

Market View Report for The Diploma in Science

QD8

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Note:

Annex 1 and 2 are attached separately and contain details on alternative 16-18 Qualifications (Annex 1) and a review of the specifications and assessment methods for current Science qualifications (Annex 2).

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Section 1 - Introduction

On 23 October 2007, the Government announced that three further specialised Diplomas will be available for introduction from 2011, as part of the same entitlement as the original 14 lines of learning and the wider 14-19 educational reforms.

The Diploma in Science, alongside Diplomas in Languages and Humanities, represents a new departure that will focus on creating challenging, work-related content to be developed by the Science Diploma Development Partnership (DDP) in collaboration with leading employers and academics.

The Science Diploma Development Partnership (SDDP) consists of eight Sector Skills Councils representing UK industrial sectors with a strong interest in science, technology and innovation.

The partnership, as listed below, is chaired by Professor Hugh Lawlor and is being facilitated by SEMTA:-

- **Cogent** – the Sector Skills Council for the chemicals, nuclear, oil and gas, petroleum and polymer industries
- **ConstructionSkills** – the Sector Skills Council for the construction industry
- **EUSkills** – the Sector Skills Council for the electricity, gas, waste management and water utility industries
- **Improve** – the Sector Skills Council for the Food and Drink Manufacturing Industry
- **ProSkills** – the Sector Skills Council for the manufacturing and

process industries (building products, coatings, extractives, glass and print industries)

- **SEMTA** – the Sector Skills Council for the science, engineering and manufacturing technologies sectors
- **Skills for Health** – the Sector Skills Council for the UK health sector
- **Skills for Justice** – the Sector Skills Council for the justice sector, including forensic science.

The Diploma aims to:

- demonstrate the broad range of scientific activity
- provide a hands-on approach to scientific skill and knowledge attainment
- enthuse learners by showing how science learning can be effectively translated into employable, practical and intellectual skills
- offer a range of progression routes into and from the Diploma, including employment, training and further study opportunities
- provide a broad experience of scientific application through interdisciplinary team approaches and the roles of specialists within these teams
- offer learners the chance to personalise their Diploma
- develop and apply mathematics and ICT in scientific contexts
- illustrate the impact of science on society

In the context of the broad nature of science both as an academic subject and as it relates to UK occupational requirements, the development of the Diploma in Science is being undertaken on the basis of careful and comprehensive research in two main parts.

The Secondary Research Report for the Diploma has examined an extensive body of existing research by learned societies, employer representative bodies and academics. Its findings have formed an important basis for the design of the themes and topics.

The second element of research - the current document - comprises a detailed review of the “market” for science qualifications. This is intended, together with the secondary research, to assist the SDDP in creating a Line of Learning Statement by scrutinising the position of the Diploma in Science within the current qualifications market.

1.1 Aims and Objectives

The purpose of the Market View research is to establish the potential contribution of the Diploma to the qualifications market by investigating existing provision and future need.

The Market View research aims were to identify:

- how the Diploma can contribute to the various stakeholder groups and how it differs from existing science provision
- existing science qualifications across the comparable levels and the wider qualifications environment
- gaps in existing provision and the opportunities these present to meet future skills needs
- current perceptions of existing provision and future needs amongst learners, providers and employers
- market behaviour in terms of take-up and completion trends in science-related subjects (FE and HE)
- the unique selling point of the Diploma against existing science provision

Section 2 - Methodology

To meet the aims and objectives above, the Market View research was split into two phases. Phase 1 was made up of desk research, with the results used to inform Phase 2 - the primary research. Methods used in the phases included:

- an exercise to map science-related qualifications at the appropriate levels
- a review of existing provision
- an online survey and analysis (consultation of draft themes and topics)
- 100 telephone interviews - employers and providers

2.1 Desk Research (Phase 1)

Detailed desk research was undertaken to review current provision and take-up and identify any apparent gaps that may present opportunities for the Diploma. The mapping exercise of accredited science qualifications across Levels 1-3 cross-referenced against the draft themes and topics of the Diploma, highlighted gaps in current provision, whilst analysis of the UK science sector produced data on vacancies, workforce qualification profiles and current and future skills requirements.

The sources used included Sector Skills Agreements and related documents, Labour Market Information and various qualifications databases. (Including DSCF Section 96 and 97 and the National Database of Accredited Qualifications)

2.2 Primary Research (Phase 2)

Over one hundred (105) telephone interviews were undertaken with a mixture of key employers and providers. The purpose was to understand

the strengths and weaknesses of existing provision, and any perceived gaps which the Diploma might seek to fill.

Contacts were initially sourced from the eight Sector Skills Councils that form the Science Diploma Development Partnership, namely:-

<ul style="list-style-type: none">• Cogent• ConstructionSkills• Energy and Utility Skills• Improve Limited	<ul style="list-style-type: none">• Proskills• SEMTA• Skills for Health• Skills for Justice
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These contacts were, supported by desk research, used to identify companies working within dedicated science parks, specialist science schools and colleges, and science departments within Higher Education institutions.

Three question sets were used for the following three groups of respondents:-

- ❖ Employers,
- ❖ Level 2 & 3 providers
- ❖ Level 4 providers/Higher Education institutions

Each question set covered different areas of interest of the three groups, with common themes discussed by all including:-

- ❖ Curriculum content
- ❖ Development of skills and knowledge
- ❖ Work-related learning
- ❖ The importance and positioning of mathematics in science education
- ❖ Progression routes from the Diploma

For employers, this meant understanding the extent to which existing provision sufficiently prepares young people for work.

For HE providers, the focus was on the quality of level 3 provision, as part of the supply chain.

For level 1 to 3 providers, the research focused on understanding young people's perceptions of science, and provider attitudes towards the way science is currently taught.

Of the 105 interviews, 75 were conducted with employers (who, between them employ some 141,339 employees in the UK) and 30 with providers.

Location of employers interviewed

ENGLISH REGION	
East of England	4
East Midlands	7
West Midlands	10
London	4
North East	3
North West	16
South West	8
South East	20
Yorkshire & Humber	3

Employers by scientific discipline

All sciences	35
Chem/Physics	18
Chem/Biology	10
Chemistry	5
Physics	4
Biology	3

Employers 'mapped' to the SSCs' footprint

Cogent	22
ConstructionSkills	8
Energy and Utility Skills	12
Improve Ltd	2
Proskills	4

SEMTA	20
Skills for Justice	4
Skills for Health	3

Regardless of the workforce apparently "covered", the results from such a small and largely qualitative survey must be used with caution. The findings from the survey are intended to only provide indications of employer views and are presented in this report alongside other secondary findings.

Thirty respondents said that they recruit staff to science-related roles directly from school. Most commonly these roles were:

- ❖ Onto apprenticeships schemes (18 employers)
- ❖ Lab technicians (7 employers)

Sixty-six employers recruit staff to science-related roles directly from college or university, most commonly:

- ❖ Engineering specialists (22 employers)
- ❖ Graduates in chemistry (9 employers)
- ❖ Onto company graduate schemes (8 employers)
- ❖ Research and development staff (7 employers)

30 Provider Interviews:-

Level 4 providers	
Higher Education Institution	15
Level 1-3 providers	
Secondary school (11-18)	9
Sixth Form College (16-18)	2
Further Education College (16+)	2
Private Training Provider	2

Five level 1-3 providers reported having specialist science status (3 secondary schools, 1 FE college and 1 Sixth Form).

Location of training providers interviewed:-

East of England	4
East Midlands	1
West Midlands	7
London	1
North East	3
North West	3
South West	2
South East	5
Yorkshire & Humber	4

Section 3 - Presentation of Findings

3.1 Science in the Education Supply Chain

The education supply chain in the UK is extremely complex; not least because each of the four component nations operates a slightly different system.

In England - the nation in which the new Diploma in Science is expected to be launched - the system is founded on the National Curriculum which, at Key Stages 3 and 4, determines the outcomes of a young person's scientific education up to the age of sixteen.

At that point - in scientific terms - the pupil will usually have taken one of three slightly different qualifications:

- ❖ The GCSE for those seeking to achieve a Grade between D and G - usually in combined science
- ❖ The GCSE for those expected to achieve grades between A and C - in either individual sciences or a combined science
- ❖ Other Level 2 qualifications

Beyond the age of 16 young people in England traditionally have the option to go on to GCE A Level courses taking one or more of the three separate sciences - biology, physics and chemistry, commonly combined with Mathematics¹. The courses are taken in two stages - the first year up to AS Level and the second year to "full" A-Level (technically termed A2). Also available are the GCE in Applied Science as well as other Level 3 qualifications known as 'Nationals'.

These qualifications range from providing a general introduction to vocational science and is taken in two stages of AS and A Level, to a two year course providing work-related knowledge and skills for the science sector. Nationals are available in three sizes of full or part-time study,

¹ The discussion, here, is limited to traditional "academic" qualifications. Young people at 16 can also, of course, opt to follow vocational courses towards apprenticeship, among several other routes.

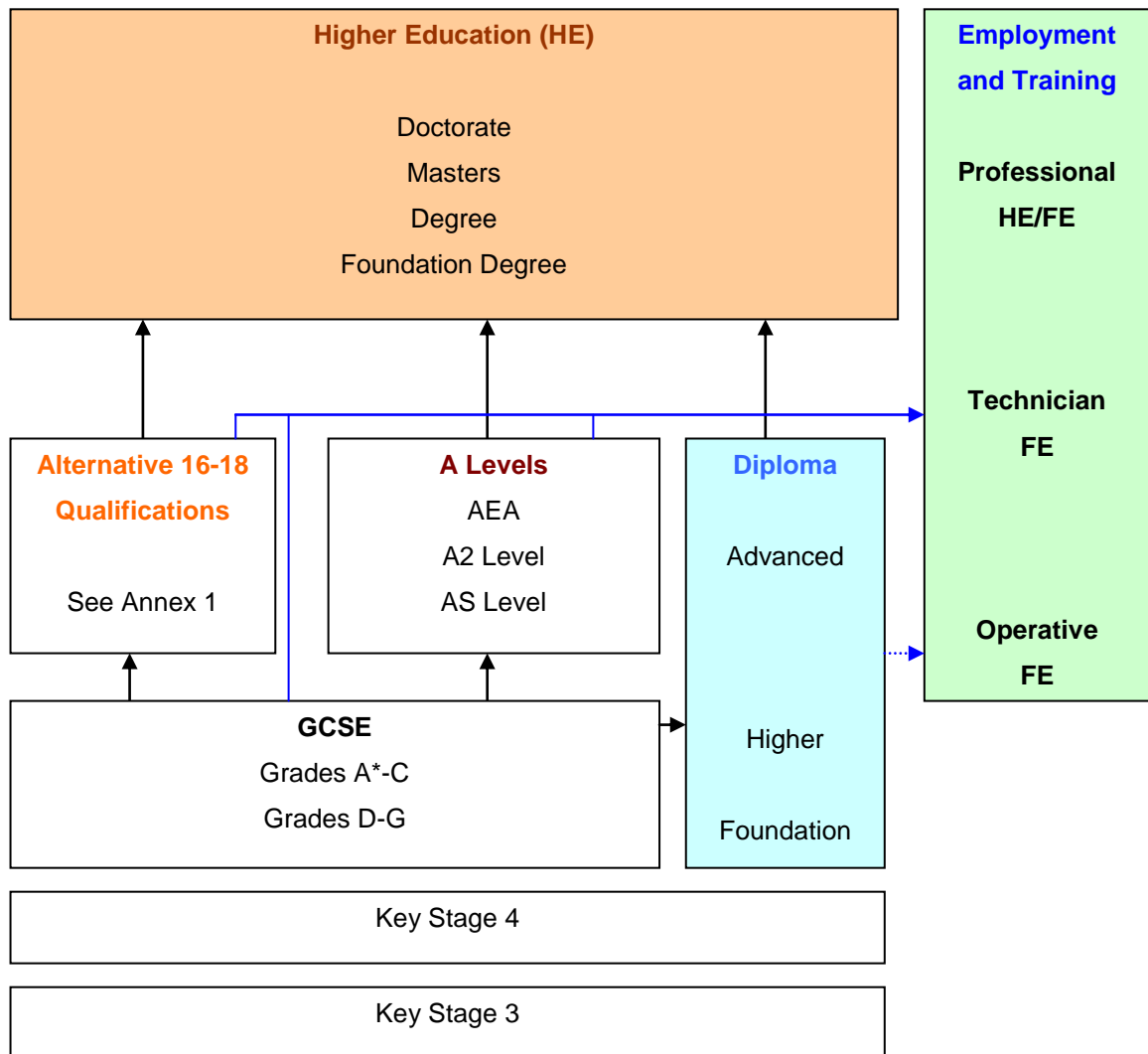
with an Award broadly equivalent to one GCE, a Certificate broadly equivalent to two GCEs and a Diploma broadly equivalent to three GCEs.

For the most able pupils there is also an additional option to take Advanced Extension Awards (AEA). These are additional, examined awards aimed specifically at the top 10% of candidates. Among many other subjects, papers are offered in Biology, Chemistry, Physics and Mathematics.²

There are, however, a number of alternatives most of which are available for relatively small proportions of the 16-19 cohort (see separate Annex 1). In addition, other similar qualifications are available in other nations of the UK and these have been described separately in order to illustrate similarities and differences with the situation in England.

² Advanced Extension Awards will be examined for the last time in 2009, with possible re-sit opportunities in 2010.

Figure 1 The Diploma in the Supply Chain



3.1.1 The Diploma in Science

The Diploma in Science is intended to sit within the National Qualifications Framework³ at Levels 1 to 3 and, as such, to parallel the main existing qualifications at those levels - GCSEs and A-Levels (see Figure 1 and Table 1).

³ This will be replaced by the Qualifications and Credit Framework, in England, and thus will close as of December 2010.

Table 1 The National Qualifications Framework at Levels 0 to 3

National Qualifications Framework	Diploma	Existing Qualifications
<p>NQF Level 3</p> <p>Aims to prepare successful candidates for progression into higher education or employment. The most common example of qualifications at this level are A Levels, of which the Advanced Diploma is worth 3.5. There is also a Progression Diploma, equivalent to NQF Level 3 which is worth an equivalent of 2.5 A Levels.</p>	<p>Advanced Diploma</p> <p>The Diploma aims to prepare successful Level 3 candidates for progression to Level 4 and onwards, in vocational learning or Higher Education.</p>	<p>A Levels</p> <p>Also: Key Skills L3 IB BTEC Diplomas, Certificates and Awards Pre-U NVQs Advanced Extension Awards (to 2009)</p>
<p>NQF Level 2</p> <p>Aims to give learners good knowledge and understanding of a subject (and sector in the Diploma's case) and the ability to perform a variety of tasks with some guidance or supervision and they are also appropriate for many job roles.</p>	<p>Higher Diploma</p> <p>The Level 2 Diploma is equivalent to 7 GCSE's at Grade A-C.</p>	<p>GCSE Grades A to C</p> <p>Also Key Skills Level 2 OCR Nationals NVQs BTEC First Diplomas and Certificates</p>
<p>NQF Level 1</p> <p>Qualifications focus on basic knowledge and skills and applying learning with guidance or supervision. They may also be linked to job competence.</p>	<p>Foundation Diploma</p> <p>Completion of the Level 1 Diploma is worth 5 GCSE's grade D-G</p>	<p>GCSE Grades D-G</p> <p>Also: BTEC Introductory Diplomas and Certificates OCR Nationals⁴ Key Skills L1 NVQs</p>
<p>NQF Level 0</p> <p>Includes Entry Level certificates and Skills for Life at Entry Level, focussing on basic knowledge and skills and applying learning to everyday situations, however these are not geared towards any specific occupations.</p>		<p>Entry Level Certificates Skills for Life</p>

From NQF Level 4 onwards the qualifications are vocational, with another framework, the Framework for Higher Education Qualifications (FHEQ) devised by the HE Sector which broadly corresponds to Levels 4-8 of the NQF.

⁴ In Science OCR Nationals are only available at Level 2, however, they are available at Level 1 in other subjects. As this table is not subject specific and indicates the general types of qualification available at each level, the reference to OCR Nationals at Level 1 remains.

3.2 The Demand Side

3.2.1 Science in the Economy and Society

There are two main sources of demand for science qualifications; one a broad and relatively fundamental need in the general population for science awareness and understanding; the other, a demand from industry and commerce for scientifically literate technicians and managers, and, at the furthest extreme, expert scientists and technologists.

In common with many other “academic” qualifications, those in “science” have no single occupational or even sectoral target and, yet, are of vital occupational and social importance at virtually every level of endeavour.

The need for scientific knowledge varies from person to person; job to job; sector to sector. At the broadest level, science interacts with all of our lives every day. In many cases this occurs as second nature, through knowledge of what is possible and impossible; normal and abnormal; safe and dangerous. At the highest level science has immense importance for the future of the UK economy in the race to create the knowledge-economy and to achieve a successful transition from lower skilled manufacturing and service industries to their high skill/high knowledge equivalents.

Science awareness and understanding is of value to everyone. From the assistant in an electronics store attempting to explain to a customer how a computer or a mobile phone works, to a cook or chef understanding the reasons for food hygiene, or a builder understanding the way force and stress operate on building materials and constructions.

The impact of science and its applications on all of our lives means that, although we can *survive* without understanding and awareness, such knowledge is of immense value in enhancing and even protecting our everyday lives. Understanding why electricity is dangerous, how food reacts to humidity and temperature, and why the environment is threatened by global warming are all modern “life skills” that can be provided by an elementary understanding of science.

The message from the New Engineering Foundation (NEF) is that the lines between science, engineering and technology are now so blurred as to be detrimental to clear planning in the educational field. At the intermediate or technician level the NEF has identified what it regards as “applied science” and, therefore, the key targets for the Diploma in Science⁵:

- *physical science applications;*
- *chemistry applications;*
- *biological and microbiological systems;*
- *bio-materials;*
- *environmental science;*
- *cosmetics and toiletries;*
- *surfactant and detergents science;*
- *forensic science;*
- *food and agricultural science;*
- *agrichemical science;*
- *science in medicine;*
- *genetics and genetic engineering;*
- *physiological measurements;*
- *scientific principles and instrumentations.*

“Demand” must, therefore, be defined at a number of levels relating to the need for scientific awareness, knowledge and skills. For immediate purposes this might best be achieved by using the levels of the proposed Diploma (which also, of course, relate closely to existing qualifications in science).

⁵ NEF “The Appliance of Science”; report by the New Engineering Foundation; 2008

Table 2 Science Diploma Demand

LEVEL 1 DIPLOMA - FOUNDATION

Equivalent to five GCSEs at grades D-G

Key stage 3 - no qualification pre-requisites

Delivers:-

Level 1 qualification

Demanded by:-

Employers - mainly for Level 1 occupations

FE for level 2 courses

Schools - as basis for progression to Higher Diploma

LEVEL 2 DIPLOMA - HIGHER

Equivalent to 7 GCSEs A*-C

Key stage 3 - predicted ability to exceed level 1 standards

Delivers:-

Level 2 qualification

Demanded by:-

FE for level 3 courses

Apprenticeships

Employment for level 2 occupations

Schools - as the basis for progression to Advanced Diploma

LEVEL 3 DIPLOMA - ADVANCED

Equivalent to 3.5 A-Levels

Delivers:-

Level 3 qualification

Demanded by:-

Higher Education

FE for Level 4 vocational courses

Level 4 apprenticeships

Employment (usually associated with further training)

3.2.2 Science Occupations

The ultimate users of science qualifications (disregarding for the moment the undeniable social value of science awareness and understanding) are UK employers in both the private and public sectors of whom two of the largest are the health services and the higher education sector.

A number of approaches are possible to attempt to determine and, if possible, quantify, this demand. However each is limited by the fact that science is arguably neither a sector, nor an industry in its own right. There is, therefore, no reliable way of being able to define demand from an industry or sectoral standpoint. Even at Level 3 (Advanced Diploma) science knowledge and skills are required in economic sectors as diverse as agriculture and energy, education and transport, health and manufacturing.

Bell and Donnelly state:-

“The question of whether science can be understood as a ‘sector’ may seem an arcane one, but it has continued to trouble those seeking to reform the science curriculum along these lines, up to

and including the exploration at the time of writing (Spring 2007) of the possibility of creating a specialised diploma. The opening section of the Criteria invites a number of important questions such as: which form of (scientific?) employment is the specification meant to be related to, and, critically, how, if at all, does it differ from the employment for which the established science curriculum and specifications prepare students?”⁶

The Working Futures 2004-2014 Sectoral Report also states that science sectors are “not exclusively defined by the [standard industrial classification]”⁷.

The alternative to attempting a sectoral analysis of demand is, therefore, an occupational one. The UK Standard Occupational Classification provides an extremely detailed picture of occupations throughout the economy and these can be used to create a more useful picture.

However, even using the 352 separate occupations of the internationally-standardised SOC, it remains almost impossible to be precise about what constitutes a “science” occupation.

Few occupations are totally dedicated to science as a subject. A larger number require significant amounts of scientific expertise, and knowledge, and many more require scientific awareness and a good grasp of scientific principles.

Pye Tait has, therefore, designed a means of arriving at demand quantification which, while by no means comprehensive, is sufficiently representative of the broader picture to add value to any discussion of demand for the sciences in the British - and more specifically, English - economy.

The *Standard Occupational Classification 2000: Volume 1* lists all recognised occupations to 4-digit level, with a summary of the main

⁶ Bell, J and Donnelly J (2007) *Positioning Applied Science in Schools: Uncertainty, Opportunity and Risk in Curriculum Reform*. Leeds: University of Leeds Centre for Studies in Mathematics and Science Education.

⁷ Dickerson, A et al. (2006) *Working Futures 2004-2014 Sectoral Report*. University of Warwick Institute for Employment Research; (p. 259)

functions of each occupation, key tasks, alternative job roles and 'typical' minimum entry requirements. Analysis of this information permits an understanding of which occupations require scientific knowledge, across all industries, together with their minimum educational entry levels.

SOC 2000 is the most recent comprehensive guide to all UK occupations, but it does not, of course, specifically highlight occupations that require science awareness, knowledge and skills to any degree, and there is no alternative information available that presents occupations that are specifically science related. The various Skills Needs Assessments of the SSCs discuss related issues but, not surprisingly given the breadth of occupational needs in every sector, are not able to discern accurately the impact of science, as a subject, on their workforces.

For the purposes of this Market View study, therefore, it has been necessary to develop a means of identifying - with an acceptable degree of accuracy - occupations that can be considered to use or require science to a "significant" extent where the word "significant" encompasses a wide range of need from entry-level occupations to high-level scientific and professional ones.

It must be noted that this approach is intended to provide only an indication of levels of demand. It is not pretended in any way that it is statistically accurate or that, in this degree of development, it presents anything other than an estimation of the "science industry".

As has been discussed above, it is recognised that, within each of the nine major SOC groups, there will be occupations that use scientific knowledge to a greater or lesser extent. The nine groups extend from 1 - a managerial and professional level - to 9 which is composed of "elementary" occupations. The groups are not, however, a simple hierarchy of professional and academic achievement. Several groups contain occupations that require either higher or lower qualifications than would be implied by the level of the group itself. It has also been necessary to take into account the fact that, to take Group 1 as an example, the occupations themselves can often be entered with

no qualifications at all or with significantly lower levels of qualification than indicated by the Group Descriptor.

