OFFICE FOR STANDARDS IN EDUCATION

Inspecting post-16

engineering and manufacturing

with guidance on self-evaluation

Office for Standards in Education
Alexandra House
33 Kingsway
London
WC2B 6SE

Telephone: 020 7421 6800

Further copies are available, while stocks last, from:

The OFSTED publications centre
Telephone **07002 637833**
Fax **07002 693274**
email **freepublications@ofsted.gov.uk**

It may also be downloaded from the
OFSTED website (www.ofsted.gov.uk)

Reference number: HMI 321

The post-16 subject guidance series currently comprises: art and design; business education; classics; design and technology; drama and theatre studies; engineering and manufacturing; English; geography; government and politics; health and social care; history; information and communication technology; law; mathematics; media education; modern foreign languages; music; physical education; religious studies; science; sociology.

Contents

Introduction

This booklet aims to help inspectors and staff in schools and colleges to evaluate standards and quality in engineering and manufacturing for students post-16. It complements the *Handbook for Inspecting Secondary Schools* (1999), the supplement *Inspecting School Sixth Forms* (2001) and the *Handbook for Inspecting Colleges* (2001).

This guidance concentrates on issues specific to engineering and manufacturing. General guidance is in the *Handbooks*. Use both to get a complete picture of the inspection or evaluation process.

This booklet is concerned with evaluating standards and achievement, teaching and learning, and other factors that affect what is achieved. It outlines how to use students' work and question them, the subject-specific points to look for in lessons, and how to draw evaluations together to form a coherent view of the subject.

Examples are provided of evidence and evaluations from college and school sixth-form inspections, with commentaries to give further explanation. These examples are included without any reference to context, and will not necessarily illustrate all of the features that inspectors will need to consider. The booklets in the series show different ways of recording and reporting evidence and findings; they do not prescribe or endorse any particular method or approach.

Inspectors and senior staff in schools and colleges may need to evaluate several subjects and refer to more than one booklet. You can download any of the subject guidance booklets from OFSTED's website www.ofsted.gov.uk.

Our Inspection Helpline team, on 020 7421 6680 for schools and 020 7421 6703 for colleges, will be pleased to respond to your questions. Alternatively, you can email schoolinspection@ofsted.gov.uk or collegeinspection@ofsted.gov.uk.

OFSTED's remit for this sector is the inspection of education for students aged 16–19, other than work-based education. In schools, this is the sixth-form provision. In colleges, the 16–19 age-group will not be so clearly identifiable; classes are likely to include older students and, in some cases, they will have a majority of older students. In practice, inspectors and college staff will evaluate the standards and quality in these classes regardless of the age of the students.

There may be a wide range of provision to consider in the evaluation and inspection of engineering and manufacturing post-16. You will need to make sure that you are familiar with the particular course objectives and examination syllabuses used by the institution. Those most likely to be encountered can be grouped into two main categories:

- general vocational courses in engineering and manufacturing – General National Vocational Qualifications (GNVQs) and Advanced Vocational Certificate of Education (AVCE) courses;
- occupational courses including National Diploma and Certificate courses, and a wide range of craft courses leading to National Vocational Qualifications (NVQs) or other craft qualifications.

In school sixth forms, it is only the first category which you are likely to encounter but, in colleges, a wide range of occupational courses is taught. If you are also evaluating courses in design and technology, you should refer to the companion booklet *Inspecting Design and Technology Post-16*.

This booklet concentrates on the most commonly found courses in or related to engineering and manufacturing for students 16-19. However, the principles illustrated in this guidance can be applied more widely.

Students aged 16 will normally have taken General Certificate of Secondary Education (GCSE) design and technology or GNVQ Part One courses. These may have introduced them to computer-aided design and manufacture (CAD/CAM) and quantity production techniques, including those which focus on quality assurance. They should already have learnt about the design and manufacture of quality products and developed skills in the use of tools and equipment.

Common requirements

All inspectors share the responsibility for determining whether a school or college is effective for all its students, whatever their educational needs or personal circumstances. As part of this responsibility, ensure that you have a good understanding of the key characteristics of the institution and its students. Evaluate the achievement of different groups of students and judge how effectively their needs and aspirations are met and any initiatives or courses aimed specifically at these groups of students. Take account of recruitment patterns, retention rates and attendance patterns for programmes and courses for different groups of students. Consider the individual goals and targets set for students within different groups and the progress they make towards achieving them.

You should be aware of the responsibilities and duties of schools and colleges regarding equal opportunities, in particular those defined in the Sex Discrimination Act 1957, the Race Relations Act 1976 and the Race Relations (Amendment) Act 2000, and the Special Educational Needs and Disability Act 2001. These Acts and related codes of practice underpin national policies on inclusion, on raising achievement and on the important role schools and colleges have in fostering better personal, community and race relations, and in addressing and preventing racism.[1]

As well as being thoroughly familiar with subject-specific requirements, be alert to the unique contribution that each subject makes to the wider educational development of students. Assess how well the curriculum and teaching in engineering and manufacturing enable all students to develop key skills, and how successfully the subject contributes to the students' personal, social, health and citizenship education, and to their spiritual, moral, social and cultural development. Judge how effectively the subject helps prepare students aged 16–19 for adult life in a culturally and ethnically diverse society.

1 See Annex *Issues for Inspection arising from the Stephen Lawrence Inquiry (Macpherson Report)* in *Evaluating Educational Inclusion*, OFSTED, 2000, p13.

1 Standards and achievement

1.1 Evaluating standards and achievement

From the previous inspection report, find out what you can about standards and achievement at that time. This will give you a point of comparison with the latest position, but do not forget that there is a trail of performance data, year by year. Analyse and interpret the performance data available for students who have recently completed the course(s). Draw on the school's *Pre-Inspection Context and School Indicator* (PICSI) report or, in the case of a college, the *College Performance Report*. Also analyse the most recent results provided by the school or college and any value-added information available. When numbers are small, exercise caution in making comparisons with national data or, for example, evaluating trends. For further guidance on interpreting performance data and analysing value added, refer to *Inspecting School Sixth Forms,* the *Handbook for Inspecting Colleges* and the *National Summary Data Report for Secondary Schools.*

Where you can, form a view about the standards achieved by different groups of students. For example, there may be data which enable you to compare how male and female students or different ethnic groups are doing, or how well 16–19-year-old students achieve in relation to older students.

