

Report on consultation on Initial Scope for the Diploma in Science (QD4a)

(Final Publication Date)

Version Number	Date amended	Date sent for review	Next review date	Version Name
1.0	21.07.08	23.07.08	SDDP to return comments to PTL 25.07.08	Initial draft for review by SDDP
2.0	29.07.08	29.07.08	Steering Group meeting 30.07.08	Draft for submission to UKCES 29.07.08
3.0	11.08.08	14.08.08	Quality Group meeting 14.08.08	Draft for review by Quality Group
4.0	28.08.08	04.09.08	Quality Group meeting 17.09.08	Amended version from initial Quality Group feedback

CONTENTS

1 INTRODUCTION	3
2 METHODOLOGY.....	3
2.1 Limitations of the consultation.....	5
3 PRESENTATION OF FINDINGS	6
3.1 General Findings	6
3.2.1 Vision Statements.....	7
3.2.2 The purpose of the Science Diploma	10
3.2.3 Possible progression routes.....	12
3.2.4 Authentic workplace practice	14
3.2.5 Scientific skills and knowledge.....	15
3.2.6 What scientists do	15
3.2.7 Organising scientific skills.....	16
3.2.8 Depth and Breadth of Learning.....	17
3.2.9 Categorisation	17
3.2.10 'General science skills' in the Diagram.....	19
3.2.11 Additional and specialist learning.....	20
3.2.12 Coverage of Key Stage 4.....	21
3.2.13 The Foundation level Diploma	22
3.2.14 Techniques-led approach	23
3.2.15 Lessons from the past	24
3.2.16 Practical skills.....	25
3.2.17 Overlap with other Diplomas.....	27
3.2.18 Critical success factors	28
4 RECOMMENDATIONS.....	30

1 INTRODUCTION

The aim of this initial consultation has been to establish the scope for the Diploma in Science prior to the start of content development.

The views of a range of stakeholders from the science community (including employers, providers (schools, colleges and HE) and professional institutes, bodies and associations) have been sought on the draft scope and rationale for the Diploma as developed by the Science Diploma Development Partnership (SDDP) project team and set out in the initial scoping document (QD1).

The consultation requested feedback on a variety of issues identified by the SDDP project team as being key to the Diploma, and this report presents the findings from that consultation. As a result of these findings, the SDDP will review and clarify, if and where necessary, the scope for the Diploma in Science to provide a sound basis for the development of the Line of Learning Statement.

2 METHODOLOGY

The document QD2 sets out in detail the methodology for the consultation, but in brief, the approach was split into two main phases.

Phase One The initial scoping document (QD1) was drafted, reviewed and submitted by the SDDP project team to UKCES, along with the consultation strategy and planning document (QD2), at the end of June 2008.

Phase Two Invitations were sent out to stakeholders to attend a consultation workshop at the Royal Society, London, on the 9th July 2008. Document QD1 (version 1.7) was also distributed to stakeholders for review. Members of the SDDP Steering Group and SDDP project team also shared the document with the organisations they represent. The feedback received during the workshop, and via additional responses through the post and by email have been collated and presented here in this report.

Workshop, 9th July 2008 The workshop held with stakeholders on 9th July included two discussion sessions, for which stakeholders separated into three smaller groups. This then enabled discussion with all stakeholders on each of the questions in document QD1, ranging from opinions on the proposed vision and purpose statements, to feedback on progression opportunities and links between the Science Diploma and the National Curriculum at Key Stages 3 and 4. These discussions were facilitated by members of the SDDP project team and digitally recorded so as to enable full transcription and analysis by the research team in preparation of this report.

In total **38 attended** the workshop and approximately 60 were emailed the document QD1 for review. A further **23 responses** to the consultation were received by post or email, in addition to feedback received during the

consultation event itself.