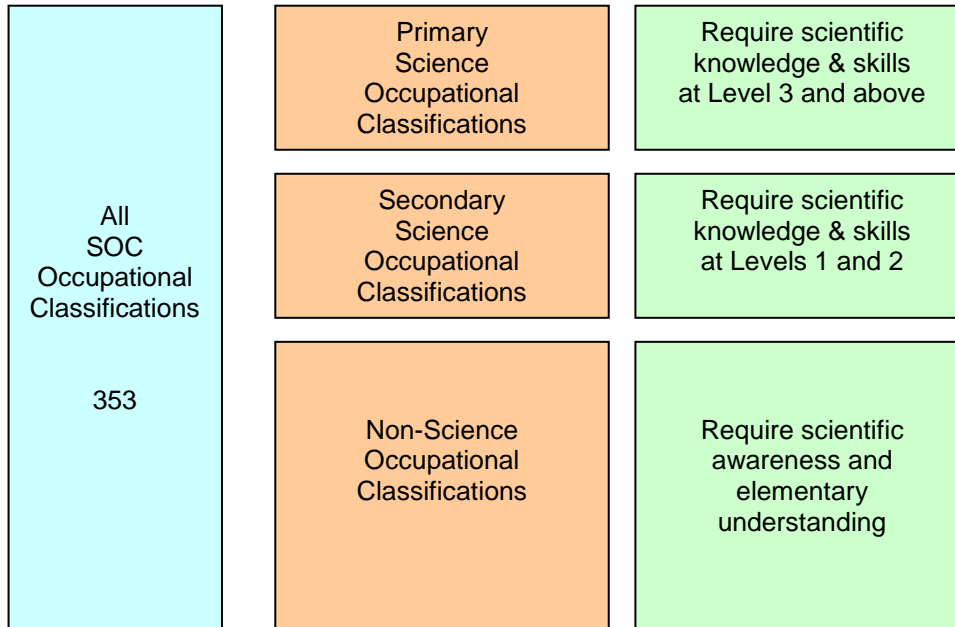
In the absence of any detailed information on the scientific content of specific occupations, therefore, we have applied a general rule at SOC Groups 1 to 3 in which a review of the SOC occupational description has been used to identify, at the very least, a reasonable degree of scientific knowledge and expertise being required.

For occupations in Groups 4 to 9 we have adopted an approach which includes them in the “secondary science” category if the occupation could be considered to require the active demonstration or use of scientific principles, knowledge or skills - for example, working in the telecommunications industry at operative level, advising on product safety, care and use, or supporting a science-based activity in a science-related industry.

The total number of “science” qualifications was then sub-divided into “primary” and “secondary” categories as illustrated in Figure 2 and listed in Appendix 1.

The approach is open to a good deal of debate but it must be recognised that there appears to be no other accessible method that would provide an approximation of the numbers of people or the types of occupations requiring scientific awareness, knowledge and skills. The results must be regarded and used as just that - approximations to be used to evaluate the scale and weight of demand rather than its exact nature and constitution. See Appendix 8 for further notes.

Figure 2 - A "Science" View of SOC Classifications



Appendix 1 presents the full list of occupations, at the most detailed (4-digit) level, that can be considered from the SOC 2000 descriptors to require (in all, most or some cases), a knowledge base in science. Further notes are provided in Appendix 8.

That Appendix has been summarised below as follows:-

- **Figure 3** shows the overall UK occupational mix, by major SOC category (detail in **Table 3**)
- **Figure 4** by comparison, shows the "primary" mix of *occupations that could be considered as requiring significant science knowledge or qualifications*, by major SOC category (detail in **Table 4**)
- **Figure 5** illustrates an equivalent picture for the mix of secondary science occupations

Table 3 SOC 2000 UK Occupational Mix and Volumes

Major SOC Group	Proportion of Occupations	Number of Occupations
1 - Managers and Senior Officials	12.75%	45
2 - Professionals	13.03%	46
3 - Associate Professional and Technical Occupations	20.68%	73
4 - Administrative and Secretarial Occupations	6.80%	24
5 - Skilled Trades Occupations	15.30%	54
6 - Personal Service Occupations	6.51%	23
7 - Sales and Customer Service Occupations	3.12%	11
8 - Process, Plant and Machine Operatives	11.90%	42
9 - Elementary Occupations	9.91%	35
Total	100%	353

Source: Derived from SOC 2000 data and Appendix 1

Figure 3 SOC 2000 UK Occupational Mix

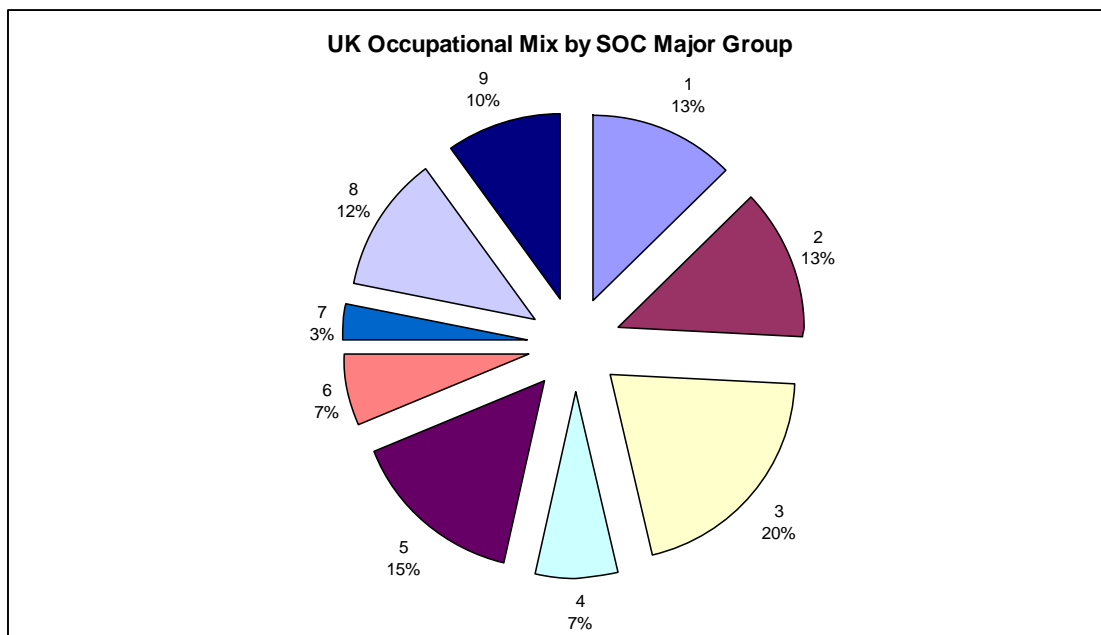
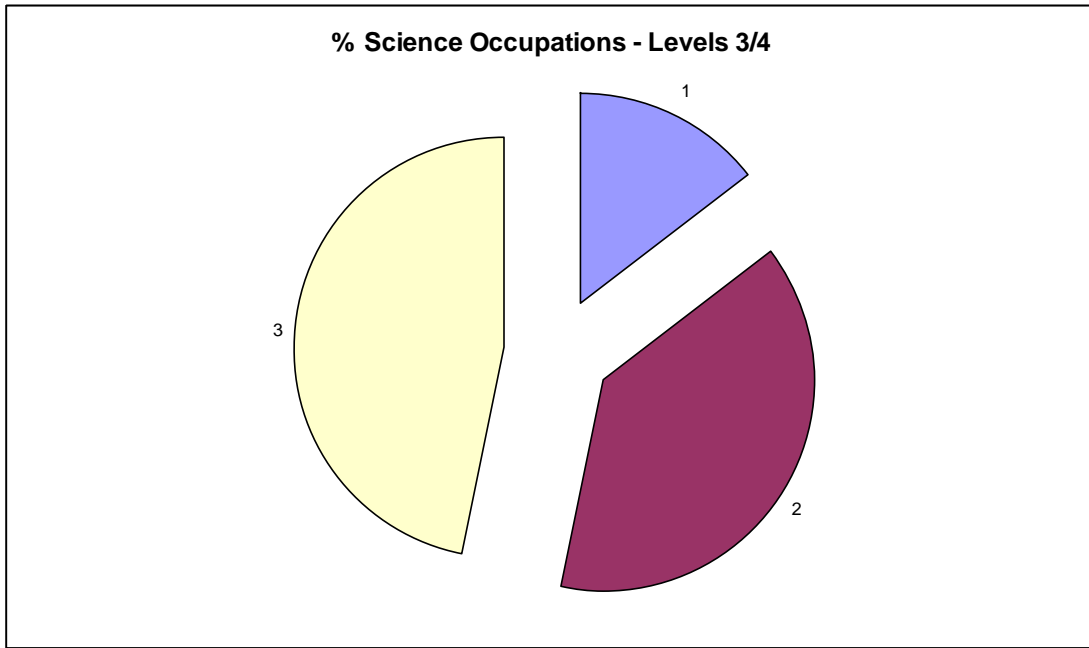
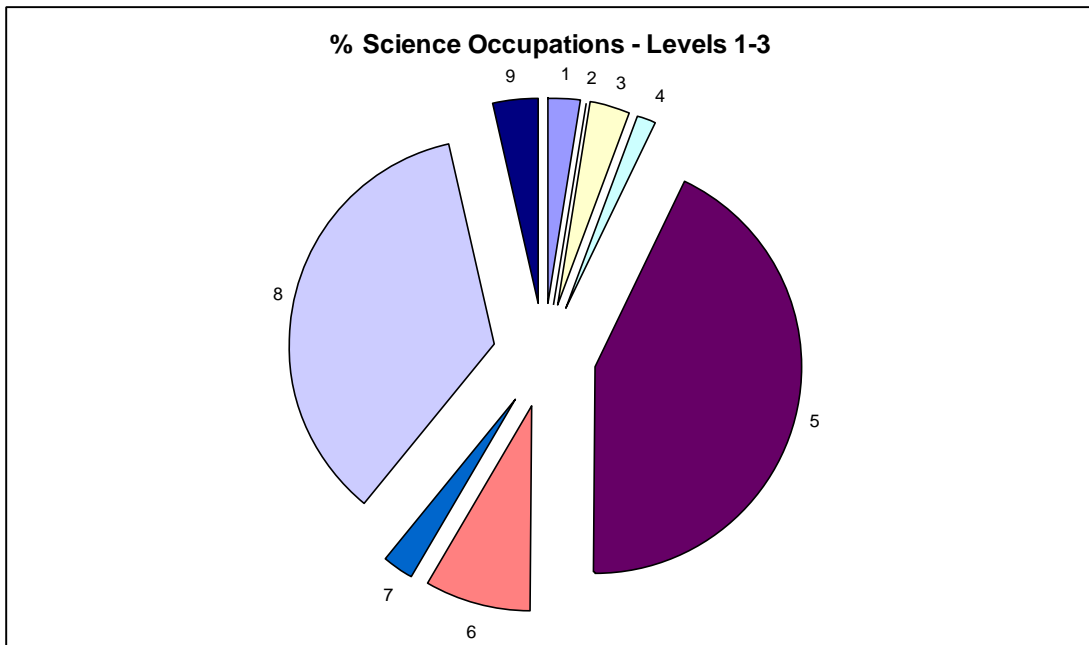


Figure 4 Mix of “primary science” occupations (Level 3 and above)



NB: Numbers relate to SOC Major Groups 1, 2 and 3 that have been identified as the primary groups for scientific knowledge and skills.

Figure 5 Mix of “secondary science” occupations (Levels 1 to 3)



NB: Numbers relate to all SOC Major Groups 1 to 9 with respect to the occupations that have been identified as the secondary groups for scientific knowledge and skills.

Table 4 (below) provides the data that support Figures 4 and 5.

Table 4 Occupational mix of “science” occupations

Major SOC Group	Number of Primary Occupations – Level 3/4	% Levels 3 to 4	Number of Secondary Occupations - Level 1-3	% Level 1 to 3
1 – Managers and Senior Officials	12	14.8	2	2.4
2 – Professionals	31	38.3		
3 – Associate Professional and Technical Occupations	38	46.9	3	3.6
4 – Administrative and Secretarial Occupations			1	1.2
5 – Skilled Trades Occupations			36	42.9
6 – Personal Service Occupations			7	8.3
7 – Sales and Customer Service Occupations			2	2.4
8 – Process, Plant and Machine Operatives			30	35.7
9 – Elementary Occupations			3	3.6
Total	81	100.0	84	100.0

Source: Appendix 1

3.2.3 Future occupational demand overall

Table 5 below illustrates the overall future projection for the workforce in selected science and “non-science” occupational classifications.

Growth in the selected categories in SOC Major Groups 2 and 3 can be compared with the projections for occupations in Groups 7, 8 and 9.

The reduction in the elementary trades and service occupations is clear evidence of the necessary switch to occupations requiring higher levels of qualifications.

Table 5 – Change in Selected Occupations 2004-2014

	2004	2014	% change
21 Science and Technology Professionals	964,000	1,137,000	17.9
22 Health Professionals	285,000	365,000	28.1
31 Science/Technology Assoc Professionals	605,000	675,000	11.6
32 Health Associate Professionals	1,081,000	1,165,000	7.8
71 Sales Occupations	1,987,000	2,220,000	11.7
72 Customer Service	424,000	559,000	31.8
81 Process, Plant and Machine Operatives	1,263,000	955,000	-24.4
82 Transport and Mobile Machine Operatives and Drivers	1,109,000	1,301,000	17.3
91 Elementary Trades, Plants and Storage Related Occupations	1,046,000	674,000	-35.6
92 Elementary Administration and Service Occupations	2,357,000	2,058,000	-12.7

Source: Working Futures, 2006 University of Warwick

Table 6 Occupational Employment 2004-14

SOC 2000 Sub Major Groups	2004		2014		Change and components of change, 2004-2014						
	000s	%	000s	%	Net change		Scale	Occupation	Industry mix		
					%	000s	effect	effect	effect	%	
11 Corporate Managers	3500	11.6	4185	13.4	18.9	685	148	485	14.2	52	1.5
12 Managers & Proprietors	1107	3.7	1031	3.3	-8.9	-78	47	-159	-14.4	38	3.2
21 Science/Tech Professionals	964	3.2	1137	3.6	17.9	173	39	104	10.8	29	3
22 Health Professionals	285	0.9	365	1.2	28.5	81	12	48	16.8	21	7.4
23 Teaching/Research Prof.	1478	4.9	1796	5.7	21.5	318	66	230	15.6	22	1.5
24 Business/Public Service Prof.	808	2.7	823	2.9	14.3	115	34	46	5.6	35	4.4
31 Science/Tech Associate Prof.	605	2	675	2.1	11.7	71	25	39	6.4	7	1.1
32 Health Associate Prof.	1081	3.6	1165	3.7	7.8	84	50	-9	-0.8	43	3.9
33 Protective Service	407	1.4	419	1.3	2.9	12	17	-10	-2.4	5	1.2
34 Culture/Media/Sport	653	2.2	808	2.6	23.7	155	28	98	15.1	28	4.3
35 Bus/Public Serv. Assoc Prof.	1554	5.2	1698	5.4	9.3	144	67	48	3	31	2
41 Administrative Occupations	2845	9.5	2740	8.7	-3.7	-105	129	-246	-8.6	13	0.4
42 Secretarial & Related	943	3.1	710	2.3	-24.8	-234	44	-315	-33.4	37	4
51 Skilled Agricultural Trades	370	1.2	427	1.4	15.4	57	15	74	19.9	-32	-8.5
52 Skilled Metal/Elect. Trades	1258	4.2	918	2.9	-27	-339	50	-313	-24.9	-76	-6
53 Skilled Construct. Trades	1171	3.9	1397	4.4	19.2	225	46	258	22	-79	-6.7
54 Other Skilled Trades	639	2.1	545	1.7	-14.7	-94	27	-118	-18.5	-3	-0.4
61 Caring Personal Service	1696	5.6	2095	6.7	23.6	400	79	287	16.9	33	2
62 Leisure/Oth Pers Service	550	1.8	588	1.9	6.9	38	25	-3	-0.5	16	2.9
71 Sales Occupations	1987	6.6	2220	7.1	11.7	232	90	135	6.8	8	0.4
72 Customer Service	424	1.4	559	1.8	31.8	135	19	110	25.9	6	1.4
81 Process, Plant & Mach Ops	1263	4.2	955	3	-24.4	-308	52	-256	-20.3	-104	-8.2
82 Transport Drivers and Ops	1109	3.7	1301	4.1	17.3	192	44	211	19	-63	-5.7
91 Elementary: Trades/Plant/Storage	1046	3.5	674	2.1	-35.6	-372	43	-337	-32.2	-78	-7.4
92 Elementary: Admin/Service	2357	7.8	2058	6.6	-12.7	-299	104	-415	-17.6	12	0.5
All occupations	30099		31399		4.3	1300	1300	0		0	

Source: Working Futures 2004-2014: Qualifications Report (table 5.2)

Table 6 shows the actual UK employment levels within each sub-major SOC group (2 digits) as at 2004, together with the forecast for 2014 across the UK.

By linking these data to the mapping of science-related occupations at 4-digit level undertaken earlier, it is possible to see the relative positions of the various broad SOC groups with respect to science-related qualifications (-Table 7).

Table 7 Major SOC Groups and Science Qualification Levels

Major SOC group	Total Employees 2004 (m)	Total Employees 2014 (m)	Growth/ Shrinkage	Percentage of science-related occupations	Usual entry level
1	4.6	5.2	+13%	82% (14 of 17)	L4 and above for c33%
2	3.5	4.2	+20%	76% (35 of 46)	L4 and above for 85% L3 for 15%
3	4.3	4.8	+12%	63% (46 of 73)	
4	3.7	3.4	-8%	26% (7 of 24)	Mainly L1 and L2
5	3.4	3.2	-6%	67% (36 of 54)	Mainly L2 and L3
6	2.2	2.6	+18%	35% (8 of 23)	L2
7	2.4	2.7	+12%	18% (2 of 11)	L2 and L3
8	2.3	2.2	-4%	67% (28 of 42)	Levels 1 to 3
9	3.4	2.7	-21%	34% (12 of 35)	Levels 1 and 2

Sources: Working Futures (op cit) and related to Appendix 1

Future occupational demand by SSCs

Due to the impossibility of estimating future demand using national statistics, the eight Sector Skills Councils (SSCs) that form the Science Diploma Development Partnership (SDDP) have been used as a proxy for future demand for science-related occupations.

The tables in Appendix 2 present a picture of future employment demand by sector, with reference to the eight Sector Skills Councils that form the core of the Science Diploma Development Partnership.

The data are presented by SSC (ie approximate sector) and by Major SOC Grouping. They permit a view of which industries hold the most opportunities for learners completing level 3 and level 4 education and training.

Major SOC groups 1,2 and 3 are of particular interest here for the following reasons:-

- ❖ SOC group 1 holds the largest proportion of UK employees;
- ❖ SOC group 2 holds the largest proportion of science-related occupations;
- ❖ SOC group 3 holds the largest number of science-related occupations and has the most diverse mix of minimum qualification entry requirements.

The three SOC groups also contain the largest proportion of level 3 and level 4 entry requirements among science-related occupations (as derived from the SOC 2000 Descriptors).

The most recent and comprehensive calculations of future workforce demand, carried out for the "Working Futures" report, provide a picture of demand by SSC footprint area for the years between 2004 and 2014.

It is possible, from that work, to identify an approximation of future sectoral demand for science.

These eight SSCs forming the SDDP represent within their footprints 26% of the UK employment market (7.6 million employees - 2004).

In terms of **expansion demand**, employment levels within these SSC groups are predicted to shrink by 1.8 per cent between 2004 and 2014. This appears to mirror the shrinkage seen in many related occupational areas in the past few years (see "Current Demand" above).

In terms of **replacement demand** however, 35 per cent of the workforce will need to be replaced over the same period.

Thus, **total demand** across these eight sectors represents a need for recruitment equivalent to 33 per cent of the 2004 workforce. In volume terms, this equates to just over 2.5 million additional recruits⁸ in the decade concerned.

Across the eight SSCs as a whole, the average 2004-2014 total employment demand for SOC groups 1, 2 and 3 is strong with rates of growth of between 32% and 44%⁹.

On the whole, overall recruitment forecasts between 2004 and 2014 for SOC groups 1, 2 and 3 are strong across the eight SSCs (some 32 per cent of existing numbers of staff). Notwithstanding that this is more to do with replacement demand than expansion demand, in each case, the figures represent a strong background to the need for scientific literacy at lower SOC levels and for advanced knowledge and skills at Levels 4 and above.

In *volume* terms, the greatest number of opportunities for level 3 and level 4 qualified entrants are within the Skills for Health and ConstructionSkills sectors.

Skills for Health present an interesting mini case study in terms of science-related occupations and predictions for the future.

⁸ Dickerson, A et al. (2006) *Working Futures 2004-2014 Sectoral Report*. University of Warwick Institute for Employment Research.

⁹ SOC group 1 (482,000/44 per cent); SOC group 2 (335,000/40 per cent); SOC group 3 (473,000/32 per cent)

Skills for Health

The Skills for Health sector employs 7 per cent of the UK employment market, joint second highest amongst the 25 recognised SSCs. In 2004, just over 2 million were employed in the sector, with just over half employed within the NHS. This makes the NHS one of the most important demand markets for science qualifications.

Of the eight SSCs, Skills for Health employers require the highest level of additional recruitment (or 'total demand') during this period, equivalent to 49 per cent, or just over 1 million additional recruits. This is partly attributable to the fact that Skills for Health is the only sector within the SDDP for which a growth is predicted in expansion demand (10%).

The NHS workforce has been rising each year since 1997, but fell for the first time in 2006, and again in 2007 but at a slower rate.

In 2007 there were 1.3 million NHS staff. Of these, just over 50% (nearly 680,700) were professionally qualified clinical staff. Within this figure there were just over 128,000 doctors and about 399,600 qualified nurses. They were complemented by around 441,000 staff in trusts and GP practices. The remainder (about 208,000) were NHS infrastructure support staff, with nearly half of those (around 100,000) in central functions; just over a third (71,000) in hotel, property & estates, and just under a fifth (36,500) in management roles¹⁰. This is presented in Figure 6.

The health sector alone will recruit well over three quarters of a million staff between 2004 and 2014 with SOC Groups 1 to 3 - representing decade growth rates of between 45% and 66% over current levels¹¹.

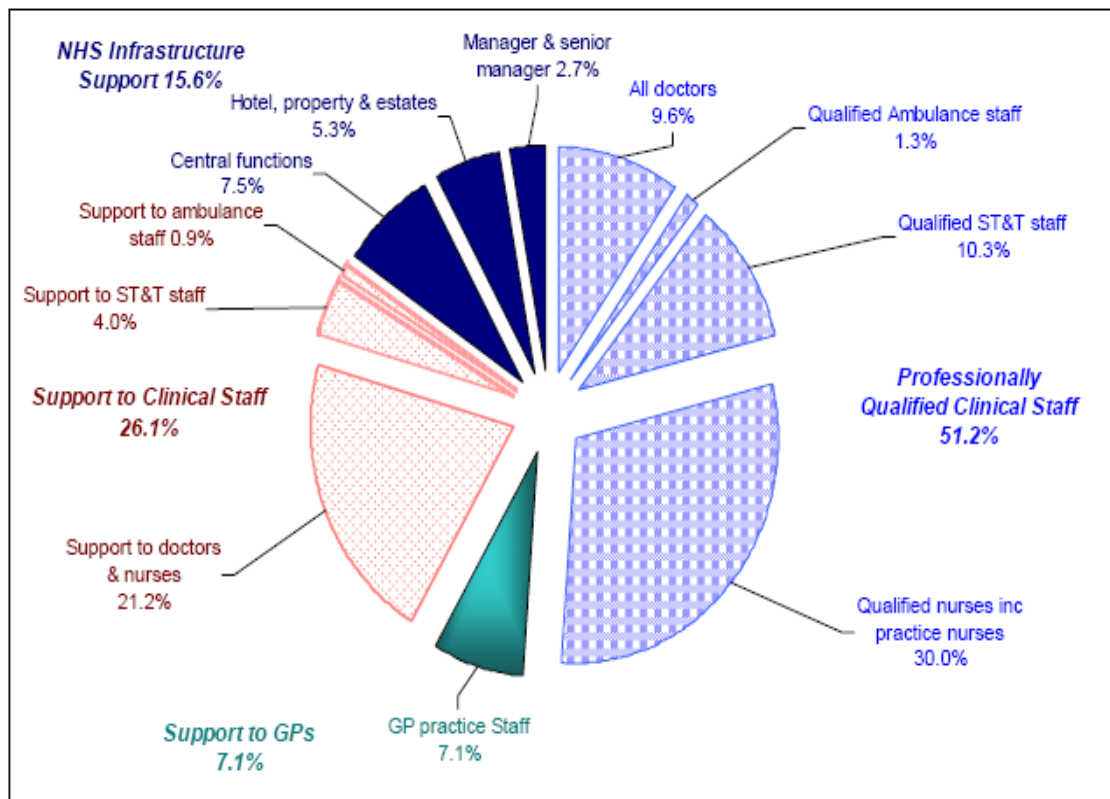
As we saw above, in *volume* terms, Skills for Health sector (alongside Construction Skills) presents the greatest number of opportunities for level 3 and level 4 qualified entrants.