Make full use of other information which has a bearing on standards and achievement, including success in completing courses, targets and their achievement, and other measures of success.

You should interpret, in particular:

- trends in results;
- comparisons with other subjects and courses;
- distributions of grades, particularly the occurrence of high grades;
- value-added information;
- the relative performance of male and female students;
- the performance of minorities and different ethnic groups;
- trends in the popularity of courses;
- drop-out or retention rates;
- students' destinations, where data are available.

On the basis of the performance data and other pre-inspection evidence, form hypotheses about the standards achieved, whether they are as high as they should be, and possible explanations. Follow up your hypotheses through observation and analysis of students' work and talking with them. Direct inspection evidence tells you about the standards at which the current students are working, and whether they are being sufficiently stretched. If the current standards are at odds with what the performance data suggest, you must find out why and explain the differences carefully.

In your observations, be alert to any differences in the standards of work of different groups of students.

As you observe students in lessons, look at their work and talk with them, concentrate on the extent to which they:

- recognise and use the knowledge and skills acquired in earlier work to inform increasingly demanding design, engineering and production activities in new situations;
- select and use a range of approaches when designing, modelling and evaluating, and consider increasingly complex design opportunities and constraints;
- communicate design ideas, methods and processes;
- demonstrate and apply their knowledge and understanding of mathematics and science, engineering principles, drawing techniques, materials processes and components;
- consider computing, systems and control, measurement, health and safety, and how quality issues affect product testing, fault finding and repair;
- use tools, equipment and materials effectively, working precisely and accurately when making good-quality products;
- evaluate designs and products, and test product performance against design criteria;
- improve designs and products;

- undertake practical and project work which requires planning, assembly, measurement, testing, problem solving and the ability to draw conclusions;
- plan manufacturing methods and select appropriate materials, processes, machines and tools;
- use information and communication technology (ICT) in the control, design and manufacture of products and in presenting information to enhance and improve the quality of their work.

Evaluate students' standards and achievements in these abilities to shape your analysis of the strengths and weaknesses in the subject. To explain your judgements, draw on the most telling evidence from looking at students' work, talking to them and observing how well they do in lessons.

1.2 Analysis of students' work

Compare the evidence from a detailed analysis of students' work with the evidence drawn from the pre-inspection analysis in order to judge how well the students are achieving.

Looking at the products made by students and at folders which contain their design development work is a very important part of the inspection process. Such an analysis reveals evidence of the demands which the teaching makes on the students, their progress over time and their growing ability to work successfully with, and develop, products which are well engineered. Hence, it can give valuable insights into their achievement.

Do not be misled by neat, bulky and colourful portfolios which fail to record secure development of design ideas and a clear understanding of engineering and manufacturing principles. The selection and use of design information and an understanding of mathematics can often be weak in such portfolios and it can be difficult to trace the development of a product.

A close analysis of students' current and completed work is important when observing lessons. Talk to students about the work they are doing, their previous ideas and products, and explore their levels of understanding of the subject.

Many departments keep copies of students' work to illustrate good practice, and may retain a sample of work from each course and year group. The sample is often used to make expectations clear to students starting on courses and to set standards of work. It is also a useful source of evidence as you follow up hypotheses identified in your analysis of performance data.

You should look in detail at the work of at least three students – of above average, average, and below average attainment – from the main courses being evaluated. Look at students' own work, the level of the subject content and analysis, students' understanding of engineering and manufacturing principles, and improvements over time as the students' knowledge and understanding increase with their maturity. This can be time consuming for teachers to organise because of the amounts of practical work involved, and it is best to adopt a flexible and negotiated approach to access and timing.

Example 1: evidence from analysing work of Intermediate GNVQ manufacturing students in a sixth-form college.

Portfolios include 3 design tasks covering Unit 2: 'Working with a design brief' and Unit 3: 'Manufacturing products'.

Higher-attaining student
Work is well planned. The portfolio shows a depth of knowledge and understanding of manufacturing industries which is well above average. Attainment is consistently very good across a range of work. The student has designed and manufactured a small drinks dispenser, working closely with a local company. The quality of design development work is very good – for example, the dispensing mechanism is an original development, and the prototype is precisely made and finished. The student has made good use of ICT to support manufacturing plans and present ideas to the company, and achieved a very good command of practical skills when planning for mass production. The work is accurately assessed at distinction level and the student is provided with very good constructive feedback on his good achievement. On entry to the college, his overall attainment was above average, and he has made good progress since. Attainment now is well above average.

Average-attaining student
Sound standards of work are evident in the portfolio. The student has a good understanding of ICT when researching and presenting design ideas, but finds it more difficult to put ideas effectively into practice. For example, he has designed and manufactured an electronic timer to use in a kitchen. The case for the prototype is well made, but the microelectronic circuit does not always work because of manufacturing faults. The student has made significant progress during the year and, in view of his previous attainment, has achieved well. He has built on very good feedback from the teacher, and should comfortably pass. The portfolio contains a sound piece of research into the impact manufacturing industries can have on the environment. Attainment is average.

Lower-attaining student
The student has found it difficult to meet the requirements of the course and may not pass. However, achievement, based on evidence of previous attainment, is satisfactory and there is evidence of hard work and effort to improve performance. All the assignments have been completed, but not to a high standard. For example, the kitchen timer circuit is completed but does not work, the quality of the case is poor, and the range of ICT applications is limited to word processing. Knowledge and understanding of mass production techniques is not good enough. For instance, although the student has accurately made a jig to manufacture the timer case in quantity, he has found it difficult to propose effective modifications to improve quality. He has persevered with much help and support from the teacher. Attainment below average.

[Overall, attainment average (4)]

Commentary

In general, standards of work match what one might expect at the end of these units. The students are benefiting from the good support provided by the teacher and show that they are mastering the subject. They are making at least satisfactory progress and for two achievement seems good.

Example 2: evidence from analysing work of National Diploma engineering students in an FE college.

