applied science A-level, but this would be very demanding given we have to deliver the new AS in Science and the new GCSEs as well as altering KS3. We feel the topic of 'momentum' gets lost in Yr 9. Should we teach it all in Yrs 7 and 8 and have Yr 9 as a motivational year or Yr 7 as motivational year and teach most of it in Yrs 8 and 9, because the content of the curriculum is sometimes de-motivating – there is not enough of the interesting things in it.

We used to do triple science but we dropped it when we found that some in the triple-set tended got three Bs when they could have got two A*/A. This is probably because they only had the same curriculum time as the dual award. Next year we are going to provide it again as very much a 'master class' for the very enthusiastic ones who want to do A-level. They will have one lesson a week after school for physics for a whole term and similarly for chemistry and biology. They will have extra study at home and if they don't do the work they will not be entered. The only group not allowed to do it is the accelerated group, the very brightest – because it won't fit in!

We are going for AQA (syllabus A) as the new GCSE, which is very conservative of us. It is a traditional-type course. We are getting rid of course work and going for the exam option and practical assessment. In A-level we don't do coursework - we do the practical because we feel we train better physicists who can work independently.

Sixth Form and Beyond

In order to progress to AS Physics we insist that they get at least a 'B' in the double award. We also ask for at least a B in GCSE maths but we don't require that they do A-level maths. We promise them faithfully that any maths they need we will teach them (some extra lessons). Some take AS maths in Yr 13 replacing another AS. Normally at A-level we get a 100% pass rate. Neither do they fail at AS. One or two get Es and they usually don't carry on and some want to finish at that stage anyway because it was their fourth AS.

We are traditional in our approach. For A-level we do OCR with timed practicals at AS and at A2 level. They are told what to do, take the measurements, plot an appropriate graph, and usually find a physical constant from the gradient of the graph. Practicals are an important part of our sixth form course. We try for one a week. I put on an extra lesson out of one of my free periods following a physics lesson and it gives me 100 mins then for a practical. We also practice with past exam papers and give them mark schemes so they can check their output. We also have a lot of revision. The students do need to be looked after when they first start AS. It is a big transition from dual award to AS, so triple science should help here. If students struggle at AS we generally advise get the best grade you can and then decide if want to withdraw. We put in programme of voluntary extra help for them.

Some of the new courses bother me. When Advancing Physics first came up it looked to me like 'Tomorrows World' physics – physics without the physics in it. It doesn't include the bits that make 'physics' physics, like it doesn't go into Snell's Law. It doesn't seek to explain from first principles and understand that that's the only way it can be. That's what physics is. Advancing Physics seems to be about learning modern technology without understanding it.

Our sixth formers take very varied combinations – for example physics plus biology, maths, and geography or plus music, maths, and DT or plus French and maths or plus DT and maths. They often take three serious ones and one for 'fun'. They are advised by the school - not by me - to have a bit of breadth by having, for example, a language if want to be a scientist. With their A-levels they go into a wide range of subjects like straight physics, astro-physics, maths, engineering, geography, and sports science.

Resources and Funding

I rarely come away empty handed if I need more money say for A-level practicals. I'm not aware of any impact otherwise otherwise from specialist status. I'm not really involved in external issues. I tend to concentrate on making my own little bit work.

Extra-Curricular Activities

We don't do as many enhancement activities as we should, mainly because we are all so busy. We are flat out with revision sessions and reports – one per child every six weeks! So the emphasis is on the curriculum. But we do realise it should be developed.

We are weak on utilising our younger staff so we've just started a science club run by an NQT and overseas-trained teacher. I'm failing as a manager if I have to organise it. I'm going through AST training and I have realised I have to get the younger staff to help me. We are trying to man the 'lab' at lunch break as an extra resource. But we do need to get more involved – external speakers, our students coming back from unis as role models etc. We are affiliated to the IoP, but we do not have much in the way of links. No one has approached me.

Why Good Physics Take-Up?

I think a lot has to do with the **results.** We've got great **enthusiasm** and high **expectations** for A-level. When I arrived there was an understanding that physics was difficult and you would only expect a 50 per cent pass rate. I said 'no', what's the point of doing it if you don't pass, so we get everybody through. If we think they can't succeed we don't take them. I take personal responsibility for their grades. I give up time for extra-revision courses. I think I'm an approachable and friendly personality. That 'openess' including the grading and marking is important. I'm very accessible. I'm your pocket teacher – you keep me in your pocket! If you're struggling and it happens to be 9 o'clock at night and I'm online you can talk to me.