Stakeholders consulted represented the following organisations:

- Association of the British Pharmaceutical Industry
- Abington Partners ScienceScope
- Advisory Committee on Mathematics Education
- Alexandra Park School
- Ashton Community Science College
- Association for the Development of Science
- Association for Science Education
- AstraZeneca Science Teaching Trust
- Association of Teachers of Mathematics
- Bankfield School
- Biosciences Federation
- British Psychological Society
- Campaign for Science and Engineering
- Centre for Education and Industry
- Centre for Mathematics Education
- Consortium of Local Education Authorities for the Provision of Science Services
- Dartford Grammar School for Girls
- Edexcel
- Earth Science Education Forum
- Engineering and Technology Board
- Experimental Psychology Society
- Framwellgate School, Durham
- Further Mathematics Network
- Greater Manchester Police
- Glaxo SmithKline PLC
- Institute of Biology
- Institute of Biomedical Sciences
- Institution of Electrical Engineers
- Institute of Food Science and Technology
- Institute of Physics
- Institution of Environmental Sciences
- London Metropolitan University
- Mathematical Association
- Mathematics in Education and Industry
- National Advisers and Inspectors Group for Science
- National Centre for Excellence in the Teaching of Mathematics
- National Endowment for Science, Technology and the Arts
- New Engineering Foundation
- NRIC
- Nuffield Foundation
- OCR Qualifications
- Ofsted
- Preston Manor High School
- Qualifications and Curriculum Authority
- Research Councils UK
- Royal Society of Chemistry
- Royal Statistical Society
- Royton and Crompton School
- School Science

- Science Learning Centres
- Science, Technology, Engineering and Mathematics Network
- Secondary National Strategy
- Serious Organised Crime Agency
- Society for General Microbiology
- Specialist Schools and Academies Trust
- STEM Advisory/Support Centres
- The Association of Applied Biologists
- The British Association for the Advancement of Science
- The Earth Science Teacher's Association
- The Royal Society
- The Science Council
- UCAS
- UK Commission for Employment and Skills
- University of Liverpool (School of Psychology)
- University of Warwick
- Urmston Grammar School

2.1 Limitations of the consultation

A concern from stakeholders has been the short timescale available for the consultation and in future, confidentiality of responses should be explicitly offered to stakeholders during any consultation activities. A shorter consultation document may have been preferable, and it will also be necessary for forthcoming activities to ensure that all stakeholders are reviewing the same version of any documents distributed.

Notes on quotes used in the report

Where quotes are used throughout this report, please note that these have in the main been attributed to organisation 'types', rather than directly naming individual respondents. However, in cases where a particular organisation has made a comment relating specifically, for example, to their subject area (or that may go against what others have said) these comments have been attributed directly to the organisation from which they originated.

3 PRESENTATION OF FINDINGS

The findings that resulted from the consultation process are set out in two sections, with section 3.1 outlining some broad findings and issues that emerged in the course of the consultation process, and section 3.2 outlining responses to the specific questions on the consultation document QD1 (version 1.7) developed by the DDP. For ease of navigation, the subsection numbers of 3.2 correspond directly to the question numbers in the consultation document.

The specific responses to the consultation questions should be read in the context of the broader issues identified in section 3.1. It should be noted, however, that defining these broader issues is inevitably a somewhat more impressionistic, and therefore imprecise, process than analysing the responses to the consultation questions.

3.1 General Findings

Timescales

There was generally some considerable enthusiasm about the *potential* contribution the Diploma in Science might make. However many of those consulted clearly felt that they were being rushed, resulting in some considerable initial negative sentiment. Almost all stakeholders expressed serious concerns about the narrowness of the timescales for consultation.

'One of the major issues that we are hearing from people is that the timescale is far too short to set up a Diploma of this size by 2011'

- Professional body

Future points to consider are the number of questions asked within a consultation document as too many can raise complexities beyond the scope and purpose of the consultation.

SCORE for instance felt that it was inappropriate to respond to the entire consultation document and eight of the nineteen questions went largely unanswered on these grounds.

Vision, Purpose and audience for the Diploma

Detailed comments on the vision and purpose are described below in relation to the relevant consultation questions. As would be expected at this early stage most delegates felt that defining these adequately is of fundamental importance in order to provide a sound foundation for the Diploma development process.