Higher-attaining student
This student started the course with high GCSE results. The portfolio is neatly filed and work is well presented. Reports show evidence of research that draws from a wide range of sources, including the Internet, books and magazines, and industrial visits. Reports are written to standard report structures and show a good command of English and technical vocabulary. The use of ICT has been thoughtfully chosen to enhance presentation, without being overpowering. A good feature is the use made of the student's own work experience to add an industrial relevance to the work. For example, project reports on industrial organisation, careers education, and computer-aided drawing use this source extensively. Student's analytical work is clearly set out and generally accurate, showing that he has a good mastery of course content. For example, an assignment on RLC circuits shows a thorough understanding of phase and resonance and a wide appreciation of their applications. The extended project on the design and manufacture of a solar heating appliance was planned thoroughly, extensively researched, considered a range of carefully evaluated options, and was manufactured to a high standard. Attainment is well above average, which is consistent with the student's previous attainment, indicating satisfactory achievement.

Average-attaining student
Again a neatly filed and presented portfolio. Research draws from a more restricted range of sources and relies too heavily on the Internet. Reports are generally written to a standard format, make sound use of ICT to enhance presentation, and show appropriate commitment to the course. Opportunities to link work to industrial applications are frequently missed. This student had a reasonable set of GCSE results on entry but has struggled to understand some of the more analytical aspects of the course. For example, early sheets on electrical circuits using Ohm's law were tackled successfully, but more complicated Kirchoff's law problems were met with very limited success. Re-submitted work finally achieved a pass grade. The main project, the design and manufacture of a hovercraft, was carefully researched but failure to purchase materials early enough resulted in rushed manufacture and a product which only partially met the design criteria. Attainment is average, but achievement unsatisfactory.

Lower-attaining student
Good set of GCSEs, but this student's work shows only limited commitment to the requirements of the course. Several assignments were handed in late, a few not submitted. Research is often quite limited and relies heavily on the Internet. Reports are written to a standard format, show a good command of English and make good use of ICT to enhance presentation. In tackling problem sheets, the earlier, easier examples are usually answered correctly but more complicated work is often not attempted at all, in spite of the teacher's written instructions to complete the work. Tutorial records show that the course leader has expressed concern both to the student and to his parents on several occasions about the lack of commitment and progress shown. The student's project, to design and make a variable voltage power supply, was poorly planned and only partially completed. The quality of the design work and the assembly is poor. Attainment is below average which, considering the student's previous attainment and his lack of commitment, represents poor achievement.

[Attainment below average (5)]

Commentary

Overall, the analysis of these three students' work indicates that attainment is below average. The higher attaining student is achieving at a level that is appropriate to his GCSE grades on entry to the course. Although the average student should pass, she is not achieving well enough. The third student is clearly underachieving, working well below the level indicated by his GCSE grades and not likely to pass the course. The teacher's comments in the portfolio and tutorial records show that this student's lack of progress has been noted on more than one occasion. While this evidence contributes to the overall judgements on attainment and achievement, it is important to explore how the work of these three students represents the work of the rest. Is there a pattern of the most capable doing well and the remainder underachieving and, if so, why?

1.3 Talking with students

Listen to discussions between students and talk with them about their current and past work. This can provide a rich seam of evidence to establish their achievement and reasons for high and low attainment. Ask the students to bring their portfolios with them to any discussions you may arrange and discuss the work they contain. It is important to explore how well students can apply their knowledge and understanding of the subject, and to record examples which illustrate the evidence.

Example 3: evidence from a discussion with 6 NVQ level 2 motor vehicle servicing and repair students in an FE college.

The students are in their first year in the college and are studying full-time. They are currently working on vehicle cooling and heating systems in the college garage. Work is up to date and neatly presented. All portfolios and logbooks show that they draw frequently and effectively on background reading from books, car manuals and videos to enhance their written work – one is not so well maintained as the others, but even this has some evidence of background reading.

During discussion, students talk confidently about the main features of a vehicle cooling system. They explain effectively the advantages of an electrical fan over a belt driven fan, list the range of maintenance checks which should be made during routine servicing and are able to discuss the possible causes of a series of faults very well. For example, they fully understand why checks should be made on the radiator, fan, thermostat and water pump when an engine overheats. Their knowledge and understanding of different types and makes of cooling systems is very good.

One student comments that she did not work well while in school and achieved very modestly in her GCSEs. However, she says that the present course is interesting and she is working much harder now. She is spending as much time as she can in the workshops and finds they are near to the learning resource area. Both can be accessed outside lesson time and all students appeared to make good use of this opportunity.

Students' progress, generally from a low starting point, and their interest and enthusiasm suggest achievement is very good.

[Attainment well above average (2)]

Commentary

These students are clearly very interested in their work. They know a lot about cooling systems and the routine servicing tasks they have to undertake. They show a very good understanding of the possible causes of a typical fault they may encounter. The discussion shows that the way the department is organised is helping them to achieve very well. For example, they are able to attend the workshops outside lesson times and have easy access to learning resources which enable them to read around the subject.

Example 4: evidence from a discussion with 3 Year 13 engineering AVCE students in a school sixth form; the students all started the course with about 4 GCSE grades A–C, the usual minimum requirement.

First student spent a week in a sports manufacturers and chose to develop a stand and resistance mechanism which would allow an ordinary pedal cycle to be used as a static exercise machine. He has produced sketches of several possible solutions and is currently producing a drawing of the favoured solution, using CAD. He talks enthusiastically about the merits of his choice of design and some of the other ideas which he has discarded, showing a very good depth of understanding. He knows a good deal about mechanical principles governing the forces in the frame, and is developing some interesting ideas concerning possible resistance mechanisms. He has a good grasp of design methodology and his work is proceeding according to schedule.

This student is using his knowledge gained in other units of the course to good effect and is proceeding according to standard design methodology. The standard of his work is well above average. Considering his previous attainment, this represents very good achievement.