¹⁰ Staff in the NHS 1997 - 2007 England (2008). The Information Centre.

¹¹ SOC group 1 (158,000/66 per cent); SOC group 2 (170,000/62 per cent); SOC group 3 (587,000/45 per cent)

The NHS workforce plan '*Modernising Scientific Careers*' is reviewing the future needs of the NHS and the current complexity of entry requirements. It is considering expanding the numbers of individuals employed at Bands 3 and 4 (associate practitioner grade) versus graduate entry into Bands 6 and 7 (specialist practitioner). The associate practitioner grade could suit those students interested in science but not wishing to go on to study at University.

Figure 6 NHS staff by main staff group, 2007



Source: Department of Health, Workforce Review 2007

Appendix 3 provides future projections 1994 to 2014 by occupational SOC code and NQF level. The predictions largely align with those made during the Working Futures research. As can be seen the demand for NQF level 3 qualifications is predicted to drop for the Science/Tech Professional level whilst the research shows that at Associate Professional level demand for Level 3 qualifications will increase.

3.2.4 Skills Shortages and Gaps

Concerns about the skills profile of the UK workforce following the Roberts¹² and Leitch¹³ reviews have stimulated extensive research on employer skills needs. The most important basic source is the *National Employer Skills Survey* (NESS) run annually on behalf of the Learning and Skills Council (LSC).

In addition, there has been a large quantity of skills needs research undertaken by the Sector Skills Councils (SSCs). The SSCs were established by the government to represent the needs of each major sector of the economy. Currently representing around 85% of the workforce, they are tasked with coordinating official action on skills, ensuring that education, training and qualifications are developed in ways that meet the current and future needs of employers within their footprint.

As part of this remit, each SSC must develop a Sector Skills Agreement (SSA) with employers in their sector, identifying skills needs and developing a consensus on strategies for resolving them. This process has involved substantial survey research with employers within each SSC footprint.

Unfortunately, the data produced by surveys such as NESS does not generally provide sufficiently detailed information to define skills needs by specific occupational role.

However, the results from the NESS are reported by SSC area, and these data can be supplemented by the findings of the SSCs own employer research.

This means that by focussing on employer skills needs within the eight SSC areas with a particular interest in science employment and which are involved in the development of the science diploma, a broad picture of the skills needs of the science sector can be presented here.

¹² Nurturing Creativity in Young People; Paul Roberts Report; 2006

¹³ Leitch Review of Skills; Prosperity for all in the Global Economy; 2006

Skills gaps by major SOC and by sector

Skills gaps are defined as areas where current employees lack the skills to do their job properly (that is, to meet the requirements of their job descriptions in full). They are, therefore, indicative of broad areas where the education and training received by the workforce has not succeeded in providing them with the full range of skills they need.

Table 8 gives a broad overview of skills gaps across the eight SSCs involved in the development of the science diploma. In absolute terms by far the most serious problems with skills gaps occur within the Skills for Health footprint (SIC 85.1; the health industry). This is to some degree to be expected, since Skills for Health has more than 2 million employees, making it one of the largest SSCs in terms of employment. The largest proportions of current skills gaps are in personal services and associate professional and technical occupations.

After Skills for Health, the SEMTA sector reports the largest numbers of skills gaps in absolute terms. This, again, reflects the size of the sector¹⁴.

The exceptional complexity and diversity of the SEMTA footprint makes it particularly difficult to develop accurate detailed data on skills gaps associated with particular occupations. However, there has been particular concern in the sector with the shortage of engineering skills at both technician and graduate professional levels. There is now substantial evidence of increased salary premiums for engineers, and this is interpreted as a direct reflection of the increasing difficulty of recruiting well-trained engineers¹⁵ who, of course, require science skills.

¹⁴ Warwick University IER, *Working Futures 2004-2014: Sectoral Report* (2006) 70.

¹⁵ ICE, *The State of the Nation - Capacity and Skills* (2008).

Table 8 Skills Gaps by Major SOC Code and by SSC

Major SOC Group	Cogent (%)	Proskills (%)	Improve (%)	Skills for Health (%)	EU Skills (%)	Skills for Justice (%)	SEMTA (%)	Construction Skills (%)
Managers	10	12	11	9	15	18	11	15
Professionals	1	5	5	3	5	3	7	9
Associate Professionals	3	6	3	19	9	34	9	9
Administrative	7	10	6	8	18	41	12	11
Skilled Trades	6	13	5	1	16	2	19	29
Personal Service	!	*	!	41	!	1	*	*
Sales	21	7	3	1	5	1	4	5
Operatives	22	28	18	*	23	-	26	7
Elementary	29	17	49	7	8	2	13	14
Numerical total Skills Gaps	31,000	16,000	24,000	96,000	12,000	15,000	75,000	59,000

* denotes a figure greater than 0 but less than 0.5%

! denotes figures excluded from the table because based on fewer than 25 interviews

Source LSC, NESS 2007 Main Report

Other areas identified as experiencing particularly serious skills gaps are craft and technical skills in the aerospace, automotive, and electronics sectors; among laboratory scientists and managers in the bioscience sector; engineers in the metals, and electrical and mechanical equipment industries; and management and leadership, and technical roles in the marine sector¹⁶.

ConstructionSkills employers also report significant skills gaps, again partly reflecting the large number of people employed in the sector. These are particularly concentrated in skilled trades and crafts, at least in part as a result of the sustained expansion of the

¹⁶ SEMTA, *Sector Skills Agreement - UK - Aerospace, Automotive and Electronics* (2005), p3 <http://www.semta.org.uk/pdf/elec%20auto%20aero%20ssa%20summary.pdf>; SEMTA, *Bioscience Sector Skills Agreement Stage 1: Skill Needs Assessment* (2007) p44 <http://www.semta.org.uk/pdf/elec%20auto%20aero%20ssa%20summary.pdf>; SEMTA, *Sector Skills Agreement - UK - Marine* (2006), p. 5 <http://www.semta.org.uk/PDF/SSA%20marine.pdf>

construction industry from the early 1990s through to 2006-7.

The resultant expansion of the workforce inevitably placed skills supply under pressure, and the ready availability of work on new build projects diminished the incentive to undertake more advanced skills training¹⁷. However, recent months have seen a dramatic contraction in the construction sector (October-November 2008), with private sector housing construction coming to an almost complete standstill. This is likely to have had a significant impact in reducing skills gaps as employers lay off less skilled employees.

In addition to the 8 core Science SSCs, the Building Services Engineering sector is a sector that has ongoing needs for scientifically-knowledgeable recruits at all levels. Its Level 3 apprentices require not only good mathematical skills but an understanding of scientific principles such as heat and energy, electricity and hydrodynamics. The Working Futures report provides a clear indication of the needs of the sector's employers for practical and technical skills in the future, as well as for higher level specialist skills (please see table below).

Table 9: Future skills needs reported by employers in the Building Services Engineering sector

	Business Skills	Legislation/Health & Safety	IT/Specialist skills	Practical Skills
Plumbing	1%	6%	19%	23%
Electrotechnical	1%	7%	12%	19%
Heating and Ventilation	1%	8%	21%	23%
Air Conditioning and Refrigeration	2%	2%	15%	27%

Source: Working Futures 2006

¹⁷ See NHTG, *Traditional Building Craft Skills - Skills Needs Analysis of the Built Heritage Sector in England* (2008).

The Cogent skills gaps are especially significant in the present context given the strongly science based nature of the sectors it represents - process chemicals, oil and gas production and storage, polymers and bulk pharmaceuticals - and the relatively small size of the sector at just over 500,000 employees¹⁸.

The Cogent sectors are unusual in the proportion of skills gaps in elementary and process occupations, probably in part reflecting the increasing skills demands being made on the process workforce as they are expected to take on responsibilities traditionally assigned to middle management roles¹⁹.

The Improve footprint covers food manufacture and distribution. The sector employs nearly 500,000 people and also has significant skills needs, largely concentrated at elementary level²⁰. However, it also has a specific need for Food Scientists and Technologists. These are currently proving difficult to recruit, although research by Improve suggests that employers have relatively little concern about the skill levels of current employees in these fields²¹. Otherwise, skills gaps are strongly concentrated in elementary and operative occupations.

The Proskills footprint includes a whole series of sectors with significant scientific, engineering and technical needs - mining, quarrying and extractives; glass; building products and refractories; paintings and coatings; and printing. These industries are estimated to employ nearly 450,000 people. The principal demand for improved skills among existing employees comes from the increasing automation of production processes and the resultant need for increased technical and ITC skills²².

Skills for Justice covers the police, prisons and courts services, and, of most relevance in this context, forensic science. Recent problems with forensic analysis in the Damilola Taylor case, brought to light during retesting of the evidence, have focussed attention on skills gaps within the forensic science service. However, the review of the

¹⁸ Warwick University IER, *Working Futures 2004-2014: Sectoral Report* (2006) 35.

¹⁹ Cogent, *A Gap Analysis for the Chemical Industry*. (2006). Cheshire: Cogent.

²⁰ Improve Ltd. *Putting the Plan into Action: The Sector Skills Agreement for the Food and Drink Manufacturing Sector* (2007), p.3. Warwick University IEC, *Working Futures Sectoral Report* (2006), 51.

²¹ Improve Ltd., *Research to Investigate the UK Requirement for Food Scientists and Technologists* (2006); Improve Ltd., *Investigation into the requirement for food scientists and technologists in the Yorkshire and Humber Region* (2007)

²² ProSkills, *Sector Skills Agreement Stage 2 Report - An Assessment of Current Provision* (2006), section 3.

forensic science failings has concluded that procedural errors (partly due to high workload), rather than skills gaps, were responsible for the problems²³.

EUSkills, representing the energy generation and distribution, water, and waste management industries, has one of the smaller SSC footprints with around 324,000 employees²⁴. However, productivity per employee is around five times the UK average, reflecting the capital intensive, high technology orientation of the EUSkills sectors²⁵. This is reflected in, and indeed depends upon, an extremely high proportion of the workforce possessing a wide range of science, engineering and technical skills.

It is of interest to point out the *relative* as well as absolute prevalence of skills gaps within the various SSC footprints. These produce significant results in the context of science qualifications, because Cogent and SEMTA, representing the bulk of UK science manufacturing and engineering, emerge as having the most significant problems. Table 10 shows the SSCs in order of the percentage of the workforce with skills gaps.

Table 10 Relative prevalence of skills gaps by SSC

Rank	SSC	Estimated Workforce	Estimated workforce with skills gaps	% of workforce with skills gaps
1	Cogent	507,500	31,000	6.1
2	SEMTA	1,408,500	75,000	5.3
3	Improve	460,000	24,000	5.2
4	Skills for Health	2,106,000	96,000	4.6
5	Skills for Justice	366,000	15,000	4.1
(6)	EUSkills	321,500	12,000	3.7
(6)	ProSkills	431,500	16,000	3.7
8	ConstructionSkills	2,065,000	59,000	2.9

Source: Working Futures 2004-2014 - Sectoral Report (2006)

²³ Home Office (Professor Brian Caddy and Alan Rawley QC), *Damilola Taylor: An independent review of forensic examination of evidence by the Forensic Science Service* (2007) pp. 2-3.

²⁴ Warwick University IER, *Working Futures Sectoral Report* (2006)

²⁵ Energy & Utility Skills, *Sector Skills Agreement Stage 2 Report* (2006), p. 14.

Improve and Skills for Health also appear to be facing particular challenges with their existing workforce. Although these are concentrated in different occupational roles in the two sectors - "personal service and associate professional and technical occupations" in the case of Skills for Health and "elementary and operative roles" for Improve - it should be noted that these are both areas where recruitment at 16 (post-GCSE) is reasonably routine.

The NESS survey provides further detail on the main skill areas in which the gaps in each SSC area are concentrated. Employers are asked in which of a series of thirteen core skills areas their employees have the greatest skills gaps.

As might be expected in a strongly technically and scientifically oriented set of sector footprints, technical and practical skills represent by far the most significant general area of skills gaps, with employers in all SSC footprints reporting that more than half of employees lacked appropriate levels of technical and practical skills. Table 11 below shows the percentages of skills gaps by nature of the skills involved (or lacking) for each SSC.

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Table 11 Employees with Skills Gaps in 13 Major Skills Areas (% by SSC)

	Cogent (%)	Proskills (%)	Improve (%)	Skills for Health (%)	EU Skills (%)	Skills for Justice (%)	SEMTA (%)	Construction Skills (%)
Technical and practical	63	66	45	55	58	56	65	61
Customer handling	28	24	10	48	38	49	15	26
Oral communication	37	28	49	54	28	28	24	31
Team working	46	43	33	54	43	47	37	31
Problem solving	32	38	41	44	35	47	36	34
Written communication	28	23	35	56	19	28	22	25
Management	16	24	25	20	26	20	22	26
General IT user skills	11	21	11	44	29	27	18	17
Literacy	30	14	27	38	17	10	17	15
Office Admin	11	16	6	34	19	38	14	19
Numeracy	27	13	30	27	10	7	15	13
IT professional skills	6	12	6	9	8	16	14	13
Foreign languages	11	6	19	8	5	12	15	7

Source: LSC National Employer Skills Survey 2007 (table 4.12)

Base: All skills gaps followed up.

Technical and practical skills represent the greatest areas of skills gaps for almost all sectors. Only in the Improve and Skills for Health sectors are there any other significant skills gaps (highlighted). Combining this with the most important skills gaps for each of the eight science-based SSC makes it possible to identify those that will need to be addressed in future science qualifications. These are tabulated in Table 12 below.

Table 12 Main Skills Gaps by SSC

Percentage of employers reporting skills gaps in specific skill areas

	Main skills gap area for each sector
Cogent	Technical and Practical 63%
Proskills UK	Technical and Practical 66%
SEMTA	Technical and Practical 65%
EU Skills	Technical and Practical 58%
ConstructionSkills	Technical and Practical 61%
Skills for Health	Written Communication 56% Technical and Practical 55%
Skills for Justice	Technical and Practical 56%
Improve	Oral Communication 49% Technical and Practical 45%

Source: LSC, National Employer Skills Survey 2007 Main Report, pp. 97-98.

'Hard to Fill' Vacancies by sector and by occupation

In addition to skills gaps within the sectors covered by the science based SSCs, each sector also reports skills shortages - defined as areas where it is difficult to recruit new staff members to fill vacancies due to a lack of suitable applicants.

Table 13 presents information on the proportion of employers with vacancies in the footprints of each SSC. It should be noted that not all vacancies necessarily involve science-related skills.

Table 13 Percentage of Employers with Vacancies and Hard to Fill Vacancies

SSC Sector	% of employers with vacancies	% of employers with Hard to Fill Vacancies
Cogent	18	6
ConstructionSkills	16	8
EU Skills	15	3
Improve	19	6
SEMTA	19	9
Skills for Health	24	7
Skills for Justice	30	6
Proskills UK	13	5
All England	18	7

Above average figures in each category are highlighted. Source: LSC National Employer Skills Survey Main Report, 2007, p. 52.

A more interesting picture emerges when skills shortages within the sectors are broken down by occupational role (see table 14). By far the most significant difficulties occur with recruitment with skilled trades occupations, especially within the SEMTA, Improve, ConstructionSkills and Proskills footprints. ProSkills and Cogent also report significant shortages at operative levels and with mid-level and technical skills.

Table 14 Skill Shortage Vacancies as a Percentage of all Vacancies (by SSC and Occupation)

Profession	Cogent	C/Skills	Improve	SEMTA	Skills for Health	Proskills UK
Managers	10	6	8	6	5	2
Professionals	21	31	0	15	5	3
Associate professionals	9	11	16	13	29	15
Administrative	3	3	9	2	11	6
Skilled Trades	9	34	38	41	1	30
Personal Service	0	0	0	0	41	0
Sales	14	2	10	4	2	16
Operative	26	9	12	17	0	25
Elementary	6	4	5	2	3	3
Unclassified	1	*	1	1	2	0

Note: A skills shortage vacancy is one that is hard to fill due to a lack of appropriate skills in the available applicants. Skills for Justice and EU Skills data are unavailable.

* denotes a figure greater than 0 but less than 0.5% Source: LSC NESS Main Report 2007, pg 60.

Source: LSC, NESS Main Report 2007

3.2.5 Recruiting Young People

Surveys by SSCs as well as the results of the annual NESS surveys report that employers often have specific concerns about the degree to which young people are prepared for work.

This section summarises the variation in recruitment levels of young people by sector, again focusing on the eight Sector Skills Councils (SSCs) that form the Diploma Development Partnership (SDDP) and that also form an appropriate proxy for science-related recruitment in general.

For these purposes "young people" are classified into three categories, namely:

- ❖ *16 year old school leavers;*
- ❖ *17 to 18 year old school college leavers, and*
- ❖ *under 24 year olds from Higher Education (HE).*

This categorisation, used in the National Employer Skills Survey (NESS) facilitates a deeper understanding of the skills gaps and perceptions of employers towards the different age groups, providing the opportunity for the Diploma in Science to address these gaps as required at each of its three levels.

Recruitment into the 'science sector'

Across the eight SSCs in the DDP, the *Working Futures* report predicts a decline in total employment numbers over the period 2004-2014 with the exception of Skills for Health.

However despite declines in total employment, the need for new recruits into these sectors remains high, with forecast total demand requirements averaging 28 per cent of the current workforce across the eight SSCs by 2014.²⁶

²⁶ LSC: National Employer Skills Survey 2007: Main Report (2008)

The positive demand forecast by *Working Futures* is predominantly made up of replacement demand, with expansion demand relatively small or negative in most of the SSCs.

The NESS also provides a limited amount of evidence of changes in the recruitment of young people into the eight sectors as illustrated in Table 15. The figures are by no means robust but they indicate what may become trends in each sector.

Table 15 - Recruitment of 16 to 24 year-old education leavers (by SSC)

Sector Skills Council	Unweighted base	Weighted base	16 year old school leavers (%)	17 or 18 year old school/ college leavers (%)	Under 24 year olds from HE (%)
All England	79,018	1,451,507	7	12	10
Cogent	1,807	13,787	6	14	10
ConstructionSkills	4,843	113,424	7	10	8
EU Skills	467	11,945	8	10	7
Improve	1,146	7,766	9	11	8
SEMTA	3,335	48,880	8	11	7
Skills for Health	2,416	42,645	4	11	11
Skills for Justice	299	3,247	3	15	22
Proskills UK	2,071	17,482	5	9	7

Source: LSC National Employer Skills Survey 2007 (table 5.6)

Base: All employers

Table 16 Percentage change in recruitment of education leavers (between 2005 and 2007)

Sector Skills Council	16 year old school leavers (%)	17 or 18 year old school / college leavers (%)	Under 24 year olds from HE (%)
All England	-	+1	+1
Cogent	-	+1	-
ConstructionSkills	-	+2	+2
EU Skills	+2	+2	+1
Improve	+1	-3	-1
SEMTA	-	-	+1
Skills for Health	-	+1	+2
Skills for Justice	-1	-	+3
Proskills UK	-	-	+1

Source: LSC National Employer Skills Survey 2005 (table 5.5) & 2007 (table 5.6)

Employer Satisfaction with young people

The NESS asks a series of questions each year relating to employers' relative satisfaction with the standard of recruits from various educational sources.

The greatest levels of dissatisfaction are expressed about *16 year old school leavers* who are considered by employers to be the least well-prepared for work of the three age groups.

Nationally 27% of employers perceive this age group as being poorly prepared for the world of work. The average for the eight Science DDP SSCs is, however, 30% (see Table 17).

ConstructionSkills and SEMTA employers report significantly higher levels of dissatisfaction (34% and 33% respectively).

Table 17 Employer Perceptions of Young People

Proportion of Employers who perceive school leaver recruits as being "poorly" or "very poorly" prepared for work

	16 yr old %	17/18 yr old %	Under 24 HE leavers %
All England	27	21	10
Cogent	31	21	15
ConstructionSkills	34	29	14
EU Skills	29	25	17
Improve	28	21	10
SEMTA	33	27	17
Skills for Health	27	22	7
Skills for Justice	!	15	5
Proskills UK	29	26	18

Base: All employers that have recruited 16-24 year old leavers of education in past 12 months

!: Denotes base size under 25. Highlighted: Denote figures at or higher than the national average

Source: LSC National Employer Skills Survey 2007 (table 5.7)

The figures for dissatisfaction are relatively high at all age points. One in four employers is concerned with the work-preparation of 16 year olds, one in five with the work-preparation of 17 and 18 year olds, and one in ten is still concerned at the work-preparedness of post-HE students.

The proportions among the science-related employers as represented by the eight SSCs are often significantly higher. Employers in engineering, construction and energy are particularly concerned but almost every sector shows levels of dissatisfaction at, or above, the national average.

Skills Gaps among young people

Table 18 displays a selection of results from NESS 2007. While a number of other skills are of concern to employers in the 16 and 17 year old cohorts, their concern with technical and practical skills virtually

doubles between the youngest school-leaving age and the point at which young people leave University or HE.

Whereas around 10% of employers are dissatisfied with the technical and practical skills of 16 year olds, double that proportion (one employer in five) is concerned with those skills in HE leavers.

Table 18 Skills Gaps among Young People – Employer View

	16 year old school leavers		17 or 18 year old school / college leavers		University or HE leaver	
	2005	2007	2005	2007	2005	2007
	%	%	%	%	%	%
Lack of life/ working world experience	16	16	14	12	12	18
Oral communication skills	16	15	13	14	9	12
Lack of motivation/ enthusiasm/ commitment	13	14	14	16	11	9
Poor education/general knowledge	12	13	13	10	7	9
Work ethic/poor attitude to work	11	11	8	11	2	11
Time keeping skills/punctuality	10	10	9	12	6	7
Literacy skills	10	9	8	7	6	8
Social/people skills	10	9	6	8	3	7
Technical, practical or job-specific skills	10	8	12	11	18	20
Numeracy skills	8	8	8	7	6	4
Interview skills	1	1	1	1	1	1

Source: LSC National Employer Skills Survey 2007 (table 5.3)

Base: All employers that have recruited 16 to 24 year old leavers from education in the previous 12 months and who say some of these recruits were poorly prepared.

Note: “*” denotes a finding of less than 0.5 per cent and greater than 0.