It is also worth noting for future diploma development purposes that many participants expressed some concern that any single qualification could enthuse young people about STEM careers, meet the needs of employers and HE as well as cater for the full ability range of learners. Stakeholders needed more explicit prioritisation of the core aims and target audience for the Diploma.

A supplementary response further emphasises such concerns, putting them in the context of the future of A levels.

'The teaching of science will need to cater to the needs of different learners: the Science Council is concerned that the needs of these differing groups has not been fully explored or taken into account hitherto in the development of the Science Diploma...In particular we would welcome greater clarity about how A levels will fit within the proposed new qualification.'

- Science Council

Such concerns may have impeded fuller responses being returned in some cases.

3.2.1 Vision Statements

The consultation document (QD1) contains four suggested vision statements for the Science Diploma, with stakeholders invited to comment on which best describes the vision for the Science Diploma. The four statements are:

- 1. The Science Diploma will ensure that young people in England start university, college or work with knowledge of science that is both broad and deep, and with the enthusiasm to increase that knowledge and apply their skills in practical ways*
- 2. It will encourage young people to explore and investigate the diversity of employment opportunities in science, and develop the skills they will need to improve their chances of getting them*
- 3. The UK needs more world-class scientists, technicians and assistants, the Science Diploma will start more young people on the road to gaining world-class scientific skills and knowledge*
- 4. A learning environment where young people can explore the world of scientists, applying scientific knowledge and skill, and relate it more directly with their needs and ambitions for the future*

From the discussions at the workshop and the responses received outside of the consultation event, it is clear that overall statement **number one** is the preferred option among stakeholders. Indeed, it seems that many professional associations, institutes and other organisations working within the science community regarded this as the main statement to be acceptable.

In addition, a significant minority of stakeholders – notably including many of those directly involved with current science provision – favoured statement **number four** on the grounds that it related the Diploma explicitly to the needs and ambitions of learners. One stakeholder representing the chemistry subject community responded to the consultation via email suggesting that there is a need to combine both statements one and four, and this was backed up by others attending the workshop event.

'...I'd tick one and four. I actually quite like four from just a young person's perspective...the vision has got to be about getting more young people involved in science in some way.'

- Head teacher of specialist school in science and technology

'I would be very sorry to lose something that doesn't talk about the learning environment in that statement and I almost would go for one, followed by 'and', then four'

- Charity supporting development of vocational education in science, engineering and technology subjects

Among the stakeholders who preferred statement number one it was widely felt that further improvement and amplification was necessary. It was pointed out that statement number one may be insufficiently distinct from existing GCSE and A level vision statements.

'The first statement I think is the best fit, but it doesn't feel that different from A levels...In the final part [where it talks] about applying those skills in a practical way, perhaps we're trying to allude to what the difference is. But at the moment, it doesn't really say.'

- Membership organisation for science professional bodies

Alongside this, there were many comments during the workshop, and also some through paper-based responses, that the vision statement needs to emphasise *'the unique selling point that makes it [the Diploma] different'* to current provision – GCSE and A levels in particular – by stressing the applied nature of the qualification and the hope that an enthusiasm for science will, as a result, be generated among learners.

'I'd like to also just put another bid in for enthusiasm, or passion, or ambition. You know, something upbeat, fun. Because that's really what we're trying to drive in there.'

- Pressure group working to promote science and engineering

In addition, many delegates suggested that it would be desirable to incorporate some important elements from the other statements into statement one:

- Revise the first phrase so that it says '*...will ensure that **more** young people...*' (as in statement three)
- Change the wording so that '*apply their skills*' also includes the application of knowledge (as in statements three and four)
- Refocus the statement so that it emphasises the learner and learning environment (as in statement four)

This suggestion of focusing on the learner has become a common theme across this initial consultation, both in enthusing them about science, but also in ensuring that they continue to develop the skills and understanding gained during earlier stages of their education, and particularly at Key Stage 3.