We have **specialist teaching** in Yrs 10 and 11 so they know they are doing physics. We do **identify** clearly which is physics, chemistry and biology from early on. Even in Yr 7 they have two units of each of physics, chemistry and biology with the teaching split between a physical scientist and a biologist. Both the pass rate and A-level take up have increased since we switched to **modular science**. With the linear courses the students were getting bored by the end - it just seemed to go on and on. The modular structure increased their **motivation**. Suddenly they go from not knowing how they were doing to getting a mark for the 1st modular exam in November of Yr 10 which they can bank. Then another one in the March and by the end of Yr 10 they had done half the modules and course work. This tends to stop the drift off in Yr 11 because the students realised it was something they could do well in.

We also make them aware that maths and physics can lead to the **highest paid jobs**. We put up displays of the jobs you can get. The IoP did a sheet of paper with starting salaries. We pick up on publicity, for example, from the TV about physics and employment and incorporate it into the lessons. We've started going to SETPOINT '**Careers Awareness Days'**, but that's after they've chosen the A-level. It has encouraged me to know what careers they can go into especially engineering through the Institute of Chemical Engineering.

What Can Be Done?

I would love to have some kind of responsibility for physics across the borough, or with other schools, encouraging physicists. Or our school could be a '**Physics Centre**' If a school had no physics teacher the pupils could come to the 'Centre' here. It could run master classes in the evening or the training of teachers who are not specialists to teach physics. As an AST I would be happy to do it. There is a problem with physics teaching that if you don't love it then you are never going to be able to put across how interesting a subject it is.

Other schools could also do some of the things we are doing. The fact we **identify the three subjects**, have **specialist teachers** for the top sets, **careers information** on the value of the A-level, and the **banking of points** early on. We analyse everything the students do. The boys can see when they are managing or not managing to achieve their targets. This helps in motivation – we use this a lot with students. I think the linear syllabus is de-motivating. We have lots of **practicals**. I suppose it comes down to personalities and being enthusiastic about the subject, which has to come from being a specialist.

But it's hard to know where we would get the specialist teachers. The obvious one is give them **more money** but you may not get better, enthusiastic teachers. Having to teach all three sciences probably puts some people off. For a physicist there can be terror at having to teach biology. We try to impress on the SMT that when we need a teacher in the science department we need a specialist. I wouldn't feel confident, for example, of doing chemistry at GCSE. I could do it but I wouldn't feel confident, I wouldn't be enthusiastic. 'Why do we have to do it?' 'Because you've got to'. It's not a good answer, whereas a specialist can make it interesting. Combining **maths and physics into a PGCE** might well go down well. We are thinking here of linking the maths and physics departments a lot more. Some teaching overlaps and we are not necessarily capitalising on that. It's a timetabling issue and we need a more consistent approach.

Case Study 15: High-Physics School from Chart 3.3 (Third on AS/A Physics)

Foundation, Coeducational, Comprehensive 11-18, Inner London, Specialist Technology, 1,800–2,000 pupils, 570-590 in sixth form, 95-105 taking AS/A Physics. 11.6% A-Level Physics. Interview with Head of Science and Head of Physics.

Context

We have a multicultural intake, with about 65 per cent from ethnic minorities, reflecting the locality though students come from out of area. About one in nine takes free school meals. Although we are coeducational about three-fifths of the intake are boys, because there are some good girls-only schools in the area. The school is greatly over-subscribed and as a former grammar school we are still able to select on ability. It is now 20 per cent though it was once 50 per cent. After ability, places are allocated on proximity and siblings. Although some of the students are extremely able the school also has support groups for SEN.

A lot of pupils join the school in the sixth form. It has a huge reputation and we recruit from a lot of the local schools, even those with science sixth forms. Some are very weak and have lied about their qualifications to get in. They usually depart. In general, they work their socks off; that is what they have come for. The school is very good at taking part in major initiatives like grant maintained status and specialist schools. The kids love the school, they are very proud of it.

Faculty Organisation

We have a head of faculty and separate subject heads. My job as head of science is to negotiate with SMT and the head of physics is there to oversee physics throughout the school, and that works very well.