3.3 The Supply Side

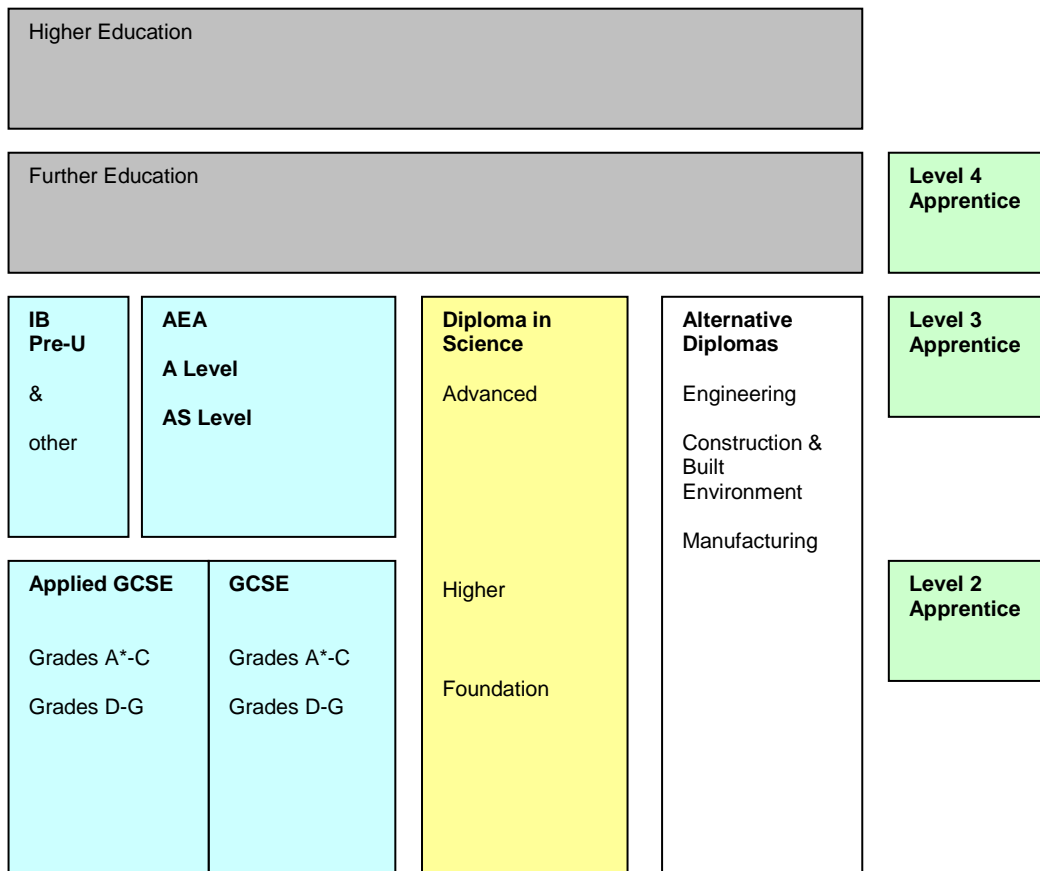
3.3.1 Science Qualifications

This section presents a summary of current science based education provision in the UK at levels 1 to 3. A detailed account of the existing qualifications can be found in Appendix 9 with an explanation of a selection of alternative and comparable qualifications in Annex 1.

Figure 7 below presents a simplified picture of the various options that will be open to young people following the launch of a Diploma in Science and it places the existing "science-related" Diplomas in context and shows how the vocational routes through (specifically) level 2 and 3 Apprenticeships relate to the Diploma and traditional academic routes.

The "traditional" level 1 to 3 route is shaded blue - extending from Level 1 GCSE (D-G) qualifications (including their Applied equivalents), through GCSE Grade A*-C achievement at Level 2 and on to AS and A levels (and their equivalents in the International Baccalaureate, Pre-U, etc) to achieve Level 3 qualification.

Figure 7 - The 14-19 Qualifications Map



3.3.2 GCSE science based provision

The National Curriculum for Science at Key Stage 4 was revised in September 2006, with more variation, more options and more opportunities in science education²⁷.

There are four core routes available (see Figure 8). Route 1 consists of GCSE Science with up to five additional and optional components, each equivalent to 1 GCSE. These are Additional Science; Additional Applied Science; Physics; Chemistry; Biology.

²⁷ *More Science: GCSE Applied Science and the new KS4 curriculum.* (2006). SEMTA.

Figure 8 - Four Routes

GCSE Science (1 GCSE): one of:	GCSE Additional Science (1 GCSE) GCSE Additional Applied Science (1 GCSE) GCSE Physics (1 GCSE) GCSE Chemistry (1 GCSE) GCSE Biology (1 GCSE)
Triple Award:	GCSE Physics (1 GCSE) GCSE Chemistry (1 GCSE) GCSE Biology (1 GCSE)
GCSE Applied Science (Double Award) (equivalent to 2 GCSEs)	
One of:	BTEC Introductory Certificate in Applied Science BTEC Introductory Diploma in Applied Science BTEC First Certificate in Applied Science BTEC First Diploma in Applied Science OCR Nationals Science Level 2

Learners are able to take GCSE Science and one of Physics, Chemistry and Biology, but this is not generally advised. DCSF does not consider these combinations as equal to two GCSEs and as such does not include them in the Science Indicator,²⁸ the tool used to calculate performance for school League Tables.

Route two consists of Triple Award Science. This is the study of GCSE Physics, Chemistry and Biology leading to three full GCSEs.

Route three consists of GCSE Applied Science (Double Award) worth two full GCSE's.

Finally route four consists of BTEC Introductory and First Certificates and Diplomas in Applied Science and OCR Nationals Science Level 2.

²⁸ DCSF, Publication of 2007 test and examination results in the school and college achievement and attainment tables, September 2007.

BTEC Introductory Certificates and Diplomas in applied science are Level 1 courses providing a basis for further training, education or employment in the science sector. BTEC First Certificate in applied science is a Level 2 qualification broadly equivalent to two GCSEs grade A*-C. BTEC First Diploma in applied science is also a Level 2 course but slightly longer, equivalent to four GCSEs grade A*-C. These qualifications give a good insight to the skills needed to work within the science sector and cover all three main strands of science. (Physics, Chemistry and Biology).

OCR Nationals Science are Level 2 qualifications available in two sizes of award and certificate, equivalent to two GCSEs grade A*-C and four GCSEs grade A*-C respectively. They are exam-free, industry relevant qualifications that take a practical approach to science learning.

Some awarding bodies offer other science-based GCSE courses that could also be taken to supplement the Core Science award, including geology; psychology; electronics; astronomy, environmental science; environmental and land-based science²⁹; human physiology and health.

The options available, and their unit constructions, vary depending on the awarding body. For instance the Additional Applied Science GCSE is offered by two awarding bodies but in contrast the Applied Science double award route is offered by four awarding bodies.

Each GCSE can, of course, be taken in either of two options: to D-G grade or to A-C grades.

In Table 19 overleaf, the transition from older syllabi to newer GCSE structures can clearly be seen, as can the balance between single Science and combined Sciences and the role of the new Applied GCSEs.

²⁹ Environmental and Land Based Science is the only single subject science GCSE that when taken with GCSE Science will be included in the Science Indicator for League Tables.

Market View Report - Phase 4 Diploma in Science

Table 19 - JCQ Science-based GCSE Candidates 2007 & 2008 (England only)

Subject		Total sat 2006	Total sat 2007	Total sat 2008	% A* - C 2006	% A* - C 2007	% A* - C 2008
Biology	Male	30,599	32,251	41,544	89.4	89.8	92.5
	Female	23,828	24,887	36,273	86.9	88.1	89.6
	All	54,427	57,138	77,817	88.3	89.0	91.1
Chemistry	Male	29,753	31,112	39,180	90.2	90.7	93.9
	Female	21,629	22,415	30,884	90.0	91.4	94.6
	All	51,382	53,527	70,064	90.1	91.0	94.2
Physics	Male	29,965	31,165	39,307	91.2	91.5	93.7
	Female	20,704	21,532	29,790	90.1	90.1	93.8
	All	50,669	52,697	69,097	90.8	90.9	93.8
Science: Double Award***	Male	438,754	436,402	0	57.0	57.5	0
	Female	444,464	443,444	0	58.4	58.6	0
	All	883,218	879,846	0	57.7	58.0	0
Science: Single Award	Male	40,716	41,940	2	21.2	22.4	50.0
	Female	40,987	42,096	3	27.1	27.7	0
	All	81,703	84,036	5	24.1	25.1	20.0
Science (new spec)	Male	-	26,888	249,240	-	52.1	58.3
	Female	-	28,261	251,995	-	55.6	60.5
	All	-	55,149	501,235	-	53.9	59.4
Additional Science (New spec)	Male	-	-	201,219	-	-	61.9
	Female	-	-	205,714	-	-	64.6
	All	-	-	406,933	-	-	63.3
Applied Science Single Award	Male	-	1,023	2	-	25.2	50.0
	Female	-	1,317	0	-	29.7	-
	All	-	2,340	2	-	27.8	50.0
Applied Science Double Award***	Male	11,562	13,499	8,811	23.0	33.3	33.7
	Female	14,246	16,065	11,185	27.1	42.1	38.6
	All	25,808	29,564	19,996	25.3	38.1	36.4
All GCSE (Full Course) subjects+	Male	2,592,736	2,625,246	2,555,332	58.2	59.3	61.8
	Female	2,652,716	2,689,460	2,611,296	65.9	66.5	69.0
	All	5,245,452	5,314,706	5,166,628	62.1	63.0	65.5

Source: JCQ

***Note that Science Double Awards count as two GCSE entries per candidate (entries are therefore counted twice in the figures for these subjects)

+ These totals do not include Applied GCSE candidates

Beyond the age of 16, the majority of pupils who remain at school go on to the AS Level courses with a view to completing the two year syllabus that culminates in the taking of the A2 (full A-Level) examinations.

In science subjects these courses are offered by almost all main awarding bodies in the separate disciplines of Biology, Chemistry and Physics.

The top 10% of the ability range can also take the same subjects in the Advanced Extension Award (AEA) in the same disciplines (these awards are graded slightly differently to the A Levels).

Alongside the traditional A Levels, a small proportion of the age cohort study for equivalent qualifications such as the International Baccalaureate (IB) and other similar qualifications (see Annex 1). Almost all of these qualifications either include traditional A Levels in their structure or do not permit the pupil to study the sciences separately.

The following tables (20 and 21), along with Figure 9, give information on A Level entries over the past decade by subject. Table 20 includes non-science A-Level subjects for comparative purposes.

The 800,000+ entries for all A-Levels in 2007 represented a 9% increase over 1996. In the same period, those sitting A-Levels in the three core sciences dropped by -2.5%.

In 1996 science A-Level candidates formed 17% of total A-Level candidates. By 2007 the proportion had dropped to just over 15%.

As Figure 9 and Table 21 illustrate, the proportionate take-up of individual science A-Levels has been largely flat or declining over the decade.

Table 20 - Number of A-level Entries (All ages; UK*)

	1996	1997	1998	1999	2000	2001
Chemistry	40418	42262	41893	40920	40261	38602
Physics	33033	33243	34209	33880	31794	30701
Biology	52053	56706	58439	56036	54650	52647
Maths	67072	68880	69919	69945	65836	66247
English	87343	95223	95316	90340	86562	76808
French	27487	25881	23923	21072	18341	17939
Business Studies	29085	33458	37644	37926	36201	36834
Total Entries in all Subjects	740470	777710	794262	783692	774364	748866

	2002	2003	2004	2005	2006	2007
Chemistry	36648	36110	37254	38851	40064	40285
Physics	31543	30583	28698	28119	27368	27466
Biology	52132	51716	52264	53968	54890	54563
Maths	53940	55917	58508	58830	63252	67965
English	72196	78746	81649	85858	86640	85275
French	15614	15531	15149	14484	14650	14477
Business Studies	27680	33133	32253	30719	30648	30193
Total Entries in all Subjects	701380	750537	766247	783878	805698	805657

* Note that, in the context of A Levels the statistics relate mainly to England, Wales, and Northern Ireland

Source: Royal Society of Chemistry; 2008; ALevel Chemistry_tcm18-98309.pdf

http://www.rsc.org/images/ALevelChemistry_tcm18-98309.pdf

Confirmed with JCQ; October 2008

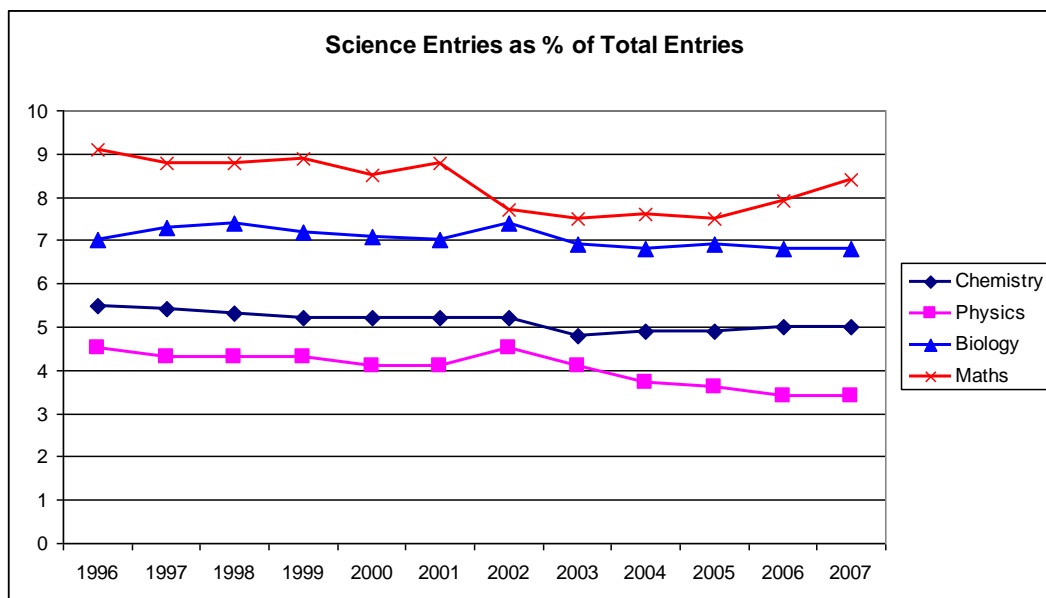
GCE Science, Applied Science, Geology and others are not shown. JCQ published statistics group all other science subjects apart from physics, chemistry and biology into one grouping, but this is available only from 2001 onwards and has not been shown in the table.

Table 21 - Specific A Level Entries as % of Total A Level Entries

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Chemistry	5.5	5.4	5.3	5.2	5.2	5.2	5.2	4.8	4.9	4.9	5.0	5.0
Physics	4.5	4.3	4.3	4.3	4.1	4.1	4.5	4.1	3.7	3.6	3.4	3.4
Biology	7.0	7.3	7.4	7.2	7.1	7.0	7.4	6.9	6.8	6.9	6.8	6.8
Maths	9.1	8.8	8.8	8.9	8.5	8.8	7.7	7.5	7.6	7.5	7.9	8.4
English	11.8	12.2	12.0	11.5	11.2	10.3	10.3	10.5	10.7	11.0	10.8	10.6
French	3.7	3.3	3.0	2.7	2.4	2.4	2.2	2.1	2.0	1.9	1.8	1.8
Business Studies	3.9	4.3	4.7	4.8	4.8	4.9	3.9	4.4	4.2	3.9	3.8	3.7

Source: Royal Society of Chemistry; 2008

Figure 9 – A Level Science Entries 1996-2007 as a Proportion of Total Entries³⁰



Source: Derived from Table 3 above

3.3.4 Work based learning provision in England

There are currently over 200 apprenticeship programmes in 16 industrial sectors³¹. In 2004, the Apprenticeships system changed slightly, allowing 14 to 16 year olds and people over the age of 25 to become apprentices³².

³⁰ Early indications are that GCE Sciences may increase in entry numbers in 2009-2010

³¹ LSC First Release *Further Education and work-based learning for young people - learner outcomes in England 2005/06..*

³² <http://www.apprenticeships.org.uk/list/aboutapprenticeships/>

Apprenticeships are, however, now taking a more prominent position in the Government's overall skills strategy. In order to meet Lord Leitch's target for the UK to become a world class leader in employment and skills by 2020, the Government has established the target of giving every young person who is suitable, and who wants one, an entitlement to an apprenticeship by 2013.

The numbers of young people starting apprenticeships in England is intended to grow to 250,000 by 2020. This equates to 1 in 5 young people undertaking an apprenticeship in the next decade³³ and would result in an average number of around half a million young people taking apprenticeships at any one time.

A catalyst for the achievement of these goals will be the launch, in 2009, of the National Apprenticeship Service (NAS), set up to provide new, focused leadership for the programme, bringing together a wide range of services and operations currently dispersed among a range of agencies³⁴.

The Diploma in Science will therefore both support and compete, to a certain extent, with these Apprenticeship ambitions. The Foundation and Higher Diploma in Science will form part of the qualifications of young people going on to "Sixth Form" study as well as those leaving school to seek apprenticeships and other work-based qualifications. Similarly the Advanced Diploma in Science will support those going on to higher education and, possibly to an increasing extent, those leaving school at 18 in order to take up work-related training and education and Level 4 Apprenticeships.

Tables 22 and 23 refer to Apprenticeships (level 2) and Advanced Apprenticeships (level 3) respectively. Each table shows the percentage of learners who completed full apprenticeship programmes in three key science-based sectors, along with the volumes of total leavers (including those that enrol but leave early). A comparison is also made in each case between 2005 and 2006.

³³ DCSF/DIUS Impact Assessment of Apprenticeships Review Policies, including the creation of the National Apprenticeships Service. Draft Bill Version 7 (14 July 2008)

³⁴ Ibid.

Table 22 Completion of Apprenticeships (level 2) in three science based sectors

	2005	2006
Engineering and Manufacturing Technology	13,200	16,614
ICT	3,700	4,840
Construction, Planning and the Built Environment	14,700	17,669
Total - ALL 16 SECTORS	119,700	131,497

Total Leavers are rounded to the nearest 100

Totals may not equal the sum of the columns due to rounding

Source: LSC First Release: Further Education and work-based learning for young people - learner outcomes in England 2005/06

Table 23 Completion of Advanced Apprenticeships (Level 3) in three science-based sectors

	2005	2006
Engineering and Manufacturing Technology	13,600	14,800
ICT	1,900	1,900
Construction, Planning and the Built Environment	7,400	7,900
Total - ALL 16 SECTORS	50,200	53,400

Total Leavers are rounded to the nearest 100

Totals may not equal the sum of the columns due to rounding

Source: LSC First Release: Further Education and work-based learning for young people - learner outcomes in England 2005/06

Although participation in apprenticeships grew between 2005 and 2006 it has since decreased as described in Table 24. However the launch of the National Apprenticeship Service and the Government's greater focus on the subject will almost certainly increase the numbers significantly

Table 24: Advanced Apprenticeships in England and Wales

	Average in learning – England
2003/04	105,100
2004/05	101,784
2005/06	101,330
2006/07	95,972

(Source: LSC data, www.apprenticeships.org.uk; WAG, *Further Education, work-based learning and community learning in Wales statistics*)

3.3.5 Higher Education trends in science based subjects

A significant element in the supply of science-qualified people to the UK economy is that of higher education (it also, of course, represents an important demand-driver in the form of its need for highly qualified science lecturers and technicians).

Tables 25 and 26 illustrate the pattern of acceptances onto science-related first-degrees over the decade from 1998 to 2007. Almost all subjects have shown increases over the period, ranging from the modest 5% and 7% increases in the numbers being accepted onto Chemistry and Physics degree courses respectively, to the 43% and 54% expansion of maths and psychology acceptances³⁵.

³⁵ Greater detail on trends in participation statistics in Higher Education are provided in Appendix 4 across the main subject groupings

Table 25 - First Degree Acceptances for Sciences and Related Subjects (Grouped) – 1998-2007

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Medicine and Dentistry	5,962	6,194	6,592	7,161	7,885	8,615	8,944	9,008	9,146	9,057
Subjects allied to medicine	19,678	21,172	22,457	24,532	19,660	21,702	23,744	26,416	26,496	27,524
Biological sciences	17,067	17,018	16,794	17,771	27,657 ³⁶	28,982	29,262	32,446	30,916	32,877
Veterinary science, agriculture and related	2,791	2,826	2,706	2,692	2,844	3,170	3,355	3,969	3,976	4,133
Physical sciences	14,729	14,105	13,071	12,662	14,145	14,305	13,878	14,980	14,927	15,733
Mathematical and computer science	21,717	24,501	26,493	29,499	26,978	25,597	23,273	23,886	23,031	23,516
Engineering	22,016	20,946	20,167	19,951	20,740	20,659	21,046	21,339	20,434	21,324

UCAS; 2008

For detail on subject groupings, see Appendix 6

Table 26 – Acceptances for First Degree Single-Subject Sciences and Related Subjects – 1998-2007

Subject	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	% 98-07
Biology	5,216	5,088	4,775	4,571	4,640	4,442	4,250	4,486	4,344	4,503	-13.7
Chemistry	-	3,720	3,312	2,984	2,892	2,798	2,797	3,191	3,597	3,907	5.0
Maths	4,138	4,152	4,066	3,698	3,379	3,700	4,091	4,533	5,412	5,915	42.9
Physics	2,997	2,810	4,049	2,433	2,726	2,642	2,435	2,654	2,934	3,228	7.7
Computer Science	12,639	14,628	2,620	20,547	15,281	13,751	11,732	11,356	11,787	11,682	-7.6
Engineering	20,064	19,995	20,149	16,896	16,840	16,098	15,505	15,532	20,986	21,914	9.2
Psychology	8,943	9,023	9,406	10,638	11,500	12,397	12,484	13,736	13,128	13,752	53.8

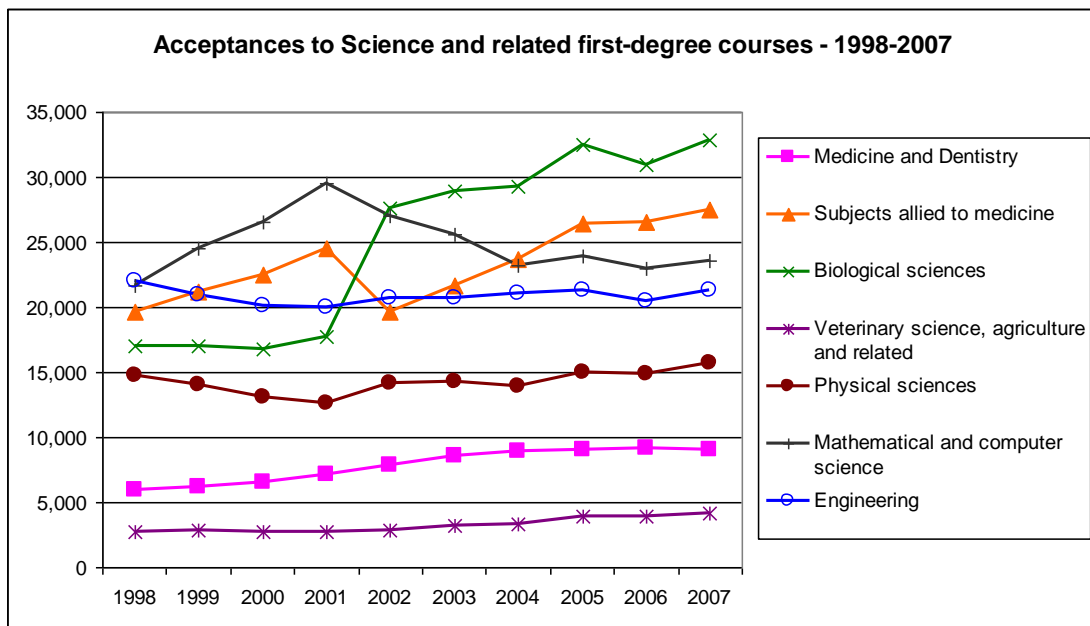
UCAS; 2008

³⁶ From 2002 onwards, 'Sports Science' has been included in the biological sciences grouping, and this accounts for the majority of the increase between 2001-2002. The actual increase is 9,886 acceptances, which when broken down includes 6,303 Sports Science acceptances and an increase of 3,231 Psychology acceptances on the 2001 figures. These 2 subjects make up 9,534 of the 9,886 increased acceptances on the previous year with 352 acceptances shared between the other subjects making up biological sciences.

As Figures 10 and 11 illustrate, the numbers of 18+ young people accepted onto science degrees has increased in most subject areas over the past decade. However, while the pattern for the physical sciences and for engineering has been flat (against the background of an expanded population and economy), those for the biological sciences, medicine and subjects allied to medicine have shown marked increases.