'The worry I've got with these statements is, it is functional and the emphasis is wrong...it's about the learning, and if it's about enthusing the learner, then all of these other points [e.g. developing and applying skills and knowledge] should fall out. So I think we've got to be thinking that you get the learner enthused as a different way of looking at science.'

- Professional association for science teachers

'If the vision is about what you ensure, it also got to be about what the children bring to it...it's continuing their understanding and development of the knowledge, skills and understanding in science, and that's very much what the Key Stage 3 curriculum is about.'

- Development programme for schools and teachers

One stakeholder responding electronically suggested that it would be important to '*look at the vision statements from the Engineering Diploma and others, and produce something that fits within the existing suite.*' For this stakeholder, it is important that the vision statement is aimed at students, appealing to both them and their parents, '*and point broadly to where the progression routes will lead*'.

3.2.2 The purpose of the Science Diploma

Stakeholders were asked whether the following proposed statements about the purpose of the Science Diploma are realistic and reasonable, and whether they deemed any other points to be missing:

- *To enthuse more young people into a science career by increasing STEM participation*
- *Increase the number of learners progressing to Higher Education*
- *Ensure all learners develop their laboratory practical skills via a techniques approach*
- *To reduce the science employer's skills gaps*
- *Develop the learner's transferable skills*
- *To enable a range of progression routes, into and from the Diplomas*

As with the proposed vision statements stakeholders, during the consultation workshop and within written responses, pointed to omissions relating to learner development, making the Diploma distinct from other provision and important skills and knowledge areas that learners might develop. Each of these is considered separately below.

Learner development

There was a perception among some stakeholders that the purpose statements seemed too driven by policy targets. For example, one delegate expressed particular concern over the second purpose statement, although this was supported by UCAS, as it corresponds with UCAS' purpose of increasing access to Higher Education.

As an alternative or addition to this 'top-down' emphasis, there was some suggestion from stakeholders that the purpose of the Diploma should focus on the learner and developing their potential. It was also suggested that by focusing the purpose more on learner development and their practical application of science, this would then '*result in all of these things*' [i.e. the purposes as currently set out in the bullet points] being included as well.

'I think the purpose of it needs to be framed in some way which is much more rooted in...where the learner is starting from. It's about their progression, it's about their development... These bullet points seem to be completely a kind of top-down vision.'

- University

'Wouldn't there be some statement about aspirations and capabilities of young people. It seems to be very much about being institutionally driven, rather than looking about the young people as learners, and as customers.'

- Professional development organisation for maths teachers

One stakeholder responding via email also suggested that the purpose statements currently do not *'appear to answer the fundamental questions about what sort of students the course is aimed at.'*

Finally, it should be noted that two respondents queried the inclusion of 'STEM' in the first statement – one questioning whether this was helpful for a Science Diploma that will not necessarily focus on all four of the STEM disciplines, and another suggesting that the first statement should be changed around so that STEM participation will be increased by enthusing learners, rather than enthusing learners by increasing STEM participation.

Making the Diploma distinct

There was a suggestion from one stakeholder that the purpose statements for the Diploma should clearly show how it is distinct from other provision.

'It [the document] talks about the fact that they are going to be learning through applications of science and through activities, rather than through the theoretical approach that most A levels and some GCSEs do. I think that perhaps that isn't reflected enough.'

- Association of the British Pharmaceutical Industry

Missing skills

There appears to be general agreement among stakeholders that in addition to a focus on '**laboratory practical skills**' there are other equally valuable skills and knowledge. Therefore this particular statement needs to be '*broader*' in scope. It was emphasised by several stakeholders that practical skills '*go beyond the lab*' and fieldwork can be carried out in a wide range of settings and contexts. One respondent suggested removing the word '**laboratory**' from the statement, although then this would not include any consideration of developing knowledge.