Staff

We have five full-time teachers plus a part-timer in physics posts. Four of us have single honours physics degrees, with the others having degrees in engineering and biology. One of the physicists is new. She was a PGCE student. In her first year she taught up to GCSE and this year she is taking some AS classes. Yr 12 is difficult to teach. It is mixed ability and can put you under pressure. You need to be able to hold your own and even people with physics degrees can't always deliver. They need time to work it out. You can't just throw them in. The engineer concentrates on teaching physics in the lower school at the moment although he does want to teach to A-level so we are going to give him the opportunity to go and refresh his knowledge.

It is a comparatively young staff. Turnover is speeding up. We had a fast track teacher who stayed three years and is now deputy head of science at another school. Nobody leaves because they are unhappy. They move on to better things, for personal reasons or because they are tempted into an independent school. We attract applicants because of the reputation of school and the opportunity for specialised teaching. To get the right calibre of teacher you have to be able to offer A-level. That is one of the first questions they ask. We also actively recruit by putting out feelers. We train teachers here and if we have good students we try to hang on to them. The students like being able to specialise here, but they have to take other subjects for their PGCE. There's a huge resistance among physics graduates to doing biology though not so much for chemistry.

Many of teachers live locally, but buying a house is a problem. The grant scheme helped but it has now dried up. Renting is plentiful. We are a bit tight on technicians. We have for one for physics and two in lower school. We need 3+3. We get people who want to be here and we train them up. That's the way schools are going.

Years 7-11

We have physics specialists teaching physics. Even in Yrs 7, 8 and 9 physics is taught by physicist apart from that is the less able whom we think are better off with one teacher. Its important to get them working with specialist teachers in Yrs 7 and 8 - by Yr 9 it's too late. We do promote the sciences as separate all the way through. At options evening we have three separate stands and we make sure the science teachers are clearly associated with them. The advantage of specialist teaching is that you don't teach a lesson by rote; people take the responsibility for crafting their own lessons. I want teachers of physics at KS3 to do their own things, do it well, even if they go slightly mad about it.

We do set for single physics and the dual award, but only vaguely. Pre-judging things is a mistake. Some kids come good in particular sciences later. Allocation is mainly according to the options they choose. There is a bottom group for the dual award, but otherwise its pretty mixed. Triple science at present is by invitation. Students who get 95 in the KS3 science SAT are offered the separate sciences and no one has so far turned down the opportunity. If they had done the dual ward they would they would have been coasting. From about 20 four years ago the cohort for the physics GCSE has grown to about 120-130 a year. The students themselves wanted it.

The course work grades are not brilliant at GCSE, but it is their work. We treat the course work as practical examinations with open-ended tasks but restricted time. At GCSE the criteria are particularly cumbersome for the kids so we have to re-interpret it for them. We had a dip in the GCSE results last year. The SMT said what are you going to do to stop this becoming a trend. So that's when we had to start extra lessons. It was an absolute disaster. We and the kids were used to them coming up to us.

With the new GCSE arrangements we are moving to all doing the triple award. It is the best solution to a bad job. We kind of bullied the school into it. It is unique in the area and the kids get a bit of a buzz. They have 'carte blanche' to go as high as they can. If they struggle they can drop to foundation level, our catch-all. It'll be tricky for teachers. They will have a mix of foundation and higher but at least they will be teaching their subject and not the mess that is dual award science. We think we have got it sorted. We can pull off 'science in the news' topics for projects. The first two modules are in essence the core – science and science studies – and next two get them up to dual award and the last two to single subject level. With triple we can go for the content-end to feed through to A-level so we are going linearly. The students are really pleased to be all doing triple. We've turned the changes to an advantage.

Sixth Form and Beyond

We normally have three classes at both AS and A-level and they are not setted. We use AS as a filter. Its sink or swim. We let students even from foundation level with a C grade enter A-level physics classes, although we don't really want that since most don't survive. AS, therefore, has a broad range of ability. If we push them we lose about a third but the rest stay on and they are fantastic.

We insist on them also studying maths at A-level. If they don't do maths they will struggle and probably won't get beyond AS level. If they start maths and drop it then why are they doing physics? One of my big concerns is because of the AS system the tendency is to leave kids to make their own decision whether they keep or drop subjects. But by dropping maths you might as well forget physics through to HE. We did run a course maths for physicists a few years ago, but the person taking it found the physics a bit daunting. One of the worst things is if students lack confidence in their teacher. We don't work particularly closely with maths. We talk to them, but not curriculum-wise. It is a large department with which it is not easy to build up relationships.