Second student discusses how he researched material for a project to design a new sorting mechanism for a food production factory. He identified the design problem during a one-week industrial placement to a local vegetable processing plant. He kept a good sketchbook. It contains appropriate annotated drawings of the production line and key systems. He is able to discuss the different control mechanisms, how they work, and consider their advantages and disadvantages. He identified a problem with a pneumatic sorting gate that used a bell crank lever mechanism. By researching maintenance records, he found it had a high failure rate when compared with other components on the line.

The student finds it more difficult to talk about his alternative, final design proposal. He struggles with basic calculations – for example, to determine the coefficient of friction on the bearing mechanism, and has replaced a thrust bearing without fully understanding its function. His response would not fully convince the production manager that his new design would improve production rates.

On balance, the strengths of his work outweigh the weaknesses and, in the light of his previous attainment, the student is achieving well. His work is above the minimum pass standard and improving quickly.

The third student has undertaken work experience with a manufacturer of mountaineering equipment and chosen to design a light-weight bivouac-style tent. His design sketches show some interesting ideas, but in discussion he is unable to talk in any depth about the range of materials which could be used for the tent fabric or frame, or of the forces the tent would have to withstand. His attainment is below average.

[Attainment average (4)]

Commentary

All three students chose design problems based in an industrial context. The first student shows a good understanding of key mechanical principles and has developed some interesting design solutions. The second student shows a good understanding of some key concepts and effectively identified a design problem in an industrial context, but attainment is no more than average overall. Although he carried out sound early research to identify the problem, weaknesses in later work – for example, his lack of investigation into the causes of the high failure rate and limited mathematical understanding – have restricted the scope and effectiveness of the final design solutions. The third student shows some innovative thinking but questioning reveals that he has done very little investigative work, for example on the range of materials which could be used, or the properties they would need.

Considering the students' starting points, at or below the minimum GCSE entry requirements, the evidence of these discussions and pieces of work suggests that the achievement of the first student is very good and of the second is good; they are learning quickly. By contrast, the third student is making little progress and not working at a level matching what might be expected, considering his previous attainment. He is not achieving well enough.

1.4 Lesson observation

Observations may take place in a class, tutorial, seminar, open learning or interview setting. A wide range of teaching methods is used in engineering and manufacturing and it is important to take the range into account. Observe the performance of different groups such as gifted and talented students and those using English as an additional language.

Example 5: evidence from a level 2 NVQ class at an FE college.

A practical session on welding.

The standard of work is good. The students have completed a tee fillet weld using oxyacetylene equipment and they easily recount the steps taken to test the quality of the weld. Their knowledge of MIG and arc welding is equally as good and they demonstrate high levels of skill and safety. On visual inspection, all the students have produced acceptable quality welds: the best is excellent and the other students produce good-quality welds as a matter of routine. The students know the possible causes of common defects such as lack of penetration and porosity, and understand the procedures used to test the weld. After practical work, they complete good-quality log books in a resource area adjacent to the workshop, with the help of a key skills support teacher.

[Attainment above average (3)]

Commentary

The students display good technical knowledge and skills, written work is of a good standard, and they know and understand how to use different types of welding equipment.

Example 6: evidence from a craft NVQ level 3 class in an FE college.

Lesson on engineering measurement.

The students are using instruments to check eight engineering components provided by local industry. They know how to use internal, external and digital Vernier calipers, micrometers, and the trigonometry that underlies their use. The students understand what happens if the tolerance is changed and how to manage the change. They know how to modify methods when inspecting different quantities of components, and understand manufacturing and inspection requirements well.

[Attainment average (4)]

Commentary

Standards of work are sound and the students know how to use measuring instruments well. They understand a range of inspection methods. Since their entry qualifications were average for the course, this suggests satisfactory achievement.

2 Teaching and learning

2.1 Evaluating teaching and learning

Interpret the *Handbook* criteria with specific reference to engineering and manufacturing. On all courses, you should look for the characteristics of effective teaching and learning, which are:

- high-quality demonstrations of skills and techniques which lead students to learn how to design and make products effectively *(subject knowledge, methodology);*
- high-quality products which are well finished and rigorously evaluated against design specifications *(expectations, subject knowledge);*
- high expectations of safe working practices, ensuring that students learn to maintain a safe working environment *(expectations, methodology, management);*
- the teacher's own careful use of technical language *(subject knowledge, expectations);*
- students being given sufficient time to consider engineering and design problems and being able to sustain work on projects which they identify themselves *(methodology, expectations, management);*
- students developing their understanding and expertise through being shown examples of high-quality work, ingenuity and innovation *(challenge, methodology, expectations, subject knowledge);*
- teachers stimulating students into choosing relevant and challenging contexts without presenting solutions and drawing their attention to potential problems *(challenge, expectations, methodology);*
- teachers timing their interventions to advance learning without inhibiting creativity *(planning, methodology, management);*
- the judicious use of advice, support and evaluative comment *(methodology, assessment);*
- the use of challenging questions to develop students' ability to think and act in a technological way *(challenge, expectations, methodology);*
- students assuming responsibility for working accurately and precisely with tools and materials and taking pride in producing quality products and creative solutions to design problems *(students' responsibility for their learning);*
- the enthusiasm of teachers to encourage students to try innovative ideas and persevere when faced with difficulties *(challenge, expectations, subject knowledge, methodology);*
- teachers' appropriate use of a range of learning materials – for example, overhead projector (OHP) slides, handouts, demonstration kits and artefacts – and references to wider reading and other learning resources which enhance students' learning *(methodology, use of resources);*
- links to industrial applications and the use of students' own experiences *(methodology, use of resources, expectations);*
- teachers carefully explaining new concepts, setting exercises and examples which stretch students and providing prompt guidance when it is needed *(methodology, expectations, assessment);*
- students undertaking challenging tasks which develop skills and related theory and writing reports which are of a high standard *(methodology, expectations);*

- the provision of a variety of learning activities which excite and motivate students to work at a good pace *(planning, challenge, methodology, pace of learning);*
- students taking responsibility for improving their levels of skill in the use of tools and materials, working safely and maintaining safe working environments *(expectations, students thinking and learning for themselves);*
- a judicious mix of class teaching, small group work, individual work, practical work and the development of theory, which makes effective use of time and leads to rapid learning *(planning, methodology, use of time, pace of work).*

Be alert to teaching which may have superficially positive features but which lacks the rigour, depth, insights and the command of good subject teaching. Examples might be teaching in which:

- students produce design and engineering folders which look impressive, but they spend excessive time on presentation and are expected to have made all the design decisions before they can start production *(methodology, subject knowledge);*
- techniques are demonstrated, but are too complex and detailed and are pitched at the wrong level for the students' present understanding *(expectations);*
- students use complex ICT equipment but for no clear purpose – for example, to manufacture a product which could be made more quickly and cheaply by other means *(use of resources, methodology).*

2.2 Lesson observation

Example 7: evidence from an electrical engineering first year National Diploma class in an FE college.