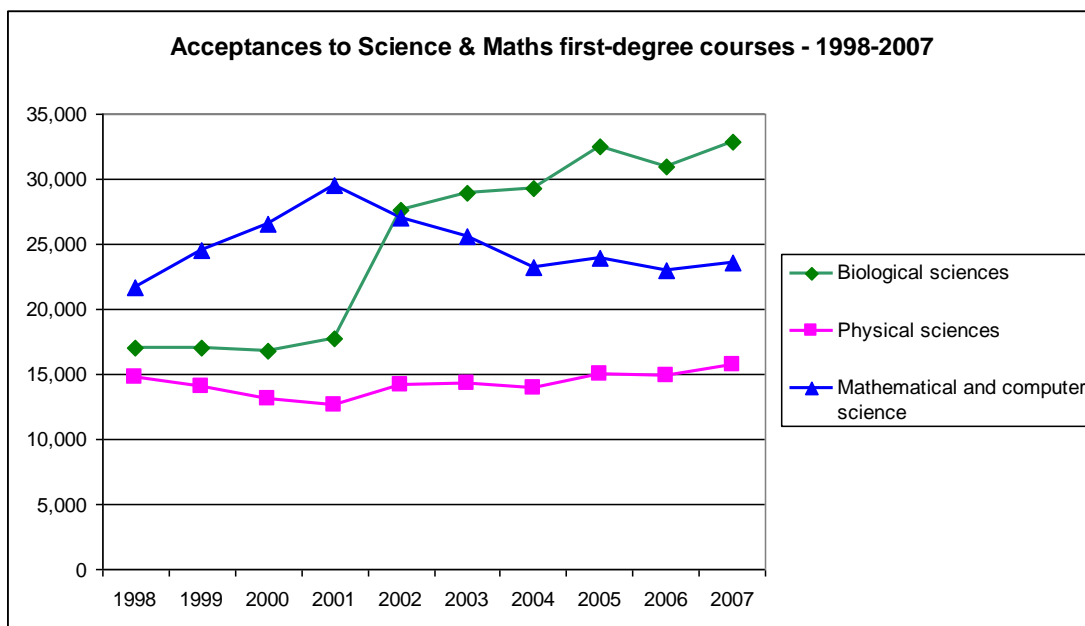
The relative growth patterns of the biological and physical sciences as compared with mathematics is shown overleaf in Figure 11.

Figure 10 - Undergraduate Entries to Selected Degree Courses - 1998-2007



Source: UCAS data, online statistical services; 2008

Figure 11 - Undergraduate Entries to Science & Maths Degree Courses - 1998-2007



Source: UCAS data, online statistical services.

3.3.6 Science in other Diplomas

The Diploma in Science is one of three in the final Phase of the Diploma development programme. They are scheduled to be introduced into the curriculum in 2011.

Teaching towards the first five sectorally-based Diplomas began in 2008 with a second set of five following in 2009; among these are a number that express specific requirements for scientific or mathematical knowledge and skills. Summaries of three different approaches to this inclusion (those underlined below) are provided in Appendix 5.

- Construction & the Built Environment
- Engineering
- Society, Health and Development
- Information Technology
- Manufacturing & Product Design (*)
- Environment & Land Based (*)

Each Diploma takes a slightly different approach to the need to include mathematics and scientific awareness, knowledge and skills with relation to their stated aims and objectives as subject areas.

In two cases (marked with an **asterisk** in the list), the Diploma specifications specifically mention the possible inclusion of science and maths A-Levels as part of the Additional (optional) components that a pupil may take.

Information Technology Diploma mentions the possibility of acquiring additional maths expertise as part of its Additional & Specialist Learning but does not specify any particular course at either GCSE or A-Level.

The Society, Health and Development Diploma takes the approach of building relatively limited amounts of maths and science teaching into the Principal Learning units. Units 5, 6 and 8 at Level 1, for example, and Unit 6 at Level 3 all contain some science and maths elements.

Construction builds maths and science, as related to Construction and the Built Environment (CBE), into the principal learning in a number of units at all levels.

Engineering takes the same approach as CBE, building science and maths requirements directly into the principal units. It does, however differ in more important respect in that the Engineering Diploma requires candidates to undertake a specific unit (Unit 8) called *Mathematical Techniques and Applications for Engineers* which includes the use and application of algebraic, trigonometric and statistical methods to solve engineering problems.

Summary of the approach for the other Diplomas

Existing Diplomas all tend to have a small amount of maths and science content but only the four listed below have any significant science and maths in their design. The first three in the list build the contextualised subject matter into their Principal Learning while the last two provide the specific suggestion that science and maths A-Levels

could form part of the pupil's Additional & Specialist Learning options.

- Construction & the Built Environment
- Engineering
- Sports and Active Leisure
- Manufacturing & Product Design
- Environment & Land Based

3.3.7 Perceptions of Current Provision

*'There is widespread recognition that current science qualifications at levels 1-3 do not fully meet the needs of the wider science community or the full cohort of young people. Many feel that recent developments in applied science qualifications are a step in the right direction, but that further work is needed to address the lack of practical science skills. These practical skills are not only required by science-based employers, but are also recognised as motivating to young people.'*³⁷

During its investigations into the need for a Diploma in Science, the Qualifications and Curriculum Authority (QCA) ran a workshop with young people to determine their views of school science provision.³⁸ The young people involved in this workshop represented a mixture of Key Stage 3 and 4 learners, post-16 students, undergraduates from science disciplines and those who had recently been recruited into a science-related industry. They were all aged between 14 and 23.

The discussions highlighted six key perceptions that young people hold about school science provision:

1. That school science did not focus on the application of knowledge or theory, and instead was concerned with achievement in tests and

³⁷ QCA (2006), Letter to ministers 08.12.06, 'Investigating the need for a specialised Diploma in applied science'

³⁸ QCA (2006), Investigating the need for a specialised Diploma in applied science: Report to the Department for Education and Skills

exams rather than *'creative exploration and learning'*

2. Further to this, that learners would appreciate school science involving a greater degree of practical learning and/or fieldwork
3. That science provision following GCSEs was perceived to be *'difficult, boring and pointless'* for learners other than those with aspirations of working within a science laboratory or as a doctor
4. That school science would be improved if teachers provided knowledge of how science is used in the wider world and industry
5. That more young people would be interested in studying science at a higher level if they were made aware of the career opportunities available to them
6. That, allied to this, young learners would like school science to have more links to industry, to help create synergy between the theoretical and practical sides of the subjects

Although they wished to see and learn more about the practical applications of science within school provision, young people attending the workshop were at the same time keen that this should not mean science subjects are *'diluted in the way that they perceive applied qualifications to be'*.

The suggestion from young people that school science does not focus adequately on the applied, practical nature of the subject was again noted in The Royal Society's most recent *State of the Nation* report – highlighting concerns from students *'about the very full and fact-laden nature of the science curriculum in England'*.³⁹ The report goes on to identify that although learners appreciate the importance of science as a curriculum subject, they often do not wish to engage with science at a higher level – suggesting that negative perceptions of science in the workplace still prevail, causing young people to lack any desire to pursue a science career.

When considering the knowledge and skills they wish learners to develop, employers highlight the importance not only of specific scientific knowledge and skills, but generic components as well – for example, critical thinking, analytical, and problem solving skills, with an awareness of how science works within the business environment. To help encourage this, employers are reported to support science learning that takes place in a work-related and applied context.⁴⁰

³⁹ The Royal Society (2008), *The State of the Nation report*

⁴⁰ New Engineering Foundation (2008), *The Application of Science - see pgs 16,23, 24.*

New research into existing qualifications

To build on this early research and to further investigate these views by discussing current provision, a series of 105 telephone interviews were conducted, by Pye Tait researchers with education and training providers (levels 1-3 and HE) and "science industries" employers.

Interviews were conducted with 75 employers and 30 providers, with questions suited to their respective background and interests. Employer questions focussed on the suitability of existing provision in terms of preparing young people for work, while the interviews with level 1-3 providers looked at young people's perceptions of science and how the subject is currently taught. With HE providers, we discussed the quality of level 3 provision in terms of learner progression onto HE science courses.

The feedback from these interviews highlighted key messages in relation to 4 main areas:

1. Perceptions of science
2. The curriculum in science and mathematics
3. Skills development
4. Work-related learning

Before looking at the results from the primary research, however, it is worthwhile reviewing the general perceptions and feedback from employers mapped to the eight Sector Skills Councils represented on the Science Diploma Development Partnership.

A summary of employer perceptions of provision (by SSC)

For further SSC-specific analysis, see *Secondary research to establish content for the Diploma in Science (section 3.2.2)*.⁴¹

	<u>Issues identified</u>
Cogent	<ul style="list-style-type: none"> • There are concerns about the lack of recruits entering the industry, with fewer people undertaking maths and science routes through higher education, or via relevant vocational programmes • Employers report a lack of business acumen and practical skills among recruits • It is thought that the career opportunities available across the Cogent footprint of careers are not currently appreciated by learners
ConstructionSkills	<ul style="list-style-type: none"> • Employers report deficiencies in technical and practical skills, as well as in generic skills such as ICT, client handling and general literacy and numeracy • Employers in the sector feel that school leavers have a poor standard of mathematics, English and science proficiency, and that secondary education needs to be increasingly practical and vocational in nature
EU Skills	<ul style="list-style-type: none"> • Employers report a need to further develop higher level provision in science, maths and technology subjects
Improve Ltd.	<ul style="list-style-type: none"> • Employers report a shortage of food scientists and technologists, with a decline in the quality of potential recruits to the industry • This decline in quality has been related the poor teaching of science-based subjects within the school curriculum • A lack of vocational and applied provision for food science
Proskills	<ul style="list-style-type: none"> • There is a need for both basic and advanced science skills within the Proskills footprint – with advanced level recruits being particularly difficult to find • Employers report graduates lacking basic scientific skills

⁴¹ (Sources: SDDP (2008), QD7 – *Secondary research report to establish content for the Diploma in Science*; Improve Ltd (2006), *Research to Investigate the UK Requirement for Food Scientists and Technologists*; SEMTA Bioscience SSA; Stage 3: Gap Analysis – UK; version 3 2007; SEMTA Bioscience SSA Stage 2: Assessment of Current Provision – July 08; EU Skills, Sector Skills Agreement: Stage 2 Report (2006); Skills for Justice: Justice Sector Qualifications Strategy 2008; SEMTA – Forensic Science: Implications for Higher Education 2004; Skills for Health 2006, 'The Case for Change: SSA Stage 3'; Assessing education and training provision for the health sector – Revised final report – 2005; Skills for Health, SQS; Proskills (2006) SSA Stage 2 Report, Assessment of Current Provision; Cogent: Assessment of Current Provision – Part 1; Cogent, Industry -specific Gap Analyses (all 2006); ConstructionSkills 2004 Market Assessment)

	<ul style="list-style-type: none"> • A need to develop a highly trained workforce in specific practical skills and techniques, particularly as technology advances
SEMTA	<ul style="list-style-type: none"> • Skills shortages in the biosciences are substantially higher than the UK average – suggesting that current provision is not developing an adequate number and quality of recruits into the sector • Vocational and work-based learning are currently thought to be under-utilised for biosciences • Crucially, employers in the bioscience and pharmaceutical industries are reporting among recruits poor subject knowledge, with a lack of understanding in basic principles and scientific method, coupled with a lack of analytical and statistical skills, practical skills and experience • Current provision is thought not to be producing: high quality scientific researchers, high quality practical scientists, highly skilled scientific technicians
Skills for Health	<ul style="list-style-type: none"> • Employers would like to see increased flexibility in the range and nature of the provision available below degree level - for example, vocational qualifications are likely to become more important to employers in the future • There is a need for specific skills in generic areas such as ICT, management and leadership – particularly for those at levels 2 and 3 (such as dental nurses and pharmaceutical dispensers, routine laboratory testers) • Skills needs are particularly marked among recruits entering the workforce with GCSEs or equivalent vocational qualifications (e.g. healthcare assistants) with five core skills required: customer handling, communication, team-working, problem solving, technical and practical and literacy skills
Skills for Justice	<ul style="list-style-type: none"> • Employers report specific gaps in scientific knowledge and technical skills – particularly biology, laboratory and crime scene investigation skills • Traditional recruits to crime scene investigation and fingerprint officer roles are below graduate level, with these entrants displaying a need for increased awareness of the workplace environment and improved communication skills • The majority of employers are looking for recruits with a solid science background, but at the same time are encountering a lack of work experience, IT and mathematics skills

Further detailed background work on scientific skills needs and perceptions of science provision has already been carried out as part of the development of the Diploma in Science through deliverable QD7 – *Secondary Research to establish content for the Diploma in Science*.

In summary, the main findings of that research were as follows:

Summary of employer needs (from the secondary research)

- A more engaging science curriculum to ensure the need for entrants into the science industry at all levels is met
- A stronger focus on core scientific theory and principles
- More content in the science curriculum on scientific method, protocols and investigation
- Increased links between the classroom and workplace to improve awareness of opportunities available in science
- Better development of practical skills
- A stronger foundation of mathematics and statistics within the science curriculum

Summary of secondary-level provider views (secondary research)

- Less prescription in content to improve understanding and allow flexibility in subject matter
- Practical work is made difficult by a lack of time, equipment and learner misbehaviour
- Enquiry-based methods of learning help to develop problem-solving skills
- A need for more flexible assessment, particularly in terms of practical work
- Some teachers call for more integration of mathematics into the science curriculum to enhance learners' understanding
- Concerns among teachers about teaching outside of their own subject specialism

Primary Research

This section discusses the key messages from the 105 telephone interviews. It has been sub-divided into three stakeholder groups:

- Providers of Level 1 -3 learning
- Providers of Level 4 (and above) learning
- Employers

And the perceptions of each group are explained under four topic areas:

- Perceptions of science
- The curriculum in science and mathematics
- Skills development
- Work-related learning

Level 1-3 Providers

Perceptions of science

The providers who took part in the interviews said that, on the whole, learners at Levels 1 and 2 tend to perceive science at FE and beyond as difficult and as such choose not to progress. Around half of the providers think that the requirement for mathematical knowledge causes learners to lose interest beyond level 2. Some providers suggest that science only attracts 'academically-minded' students rather than those who prefer a practical approach to learning and to their future careers.

The curriculum in science and mathematics

Most providers (13 of 15) agreed that existing science qualifications teach young people sufficient theory in science and maths, with three suggesting that learners are not equipped with sufficient theory in maths.

The majority (13 out of 15) stated that mathematics qualifications gained between 14 and 19 are very important to the science curriculum. Seven added that this is particularly the case where physics is studied.

Half of providers at this level agreed that maths should be taught at the same level as the science being studied, with a further quarter of those interviewed suggesting that it should be offered as an optional subject

The majority of level 1-3 providers are not in favour of GCSE, AS or A level science being taught in an interdisciplinary format.

Providers at this level agreed that maths is a necessary 'tool' for science learning and that it should be closely linked to the science in some form.

Of the curriculum areas that providers believe require enhancing, the following were the most commonly mentioned (in order of priority):

- physics,
- practical application of knowledge,
- mathematical ability
- literacy,
- thinking and problem solving skills, and
- environmental, moral and ethical issues of science (e.g. genetic engineering).

Skills development

Providers at Levels 1 to 3 are divided as to whether young people are currently leaving education with the skills required to meet employer needs (7 agree that they are, 6 do not believe so):

- Where they did agree, providers specified that this is particularly the case for learners undertaking vocational qualifications at 14-19
- Where they disagreed, 2 suggested this is because 14-19 qualifications are not sufficiently vocationally-related and three cited a lack of development of practical skills or ability for learners to apply theoretical knowledge

The majority of providers (13 of 15) feel that deficiencies in the current curriculum can be remedied by a new qualification such as the Diploma that places a premium on employment needs and practical, work-related experience. They suggest that such a qualification would help students apply the scientific theory they learn, and could potentially raise motivation and enthusiasm.

Work-related learning

Eleven of the fifteen level 1-3 providers say that science subjects should be made more relevant to industry at all levels between 14 and 19 (with four adding that this would help learners contextualise theory so that they can understand the relevance of what they are learning).

The majority (13 of 15) believe that, between 14 and 19, science subjects should be taught in an applied and work-related way.

Twelve providers support the contention that work placements are a valuable part of the science curriculum at 14-19. However, half of these respondents pointed out that work-placements are extremely difficult to arrange due to a lack of availability, regulations such as stringent Health and Safety requirements, and logistical difficulties. Even when arranged, several providers argued that the pupils rarely acquired experience and knowledge that substantively enhanced their science education.

Following on from this, the same majority of providers went on to argue that more needs to be done to build partnership working between their institution and employers. They suggest that:

- there needs to be a national strategy in place to help schools link with industry
- Health and Safety regulations are a major difficulty when arranging for young people to spend time in a science-based work environment
- employers must be able to see the benefits to them and are enthusiastic about being involved
- it would be helpful if local authorities were able to compile a database of

employers in the area willing to work with schools

Level 4 Providers

Perceptions of science

HE providers highlighted a range of strengths and weaknesses that they could identify with current science provision at levels 1-3. The most cited comment was that A level students progressing onto HE science courses show a weakness in competence in maths.

HE providers were critical of the mathematical ability of Level 2 school-leavers entering onto technical apprenticeships such as those in engineering, construction and building services. They argue – unanimously - that practical skills such as measuring and calculating (area/ volume, capacity, etc), understanding of the metric (and Imperial) systems, and intermediate mathematical operations are beyond many of the young people despite what appears in the syllabi for GCSE.

Some HE providers were extremely concerned with the inability of a high proportion of good GCSE entrants to understand the conceptual advantages of algebra and geometrical theorems to the occupations and sectors in which they were seeking to work.

HE providers were virtually unanimous in their dissatisfaction with their students' grasp and retention of basic scientific principles. Several mentioned that – again in spite of what was actually written in the various Level 1-3 syllabi – students were having to be given extensive remedial attention in basic principles/ fundamental maths, thereby reducing the amount of time that could be spent on the content of their own courses at Levels 3 and 4.

All of the providers, who were interviewed, agreed with the general principle that pupils should receive more practical and applied science experience between the ages of 14 and 19 but all also stressed that this must not be at the expense of fundamental principles and deeply embedded scientific and mathematical understanding and skills. A number of providers (7 of 15) specifically mentioned that they have seen a distinct deterioration in pupil ability over the past twenty or thirty years to the extent that modern cohorts require "spoon-feeding" and are

often unable to pursue genuine learning on their own.

This criticism also extended to the majority of those interviewed (12 of 15) mentioning the marked deterioration in the ability of modern cohorts to listen and to take useful notes.

Two thirds of the respondents (10 of 15) agree in principle with the idea of the Diploma in Science providing progression into work-related Level 3 and Level 4 learning. Four HE providers add that they would wish to see such a Diploma based not just on practical skills, but on the "genuine" acquisition of knowledge regarding scientific theory and principles⁴².

The HE providers were particularly insistent that mathematics should form a core of the Diploma requirements – particularly for progression onto physics, or physics-related, degree courses. Similarly, providers were equally anxious to see practically-oriented mathematical skills being instilled at Levels 1 and 2.

The curriculum in science and mathematics

Some 11 of the 15 providers who were interviewed regard the "modular" approach as not being useful and, in many cases, counter-productive. They stressed that it can lead to what many called a "learn and forget" culture, as pupils are assessed for material learned in one module and then set it aside (and forget it) as they move on to the next.

Several also mentioned the inappropriateness of the modular approach in preventing providers understanding clearly what their students have actually learned in their previous courses.

Nine of the 15 providers regard physics and chemistry qualifications as having been "dumbed-down". The HE providers regard independent learning and thinking skills as critical to the potential for Advanced Diploma learners successfully progressing onto science-based HE courses.

Providers were split on the issue as to whether maths should be embedded or treated as a separate subject in the Diploma. Eight providers think that maths should be embedded within the content of the Principal Learning; a further five

⁴² When questioned further on the precise meaning of the word "genuine", the HE providers defined it as meaning "knowledge retained and thoroughly understood" rather than merely covered in a project and subsequently forgotten.

believe that a new specialist unit should be developed for ASL that is stretching and more challenging than current A2 units.

Skills development

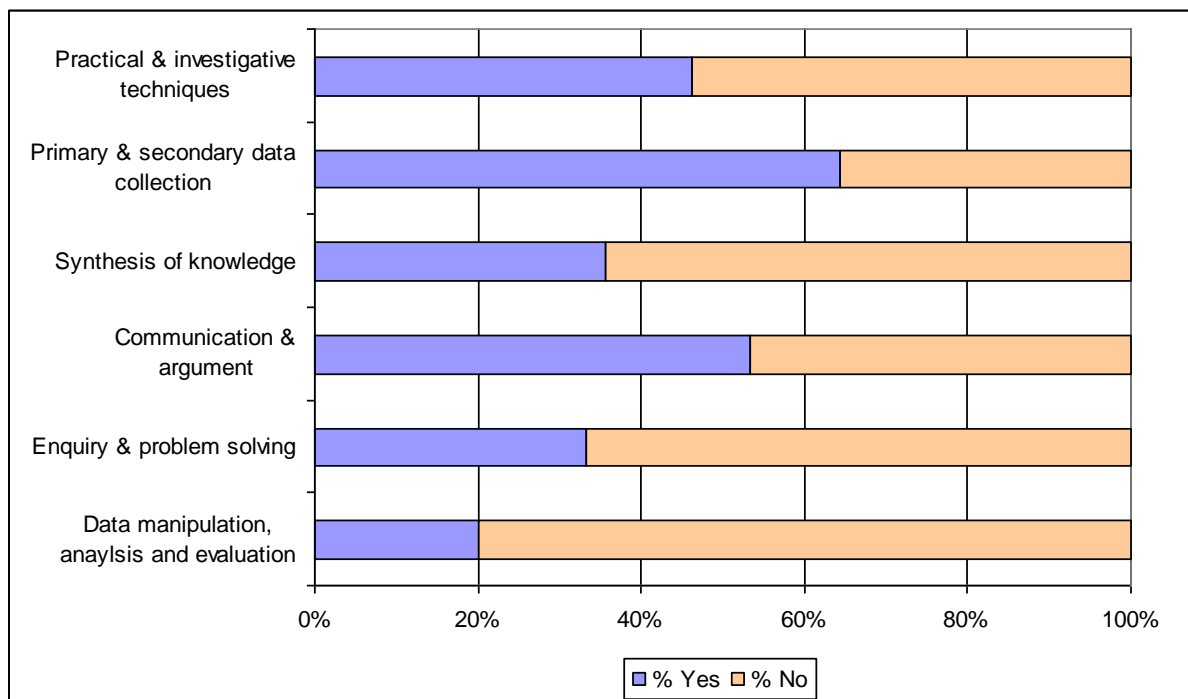
Figure 12, below, illustrates provider views on specific skill areas with respect to current qualifications. The respondents were asked whether they feel that these skills are being sufficiently well developed by existing qualifications.

Only in the case of two sets of skills - data collection, and communication and argument skills, were a majority of providers of the view that existing provision is developing these skills sufficiently well.

There are three skill areas, in particular, that providers believe are not being well developed:

- data manipulation, analysis and evaluation
- enquiry and problem solving skills, and
- the synthesis of knowledge

Figure 12: Provider perceptions of skill development in existing qualifications.



Source: Market View telephone interviews, October 2008

All providers agreed that functional skills in English, Mathematics and ICT will add value to the preparation of students for higher education.

When asked to what level they believed functional skills should be developed as part of the Advanced Diploma, providers were divided in terms of English and Maths (half saying they should be developed at Level 2 or Level 3 respectively), but were much more emphatic that ICT skills needed to be developed to Level 2 only for the Advanced Diploma (8 providers, versus only 2 suggesting Level 3 ICT).

All providers responding to the question were in agreement that the potential of the extended project to encourage critical, reflective and independent learning will add value to a learner's preparation for further study. Sector and subject relevance was also a key feature for providers.

In terms of Additional and Specialist Learning, providers at this level are divided as to whether learners should specialise in depth within one subject, a range of subjects, or have the option of both of these (4 providers opted for each of these possibilities).

Work-related learning

All of the providers responding to a question on work-related learning agree that inter-active learning such as e-learning and distance learning should be included within the Diploma. Their views were largely that such approaches will enable the pupil to acquire a broader and deeper understanding than may be possible from a single teacher or lecturer.

Half of the providers argue that visits to, and learning in, the workplace help learners to see exactly how the science they learn is applied within industry, thereby underpinning their knowledge and deepening their understanding of practical work such as laboratory skills. However, the providers were unanimous in doubting the ability of any system to acquire sufficient genuinely useful work-centred visits.

In terms of actual work experience, six providers agree that ten days is a 'reasonable' or 'realistic' length of time for a work experience placement as part of the Advanced Diploma. Three others stress that the placement should be no

less than of ten working days duration. Two providers suggested twenty days but not necessarily in a single block placement.