Additional suggestions

In addition to the points on specific issues raised above, some additional suggestions for inclusion within the purpose section have been made:

- *'The Diploma should provide, at all levels, a good grounding in all aspects of science...it should teach science through applications and activity and should equip more young people with a comprehensive science education that will enable them to go on to further study of science, or work in science'*
- *'Being able to use and apply maths is essential to scientific areas of work, the Science Diploma should therefore also provide a sound foundation in maths and should enable students to use and apply mathematics'*
- *'Raising aspirations and preparing learners for Higher Education'*
- *'Develop an enthusiasm for learning and the application of that learning'*
- *'To ensure that young people have the tools to understand the scientific issues of the day'*

- *'Focus on the relationship between sciences and the wider society/how society affects science development'*
- *'To provide an integrated (i.e. interdisciplinary) view of the scientific endeavour'*

SCORE provided one of the most detailed responses, suggesting a variety of purposes that differ according to the level of the Diploma.

- At Foundation and Higher levels, the Diploma should focus on enriching the statutory curriculum and increasing learner motivation, while enabling learners to keep open their options for the future
- At Advanced level the Diploma should fulfil two purposes, one to prepare for science-based employment, and the other to prepare learners for science degrees

3.2.3 Possible progression routes

There have been two main points raised by stakeholders in relation to the possible progression routes highlighted in QD1.

1. That the current examples for employment routes are not fully comprehensive
2. That there should be greater emphasis on progression onto other learning routes

Employment routes

There appears to be general agreement among stakeholders that the current examples given for progression into employment are not comprehensive enough as they stand. The most common query in terms of routes being appropriate is the inclusion of **'nursing'** at level 2, generally regarded by stakeholders as being a graduate discipline. Nevertheless, some did point out that career opportunities are available within organisations such as the National Health Service at below degree level, so it may be that further clarification of these roles is required here. The inclusion of 'engineering' was also queried in one response, as this too was perceived to be a graduate profession.

'[The progression] seems reasonable but the examples don't seem to be equitable. Why would you go into nursing after level 2 but beauty therapy at level 3?'

- STEM outreach officer of major sector employer

It was also highlighted that examples of employment will need to be considered carefully, as these could potentially *'limit the perception of what it could lead to,'* with some queries as to what is meant in the document by a **'science career'**.

Helpful suggestions that could help address such issues included changing the wording so that the purpose statements refer to **'careers from science'** or

‘careers which utilise their science skills’. It was thought by stakeholders that this would help ensure that employment opportunities relating to, but not primarily based in, science are also considered by Diploma students.

‘We’ve also got to remember that these things have got to provide the opportunity so that a student can bounce off and go almost anywhere else, not simply come back into science.’

- Professional association for science teachers

One delegate at the consultation event stressed the importance of science skills in a wide range of other employment sectors: *‘...we need them in law, we need them in banking, we need them all through industry.’* An additional response received electronically emphasised that *‘the science workplace is as vast as the content we need to cover in the Diploma’* and that this can include working in academia, as well as the use of science-related skills such as analysis, modelling and problem solving within other *‘non-science workplace environments’* and applied to *‘non-science issues.’* Subsequently, it was suggested that it will be important to develop learners wishing to progress into science specifically, but also *‘open up the employment routes from science qualifications.’*

Other qualifications

Some stakeholders highlighted progression into other learning programmes and onto other qualifications as another area requiring more detail for future consideration.

To counter any worries that taking such a large qualification as the Science Diploma might force learners to ‘brand themselves’ as scientists as young as age 14, suggestions were made for the inclusion of *‘routes into other learning opportunities’* such as *‘apprenticeships and other qualifications from each level’* and that these examples should be *‘comprehensive.’*

Stakeholders expressed a request that learners studying other Diplomas at Foundation and Higher levels should be able to progress onto the Science Diploma and be clearly aware of this possibility.

Finally, some stakeholders, notably those represented through SCORE, advocate two distinct, clearly marked routes through the Advanced level Diploma: one for learners intending to progress into employment or apprenticeships, and the other for those intending to take science subject or science-related degrees in Higher Education.

However, another questioned the real level demand for science employees with qualifications below degree level.