Lesson on alternating current theory.

A very well-planned lesson, following on from one on the theory of alternating current, supported by a set of good practical assignments. Well-equipped electronics laboratory, with each pair of students having easy access to electronic equipment and adequate writing areas.

An interesting introduction recapped on the work of previous weeks. The teacher's very brisk questioning, directed at individual students, about inductors, capacitors and the underlying theory of alternating waveforms meets with ready and accurate responses. This very effective short introduction enables the teacher to place the students 'on their mettle', ascertains that they generally have a very good grasp of the underlying theory, and gives an opportunity to correct a misconception one student has about leading and lagging waveforms. It is very effective in focusing students' minds on the topic and checking on levels of understanding, which are very secure.

The teacher then discusses with the students the current response they would expect in resistive, inductive and capacitive circuits. The students respond very thoughtfully and the teacher skilfully involves all of them in the discussion. At appropriate stages, the students connect relevant circuits and test their ideas. They work exceptionally quickly, take neat notes, using a set of very good-quality handouts, supported by OHP slides. They show a good level of skill in using the oscilloscope. Through a judicious mix of sharp questioning, practical work, note-taking and example-solving, the concepts of reactance, impedance, phasor methods and resonance in series circuits are developed very well.

The session is completed with a snappy, short summary, making very effective use of questioning, helpful reference to future work, and the issue of an examples sheet, clearly designed to reinforce the developments in this and the previous lesson. The students are required to work through it in their free study time.

[Teaching and learning very good (2)]

Commentary

The lesson is very well planned and makes effective use of a good variety of activities. The students are used to the very successful questioning style of the teacher and are able to relate their practical and theory work well. The quality of learning is very good, as the initial introduction by the teacher has set the scene very well and motivated the students to correct misconceptions. The pace is brisk and the summary is highly successful in pulling together the main ideas. The examples sheet is well designed to reinforce the students' understanding, which is at a high level.

Example 8: evidence from a GNVQ Intermediate engineering class in a sixth-form college.

Material properties and common engineering materials.

Good summary. A very mixed group of students questioned keenly by the teacher during this introduction, and this is very effective, in part, in drawing out the knowledge higher attainers have gained during previous lessons. However, the teacher does not succeed in producing responses from other students. The teacher then draws upon examples of material failure, from his own experience in design work, from the experience of the students and from major failures of the past. His manner is authoritative and humorous, but the students do not all respond well. Some react to his attempts at humour with obvious cynicism. A few lose interest early on and contribute little, despite the teacher's continuing attempts to engage them. For example, using an exploded drawing of the important components of a power drill, the students are asked in turn to suggest preferred and second materials which could be used for each component, and reasons why. The teacher draws out good suggestions from one or two individual students showing clear interest, but several are restless and bored.

He attempts to regain students' interest by using differentiated questions. For example, he asks higher attaining students more challenging questions about the possible consequences of the wrong choice. Many of his targeted questions to lower attainers receive no response, however. The teacher draws on his own experience as a designer, when commenting on the students' choices and the implications for manufacture. He continues to try to include all students in this discussion, but he is not successful in drawing in those on the very fringe of the lesson. The higher attaining students work well, learning quickly and consolidating their understanding. They are very interested in the final choice of materials made by the manufacturer.

The teacher eventually reprimands three students for persistent chatter off the subject.

[Teaching satisfactory (4); learning unsatisfactory (5)]

Commentary

In this lesson, the teacher makes good use of his own design experience and of his knowledge of past engineering failures to engender a high degree of interest among the higher attaining students. Good use of questioning contributes to their rapid learning. However, he does not succeed in capturing the interest and involvement of students of other levels of attainment. Some students respond well, consolidating and extending their understanding of the subject, and the teacher ensures that they are kept 'on track'. For them, learning is good, but for other students there is so little learning that, overall, learning must be regarded as unsatisfactory.

Usually, unsatisfactory learning would indicate unsatisfactory teaching. In this case, teaching is judged to be satisfactory because the disaffection of some students appears to have been a factor outside the teacher's control. Although a more charismatic teacher might have succeeded where this teacher did not, his subject knowledge, use of resources and use of discussion and differentiated questions were strengths which would have resulted in satisfactory or good learning for most groups of students. The reasons for the obvious disaffection of a few students need to be explored further.

Example 9: evidence from a second year level 3 class in an FE college.

Lesson on microelectronics.

The students are using input and output ports to scan a keypad and sense the number of the key pressed to a seven-segment display. Sound introduction, lesson objectives effectively explained, and individual students appropriately questioned to establish their understanding. The teacher links the task to a previous theory lesson well and students clearly understand the underlying theory. Sound level of individual support, with the teacher prompting and assisting students where necessary and monitoring progress carefully. Students tackle the task with moderate interest, and many complete it on time. The teacher uses the final part of the lesson to summarise the work, and five students who have produced the best work are invited to talk briefly on the method they used to solve the problem. The few who have not completed the task are encouraged by the teacher to attend the learning resource centre, where they can access equipment used in the lesson.

[Teaching and learning satisfactory (4)]

Commentary

A well-planned lesson, which provides students with an opportunity to apply theory work from a previous session. The lesson is pitched at an appropriate level. The teacher gives sound support and guidance to students who encounter difficulties. During the lesson summary the teacher successfully uses the experiences of the best students to highlight good practice. Students respond with moderate interest to the work, following a carefully planned introduction by the teacher. Most students accomplish the task, achieving the standards expected of them.