All expressed concerns about the provision of a sufficient number of such placements being found for every young person undertaking even the Advanced Diploma, or that employers would be able to provide more than merely a work-culture induction and a view of the conditions within a science-based company or organisation.

Employers

The curriculum in science and mathematics

Some 75 employers were interviewed for this research (the detail of their characteristics is provided in the Introduction to this report).

The majority of employers agree that 14-19 science and mathematics qualifications are very important to the skills and knowledge that their company needs.

Eight per cent stated that science qualifications at 14-19 are not that important to their company's needs (for example where they mainly recruit graduates), but that they regard them as important in terms of providing a good basis for progression onto higher levels of study and training.

For around two-thirds (64%) of employers, mathematics is seen as fundamental. These respondents stressed that the subject should be studied at the same level as science at all stages.

Just over four in ten employers believe that existing 14-19 qualifications do not teach young people sufficient theory in science and maths. They perceive the qualifications as being too broad and not offering a deep enough understanding of scientific and mathematical principles.

While half of the employer respondents (49%) believe there is scope for an interdisciplinary approach to be taken at GCSE level, over 80% of the respondents were against such an approach being taken at AS or A2 level.

Skills development

Two thirds of the employers (67%) state that their staff have knowledge and skills gaps as a result of deficiencies in the 14-19 curriculum. These are made up of practical and generic skills and include the need for learners to develop an awareness of how science is applied within industry. Specific areas that were cited include:

- Literacy (11 employers)
- Practical skills (11 employers)
- Communication (10 employers)
- Maths (6 employers)
- Awareness of the relevance of science to industry/business (6 employers)
- Theoretical knowledge (4 employers)

More than three-quarters of employers identifying these skills gaps (80%) agreed that such deficiencies can be addressed through a new qualification such as the Diploma that emphasises practical and work-related experience.

Indeed, employers were the most vocal interview participants in their overall support for the Diploma in Science, with 9 making specific comments to say that the qualification was a very positive development – in particular, two said that the Diploma was just ‘what is needed’ and two others commented that they thought the Diploma is an excellent ‘way forward’.

Work-related learning

Employers are strongly in favour (73%) of science subjects being made more relevant to industry at all levels between 14 and 19.

Fourteen emphasise that this would ensure that science becomes meaningful for learners at this age, remove any misperceptions they may have about how science is used within industry and, ‘get them inspired’ by the opportunities available to them and ‘see the connection for jobs in the future’:

A significant majority of employers (86%) agree that science should be taught in an applied and work-related way and the same proportion were keen to see learners develop an increased commercial and business awareness (e.g. understanding ISO procedures, considering the financial cost of the work they carry out, etc.)

The employers were less certain of the benefits of a work-related approach than either group of providers.

While two thirds (68%) believe that existing 14-19 qualifications do not offer sufficient practical and work-related experience in science and maths, 30% caveated this by stating they would not want to see an applied and work-related approach to science subjects detract from the theoretical knowledge that young people need to learn, for example if they are planning to progress onto a science-based higher education course.

Just under 15% of the employers are concerned that an applied and work-related approach to 14-19 science might have the potential to put the youngest learners off science by making them have to think about the world of work too early.

Nine out of ten of those interviewed agreed that work experience placements for 14-19 year olds are a valuable part of their science education.

However, although they are regarded by employers as allowing learners to develop an understanding of how scientific theories are applied in the workplace, around a third of respondents raised concerns relating to the practicalities of arranging and providing meaningful work placements to science students. Specific issues mentioned were:

- Having to work within the constraints of Health and Safety regulations
- The danger of work placements de-motivating learners away from science if they are only given basic, unchallenging tasks to perform
- The need to ensure that work placements are well structured and managed to ensure, for example, that learners have a specific "science-centred" objective to achieve as a result of the experience.

Section 4 - Summary of Issues

4.1 Issues with Existing Qualifications

The GTCE welcomes the introduction of new diploma lines in Humanities, Science and Languages. The Council believes that creating diplomas across all subjects, encompassing those subjects currently delivered through A-levels, would be the next natural development following the addition of these three new diplomas.

General Teaching Council for England (GTCE) Response to DCSF: Promoting achievement, valuing success: A strategy for 14-19 qualifications; June 2008; para 5

The secondary and market view research reports, for the development of the Diploma in Science, have examined a huge range of existing and ongoing research on the subject of science education. Many - but by no means all - of these reports have been discussed and referenced in the two reports.

That the issue of science education is extremely important to the future of the UK is evidenced by the number, range and eminence of the bodies concerned, and by the fact that it is being researched and evaluated in a similar fashion across the developed world.

There is considerable support for existing science qualifications, and no-one questions their inherent quality in terms of syllabi, but the research has also shown that there are serious - and arguably growing - concerns with them. At Levels 1 and 2 the revised GCSEs offer a slightly different approach to science between the ages of 14 and 16 but they are recently introduced and therefore unproven. There is also concern that their introduction fails to address the questions of the integration of, and progression between, science qualifications at each of the levels from 1 to 3.

Four fundamental issues with the existing qualifications could be

summed up as follows:

- The fact that industry is crying out for far more technologists and scientists than they can currently employ⁴³.
- The fact that employers across the whole science and technology spectrum are dissatisfied with the knowledge and technical skills of their recruits at both technician and post-graduate level.
- The fact that the proportion of young people taking A Level sciences is declining year by year.
- The fact that Universities are dissatisfied with the quality of their new under-graduates in terms of their mathematical ability, their practical skills, and their fundamental scientific understanding and knowledge.

To expand a little ... these issues are not solely those of the 18 and 19 year old school leavers with A Levels (serious as these are); they are crucially important to the UK at intermediate, or what can be given the shorthand title of "technician" level.

Employers are on record across many sectors as being dissatisfied with the mathematical and scientific knowledge and skills of young people leaving school at 16 to enter the world of work and follow vocational routes including Apprenticeship, college-based vocational qualifications and NVQs. The fundamental lack of "applied" scientific understanding was clearly stated in the recent report by the New Engineering Foundation:

⁴³ For another view of this see the NEF's *Appliance of Science* 2008 report and its sections on the scale of skills shortages and gaps.

"There is a clear disconnect [sic] between the way in which the fast moving scientific arena is evolving and transforming itself, and the way in which educationalists and policy makers are addressing the education and training provision, particularly at level 3.

One of the indicators that can demonstrate this misalignment is the small number of learners undertaking A-level Applied Science in any one year which, according to the DCSF's National Statistics website, was only 801 in 2007..."⁴⁴

But the subtext to this concern with the lack of applied and practical skills is the equal concern of employers and HE with the lack of mathematical ability - and the corresponding disengagement of young people with maths as a subject.

The ABPI report (2007) reports the sector's concern that too few students continue to study maths beyond school level, or even post-16. This, the report argues, leads to UK graduates lacking the quantitative skills necessary to analyse and interpret data and to have confidence in their analysis. The survey found that employers have deep concerns about the mathematical ability not-only of new graduates but of post-graduates, too⁴⁵.

Similarly both employers and higher education institutions have expressed concern at the relative lack of knowledge and skills in those going on to higher education in science-related subjects and from thence into work.

Around 900,000 young people take GCSE science subject exams each year and a further 120,000 sit for A-Levels in science subjects.

Every year, Universities accept around 90,000 of these young people into the main first-degree science groups. Among them are around 11,500 young people who begin degree courses in the three main single

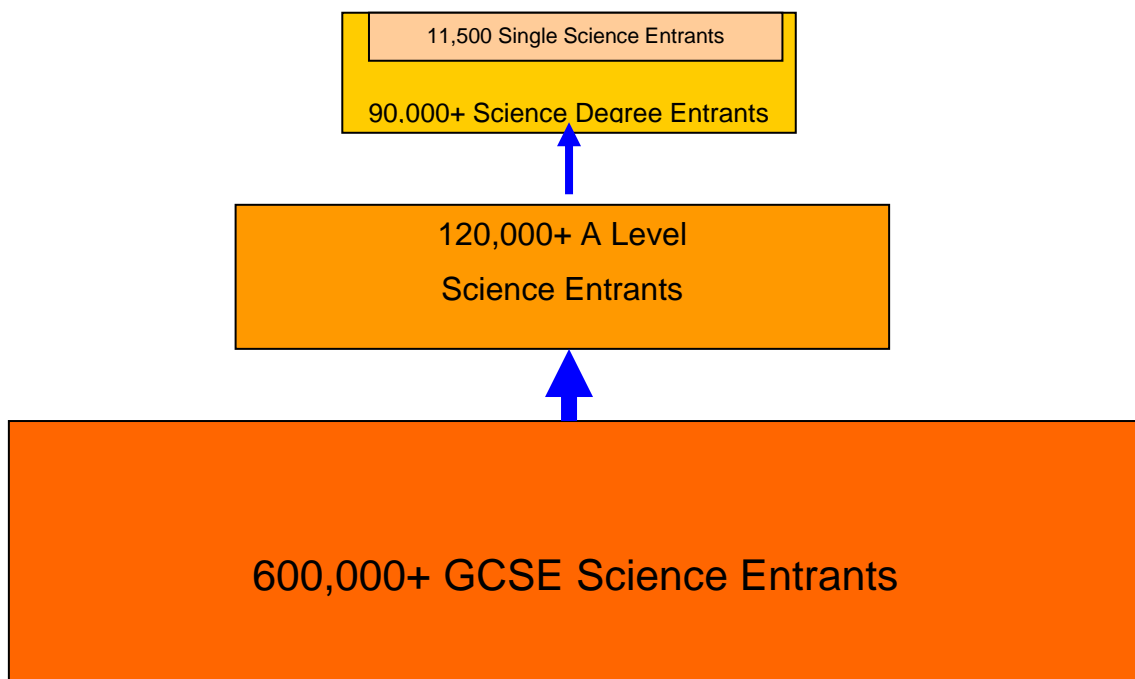
⁴⁴ NEF; *The Appliance of Science*; New Engineering Foundation Report; 2008

⁴⁵ Secondary Research Report, DDP Science; op cit (page 51)

sciences⁴⁶.

In theory, therefore, England produces around 450,000 16 year olds who have taken GCSE science but who have not gone onto A level, of whom some 90% pass and a good proportion of whom will have taken combined sciences to the highest grades (A*-C). Vacancies in "Associate Professional" and "Skilled Trades" roles alone are said by NESS 2007 to exceed 170,000 but, for some reason, the production of Level 2 GCSE science pupils are not filling that gap.

Figure 13 - The Science Qualifications Supply Line



NOTE: The total has been calculated according to the following approach to Table 19.

- ❖ Averaging the numbers across the years shown taking the three separate sciences, as these will each generally be taken by the same learners (Physics, Biology, Chemistry)
- ❖ Adding the totals for all other routes available in the different years, minus the Additional subjects (which will be the same learners as those counted elsewhere)
- ❖ *Except* Double Awards, the total figures have been halved before using them - to get the number of individual learners on these courses.

On paper the supply line seems robust but, as the secondary research for this Diploma revealed, there are serious issues with the component

⁴⁶ Some 78,000 people graduated in 2007 from the physical and biological sciences plus medicine from British Universities. In addition a further 80,000 graduated in subjects allied to medicine.

qualifications (GCSEs and A levels) of the supply chain.

- Both FE and HE findings reveal that they are dissatisfied with the maths ability of new science undergraduates and those entering FE on science-related courses
- Employers and FE institutions are concerned with the lack of practical science skills and the basic scientific ability of new apprentices and other recruits
- A wide range of employers and organisations have expressed serious concern with the lack of knowledge and skill of school-leavers who enter work in technician roles with a view to training for associate professional roles
- The Secondary Research revealed significant concerns with the effects of "modularisation" in syllabi at all levels. The view was that this creates a "learn and forget" culture in pupils whereby they study hard for a specific module or project, achieve a grade, and then forget the material and move on to the next topic area
- Higher education is also concerned with the lack of practical skills of new undergraduates (the precise nature of these practical skills is discussed in a number of sources including Appendix IV of the ABPI Report *Sustaining the Skills Pipeline* (2005) and the Institute of Physics' *Schools and Colleges* service (also see Secondary Research Report, Science DDP; 2008).
- Higher education is dissatisfied with the quality of the fundamental scientific knowledge of under-graduates (see Tables 28 and 29 below).
- HE and the bio-pharmaceutical sector are concerned with the relative over-emphasis on human biology from 16-18 and the relative lack of in-vivo experience and ability in new under-

graduates

- There is concern at the "drop-out" rate from University science (ie those who do not go on to study or practice in scientific fields after graduating)
- There is widespread concern with the lack of young people studying physics from 16-19 and the declining numbers of young people going on to study the subject (and related subjects) at University.
- In addition to the issues raised by employers and FE/HE providers it is also appropriate to point to the apparently declining interest in the existing science A-Levels at a time when the UK economy is attempting to underpin and, if possible, reinvigorate its knowledge and science base.

Table 27 - Percentage of University courses on which students have the stated skills and knowledge

How many students have the necessary:	Mathematical skills	Practical skills	Elementary knowledge
Half or more of the students	42%	53%	66%
Fewer than half of the students	58%	47%	34%

Source: <http://www.savebritishscience.org.uk/documents/2003/SBS0313.htm>

Table 28 - Percentage of respondents reporting student standing in key skills and knowledge

How do students stand with respect to:	Mathematical skills	Practical skills	Elementary knowledge
Students are better now	7%	21%	20%
Students were better ten years ago	93%	71%	80%
There has been no change	0%	7%	0%

Source: <http://www.savebritishscience.org.uk/documents/2003/SBS0313.htm>

4.2 The Diploma Difference

There are a number of ways, therefore, in which the three levels of the Diploma in Science could address the stated concerns about existing qualifications not so much as qualifications, per se, but as "routes" to employment and higher education.

Before summing up the important opportunities represented by the new Diploma, however, it is important to bear a number of considerations in mind.

Important Considerations

Teaching resources

The dynamism and novel approaches inherent in the new Diploma in Science will place significant demands on teachers and lecturers. The specialisms of teachers may make teaching "topic" and enquiry-led issues more problematic but this could be solved by the development of perhaps a single route to all teaching resources for science and technology as opposed to the myriad websites and forms of support currently available.

The sheer number of organisations now seeking to support science education may actually be an issue for the Diploma. These organisations provide an excellent resource but it is often duplicated and may not be known-of by some individual teachers and pupils.

The very nature of science will make genuine work-experience difficult for many pupils to obtain but this could be resolved through imaginative on-line links to up-to-date work-related resources.

Mathematics

The research has underlined - in emphatic terms - the crucial importance of higher levels of mathematical ability at all levels of the Diploma.

There is a clear element of fear of maths among English school-children, and therefore the way in which maths is presented and integrated with the Diploma in Science syllabus will be crucial to the quality of the emerging young people.

Separate Sciences

Employers and higher education have expressed the wish for the scientific disciplines to be maintained as separate entities in order to preserve the depth and rigour of knowledge and understanding. This may present problems for the designers in terms not only of meeting the need for strong practical skills but of the balance between the three main disciplines.

Physical Resources

The new Diploma - with its emphasis on work-related, practical skills and enhanced abilities (eg in-vivo experience) - may place additional pressure on the available physical resources.

The opportunities can be summed up as:

Integration and progression

Through iterative learning, lack of duplication but reinforcement of material and constant reference to fundamental knowledge rather than modularisation the Diploma in Science offers an opportunity to achieve a better integration of science with the real world and employment opportunities. It will also permit smoother and more effective progression between qualification levels from 1 to 4.

Links to the Real World of Science

Unlike existing qualifications, the Diploma has the opportunity to create strong links to "real world" applications of science and to industry through the imaginative use of on-line resources and even simulations (for instance, a computer simulation biogenetics facility).

Practical Skills and Applied Science

The Diploma presents the opportunity for a truly effective focus on practical skills and applied science - perhaps through the topics and the way in which the courses are linked to the world of work not just through visits and placements but through comprehensive on-line support, simulations and case studies.

There is also the opportunity to address "applied science" issues through the Level 1 and 2 courses, in particular, and to engage young people in such subject matter to provide a firmer foundation for them to enter technically-related work.

Critical Thinking

Critical thinking and communicating are both highly regarded by higher education and employers. The research has shown that both groups want them to be taught in a more effective way than the existing GCSEs and A Levels.

The Apprenticeship Priority

The Government is determined to make the Apprenticeship an equally desirable route into employment alongside the traditional academic routes. The launch of the NAS in 2009 will begin the process of driving up demand for this route.

The Diploma in Science at Levels 1 and 2, because of its work-focus and practical slant, will provide an excellent grounding for apprenticeships in the health sector or in manufacturing or engineering environments such as

- The health sector
- The aviation sector (airframe, engines, avionics)
- Building Services Engineering (electrical, heating & ventilation, plumbing, etc)
- Construction
- Engineering of all types
- Computing

Theory and Practice at Advanced Level

At the Advanced level the Diploma in Science will have the potentially powerful ability to offer candidates strong practical skills as well as a solid foundation in maths and the separate sciences especially together with a specially designed "Maths for Science" course modelled on the similar component of the Engineering Diploma.

Bridging the Gap

The Diploma in Science offers a unique opportunity to attempt to bridge the gender gap where science is concerned.

For example, the Institute of Physics has published its serious concern with the low numbers of girls taking up the subject, and the relative aversion of females to physics as opposed to biology or chemistry has been well documented. Similarly, the ABPI has stressed that the tendency for girls to prefer topics in human rather than animal and plant biology is a genuine issue for the future.

The Secondary Research for the Science DDP reported the main topics of interest to boys and girls (see Appendix 7) and it is to be hoped that the design of the various stages of the new Diploma can be so structured as to attract considerably more girls to the physical sciences and to involve girls more in botany and environmental sciences as opposed to human biology.

The key to a successful Diploma in Science will be the degree to which its design, at the three levels, permits the learner to achieve the depth

of scientific practical skills and the theoretical knowledge to meet progression and Higher Education needs, while at the same time offering young people a more work-related set of skills that they can take into apprenticeships or directly into the work-place across a wide range of sectors.

Appendices

Appendix 1 - List of science-related occupations (broad definition)

Primary "Science" Occupations

MAJOR GROUP 1: MANAGERS AND SENIOR OFFICIALS

112 Production Managers

1121 Production works and maintenance managers

1122 Managers in construction

1123 Managers in mining and energy

113 Functional Managers

1136 Information and communication technology managers

1137 Research and development managers

117 Protective Service Officers

1173 Senior officers in fire, ambulance, prison and related services

118 Health And Social Services Managers

1181 Hospital and health service managers

1182 Pharmacy managers

121 Managers In Farming, Horticulture, Forestry And Fishing

1211 Farm managers

1212 Natural environment and conservation managers

1219 Managers in animal husbandry, forestry and fishing n.e.c

123 Managers And Proprietors In Other Service Industries

1235 Recycling and refuse disposal managers

MAJOR GROUP 2: PROFESSIONALS

211 Science Professionals

2111 Chemists

2112 Biological scientists and biochemists

2113 Physicists, geologists and meteorologists

212 Engineering Professionals

2121 Civil engineers

2122 Mechanical engineers
2123 Electrical engineers
2124 Electronics engineers
2125 Chemical engineers
2126 Design and development engineers
2127 Production and process engineers
2128 Planning and quality control engineers
2129 Engineering professionals n.e.c

213 Information And Communication Technology Professionals

2131 IT strategy and planning professionals
2132 Software professionals

221 Health Professionals

2211 Medical practitioners
2212 Psychologists
2213 Pharmacists/pharmacologists
2214 Ophthalmic opticians
2215 Dental practitioners
2216 Veterinarians

231 Teaching Professionals

2311 Higher education teaching professionals
2312 Further education teaching professionals
2314 Secondary education teaching professionals
2315 Primary and nursery education teaching professionals
2316 Special needs education teaching professionals

232 Research Professionals

2321 Scientific researchers
2322 Social science researchers
2329 Researchers n.e.c.

243 Architects, Town Planners, Surveyors

2431 Architects
2433 Quantity surveyors
2434 Chartered surveyors

MAJOR GROUP 3: ASSOCIATE PROFESSIONAL AND TECHNICAL OCCUPATIONS
--

311 Science and Engineering Technicians

3111 Laboratory technicians
3112 Electrical/electronics technicians
3113 Engineering technicians
3114 Building and civil engineering technicians
3115 Quality assurance technicians
3119 Science and engineering technicians n.e.c

312 Draughtspersons And Building Inspectors

3121 Architectural technologists and town planning technicians

3122 Draughtspersons
3123 Building inspectors

313 IT Service Delivery Occupations

3131 IT operations technicians
3132 IT user support technicians

321 Health Associate Professionals

3211 Nurses
3212 Midwives
3213 Paramedics
3214 Medical radiographers
3215 Chiropodists
3216 Dispensing opticians
3217 Pharmaceutical dispensers
3218 Medical and dental technicians

322 Therapists

3221 Physiotherapists
3222 Occupational therapists
3223 Speech and language therapists
3229 Therapists n.e.c.

331 Protective Service Occupations

3313 Fire service officers (leading fire officer and below)

343 Media Associate Professionals

3434 Photographers and audio-visual equipment operators

344 Sports And Fitness Occupations

3441 Sports players
3442 Sports coaches, instructors and officials
3443 Fitness instructors
3449 Sports and fitness occupations n.e.c

351 Transport Associate Professionals

3511 Air traffic controllers
3512 Aircraft pilots and flight engineers
3513 Ship and hovercraft officers
3514 Train drivers

355 Conservation Associate Professionals

3551 Conservation and environmental protection officers
3552 Countryside and park rangers

356 Public Service And Other Associate Professionals

3565 Inspectors of Factories, Utilities, Trading Standards
3567 Occupational hygienists and safety officers (health and safety)
3568 Environmental health officers

Secondary "Science" Occupations

122 Managers And Proprietors In Hospitality And Leisure Services

1223 Restaurant and catering managers

1225 Leisure and sports managers

342 Design Associate Professionals

3421 Graphic designers

3422 Product, clothing and related designers

354 Sales And Related Associate Professionals

3542 Sales Representatives

MAJOR GROUP 4: ADMINISTRATIVE AND SECRETARIAL OCCUPATIONS

421 Secretarial And Related Occupations

4211 Medical secretaries

MAJOR GROUP 5: SKILLED TRADES OCCUPATIONS

511 Agricultural Trades

5111 Farmers

5112 Horticultural trades

5113 Gardeners and groundsmen / groundswomen

5119 Agricultural and fishing trades n.e.c

521 Metal Forming, Welding And Related Trades

5211 Smiths and forge workers

5212 Moulders, core makers, die casters

5213 Sheet metal workers

5214 Metal plate workers, shipwrights, riveters

5215 Welding trades

5216 Pipe fitters

522 Metal Machining, Fitting And Instrument Making Trades

5221 Metal machining setters and setter-operators

5222 Tool makers, tool fitters and markers-out

5223 Metal working production and maintenance fitters

5224 Precision instrument makers and repairers

523 Vehicle Trades

5231 Motor mechanics, auto engineers

5232 Vehicle body builders and repairers

5233 Auto electricians

5234 Vehicle spray painters

524 Electrical Trades

5241 Electricians, electrical fitters
5242 Telecommunications engineers
5243 Lines repairers and cable jointers
5244 TV, video and audio engineers
5245 Computer engineers, installation and maintenance
5249 Electrical/electronics engineers n.e.c

531 Construction Trades

5311 Steel Erectors
5314 Plumbers, heating and ventilating engineers
5316 Glaziers, window fabricators and fitters
5319 Construction trades n.e.c

542 Printing Trades

5421 Originators, compositors and print preparers
5422 Printers
5424 Screen printers

543 Food Preparation Trades

5431 Butchers, meat cutters
5432 Bakers, flour confectioners
5433 Fishmongers, poultry dressers
5434 Chefs, cooks

549 Skilled Trades NEC

5495 Goldsmiths, silversmith, precious stone workers

MAJOR GROUP 6: PERSONAL SERVICE OCCUPATIONS

611 Healthcare And Related Personal Services

6111 Nursing auxiliaries and assistants
6112 Ambulance staff (excluding paramedics)
6113 Dental nurses
6115 Care assistants and home carers