A big thing with us over the past three or four years has been to make the 'course work' work which goes counter to the prevailing results culture. We give them a chance to do a real investigation. They can tackle it at a level to suit them. If they do take it to a high level it is the equivalent of a first year university degree project. Obviously the work has to fit the criteria. Curiously, some of the brightest kids don't like practicals. The weaker ones often do and some of the best bits of work they do for us are in practicals.

We get a few going to Oxbridge and quite a few studying physics at university. Medicine is a very popular choice or rather families push the students into it. In some cases parents and students are deluding themselves because they do not realise how stiff the competition is. If they miss out on medicine they tend to try for dentistry. Last year a girl went up to Oxford to read physics and this year one is going to Manchester. But they are few on the ground bearing in mind that this is mainly a boys' school.

Resources and Funding

We have benefited from specialist school status. We have had an injection of £30,000 in last couple of years, two lots on top of our budget. We are not terribly over-resourced. That could be a put-off. The head uses the resource to keep staff. The school does value its staff.

Extra-Curricular Activities

The school not too keen on lots of trips out. We went to Oxford University and we go to the Philip Allen lectures. It is easier to get people in than the year group going out. We have good programme of external speakers. The students are beginning to see them as being positive. Before the school tried to force them all to turn up after classes and many didn't want to come.

At KS3 we have lunch time science clubs where they work on little projects like the 'silent alarm clock'. We have taken part in competitions like the physics Olympiad and the New Scientist essay competition. But it is becoming increasingly difficult to find the time with all the changes.

Why Good Physics Take-Up?

It's a damn good school with a lot of highly qualified and motivated **teachers**. We bounce ideas off each other and support each other. If we get a PGCE student, who quails at the thought of a practical with a big group we don't let them sink or swim. We say 'hang on, this will take time to handle and why not approach it like this'.

We actually think the **subject is worth teaching**. In some schools and initial teacher training departments they don't seem to think it is and that's your problem. We also have a critical mass of **very able science students.** About two-fifths get level 7 at KS3. Our view is that you win if you target the top end - make sure it is being stretched and in that respect that they have got somewhere to go.

The sciences are taught as separate all the way through from Yr 7, so the students can **recognise physics and know whether they like it**. The way it works is that kids spot a teacher they have confidence in and stay with them. We have as much **ambition** as we can possibly have here for our students at A-level to go on to the best universities and to study physics and related subjects. The gold standard is to get them into Oxbridge, Imperial, and wherever to study physics and then we have done something. While we do show the kids how important physics is for getting a job we tell them they are going to university to study a subject not to get a job so make sure it's a subject they enjoy. They know everybody thinks physics is difficult. Our job is to get them keyed into it and it works. Once they get into it you can't get rid of them, they come back for clubs etc, it's about creating a **'culture'** around the department and the teachers

What Can Be Done?

Other schools could try to develop that culture. We need to train more specialist teachers and teach physics rather than science, or science news. It is no good throwing physics teacher trainees or NQTs in at the deep end. They need time to develop their confidence in the classroom and they need the support of other physics teachers.

Case Study 16: High-Physics School in South East from Chart 3.2

Community, Coeducational, Comprehensive 11-18, South East, 1,200-1,400 pupils, 200-220 in sixth form, 11.8% A-Level Physics. Interview with Head of Science who is also Head of Physics.

Context

I would say we are in a pretty advantaged area – so it's generally advantaged boys and girls coming into the school. We are probably the best school in the LEA. About 8 per cent are creamed off by independent schools, but otherwise the top pupils tend to come here. When you look at the CAT scores in Yr 7 the average score is 105, so we tend to be skewed towards the top end though we have a long tail. About 10 per cent have learning difficulties or physical disabilities. Nearly all of the pupils are white British and there is low eligibility for free school meals.

Faculty Organisation

I came as head of science and head of physics nearly twenty years ago. Ideally, I would like them separated but it is not possible as physicists are in such short supply. The subject heads look after day-to-day management. I am responsible for the philosophy, the way I want the groups structured, curriculum time and overall discipline within the department. I set the tone and administer the capitation. I expect subject heads to develop their subjects to the highest standard possible, running a lively team to excite interest. I want healthy competition between the three sciences to turn the turn kids on and to take the A-levels.