Example 10: evidence from a level 2 mechanical craft course in an FE college.

Introduction to the main features of machining by milling.

The lesson demands very little from the students except listening and note-taking. The teacher spends much of the time dictating notes and presenting poor-quality OHP slides, which the students find very difficult to copy. Slow pace, with two students, who are clearly bored, deliberately spelling technical words incorrectly. Students who write slowly delay others who finish quickly but have nothing else to do. The notes are consistently untidy, difficult to read, and not kept well in files. Just under half of the group have already used the milling machines in their practical work, and the remainder are unfamiliar with milling processes. The teacher makes no attempt to reflect the differing levels of background knowledge. After about 45 minutes the group is taken to the workshop to see some of the machine tools and equipment. Technicians in the workshop have not been prepared for the visit. The group is too large for this approach to be successful, some of the students paying attention while others are too far away or poorly positioned to be able to see or hear. The teacher's attempts to summarise the lesson through questioning meet with a poor response from the students and time is lost dealing with incidents of poor behaviour at the end of the lesson.

[Teaching and learning poor (6)]

Commentary

The teacher does not consider the different previous knowledge of the students, their ability to write quickly and neatly, or the ease with which they become bored. The teaching is unimaginative. As a result, the first part of the lesson is delivered at a very slow pace, with students wasting time making notes that are of little value. Lesson preparation is poor; workshop personnel, who could have had machines and equipment readily available, have not been notified and the group is too large to enable a simple presentation to the whole group in a workshop situation to succeed. This part of the lesson is also ineffective, with time being wasted and some students benefiting little from being shown the tools and equipment.

2.3 Other evidence on teaching and learning

Lesson observation is usually the most important source of evidence on the quality of teaching and learning, but the analysis of work and discussions with students can also yield valuable information. This is particularly important when the work includes a coursework component undertaken over time. Under these circumstances, the observation of individual lessons may give a very partial picture of the students' learning experiences and of the support provided by teachers.

The work analysis will give you a good feel for the overall rate of progress, and, therefore, the pace of the teaching and learning. It will show the range and depth of the work which the students are required to do. For example, the pace of teaching and learning is often revealed by looking at the projects and practical work completed in the first stages of the course.

Discussions with students will give you a sense of their motivation and the range of their experiences. You can ask questions to show whether they understand clearly how well they are doing and what they must do to improve.

3 Other factors affecting quality

Other factors are only significant if they have a noticeable impact on the students' learning and standards. Note and evaluate any significant features of the curriculum, leadership, management, staffing, accommodation or resources. The following are examples of considerations specific to engineering and manufacturing.

Staffing

Consider to what extent teaching is carried out by specialists who are confident in their understanding of the subject, and how this impacts on students' learning. Are each teacher's specialist background and experience used sensibly and equitably across courses and levels?

Consider whether learning is affected by the way technicians are deployed.

Accommodation and resources

Is learning helped or hindered by storage arrangements for materials, equipment and students' work or by the relationship between group sizes and the available workroom space? Is adequate provision made for practical and investigative work?

Curriculum and management

Curriculum plans should include the development of design, production and engineering skills alongside knowledge and understanding. Students on the different courses may have widely differing previous experiences and the curriculum and schemes of work should take this into account. Where a course is made up of a number of different units taught by different teachers, consider the impact this has on students' learning. Do teachers make sufficient links between units? Or is learning impeded because students fail to see the connections between different parts of their course?

Are funds maintained to allow for repair, maintenance and replacement of equipment on a rolling programme?

4 Writing the report

The following are two examples of post-16 subject sections from inspection reports, the first from a school sixth form and the second from an FE college. (They do not necessarily reflect the judgements in any or all of the examples given elsewhere in this booklet.) The summative judgements in these reports use, for schools, the seven-point scale: *excellent; very good; good; satisfactory; unsatisfactory; poor; very poor.* For colleges, there is the five-point scale: *outstanding; good; satisfactory; unsatisfactory; very weak*. The summative judgements *excellent/very good* used in school reports correspond to *outstanding* in colleges; *poor/very poor* used in schools correspond to *very weak* in colleges.

Engineering

One sixth-form course in this curriculum area was inspected: GNVQ Intermediate engineering

Overall, the quality of provision in engineering is **satisfactory.**

Strengths

- Students have positive attitudes to the course and work hard to improve their engineering skills.
- Good leadership has led to new plans to increase the pace of learning and improve the course content.
- Students receive good additional support in some lessons to help with particular needs such as the application of mathematics.

Areas for improvement

- Students need more guidance and support in developing their portfolios.
- Teaching does not always have the brisk pace found in other lessons in the faculty.
- The previous attainment of a few students is too low for them to benefit from the course.

Standards in GNVQ Intermediate engineering are below average but are broadly as expected in the light of students' previous attainment. Results have declined over the last two years, but the level of entry qualifications has also gone down. As more students in the school have gained success at GCSE and gone on to study A-level courses, the engineering course has recruited students of lower previous attainment. This year nearly all the students started the course with low GCSE results

Work seen during the inspection was also below the expected standard. A minority of students, male and female, in Year 12 are finding difficulties in meeting the course requirements. However, most students are making useful progress and gaining new knowledge and skills. They make effective use of manual and computer controlled machines and the majority can handle mathematical analyses competently when carrying out engineering tasks. The weakest students find it difficult to produce accurately engineered products, for example when designing and making a plastic injection mould. Although these students are not doing well enough, for most of the class achievement is satisfactory.

Teaching is satisfactory overall and in some lessons it was good. For example, students in a Year 12 lesson were conducting an experiment to establish the efficiency of a kettle. The task involved calculating input and output energy. At the start of the lesson, a minority of students struggled with an energy output calculation and were not sure what units to use when recording mass. During the lesson, they had good teaching support, which included a special educational needs teacher helping with mathematical problems. By the end of the lesson, the students had mastered the calculation and were confidently plotting their results on graphs. In about half of their lessons each week, five students receive effective help with their mathematics, enabling them to make satisfactory progress in the subject.

The teaching of engineering does not always have the brisk pace found in other lessons in the technology faculty.