613 Animal Care Services

6131 Veterinary nurses and assistants
6139 Animal care occupations n.e.c.

629 Personal Services Occupations n.e.c.

6292 Pest control officers

MAJOR GROUP 7: SALES AND CUSTOMER SERVICE OCCUPATIONS

711 Sales Assistants and Retail Cashiers

7111 Sales and Retail Assistants

722 Customer Service Occupations

7212 Customer Care Occupations

MAJOR GROUP 8: PROCESS, PLANT AND MACHINE OPERATIVES

811 Process Operatives

- 8111 Food, drink and tobacco process operatives
- 8112 Glass and ceramics process operatives
- 8113 Textile process operatives
- 8114 Chemical and related process operatives
- 8115 Rubber process operatives
- 8116 Plastics process operatives
- 8117 Metal making and treating process operatives
- 8118 Electroplaters
- 8119 Process operatives n.e.c

812 Plant And Machine Operatives

- 8121 Paper and wood machine operatives
- 8122 Coal mine operatives
- 8123 Quarry workers and related operatives
- 8124 Energy plant operatives
- 8125 Metal working machine operatives
- 8126 Water and sewerage plant operatives
- 8129 Plant and machine operatives n.e.c

813 Assemblers And Routine Operatives

- 8131 Assemblers (electrical products)
- 8132 Assemblers (vehicles and metal)
- 8133 Routine inspectors and testers
- 8135 Tyre, exhaust and windscreen fitters
- 8138 Routine laboratory testers
- 8139 Assemblers and routine operatives

814 Construction Operatives

- 8141 Scaffolders, staggers, riggers
- 8142 Road construction operatives
- 8143 Rail construction and maintenance operatives
- 8149 Construction operatives

821 Transport Drivers and Operatives

- 8216 Rail Transport Operatives
- 8217 Seafarers (Merchant Navy); Barge; Lighter and Boat Operatives

MAJOR GROUP 9: ELEMENTARY OCCUPATIONS

911 Elementary Agricultural Occupations

- 9111 Farm workers
- 9112 Forestry workers
- 9119 Fishing and agriculture related occupations n.e.c

Source: SOC 2000

Appendix 2 - Occupational Demand by SSC Sector and Major SOC Grouping

Note: ED = Expansion Demand; RD = Replacement Demand; TR = Total (%) Requirement

SSC: Cogent

SOC2000 Major groups	Employment (000s)			
	2004 levels	changes 2004-2014		
		ED	RD	TR
1. Managers & Senior Officials	73	2	25	26
2. Professional Occupations	42	0	13	13
3. Associate Professional & Tech.	60	-1	19	18
4. Administrative, Clerical and Sec.	47	-5	19	14
5. Skilled Trades Occupations	69	-9	23	14
6. Personal Service Occupations	12	2	5	6
7. Sales & Customer Service Occs.	33	5	11	15
8. Machine & Transport Operatives	119	-18	42	24
9. Elementary Occupations	63	-21	21	0
Total employment	517	-46	176	130

SSC: Proskills UK

SOC2000 Major groups	Employment (000s)			
	2004 levels	changes 2004-2014		
		ED	RD	TR
1. Managers & Senior Officials	68	3	23	26
2. Professional Occupations	21	1	7	7
3. Associate Professional & Tech.	67	4	21	25
4. Administrative, Clerical and Sec.	42	-14	16	2
5. Skilled Trades Occupations	80	-13	26	13
6. Personal Service Occupations	9	-1	4	2
7. Sales & Customer Service Occs.	13	-2	4	2
8. Machine & Transport Operatives	92	-12	31	19
9. Elementary Occupations	51	-20	16	-4
Total employment	445	-55	149	94

SSC: Improve Ltd

SOC2000 Major groups	<i>Employment (000s)</i>			
	2004 levels	changes 2004-2014		
		ED	RD	TR
1. Managers & Senior Officials	62	9	22	30
2. Professional Occupations	18	2	6	8
3. Associate Professional & Tech.	40	0	13	13
4. Administrative, Clerical and Sec.	40	-11	16	4
5. Skilled Trades Occupations	70	-7	23	16
6. Personal Service Occupations	4	0	2	1
7. Sales & Customer Service Occs.	40	-7	12	5
8. Machine & Transport Operatives	122	-6	44	38
9. Elementary Occupations	74	-24	26	2
Total employment	471	-45	163	118

SSC: SEMTA

SOC2000 Major groups	<i>Employment (000s)</i>			
	2004 levels	changes 2004-2014		
		ED	RD	TR
1. Managers & Senior Officials	194	2	65	66
2. Professional Occupations	127	0	39	39
3. Associate Professional & Tech.	152	-1	45	44
4. Administrative, Clerical and Sec.	113	0	44	45
5. Skilled Trades Occupations	376	-69	119	50
6. Personal Service Occupations	18	2	7	9
7. Sales & Customer Service Occs.	28	9	9	18
8. Machine & Transport Operatives	289	-39	101	62
9. Elementary Occupations	145	-54	46	-9
Total employment	1,443	-150	474	324

SSC: Energy & Utility Skills

SOC2000 Major groups	<i>Employment (000s)</i>			
	2004 levels	changes 2004-2014		
		ED	RD	TR
1. Managers & Senior Officials	46	3	16	19
2. Professional Occupations	28	-1	9	8
3. Associate Professional & Tech.	51	-5	14	10
4. Administrative, Clerical and Sec.	36	-8	13	5
5. Skilled Trades Occupations	50	1	16	17
6. Personal Service Occupations	10	0	4	4
7. Sales & Customer Service Occs.	29	5	9	14
8. Machine & Transport Operatives	30	2	10	13
9. Elementary Occupations	41	-7	13	6
Total employment	322	-9	105	96

SSC: ConstructionSkills

SOC2000 Major groups	<i>Employment (000s)</i>			
	2004 levels	changes 2004-2014		
		ED	RD	TR
1. Managers & Senior Officials	296	31	100	130
2. Professional Occupations	161	22	50	72
3. Associate Professional & Tech.	182	20	56	75
4. Administrative, Clerical and Sec.	186	-22	74	52
5. Skilled Trades Occupations	813	-14	254	240
6. Personal Service Occupations	19	3	7	10
7. Sales & Customer Service Occs.	37	9	12	20
8. Machine & Transport Operatives	204	-15	67	52
9. Elementary Occupations	176	-50	54	4
Total employment	2,074	-17	673	656

SSC: Skills for Justice

SOC2000 Major groups	<i>Employment (000s)</i>			
	2004 levels	changes 2004-2014		
		ED	RD	TR
1. Managers & Senior Officials	53	8	19	27
2. Professional Occupations	43	3	15	18
3. Associate Professional & Tech.	88	-3	25	22
4. Administrative, Clerical and Sec.	83	-17	32	15
5. Skilled Trades Occupations	15	-1	5	4
6. Personal Service Occupations	15	3	6	9
7. Sales & Customer Service Occs.	7	0	2	3
8. Machine & Transport Operatives	15	-1	5	4
9. Elementary Occupations	50	-8	16	9
Total employment	369	-16	125	109

SSC: Skills for Health

SOC2000 Major groups	<i>Employment (000s)</i>			
	2004 levels	changes 2004-2014		
		ED	RD	TR
1. Managers & Senior Officials	241	63	95	158
2. Professional Occupations	272	68	101	170
3. Associate Professional & Tech.	587	39	227	266
4. Administrative, Clerical and Sec.	173	-31	73	42
5. Skilled Trades Occupations	39	4	14	18
6. Personal Service Occupations	557	102	224	326
7. Sales & Customer Service Occs.	32	3	12	15
8. Machine & Transport Operatives	35	-1	13	13
9. Elementary Occupations	111	-44	45	1
Total employment	2,047	203	805	1,008

Source: National Employer Skills Survey 2007

Appendix 3 - Current and projected future qualifications mix by 2-digit SOC code

Occupation	1994	Projected (%)			1994	Projected (000s)	
		2004	2014			2004	2014
Corporate Managers							
NQF 5	3.7	8.5	12.7	NQF 5	95	298	534
4	30.5	36.0	45.3	4	783	1262	1904
3	19.0	19.5	20.6	3	488	684	867
2	21.5	18.0	13.0	2	552	632	546
1	16.1	13.0	8.0	1	412	454	335
0	9.2	4.9	0.3	0	236	173	12
total	100.0	100.0	100.0	total	2565	3503	4199
Managers & Proprietors							
NQF 5	1.8	3.2	4.8	NQF 5	19	36	49
4	17.9	22.6	32.0	4	190	250	329
3	18.3	21.6	27.6	3	194	239	284
2	23.2	21.0	18.1	2	246	233	186
1	20.2	18.0	13.8	1	214	199	142
0	18.7	13.5	3.8	0	199	150	39
total	100.0	100.0	100.0	total	1063	1107	1028
Science/Tech Professionals							
NQF 5	10.2	16.2	20.7	NQF 5	72	157	237
4	52.0	52.0	55.3	4	365	503	633
3	16.8	14.7	12.7	3	118	143	145
2	11.6	10.0	7.4	2	81	97	84
1	6.6	5.8	3.9	1	46	56	44
0	2.8	1.2	0.0	0	20	12	0
total	100.0	100.0	100.0	total	702	968	1144
Health Professionals							
NQF 5	25.0	36.2	44.8	NQF 5	52	103	165
4	64.9	54.1	46.8	4	134	154	172
3	1.8	2.2	2.7	3	4	6	10
2	3.5	3.0	2.2	2	7	8	8
1	4.1	4.2	3.4	1	9	12	13
0	0.7	0.3	0.0	0	2	1	0
total	100.0	100.0	100.0	total	207	285	368
Teaching/Research Prof.							
NQF 5	16.7	40.1	60.1	NQF 5	192	592	1080
4	72.2	52.3	35.9	4	831	773	645
3	3.0	2.7	2.5	3	35	40	45
2	4.0	2.4	0.8	2	46	36	15
1	3.3	2.0	0.6	1	38	30	11
0	0.8	0.4	0.0	0	9	6	1
total	100.0	100.0	100.0	total	1151	1478	1797

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Occupation	Projected (%)			Projected (000s)			
	1994	2004	2014	1994	2004	2014	
Business/Public service Prof.							
NQF 5	9.1	17.9	24.0	NQF 5	56	145	222
4	57.2	58.4	61.4	4	351	472	569
3	10.5	10.4	10.1	3	64	84	93
2	12.2	8.2	3.5	2	75	66	32
1	7.8	4.5	1.0	1	48	36	9
0	3.2	0.6	0.0	0	19	5	0
total	100.0	100.0	100.0	total	614	809	926
Science/Tech Associate Prof.							
NQF 5	3.4	5.4	7.0	NQF 5	16	33	48
4	37.7	39.2	43.3	4	178	237	295
3	22.3	24.6	27.2	3	105	149	185
2	18.2	17.2	14.1	2	86	104	96
1	11.6	11.1	8.3	1	55	67	57
0	6.8	2.5	0.0	0	32	15	0
total	100.0	100.0	100.0	total	472	606	681
Health Associate Prof.							
NQF 5	1.7	5.9	9.2	NQF 5	15	64	108
4	74.0	67.5	63.8	4	658	730	744
3	5.7	9.4	13.1	3	50	102	152
2	8.2	9.3	8.9	2	73	101	104
1	6.6	6.5	5.0	1	59	71	58
0	3.8	1.4	0.0	0	33	15	0
total	100.0	100.0	100.0	total	888	1082	1166
Protective Service Occs							
NQF 5	0.4	1.6	2.6	NQF 5	1	6	10
4	11.0	19.9	30.7	4	30	81	125
3	23.7	28.9	34.3	3	65	117	139
2	29.2	29.0	25.1	2	80	118	102
1	24.6	16.9	7.3	1	67	69	30
0	11.2	3.8	0.0	0	31	16	0
total	100.0	100.0	100.0	total	273	406	407
Culture/Media/Sport Occs							
NQF 5	5.5	8.7	11.2	NQF 5	22	57	90
4	39.1	47.7	60.1	4	154	312	486
3	17.7	15.9	14.3	3	70	104	115
2	19.3	14.7	8.7	2	76	96	70
1	12.3	9.5	5.3	1	48	62	43
0	6.0	3.5	0.4	0	24	23	4
total	100.0	100.0	100.0	total	394	654	808

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Occupation	Projected (%)				Projected (000s)		
	1994	2004	2014	1994	2004	2014	
Bus/Public Serv. Assoc Prof.							
NQF 5	3.6	7.6	11.0	NQF 5	42	118	187
4	31.3	35.9	43.9	4	373	558	745
3	17.9	20.2	23.0	3	213	314	390
2	22.6	19.6	14.6	2	270	305	248
1	17.2	13.2	7.4	1	204	205	125
0	7.4	3.5	0.0	0	88	54	1
total	100.0	100.0	100.0	total	1192	1554	1697
Administrative Occupations							
NQF 5	0.9	2.0	3.1	NQF 5	25	56	85
4	13.8	18.7	27.3	4	379	534	753
3	15.2	20.2	27.3	3	420	575	753
2	30.1	27.7	23.8	2	829	790	657
1	27.8	24.4	17.8	1	766	694	490
0	12.2	7.0	0.8	0	335	199	22
total	100.0	100.0	100.0	total	2753	2849	2760
Secretarial & Related Occs							
NQF 5	0.4	1.0	1.8	NQF 5	5	10	12
4	12.3	14.9	21.3	4	148	141	150
3	12.0	16.6	24.1	3	144	156	170
2	32.3	29.5	26.3	2	388	277	185
1	34.1	30.1	23.3	1	410	283	164
0	8.9	7.9	3.2	0	107	74	22
total	100.0	100.0	100.0	total	1202	941	703
Skilled Agricultural Trades							
NQF 5	0.8	2.3	4.3	NQF 5	3	9	18
4	9.4	12.7	20.4	4	33	47	87
3	14.8	16.8	22.5	3	52	62	96
2	19.0	21.3	24.5	2	66	79	104
1	18.8	20.5	20.9	1	65	76	89
0	37.3	26.3	7.4	0	130	97	32
total	100.0	100.0	100.0	total	348	370	427
Skilled Metal/Elec Trades							
NQF 5	0.3	0.6	0.9	NQF 5	5	8	8
4	10.7	10.0	10.9	4	164	126	100
3	36.3	41.8	51.9	3	557	524	475
2	28.1	25.7	22.2	2	430	323	203
1	13.1	13.1	11.4	1	200	165	104
0	11.5	8.8	2.7	0	176	110	25
total	100.0	100.0	100.0	total	1532	1256	915

Market View Report - Phase 4 Diploma in Science

Occupation	1994	Projected (%)			1994	Projected (000s)	
		2004	2014			2004	2014
Skilled Construct. Trades							
NQF 5	0.1	0.4	0.8	NQF 5	2	5	11
4	4.0	3.8	4.5	4	41	44	62
3	35.9	37.8	45.7	3	370	441	637
2	28.5	27.2	25.8	2	294	318	360
1	12.6	16.9	19.1	1	130	197	266
0	19.0	13.9	4.1	0	196	162	57
total	100.0	100.0	100.0	total	1032	1167	1394
Other Skilled Trades							
NQF 5	0.2	0.8	1.6	NQF 5	1	5	9
4	5.7	8.6	14.1	4	41	55	77
3	21.1	24.2	31.5	3	154	155	172
2	24.8	27.6	30.2	2	182	176	165
1	22.6	21.7	18.7	1	165	139	102
0	25.6	17.1	4.0	0	187	109	22
total	100.0	100.0	100.0	total	731	640	546
Caring Personal Service Occs							
NQF 5	0.6	1.2	1.7	NQF 5	6	20	35
4	13.9	17.1	22.1	4	135	290	460
3	9.2	20.7	33.1	3	90	351	688
2	20.7	28.4	31.9	2	202	480	663
1	30.7	22.3	11.2	1	299	378	234
0	24.9	10.3	0.0	0	243	174	1
total	100.0	100.0	100.0	total	975	1694	2081
Leisure/Oth Pers Serv Occs							
NQF 5	0.3	0.5	0.8	NQF 5	2	3	5
4	7.4	10.7	16.2	4	40	59	95
3	22.1	29.0	39.1	3	118	160	230
2	28.2	29.3	28.7	2	150	161	168
1	20.7	18.7	14.3	1	111	103	84
0	21.3	11.7	0.9	0	114	64	5
total	100.0	100.0	100.0	total	534	550	587
Sales Occupations							
NQF 5	0.2	0.7	1.3	NQF 5	3	14	30
4	6.4	8.2	12.4	4	106	164	276
3	12.7	20.1	31.9	3	211	400	709
2	25.4	29.1	32.7	2	423	579	728
1	27.8	23.7	17.7	1	463	471	394
0	27.5	18.1	4.1	0	457	360	90
total	100.0	100.0	100.0	total	1663	1988	2227

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Occupation	Projected (%)			Projected (000s)			
	1994	2004	2014	1994	2004	2014	
Customer Service Occupations							
NQF 5	0.7	0.8	0.8	NQF 5	2	3	5
4	13.0	15.2	19.8	4	27	65	111
3	14.6	24.2	35.5	3	30	103	199
2	27.7	31.4	31.8	2	58	133	178
1	28.7	21.7	12.1	1	60	92	68
0	15.3	6.7	0.0	0	32	28	0
total	100.0	100.0	100.0	total	209	424	560
Process Plant & Mach Ops							
NQF 5	0.2	0.5	0.9	NQF 5	2	6	9
4	4.5	5.1	7.8	4	71	65	74
3	15.8	17.3	23.6	3	254	218	224
2	19.1	23.7	30.7	2	307	298	292
1	24.7	26.7	28.1	1	396	336	267
0	35.7	26.7	9.0	0	573	336	85
total	100.0	100.0	100.0	total	1603	1259	950
Transport Drivers and Ops							
NQF 5	0.2	0.5	0.8	NQF 5	2	5	11
4	3.4	4.2	6.8	4	34	47	88
3	16.7	17.3	22.7	3	166	192	295
2	26.2	26.0	28.2	2	261	289	367
1	34.9	33.7	32.3	1	346	374	419
0	18.6	18.2	9.1	0	185	202	119
total	100.0	100.0	100.0	total	993	1108	1299
Elementary: Trades/Plant/Stor							
NQF 5	0.2	0.2	0.3	NQF 5	2	2	2
4	3.7	3.5	4.9	4	49	37	33
3	14.8	14.7	19.2	3	195	154	129
2	19.5	23.0	30.1	2	256	241	203
1	26.9	29.7	33.3	1	354	311	225
0	34.9	28.9	12.2	0	458	302	82
total	100.0	100.0	100.0	total	1312	1047	675
Elementary: Admin/Service							
NQF 5	0.1	0.5	1.1	NQF 5	2	12	22
4	4.2	5.7	9.5	4	100	134	195
3	11.5	15.4	24.1	3	273	363	496
2	20.0	23.2	28.6	2	473	546	587
1	25.5	26.7	27.4	1	604	629	562
0	38.7	28.5	9.3	0	917	672	191
total	100.0	100.0	100.0	total	2368	2357	2053

Source: Working Futures 2004-2014: Qualifications Report (table 5.4)

Appendix 4 - Higher Education participation statistics in science

Subject	2003-2004		2004-2005		2005-2006		2006-2007	
Medicine and Dentistry	52,965	+8%	55,960	+6%	59,585	+6%	63,245	+6%
Broadly-based programmes within medicine & dentistry	0		0		10		10	0%
Pre-clinical medicine	13,805	+3%	14,490	+5%	15,565	+7%	15,495	-1%
Pre-clinical dentistry	1255	-20%	1190	-5%	1390	+17%	1245	-10%
Clinical medicine	32,385	+11%	34,340	+6%	36,590	+7%	39,980	+9%
Clinical dentistry	4990	+15%	5250	+5%	5255	0.1%	5830	+11%
Others in medicine & dentistry	530	-12%	690	+30%	775	+12%	685	-12%

Subject	2003-2004		2004-2005		2005-2006		2006-2007	
Biological sciences	147,355	+17%	149,520	+1%	155,220	+4%	164,215	+6%
Broadly-based programmes within biological sciences	905	-12%	825	-9%	925	+12%	1435	+55%
Biology	25,400	+4%	26,290	+4%	27,075	+3%	27,580	+3%
Botany	965	+14%	845	-12%	750	-11%	775	+3%
Zoology	4030	+4%	3800	-6%	3810	+1%	4040	+6%
Genetics	2680	-1%	2550	-5%	2290	-10%	2240	-2%
Microbiology	4340	+3%	4470	+3%	4370	-2%	4880	+12%
Sports science	22,325	+27%	25,505	+14%	29,050	+14%	30,835	+6%
Molecular Biology, biophysics & biochemistry	9805	+6%	9600	-2%	9945	+4%	10,460	+5%
Psychology	64,480	+27%	68,265	+6%	71,185	+4%	72,475	+2%
Others in biological sciences	12,425	+11%	7370	-41%	5825	-21%	9495	+63%

Subject	2003-2004		2004-2005		2005-2006		2006-2007	
Subjects allied to medicine	288,580	+8%	300,140	+4%	309,405	+3%	300,900	-3%
Broadly-based programmes within subjects allied to medicine	1270	-12%	1165	-8%	875	-25%	965	+10%
Anatomy, physiology & pathology	14,310	+13%	16,325	+14%	17,115	+5%	16,930	-1%
Pharmacology, toxicology & pharmacy	16,465	+5%	17,840	+8%	20,195	+13%	21,675	+7%
Complementary medicine	4000	+35%	5685	+42%	6805	+20%	6765	-1%
Nutrition	3310	+12%	4580	+38%	5285	+15%	5845	+11%
Ophthalmics	3685	-2%	3900	+6%	3960	+2%	3290	-17%
Aural & oral sciences	3790	+37%	3360	-11%	3820	+14%	4080	+7%
Nursing	186,665	+6%	191,425	+3%	194,335	+2%	183,580	-6%

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Medical technology	7520	+14%	8540	+14%	8590	+1%	8325	-3%
Others	47,565	+16%	47,325	-1%	48,420	+2%	49,450	+2%

Subject	2003-2004		2004-2005		2005-2006		2006-2007	
Veterinary science	4080	+6%	4380	+7%	4465	+2%	4875	+9%
Pre-clinical veterinary medicine	1530	+26%	1725	+13%	1575	-9%	1490	-5%
Clinical veterinary medicine & dentistry	2550	-3%	2650	+4%	2890	+9%	3385	+17%

Subject	2003-2004		2004-2005		2005-2006		2006-2007	
Agriculture & related subjects	15,330	+2%	15,150	-1%	17,275	+14%	16,085	-7%
Broadly-based programmes within agriculture & related subjects	5	%	0	%	0	%	0	%
Animal science	2755	+7%	2670	-3%	2885	+8%	3220	+12%
Agriculture	7810	-2%	7505	-4%	7595	+1%	7295	-4%
Forestry	690	+5%	695	+1%	700	+1%	790	+13%
Food & beverage studies	3020	+5%	2850	-6%	2830	-1%	2650	-6%
Agricultural sciences	390	+59%	415	+6%	360	-13%	360	0%
Others in veterinary sciences, agriculture & related subjects	655	0%	1020	+56%	2905	+184%	1770	-39%

Subject	2003-2004		2004-2005		2005-2006		2006-2007	
Physical sciences	73,730	+4%	78,685	+7%	82,740	+5%	83,905	+1%
Broadly-based programmes within physical sciences	1160	+25%	1190	+3%	1280	+8%	1040	-19%
Chemistry	18,525	-3%	18,520	-1%	18,375	-1%	19,585	+7%
Materials science	505	+16%	545	+8%	630	+16%	650	+3%
Physics	13,360	+4%	14,610	+9%	15,035	+3%	14,935	-1%
Forensic & archaeological science	4085	+4%	6140	+50%	8535	+39%	9115	+7%
Astronomy	2325	-11%	2280	-2%	2335	+2%	2950	+26%
Geology	7730	+15%	8310	+8%	8790	+6%	9145	+4%
Ocean sciences	1260	%	1315	%	1315	%	1265	%
Physical & terrestrial geographical & environmental sciences	21655	-1%	20,500	-5%	20,615	+1%	20,530	-1%
Others	3125	+29%	5275	+69%	5825	+10%	4695	-19%