Staff

There are 12 science teachers, four for each science and we teach that way from Yr 9 onwards. In physics three of the teachers have a degree the subject and one, a medic, has qualifications coming out of his ears. The whole team share the A-level teaching. One is going this summer and we will be down to three physicists. I needed a chemist and we've recruited a strong chemist with some integrated science. I can just get by on three, but I'll get it back. My model is starting to break a little. We had a good field of applicants for the chemistry post and I'd like to think it might have been similar if we'd advertised for a physicist. It's a nice area. But our two recent vacancies haven't attracted many applicants. We appointed to a physics post two years ago. We trawled nationally with the job advertised at 1 point and got six applicants, all okay, and we interviewed four. Last year we had four applicants for that physics post. I find it worrying that national adverts should bring in so few responses. We have, however, been able to appoint two well-qualified young physicists. But I have had to train them up a bit. They are not as familiar as I thought they would be with the physics experiments. I have to spend more time than I thought I would have to showing them what's available, schemes of work and things like this. We do help to train PGCE students, with the occasional physicist, but we haven't had any GTPs.

We have two full-time and one part-time technicians, which is slightly under the full complement. The ASE would recommend I think 3.2. We have terrible trouble in getting a physics technician, but the others have been here years. We want the physics technician to get involved with knowing the equipment as it's so specialised and I try to get the person trained up as such. The current physics technician has only been here a year and now wants to train to be a teacher (he has a degree in sports science). So I'm about to look for another one.

Years 7-11

We don't segregate on ability. We subscribe to the comprehensive ideal. We leave allocation to the different science course to the pupils. If they want to do the separate sciences we ask, 'are you prepared to spend 30 per cent of your curriculum on them?'. It is a test of their motivation. But it so happens that the most able pupils tend to choose the separate sciences. The separate sciences take more time. Originally we had one extra lesson in Yr11, now we have 30 per cent curriculum time, the dual award has 20 per cent and the single science has 10 per cent. About three-quarters of our Yr 12/13 come from those who have taken GCSE physics. But we don't have any problem in integrating the other 25 per cent into the AS group. The skill to do A-level is very much an A-level skill. I don't go with the argument that there is a problem with transitions to A-level from the dual award. Either route is perfectly acceptable to me. I don't make a big play. I don't have any 'catch-up'. We go straight into A-level topics with that sort of intensity and analytical skills.

Separate sciences at GCSE boost uptake of science A-levels. The plus factor is that pupils identify with a member of staff who teaches the subject. With the dual award you are part of the team of three and the pupils don't quite see the subjects in the same light. For the dual award they don't see me as a physics teacher, but as part of the team. But in GCSE Physics they see me as 'Mr Physics' with all my stories and anecdotes to do the subject. I've always preserved the identity of three departments here. The pupils can identify with the separate staff in their labs.

Yrs 7 and 8 are a bit different. We use 'Exploring Science', an integrated scheme with physics, chemistry and biology topics, and one teacher has taught each class. But next year there will be two teachers – a biologist and a physical scientist - so we are going to start the identification of the subjects even younger.

We've chosen AQA for the new GCSE, roughly staying with the same model. Pupils who want to do the three separate sciences will get 30 per cent time again. The core will be taken in Yr 10, but we won't cash in until Yr 11. We chose AQA because the practical investigations were wearing us out. All the paper work and pupils not meeting deadlines. AQA offered a simple way through this. One of big bugbears of the current dual award is pupils letting you down with deadlines. I've actually tried to tighten up this year and a letter has gone to parents giving the deadline. They have to have it done by the end of the summer term in Yr 10. Then I have the freedom in Yr 11 to decide whether we are going to let the pupils improve and basically just get through the work.

Sixth Form and Beyond

Our sixth form is very much in house and we rarely have students coming in from outside. Any pupil with five A*-C is able to take A-levels, but we do say to them that they may struggle if they are coming on to physics on a 'C' basis. Maths is a good indication of success in physics at A-level, so we would be looking for at least a 'B' in GCSE. The maths department has roughly the same policy. We used to run 'Maths for Physics' classes and we are thinking of re-introducing it next year. We are finding they need more support since they are finding the maths harder to cope with. We lose about 20 per cent of the pupils from AS to A2, which is low since with four ASs down to three A-levels you would expect drop-out of roughly a third. The ones going usually only intended physics as a supplementary.

About 20 per cent of the A-level students are girls, along with the national trend, though it did reach nearly 40 per cent. We possibly have possibly had a little more attraction in the past for girls because we've had more physics teachers who have been women, but I still have one.