Students' coursework revealed weaknesses in planning and organisation and there is room for improvement in the support and guidance students receive in developing their portfolios.

Students' attitudes are positive and they are good at working in pairs and as a group. They are committed to the course and work hard to improve their engineering skills. They have ready access to the Internet, which some students use very well.

Course management is satisfactory. There is good leadership by the new faculty co-ordinator who has identified weaknesses in course planning and teaching. There are new plans to increase the pace of learning and improve course content. The improvements remain central to raising standards, as does setting minimum entry requirements. Some students are being recruited onto this course whose previous attainment is too low for them to benefit sufficiently from it.

Engineering

Overall, the quality of provision is **good.**

Strengths

- Advanced-level and day-release retention and pass rates are high.
- Advanced-level students produce work of above average standard and their achievement is good.
- Teaching for Advanced-level courses is good; it challenges students and requires them to engage in wider research, and teachers monitor students' progress well.
- Students respond well to opportunities for practical work.

Areas for improvement

- The written work of students on lower level full-time courses is often poorly presented and grammatically weak.
- Some aspects of the teaching on these courses are insufficiently demanding.

Standards and achievement

Standards overall are above average. Retention rates on the day-release and Advanced-level full-time courses are good. They are well above national benchmarks and in many cases are improving. On the full-time lower-level courses, they have declined over the last three years to present levels, which are slightly below the national benchmarks. Pass rates have fluctuated over recent years but are generally at or above the national benchmarks, and the proportions of AVCE students who obtain higher grade passes are above the national average. There is a good proportion of higher grades for units on National Diploma courses. Pass rates are about average on the First Diploma course and the full-time craft courses.

By the second year, students on Advanced-level courses are handling mathematical analysis competently, despite the fact that many of them had only moderate levels of achievement in mathematics at the start of the course. In the workshops, laboratories and drawing offices, they work in a mature fashion, use machine and hand tools and equipment with appropriate dexterity, and produce high standards of work. On the AVCE and National Certificate courses and the day-release craft courses, students maintain good portfolios of work. Their written work is carefully researched, well presented, and makes appropriate use of ICT to analyse data and enhance the overall presentation. The written work of students whose first language is Gujurati shows an excellent command of technical language. The day-release students make good use of their employment to provide a work-related focus to their college assignments. Students on the First Diploma course and on full-time craft courses work diligently during workshop activities, producing work of an appropriate standard. However, their written work is not so good. In many cases, it is poorly presented and grammatically weak and, in a few cases, it is too limited in its scope.

Students on Advanced-level courses are achieving well in relation to their previous attainment, which was generally modest. They respond well to teaching which has high expectations of them. The achievement of students on the lower-level full-time and day-release courses is satisfactory overall; it is significantly better in their practical than in their written work.

Quality of education

The quality of teaching is good overall. On the Advanced-level courses, teachers plan their work carefully and ensure an appropriate variety of activities. Assignment work is demanding. It requires students to engage in practical work and answer questions involving wider reading and research. These students show a keen interest and make good progress. The teaching on the lower-level full-time courses and some of the day-release craft courses is not usually of such a high standard, but nevertheless it is satisfactory overall. Practical work is well organised; students receive good support and help and students of different levels of attainment are able to make good progress. They show interest in this aspect of the work and enthusiasm for it. However, more use could be made of students' experiences with practical work to bring life to the more theoretical parts of the course. In a few lessons, there is too much use of dictated notes or copying from the overhead projector for extended periods, and this results in unsatisfactory learning.

Attendance in the lessons observed was high overall, but no better than average on some of the full-time craft courses. Students respond well to the teaching, particularly where they are required to perform practical tasks. Advanced level students respond particularly well in class. They answer the teacher's questions eagerly and show good levels of understanding. In a lesson on microelectronics, the teacher kept the students on their mettle and ensured a good grasp of the underlying theory. On the craft courses, some of the teaching allows students, particularly younger ones, to be too passive. In a lesson on mechanical craft, many showed overt signs of boredom.

Students' progress is carefully monitored on the practical units of the craft courses. Charts display the progress of each student in relation to the rest of the group and teachers frequently review progress with individual students. On the Advanced-level courses, the progress of each student is carefully monitored during frequent meetings with the course tutor, who is well informed of each student's progress. Two hearing impaired students are making good progress. Short-term action plans to improve each student's performance are established and their implementation monitored rigorously.

Leadership and management

Course management on the Advanced-level courses is good. Practical work and theory are integrated well and students are required to carry out a significant amount of work in their own time. Additional qualifications, such as an NVQ in manufacturing, a CAD qualification and work experience, enhance employment prospects. The division's facilities are open and accessible to the students in lessons and free time. However, the leadership of the lower level full-time work has failed to recognise and rectify weaknesses in teaching the theoretical parts of some of the courses.