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Subject	2003-2004		2004-2005		2005-2006		2006-2007	
Mathematical sciences	30,770	+17%	31,370	+2%	32,425	+3%	33,790	+4%
Broadly-based programmes within mathematical sciences	450	-16%	85	-81%	140	+65%	165	+18%
Mathematics	24,025	+19%	25,555	+6%	26,935	+5%	28,590	+6%
Operational research	1190	+46%	965	-19%	810	-16%	795	-2%
Statistics	3620	-8%	3445	-5%	3370	-2%	3550	+5%
Others in mathematical sciences	20	0%	15	-25%	10	-33%	5	-50%
Others in mathematical & computing sciences	1470	+92%	1300	-12%	1165	-10%	690	-40%

Subject	2003-2004		2004-2005		2005-2006		2006-2007	
Engineering & technology	134,805	+2%	137,825	+2%	136,695	-1%	140,580	+3%
Broadly-based programmes within engineering & technology	285	+84%	235	-18%	265	-13%	220	-17%
General engineering	20,695	+9%	21,380	+3%	21,035	-2%	21,665	+3%
Civil engineering	17,860	+9%	19,750	+11%	19,830	+1%	22,115	+12%
Mechanical engineering	20,790	-1%	21,215	+2%	21,955	+3%	22,600	+3%
Aerospace engineering	7070	+6%	7605	+8%	7580	-1%	8220	+8%
Naval architecture	540	-19%	485	-10%	625	+29%	530	-15%
Electronic & electrical engineering	35,650	-5%	34,590	-3%	32,795	-5%	32,345	-1%
Production & manufacturing engineering	9225	+7%	7980	-13%	7255	-9%	6850	-6%
Chemical, process & energy engineering	5780	+3%	6080	+5%	6215	+2%	6845	+10%
Others in engineering	2150	+122%	1520	-29%	1590	+5%	1325	-17%
Minerals technology	405	+16%	225	-44%	210	-7%	205	-5%
Metallurgy	745	+15%	665	-11%	640	-4%	670	+5%
Ceramics & glasses	235	+42%	125	+47%	120	-4%	120	0%
Polymers & textiles	2380	-21%	2405	+1%	2650	+10%	2710	+2%
Materials technology not otherwise specified	3065	+3%	3215	+5%	3110	-3%	2935	-6%
Maritime technology	1110	-30%	1060	-5%	1080	+2%	1455	+35%
Industrial biotechnology	90	-33%	55	-39%	130	+136%	205	+58%
Others in technology	6740	+37%	9240	+37%	9615	+4%	9570	-1%

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Subject	2003-2004		2004-2005		2005-2006		2006-2007	
Computer science	137,650	+3%	131,280	-5%	120,150	-8%	106,910	-11%
Computer science	90,995	-11%	81,055	-11%	76,250	-6%	72,810	-5%
Information systems	37,600	+56%	41,440	+10%	35,765	-14%	26,615	+26%
Software engineering	7480	+29%	7220	-3%	6420	-11%	6200	-3%
Artificial intelligence	675	-16%	560	-17%	580	+4%	630	+9%
Others in computing sciences	900	+23%	1005	+12%	1135	+13%	655	-42%

Source: Higher Education Statistics Authority: Students and Qualifiers Data Tables

Appendix 5 - Other Selected Diplomas

Diploma in Construction and the Built Environment

Level 1 Principal Learning Content and Maths

Level 1 is made up of 7 units of which only 2 have no science or mathematics content included. 4 of the units include some science learning which is based on environmental protection and the use of materials. Key areas include sustainability, properties of materials and their uses, pollution, hazardous materials at work and recycled materials. 3 of the 4 units have 25% science related content with one unit having 50% science related content, however in each of the 4 units the content relates to environmental protection and the use of materials.

In terms of mathematics the specification for Level 1 shows ICT and English as more prominent, with Mathematics only used in 2 of the 7 units with its use mainly related to measurements and the use of geometry and arithmetic when drawing or sketching designs.

QCA information on the mathematics skills used in the Level 1 CBE are based on recognising that a situation can be represented by mathematics, selecting mathematical information to use, using appropriate mathematical procedures, drawing conclusions and choosing appropriate language and forms of presentation to communicate results and conclusions.

Source: <http://www.qca.org.uk/libraryAssets/media/mathsCBE1.pdf>

Level 2 Principal Learning Content and Maths

Level 2 is also made up of 7 units which all have some science related learning content. Again this surrounds environmental issues and the use of materials, but goes into more depth looking at the different types of utilities and their origins, climate change and pollution and more information on sustainability and how it affects the built environment. 3 of the 7 units have around 50% of science related content with the others having less with the issues above touched on in relation to the design and creation of the built environment process.

The mathematics content within the specification for Level 2 includes preparing craft activities including layouts and calculations, with English and ICT again appeared more frequently,

however processes such as CAD are included in the design elements which may be argued are mathematical in some respects.

The QCA information on CBE Diploma Mathematics skills used at Level 2 are based on recognising that a situation can be represented by mathematics, selecting mathematical information to use and using appropriate mathematical procedures.

Source: <http://www.qca.org.uk/libraryAssets/media/mathsCBE2.pdf>

Level 3 Principal Learning Content and Maths

Level 3 consists of 7 units with only 1 not including any science related learning. The science content in the other units follows the lines of environmental issues more than the use of materials, but the difficulty is higher again (than Level 2) including topics on anthropometrics and ergonomics, internal and external elements, climate changes effect on the design process, energy saving, resource management, sustainable resources and energy conservation.

The QCA mathematics skills for the Level 3 CBE Diploma include all the skills set out in the previous 2 Levels but also deciding on the methods, operations and tools, including ICT, to use in a situation, examining patterns and relationships, finding and interpreting results and solutions and considering the appropriateness and accuracy of the results and conclusions.

Source: <http://www.qca.org.uk/libraryAssets/media/mathsCBE3.pdf>

Diploma in Engineering

Level 1

Unit 1 – includes some science related work on engineering sectors including bio-engineering and nuclear and the related environmental issues. No maths content in this unit

Unit 2 – No science content but maths work on drawings, measuring, variance and dimensions in engineering documents.

Unit 3 – Computer Aided Engineering unit, again including maths work on dimensions and their accuracy and proportions

Unit 4 – Some science related work but not a huge amount, relating to corrosion of products

Unit 5 – All science related based on materials and their properties, the maths content includes materials in abbreviated form in engineering documents, visual and tactile inspection of engineering components.

Unit 6 – Whole unit on electronics, with maths work on the values of circuits, tolerances, symbol values, calculation of circuits, checking calculations and producing results

Unit 7 – Science related work on new materials, recycling and disposal, renewable energy sources and the environmental issues associated with them. No maths content in this unit.

Level 2

Unit 1 – As with Level 1 this is based on engineering sectors but also includes work on those working within the sectors, i.e. nuclear engineers. No maths content in this unit.

Unit 2 – No science content in this unit but maths work includes producing 3 design proposals and submitting a detailed design activity log and final design solution document.

Unit 3 – This unit is based on computer aided engineering but the use of it in engineering not learners using CAD style programs. It includes the use of computers in engineering sectors such as nuclear and chemical. There is no maths present in the unit.

Unit 4 – Science in this unit is based on selecting sustainable materials, with maths including comparing dimensions of work with those on engineering drawings, measuring, comparing results and establishing variance, checking dimensions whilst work is in progress and recording numerical results of inspection and producing a plan of action.

Unit 5 – This unit is based on electronics and electrical circuits, but is more detailed than Level 1 including constructing and testing circuits. Maths content includes calculating values of components, circuit parameters and fuse ratings, checking calculations against an expected range of variables, producing results from measurements and comparing them with given values and finding results and solutions and drawing conclusions in the light of the situation when they are calculating resistance, voltages, currents and power in circuits and with the aid of calculations justifying given component values.

Unit 6 – this unit doesn't include science content but does include maths content on Using quality control techniques, including statistical methods, correctly to establish whether a sample of engineered products conform to the standards specified and analysing quality control and statistical data to identify problems and modify production activities.

Unit 7 – This is a unit on maintenance and contains no science content. The maths content is based on calculating mean-time-to-failure from given data based on equipment failure rate and weighting factors and drawing a conclusion and using a statistical method to analyse a trend in product, plant or equipment performance.

Unit 8 – This unit contains science related content on materials, the environmental impact of engineering and the sustainability of resources, however there is no maths for this unit.

Level 3

Unit 1 – This does contain a little science content again in the form of how engineering companies operate in industry such as nuclear and chemical. In maths learners will enter and manipulate data when using appropriate mathematical procedures with numerical solutions, and develop sketching diagrams and plotting graphs.

Unit 2 – This unit is based on applications of CAD with no maths content.

Unit 3 – This includes science content throughout on materials and their properties and environmentally friendly materials. (See end for maths content)

Unit 4 – This unit includes science based information with content on analogue and digital signals, systems, sensors and transducers. (See end for maths content)

Unit 5 – this unit does not relate to science

Unit 6 – this unit contains some science related content in manufacturing processes in chemical, nuclear and other energy industries. (See end for Maths content)

Unit 7 – this unit contains a small amount of science related information in terms of sustainable resources, energy use, pollution, material disposal and eco-friendliness/

Unit 8 – this unit is entitled Mathematical Techniques and Applications for Engineers and includes use of algebraic, trigonometric and statistical methods to solve engineering problems.

Level 3 Maths

Due to a mistake in the specification we cannot see exactly which maths content/skills relate to each unit but QCA data gives us the following maths skills needed throughout the Level 3 Engineering Diploma.

Applying mathematical methods to analyse engineering processes and environmental data
Understanding and applying mathematical and scientific principles in engineering analysis, design and problem solving

Application of statistics

Mathematical techniques and applications for engineers

Use mathematical modelling and mathematical techniques to solve engineering problems

Diploma in Society, Health and Development

Level 1

Unit 1 – There is no science content in this unit and no maths content.

Unit 2 – This contains no science

Unit 3 – This contains no science but includes maths work on planning and checking costings.

Unit 4 – This contains a slight degree of science related work that is used to contextualise situations relating to communication such as interacting with babies and the importance of storing medical records.

Unit 5 – The science content in this unit is based on health and safety and infection, with maths content on creating scaled diagrams of hazards and quantifying risk.

Unit 6 – this unit has science related content based on health and well-being, including short term and long term affects on health of smoking, alcohol, diets, exercise, and understanding the

measurements of health. The maths content is made up of researching and interpreting health statistics.

Unit 7 – this unit is based on people's needs with the science content based on medical needs, but this only makes up a small proportion of the unit. There is no maths content in the unit.

Unit 8 – This unit is entitled Growth and Development and covers scientific issues such as physical development across the lifespan, health issues relating to age and ageing, and physical impairments. There is no maths content in the unit.

Level 2

Unit 1 – This unit contains no science and is based on people's values, with no maths content.

Unit 2 – the science content in this unit is based on communication and its many forms, including verbal, non-verbal, body language, listening etc. There is no maths content in this unit.

Unit 3 – This unit uses science to contextualise again in terms of infection control, but this only makes up a tiny proportion of the unit. Maths content includes deciding on the methods operations and tools to use in a situation.

Unit 4 – This unit is called Growth, Development and Healthy Living and builds on the scientific knowledge from Unit 3 above. It also includes assessing and affecting people's health, disabilities and further illnesses. There is no maths content in this unit.

Unit 5 – This is the needs and preferences unit with a small amount of science related work on care services. There is no maths content on this unit.

Unit 6 – this contains no science but includes maths content of carrying out survey and analysis, graphs and charts.

Unit 7 – This contains a small amount of scientific information based on children's stages of development, with no maths content.

Unit 8 – this unit is called patient centred health and includes science related information on normal baselines for health and their measurement, conditions that affect people throughout their lifetime and the different types of medical practitioners available. This unit contains

substantial maths content on measuring and interpreting at least three baseline measurements for health and interpreting normal and abnormal measurements.

Unit 9 – This unit is based on disability but only a small amount of it is on the medical reasons for it, it is more concerned with the social aspects of it. The maths content includes carrying out a survey on society's attitudes towards disability, interpreting results and solutions and communicating data in a recognised format and using appropriate mathematical procedures to analyse the survey.

Level 3

Unit 1 – The science in this unit relates to the health sector but only in terms of what constitutes it. The maths content is presenting primary research results, including statistics within the public domain.

Unit 2 – A small amount of science based work on health legislation such as the mental health act. The maths content is presenting the results of primary research.

Unit 3 – this unit contains no science content but maths is included in the form of performing the cost analysis of the team event.

Unit 4 – This unit builds on the communication unit in Level 2 including how different forms of communication are understood and used in different situations, the forms are the same, (verbal non-verbal, listening etc) but there is more content here. There is no mathematics content.

Unit 5 – There is no science or maths in this unit.

Unit 6 – This includes scientific legislation on issues such as food hygiene and infection control and work on hazard identification and risk and control. The maths content includes recognising that a situation has aspects that can be represented using mathematics by carrying out a risk assessment, using appropriate mathematical procedures to analyse the risk assessment and interpreting results and solutions and communicating data in a recognised format.

Appendix 6 - Degree Subject Grouping Definitions

Medicine and Dentistry	Pre clinical Medicine Pre clinical Dentistry
Subjects allied to medicine	Anatomy Physiology and Pathology Pharmacology, Toxicology and Pharmacy Complementary Medicine Nutrition Ophthalmic Aural and Oral Sciences Nursing Medical Technology Others in subjects allied to medicine Combinations within subjects allied to medicine
Biological Sciences	Biology Botany Zoology Genetics Microbiology Sports Science Molecular Biology, Biophysics & Biochemistry Psychology Others in biological sciences Combinations within biological sciences
Veterinary science, agriculture and related	Vet Science, Agriculture & related: any area of study Pre-clinical Veterinary Medicine Clinical Veterinary Medicine & Dentistry Animal Science Agriculture Forestry Food and Beverage studies Agricultural Sciences Others in Vet Science ,Agriculture & related subjects Combinations within Vet Science, Agriculture & related subjects
Physical Sciences	Physical Sciences: any area of study Chemistry

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	<p>Materials Science</p> <p>Physics</p> <p>Forensics and Archaeological science</p> <p>Astronomy</p> <p>Geology</p> <p>Ocean Sciences</p> <p>Physical & Terrestrial Geog & Environmental Science</p> <p>Others in physical sciences</p> <p>Combinations in physical sciences</p>
Mathematical and computer science	<p>Mathematical & Comp Science: any area of study</p> <p>Mathematics</p> <p>Operational Research</p> <p>Statistics</p> <p>Computer Science</p> <p>Information Systems</p> <p>Software Engineering</p> <p>Artificial Intelligence</p> <p>Others in mathematical and computer science</p> <p>Combinations within mathematical and computer science</p>
Engineering	<p>General Engineering</p> <p>Civil Engineering</p> <p>Mechanical Engineering</p> <p>Aerospace Engineering</p> <p>Naval Architecture</p> <p>Electronic and Electrical Engineering</p> <p>Production and Manufacturing Engineering</p> <p>Chemical, Process and Energy Engineering</p> <p>Others in Engineering</p> <p>Combinations within Engineering</p>

Appendix 7 - The Interests of School Pupils in Science Topics

Table 30 Most Interesting Science Topics by Gender

Boys	Girls
Explosive chemicals (3.38)	Why we dream when we are sleeping and what the dreams may mean (3.47)
How it feels to be weightless in space (3.29)	Cancer, what we know and how we can treat it (3.35)
How the atom bomb functions (3.24)	How to perform first-aid and use basic medical equipment (3.33)
Biological and chemical weapons and what they do to the human body (3.22)	How to exercise to keep the body fit and strong (3.20)
Black holes, supernovae and other spectacular objects in outer space (3.17)	Sexually transmitted diseases and how to be protected against them (3.11)
How meteors, comets or asteroids may cause disasters on earth (3.14)	What we know about HIV/AIDS and how to control it (3.10)
The possibility of life outside earth (3.12)	Life and death and the human soul (3.05)
How computers work (3.08)	Biological and human aspects of abortion (3.04)
The effect of strong electric shocks and lightning on the human body (3.07)	Eating disorders like anorexia or bulimia (3.03)
Brutal, dangerous and threatening animals (3.04)	How alcohol and tobacco might affect the body (3.03)

Source: Jenkins & Pell (ROSE), 2006
Average score in parentheses

Appendix 8 - Notes on SOC Categories and Science Content

A number of occupations are generic to the point that they could serve a number of both scientific and non-scientific industries and sectors, but, given that a requirement for scientific knowledge is possible, it is important to capture them as a potential market for science qualifications, no matter how small they may be.

For example, occupation 7111 - Sales and Retail Assistants - may be involved with products such as food, medicine or electrical hardware, each of which have clear requirements for, at the very least, scientific awareness, and more probably, a degree of scientific knowledge.

On the other hand, occupations in Major Group 1, Sub-Major Group 11 (focussing on management) are more strategic and less technical. The skills required by job holders in these occupations will be less about 'product' and more about process - the management of the organisation and/or department functionality. The skills of job holders at this level are transferable across multiple industries. For example, occupation 1142 - Customer Care Managers - has been deemed a strategic one and not included within the parameters of science. The job overview for this category in SOC 2000 states:-

“workers ... plan, organise, co-ordinate and direct resources necessary for receiving and dealing with the responses, complaints or further requirements of purchases and users of a product or service”⁴⁷.

Clearly many of these staff will require scientific awareness and even some knowledge, but it is likely that the level of scientific knowledge required will not be equivalent to their level in the business. Most of the employees in this SOC group therefore fall into the very large number of the population who require basic scientific awareness or fundamental knowledge and skills.

⁴⁷ Office for National Statistics (2000) *Standard Occupational Classification 2000: Volume 1 Structure and descriptions of unit groups*. London: The Stationery Office.

Conversely, occupation 7212 - Customer Care Occupations - requires a much greater degree of knowledge and expertise around the products or services being offered. Such products or services may require an understanding of scientific principles no matter how basic, ranging from sales support of motor parts, to wireless internet networking. The job overview within SOC states:-

“workers in this unit group provide information to existing and potential clients regarding the products and services offered by an organisation, and further services to customers after the point of sale⁴⁸”.

It should be noted, though, that whilst SOC 2000 represents the most comprehensive presentation of 353 UK occupations (plus variable job titles), these classifications are now eight years old and therefore may not take into account changes in the qualifications and skills composition of the national workforce, as well as changes in industry standards, legislation, regulation and competition, that may have impacted the minimum required entry levels in the intervening period.

⁴⁸ Ibid.

Bibliography

Bell J and Donnelly J (2007) *Positioning Applied Science in Schools: Uncertainty, Opportunity and Risk in Curriculum Reform*. Leeds: University of Leeds Centre for Studies in Mathematics and Science Education.

Bosworth D and Wilson R (2006) *Working Futures 2004-2014: Qualifications Report*. Coventry: Institute for employment; University of Warwick.

Briscoe G and Hogarth T et al (Institute for employment; University of Warwick) (2008) *The State of the Nation - Capacity and Skills*. London: Institute of Civil Engineers.

Carmen L and Roderio V (2007) 'Uptake of GCSE subjects 2000-2006': *Statistics Report Series No.4*. Cambridge: Cambridge Assessment.

Cogent (2006) *A Gap Analysis for the Chemical Industry*. Cheshire.

Cogent (2006) 'Cogent, Industry -specific Gap Analyses'; *Assessment of Current Provision - Part 1*. Cheshire.

ConstructionSkills (2004) *Construction Skills Needs Analysis for Construction*. Norfolk.

ConstructionSkills (2004) *Built Environment Professional Services Skills Survey 2003/2004*. Norfolk.

DCSF/DIUS (2008) *Impact Assessment of Apprenticeships Review Policies, including the creation of the National Apprenticeships Service - Draft Bill Version 7*. London.

Dickerson A, Homenidou K, and Wilson R (2006) *Working futures 2004-2014: National Report*. Coventry: University of Warwick.

Dickerson A, Homenidou K, and Wilson R (2006) *Working Futures 2004-2014 Sectoral Report*. Coventry: University of Warwick.

Emery L (2007) 'Uptake of GCE A-Level subjects in England 2006' *Statistics Report Series No.5*. Cambridge: Cambridge Assessment.

Energy & Utility Skills (2006) *Sector Skills Agreement Stage 2 Report*. Solihull.

Energy and Utility Skills (2006) *Sector Skills Agreement: Stage 2 Report*. Solihull.

Higher Education statistics Agency (HESA) (2007) *Statistical First Release 124 - Destinations of Leavers from Higher Education in the UK for the Academic Year 2006/07*. Cheltenham.

IFF Research LTD Staff (2008) *National Employer Skills Survey: Main Report*. Coventry: LSC.

Institute for Employment (2006) *Work Related Learning in Science*. Coventry: University of Warwick.

Improve staff (2007) *Putting the Plan into Action: The Sector Skills Agreement for the Food and Drink Manufacturing*. York.

Improve Staff (2006) *Research to Investigate the UK Requirement for Food Scientists and Technologists*. York.

Improve Staff (2007) *Investigation into the requirement for food scientists and technologists in the Yorkshire and Humber Region*. York.

Joint Council for Qualification Staff (JCQ) (2008) *Results 2008 - England*. London.

Leitch (2006); *Leitch Review of Skills; Prosperity for all in the global economy*.

National Heritage Training Group (NHTG) (2008) *Traditional Building Craft Skills - Skills Needs Analysis of the Built Heritage Sector in England*. London.

New Engineering Foundation *The Appliance of Science*; NEF Report July 2008

New Engineering Foundation *Preparing for the Future*; NEF Report October 2008

Office for National Statistics (2000) *Standard Occupational Classification 2000: Volume 1 Structure and descriptions of unit groups*. London: The Stationery Office.

ProSkills Staff (2006) *Sector Skills Agreement Stage 2 Report - An Assessment of Current Provision*. Sheffield.

Science Development Diploma Partnership (Pye Tait) (2008) *Secondary research report to establish content for the Diploma in Science - QD7*. London.

QCA Staff (2006) *Investigating the need for a specialised Diploma in applied science: Report to the Department for Education and Skills*; London.

Rawley A QC, Prof Caddy B (2006) *Damilola Taylor: An Independent Review of Forensic Examination of Evidence by the Forensic Science Service*; London: Home Office.

SEMTA Staff (2005) *Sector Skills Agreement UK - This covers Aerospace, Automotive and Electronics within SEMTA's footprint*. Watford.

<http://www.semta.org.uk/pdf/elec%20auto%20aero%20ssa%20summary.pdf>.

SEMTA Staff (2006) *Sector Skills Agreement for the UK Marine Sector*. Watford.

<http://www.semta.org.uk/PDF/SSA%20marine.pdf>

SEMTA Staff (2007) *'Bioscience SSA Stage 3: Gap Analysis - UK; version 3'*. Watford.

SEMTA Staff (2004) *Forensic Science: Implications for Higher Education*. Watford.

SEMTA Staff (2008) *Bioscience SSA Stage 2: Assessment of Current Provision*. Watford.

SEMTA Staff (2007) *More Science: GCSE Applied Science and the new KS4 curriculum*. Watford.

Skills for Justice Staff (2008) *Justice Sector Qualifications Strategy*. Sheffield.

Skills for Health Staff (2006) *Sector Skills Agreement for Health Stage 3: Delivering a Flexible Workforce to Support Better Health and Health Services - The Case for Change*. Bristol.

The Information Centre Staff (2008) *Staff in the NHS 1997 - 2007 England*. Leeds: The Information Centre for Health and Social care.

The Royal Society (2008) *State of the Nation report*. London.

Press

[Baccalaureate 'overvalued' against A-level](#) - Times Online, 2 April 2007

['Too easy' A-levels boost interest in baccalaureate](#) - The Independent, 12 August 2007

[International Baccalaureate: why the broad IB beats A-levels](#) - The Independent, 25 October 2007