We're good at getting students to physics and physics-related subjects at university. It's about half. One year we had five at Oxbridge doing straight physics. In the current Yr 13 over 40 per cent are going on to physics. The others are going to engineering, biotechnology, biology, philosophy, army, and a couple either self-employed or unemployed.

Resources and Funding

We've been one year as a specialist school in maths and ICT. The funding partners are from local industry. There was no suggestion that science might be included. I don't know why - within the school we are under-resourced. Specialist status has brought us two white boards; for the school it has meant a big capital build. We are desperate for more white boards. We've been promised some because the new AQA syllabus is very much e-learning.

Extra-Curricular Activities

We have clubs, a long-standing astronomy club. Last year we offered AS electronics as an extra-curricular activity and now that has got into the option package. We do the Physics Olympiad. We put in four last year and a lad came in the top ten. We go to the IoP lectures at the University. We've done trips to Jodrell Bank. Alton Towers for the physics of circular motion. We've just sent a couple of kids on a taster week for would-be engineers.

Why Good Physics Take-Up?

I don't know how to answer that. I have thrown it around the staff. They said 'you're **enthusiastic** about your subject'. I do 'talk' physics early on and I think I might sow a seed here and there. I'm always talking positively about 'when I teach you in the sixth form for physics'. It's tenuous. I can't really quantify it. I'm active at open evenings. I'm enthusiastic.

We **teach physics as physics** from Yr 9 and the A-level teachers also teach Yrs 7-11 so **the kids can see who they will be getting**. A **core of physics teachers** is vital. We can sit down and talk about physics, the latest developments, what's in the news. In the sixth form they swap ideas and also they put pressure on you to some extent so you need the knowledge base to draw on to fuel their interest.

I've always believed in choice and tried to give as much science choice as I'm allowed to do. So at GCSE it's single, double or **triple**. I'm quite adventurous. At one time I was thinking of doing the single science in Yr 9 to free up choices in Yrs 10 and 11. A relatively high proportion of the children who come here have the **ability** to do well in physics, but that does not necessarily mean they would take it. That they do is down to us.

What Can Be Done?

There are issues affecting retention, for instance, a lack of control in many schools. But it is especially tough starting out. It is important to be able to feed off experienced teachers. I've found that out with my department. It is essential to have **good specialists to learn from**. Just following the book would be literally a paper exercise.

There perhaps ought to be compulsory and universal **sabbaticals** for science teachers so that they can keep up-to-date. If I come across something new in physics I get myself onto a two-week residential course as soon as possible.

I also think **management teams** have to understand the importance of the subject: that it is central to the economy and our well-being as a country. It's absolutely an essential subject. But the way curriculum planning has gone it could easily disappear unless you get that vocal support for the subject. It's shrouded in figures. There's such a drive on value-addedness and passing exams for the sake of it that the educational value of the subject is being thrown out of the window. You might as well just take Spanish if you can get an easy result that way. A lot of SMT would drop physics to take on something else if it yielded a better result.

Case Study 17: Successful Girls' School from Chart 3.2

Foundation, Girls, Comprehensive 11-18, Outer London, 1,500-1,700 pupils, 380-400 in sixth form, 5.9% A-Level Physics. Interview with Head of Science who is also Head of Physics.

Context

The catchment area is 'leafy London suburbia' and most parents are very supportive. We feel our intake is a good comprehensive spread, skewed to the upper end. We were once a girls-only grammar school and up to 1999/2000 we selected 15 per cent on general ability and ten per cent on music ability though that has now gone. Boys are increasingly being admitted to the sixth form. We are heavily over-subscribed though we do miss out on a few girls who go to independents and grammars. Most of the pupils are white British, but the pupils come from a wide variety of ethnic backgrounds. Take-up of free school meals and the proportion with special educational needs are lower than average. As well as having specialist status, we are a leading edge school.

Faculty Organisation

We have separate heads of department, but are very much integrated as a faculty. We send out a message I hope, of quite a large team pointing in the same direction, within which there are various categories of science, not competing with one another but adding to one another, to produce a coherent attitude that I hope delivers quite a good package at the end of the day. The job of the subject heads is to promote the subject, make it appealing, to make sure teaching is good, that the subject is approachable, to develop resources. My job as head of science is at the interface with the whole school – get involved with whole school issues which affect us but not directly related to the teaching of science or physics. So I wear two completely different hats. Ideally we should have a separate a head of physics.