RT AND DESIGN BUSINESS EDUCATION CLASSICS DESIGN AND TECHNOLOGY DRAMA AND THEATRE STUDIES ENGINEERING ENGLISH GEOGRAPHY GOVERNMENT AND POLITICS HEALTH AND SOCIAL CARE HISTORY
BUSINESS EDUCATION CLASSICS DESIGN AND TECHNOLOGY DRAMA AND THEATRE STUDIES ENGINEERING ENGLISH GEOGRAPHY GOVERNMENT AND POLITICS HEALTH AND SOCIAL CARE HISTORY INFORMATION
EDUCATION CLASSICS DESIGN AND TECHNOLOGY DRAMA AND THEATRE STUDIES ENGINEERING ENGLISH GEOGRAPHY GOVERNMENT AND POLITICS HEALTH AND SOCIAL CARE HISTORY INFORMATION AND COMM
ASSICS DESIGN AND TECHNOLOGY DRAMA AND THEATRE STUDIES ENGINEERING ENGLISH GEOGRAPHY GOVERNMENT AND POLITICS HEALTH AND SOCIAL CARE HISTORY INFORMATION AND COMMUNICATION TEC
D TECHNOLOGY DRAMA AND THEATRE STUDIES ENGINEERING ENGLISH GEOGRAPHY GOVERNMENT AND POLITICS HEALTH AND SOCIAL CARE HISTORY INFORMATION AND COMMUNICATION TECHNOLOGY LAW MAT
DRAMA AND THEATRE STUDIES ENGINEERING ENGLISH GEOGRAPHY GOVERNMENT AND POLITICS HEALTH AND SOCIAL CARE HISTORY INFORMATION AND COMMUNICATION TECHNOLOGY LAW MATHEMATICS MED
EATRE STUDIES ENGINEERING ENGLISH GEOGRAPHY GOVERNMENT AND POLITICS HEALTH AND SOCIAL CARE HISTORY INFORMATION AND COMMUNICATION TECHNOLOGY LAW MATHEMATICS MEDIA EDUCATION M
NGINEERING ENGLISH GEOGRAPHY GOVERNMENT AND POLITICS HEALTH AND SOCIAL CARE HISTORY INFORMATION AND COMMUNICATION TECHNOLOGY LAW MATHEMATICS MEDIA EDUCATION MODERN FOREIG
ENGLISH GEOGRAPHY GOVERNMENT AND POLITICS HEALTH AND SOCIAL CARE HISTORY INFORMATION AND COMMUNICATION TECHNOLOGY LAW MATHEMATICS MEDIA EDUCATION MODERN FOREIGN LANGUAG
GEOGRAPHY GOVERNMENT AND POLITICS HEALTH AND SOCIAL CARE HISTORY INFORMATION AND COMMUNICATION TECHNOLOGY LAW MATHEMATICS MEDIA EDUCATION MODERN FOREIGN LANGUAGES MUSIC P
VERNMENT AND POLITICS HEALTH AND SOCIAL CARE HISTORY INFORMATION AND COMMUNICATION TECHNOLOGY LAW MATHEMATICS MEDIA EDUCATION MODERN FOREIGN LANGUAGES MUSIC PHYSICAL EDUCAT
OLITICS HEALTH AND SOCIAL CARE HISTORY INFORMATION AND COMMUNICATION TECHNOLOGY LAW MATHEMATICS MEDIA EDUCATION MODERN FOREIGN LANGUAGES MUSIC PHYSICAL EDUCATION RELIGIOUS ST
D SOCIAL CARE HISTORY INFORMATION AND COMMUNICATION TECHNOLOGY LAW MATHEMATICS MEDIA EDUCATION MODERN FOREIGN LANGUAGES MUSIC PHYSICAL EDUCATION RELIGIOUS STUDIES SCIENCE SO
HISTORY INFORMATION AND COMMUNICATION TECHNOLOGY LAW MATHEMATICS MEDIA EDUCATION MODERN FOREIGN LANGUAGES MUSIC PHYSICAL EDUCATION RELIGIOUS STUDIES SCIENCE SOCIOLOGY ART
FORMATION AND COMMUNICATION TECHNOLOGY LAW MATHEMATICS MEDIA EDUCATION MODERN FOREIGN LANGUAGES MUSIC PHYSICAL EDUCATION RELIGIOUS STUDIES SCIENCE SOCIOLOGY ART AND DESIGN B
OMMUNICATION TECHNOLOGY LAW MATHEMATICS MEDIA EDUCATION MODERN FOREIGN LANGUAGES MUSIC PHYSICAL EDUCATION RELIGIOUS STUDIES SCIENCE SOCIOLOGY ART AND DESIGN BUSINESS EDUCATI
CHNOLOGY LAW MATHEMATICS MEDIA EDUCATION MODERN FOREIGN LANGUAGES MUSIC PHYSICAL EDUCATION RELIGIOUS STUDIES SCIENCE SOCIOLOGY ART AND DESIGN BUSINESS EDUCATION CLASSICS DESI
MATHEMATICS MEDIA EDUCATION MODERN FOREIGN LANGUAGES MUSIC PHYSICAL EDUCATION RELIGIOUS STUDIES SCIENCE SOCIOLOGY ART AND DESIGN BUSINESS EDUCATION CLASSICS DESIGN AND TECHNOL
EDIA EDUCATION MODERN FOREIGN LANGUAGES MUSIC PHYSICAL EDUCATION RELIGIOUS STUDIES SCIENCE SOCIOLOGY ART AND DESIGN BUSINESS EDUCATION CLASSICS DESIGN AND TECHNOLOGY DRAMA AND
ODERN FOREIGN LANGUAGES MUSIC PHYSICAL EDUCATION RELIGIOUS STUDIES SCIENCE SOCIOLOGY ART AND DESIGN BUSINESS EDUCATION CLASSICS DESIGN AND TECHNOLOGY DRAMA AND THEATRE STUDIES
NGUAGES MUSIC PHYSICAL EDUCATION RELIGIOUS STUDIES SCIENCE SOCIOLOGY ART AND DESIGN BUSINESS EDUCATION CLASSICS DESIGN AND TECHNOLOGY DRAMA AND THEATRE STUDIES ENGINEERING ENG
PHYSICAL EDUCATION RELIGIOUS STUDIES SCIENCE SOCIOLOGY ART AND DESIGN BUSINESS EDUCATION CLASSICS DESIGN AND TECHNOLOGY DRAMA AND THEATRE STUDIES ENGINEERING ENGLISH GEOGRAP
EDUCATION RELIGIOUS STUDIES SCIENCE SOCIOLOGY ART AND DESIGN BUSINESS EDUCATION CLASSICS DESIGN AND TECHNOLOGY DRAMA AND THEATRE STUDIES ENGINEERING ENGLISH GEOGRAPHY GOVERN
IGIOUS STUDIES SCIENCE SOCIOLOGY ART AND DESIGN BUSINESS EDUCATION CLASSICS DESIGN AND TECHNOLOGY DRAMA AND THEATRE STUDIES ENGINEERING ENGLISH GEOGRAPHY GOVERNMENT AND POLI
SCIENCE SOCIOLOGY ART AND DESIGN BUSINESS EDUCATION CLASSICS DESIGN AND TECHNOLOGY DRAMA AND THEATRE STUDIES ENGINEERING ENGLISH GEOGRAPHY GOVERNMENT AND POLITICS HEALTH AN

Designed and produced by Matrix Print Consultants Ltd, Rothwell, Northants 01536 713811