Staff

There are 15 teachers in the science faculty, including three physicists all of whom have single honours degrees in physics and two have higher degrees. We are fully staffed in physics, in other words we can cope. They teach all the way through from Yr 7. For pupils to see dedicated subject specialists is crucial. There is some imbalance because four are chemists and the rest biologists. So the physicists do A-level, GCSE and usually only one group in Yrs 7, 8 and 9. We have just taken on two new science teachers for next year. We didn't need a particular specialism since they are covering for maternity, but all the interviewees turned out to be biologists apart from one chemist. There were no physicists. The last appointment we made to physics was two years ago. We found him through a contact of the head's and he's very good in the classroom. But the advert itself only drew three responses none of which was anywhere near suitable. Chemistry is not that easy either. Two of us are due to go in the next five years or so, which the school may find very difficult.

It's difficult to attract teachers. It's a difficult subject and it seems to appeal to a different sort of person to those that want to teach. We play our part in training. We take two ITT students in science every year, but we almost never get physicists. We can't, therefore, easily grow our own teachers.

We are comparatively well off for technicians. We have five, four full-time, who work in two prep rooms. We've been lucky, because the money is awful. It attracts working mothers and often more mature people who have retired from the rat race and want to do something. We have one in his mid-50s who retired from a high-powered job in an industrial concern and took an enormous drop in salary. He's been wonderful. He has helped to run the science club and is really enthusiastic. It's not always easy to get good people, but ours are brilliant. We have some absolutely superb working mums.

Years 7-11

In Yrs 7/8 we teach mixed ability groups through six modules of work, two for each subject. We don't go overboard in the distinction. There are five science periods in Yr 7 covered by two teachers one of whom may be a physical scientist and the other a biologist so there is some gentle but not obvious distinction between the subjects in Yr 7. In Yr 8 it is more obvious. The course is in two sections which have different teachers who always teach their specialism and share the rest between them. In Yr 9 the distinction between the sciences is clear with three different teachers. Although we are careful to distinguish the sciences in my opinion up to KS3 a scientist can teach all three sciences. At GCSE it is reasonable to expect people to manage, but you have to be a long way ahead of A-level students if you are going to give authoritative teaching and be able to answer the really quite difficult, off-the-beam questions that they sometimes ask.

At GCSE we offer triple sciences and the dual award. I have also wanted to offer the single award for less able pupils, but the headteacher didn't agree. We brought in triple science because we felt a lot of girls were finding the dual award too easy, without sufficient intellectual challenge and too slow. We teach the three sciences in the same timetable time as the dual award, but have an extra 45 min lesson each week after school, rotated between the three subjects. But the main way we do it is to move them along much faster.

We decide who is to take the separate sciences at end of Yr 9 through negotiation. In late May, when they've done the SATs, we ask pupils to put their names down if they are interested in doing the separate sciences. We then go into their history of effort, achievement, maths ability, grades, progress, and CAT scores. We don't want really hard workers taking it on and then struggling desperately. We don't want able girls who are lazy either, so we advise both groups against. We have more expressing interest than can be fitted it. A complicated system of grading then comes into play, based on SATs, end of module test results, and effort grades to arrive at a consensus. Between 50 and 60 a year – two classes - out of 240 emerge through this process to take triple science.

We are keeping the triple science group in the new GCSE arrangements. They are good for A-levels and it is good to give the more able more of a challenge. We're doing AQA. We had quite a debate about it. I liked OCR '21st Century Science', but the head of chemistry did not. He's a bit more of a traditionalist than me. The issue was the course work. This has some interesting aspects and they have to write a mini essay on something of topical scientific interest. He thought it would take up too much time. So we've gone for AQA as a safer bet.

For the current course work in physics we have been doing the same experiment for years. We set aside three weeks at the end of Yr 10. We gear them up through practicals, where we rehearse what they have to do in an investigation, like planning and analysis. It's a bit artificial and I am not keen on doing it this way. In fact, I don't like doing practicals – my lessons are more theoretical and mathematical.

Sixth Form and Beyond

We ask for a 'B' in GCSE Physics or the dual award for entry to A-level physics though we do bend and accept a 'C'. They need also a 'B' in higher tier maths. About three-quarters of those moving up from the lower school (about 70 per cent of Yr 11 stay on) come from the GCSE physics. We do get some doubles, the most able girls among them with the greatest interest and enthusiasm. Girls who choose physics usually are pretty good and keen and are less inclined to choose it as an add-on extra. About 20-30 per cent are boys who have been admitted in the sixth-form.

We lose about a third from AS to A2, about half because physics was taken as a complementary subject and about half because they are struggling. We have a lot interested in medicine and physics is no longer essential, so chemistry numbers are higher and most also choose biology. Psychology is a very popular A-level with around 60 taking AS and possibly 45 A-level. We don't insist in physics that they are doing A-level maths. We do give some extra tuition in maths for those who aren't taking it at A-level so they can brush up at A2.

Our A-level syllabus is OCR 'B' syllabus which is 'Advancing Physics'. It polarises opinion. We chose it after we had previously done a very traditional course, which was also OCR but very much book-work and chalk and talk. We felt the course work in 'Advancing Physics' was very innovative and liked how the course is structured. We think it has helped with numbers. We also offer the science AVCE. It tends to be perceived very mistakenly as a course for those who can't cope with academic science. The science in the VCE is difficult – do some forensic science, liquids and rates of flow, colouration, medical and nuclear physics – all geared to an industrial approach. I don't think it's any easier really. There is also the Advanced Extension if people want it. Our first girl to do it took it last year. It is not mainstream at all.

About 75-80 per cent of the A-level physics students go to university. This summer three went to engineering, two to physics-related, two to maths, three to other subjects and one went directly into employment. One of the boys went up to read geography and the other is training to be an airline pilot. We don't have that many girls going through to do physics at university. I don't know why. When I teach them in KS4/5 I always talk about developments in physics in the lesson. That's partly why they choose it at KS5, but then they still see it as a difficult subject. It's also partly to do with money. Many parents are working-class-made-good looking to the professions for their daughters.

Resources and Funding

In terms of resources it is about as good as we could hope for. A new science block was built six years ago with 11 labs, three for each subject and two general all-purpose. The previous labs were very old-fashioned, even archaic. It's made a big difference. Not only is it a pleasant teaching environment, but it has also changed attitudes.

Pupils now perceive the sciences as something modern, something to be enjoyed in amenable circumstances. In the building there are two prep rooms and we are fully staffed with excellent technicians.

Being a technology college has had an impact on science. The status had to be seen as making a difference. A higher profile emerged for the three sciences. They have been promoted as being at the forefront of the curriculum in a girls' school. There was also some extra funding mainly for data-logging equipment, sensors, and software. We went down the technology route because the sponsorship was there from the technology trust and industry, but the push has been across the sciences. GCSE results went up throughout the school though now they have plateau-ed with about 20 per cent not getting five good passes. We are, after all, a comprehensive taking the full ability range.

Extra-Curricular Activities

We have a science club in the lower school and also an astronomy club. We do the IoP's Paperclip Physics, and the Royal Academy's Engineering Education Scheme. The students find it quite hard setting up a project and designing a solution and this is where local industry comes in. We'd like to do more trips and excursions to physics orientated places. We go to the JET Nuclear Fusion experiment at Oxford, the National Space Centre in Leicester, and Thorpe Park – there so much physics there. We're affiliated to IoP and regularly go to lectures there.

Why Good Physics Take-Up?

We have the advantages I've described – **bright girls**, **good labs and technicians**, and the **three sciences** taught as themselves within a mutually supportive faculty. It is also to do with **money and resources**. But the **teachers** make a huge difference. We went to a conference where there were lots of other physics teachers there and you could tell the ones with blossoming departments - because they were the more accessible to talk to and have the ideas. We do have that critical mass of bright and enthusiastic physics specialists, but many schools don't. The two of us who teach A-level also teach down the school. I know the girls like the teachers and that influences their A-level choices.

We do well in terms of girls taking physics, in part, because we are a girls' school so they don't necessarily perceive physics as a boys' subject. By the time they encounter boys in the sixth form, they have already made their choices. I think it was right in the 80's and 90's to remove some obstacles to girls studying science especially the physical sciences so now in theory there is complete equality of access and opportunity. But for whatever reason physics doesn't seem to appeal to girls as much.

We do try and **market** the subject. When the girls are choosing A-level options we give presentations in the lessons on what physics means in terms of employment, what the A-level is like, and gearing it to something they want to do. Able pupils can find it difficult making choices for A-level if they don't have a leading inclination.

What Can Be Done?

Teachers are the key, but where are they going to come from. Joining us here must be quite different from going into a school as the only physics specialist. I wonder if something could be done to ease the induction of the NQTs. **Facilities and technician back-up** also make a huge difference. I can well see physics graduates opting out to teach maths if they don't get sufficient help in setting up practicals.

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