'An ambition that has been laid out is that young people who follow this new expanded Diploma qualification will be more fully prepared for technical based jobs in the science based industries. This could be an attractive option, but we have not been able to identify strong evidence to show high levels of demand for post 16 and 19 entry into science based industries for those without Higher Education qualifications.'

- Science Council

3.2.4 Authentic workplace practice

The concept that the Diploma should be based on authentic and contemporary workplace practice was, in general, agreed upon and viewed positively by stakeholders involved in the consultation. However, there were some concerns as to how 'authentic workplace practice' is defined and ultimately, interpreted.

This was demonstrated by a number of stakeholders who took authentic workplace practice to mean the same thing as direct work experience placements with employers, highlighting concerns over issues such as Health and Safety. Another stakeholder – an employer – also queried whether the definition of authentic workplace practice could be agreed upon across the science community.

'I think it would be helpful to define what we mean by authentic workplace practice. As an SME we would probably see this as quite different from a research lab and, equally as a manufacturing facility...I could see getting into a very long debate about what was 'authentic'. I am not sure that any two companies would agree.'

- Employer

There were also concerns raised as to whether consortia would be able to access the facilities and equipment required in order to offer experiences of 'authentic workplace practice', that teachers would need '*access to resources showing how to use this approach*', and also that this approach may sometimes require relationships to be developed with local HE providers who may have the more expensive pieces of equipment available.

Another concern was that too great a focus on applied and work-related learning could compromise the Diploma as a preparation for GCE A level science subjects.

These concerns aside, it was generally agreed that the approach of the Diploma should include '*formally applied practical skills*' whilst '*raising awareness*' of issues such as Health and Safety and good practice, and ensuring that learners develop an understanding about the '*principles on which they [workplace techniques] are based.*'

3.2.5 Scientific skills and knowledge

Overall, the statement on scientific skills and knowledge was greeted somewhat warily by most stakeholders. Although some wholly agreed with it, most had some concerns with wording or items that were either perceived as being missing or unclear.

Skills suggested for consideration at this point by several stakeholders are:

- Problem solving skills
- Critical/creative thinking skills
- Data handling skills (e.g. recording, analysing and interpreting data)
- Testing and evaluating (e.g. hypotheses or other people's work; or being able to dispute/evaluate issues such as the quality of data collection procedures and other scientific processes, and how errors can occur)
- Drawing conclusions from data and reporting and summarising these (rather than just analysing and judging validity of data)

'I know it is meant to be a work based applied thing but you can't do it without the thinking and there's nothing here about asking the right questions. You know, for me, being a scientist is asking the right questions...Hypothesising, theorising, thinking, questioning.'

- Pressure group working to promote science and engineering

One attendee at the event queried the inclusion of 'generic' skills such as teamwork and communication within a section headed 'scientific skills and knowledge.' It was therefore suggested by members of that particular discussion group that, although these skills are important, the statement needs to be *'unpicked a bit more'* so that it is clearly identified how each of the generic skills is applied within a scientific context (e.g. time management required when carrying out scientific processes).

3.2.6 What scientists do

The idea of an approach focusing on 'what scientists do' was generally liked by stakeholders, although the majority also suggested further additions to this list so that it covers, as one stakeholder put it, *'why scientists do what they do'* – i.e. that a sound foundation of theoretical knowledge will be an essential element to the Diploma. This was suggested not only to help develop a learner's understanding of the principles behind scientific processes, but also to ensure the Diploma considers the wide range of ways in which science can be applied in the world of work and *'in the wider economy'* (not just within a laboratory setting).

Specific suggestions include:

- Explanation and theory as part of **‘modelling’**
- Within the **‘modelling’** section include enquire, investigate, question, communicate, research
- Add **‘research’** as a separate section (e.g. designing, discovering, inventing)
- Add **‘trailing’** as a separate section (e.g. large scale tests to establish cause and effect)
- Add **‘communicate’** as a separate section (e.g. developing reports and summaries of work, input into science-related policy, peer review, participating in forums, conferences etc.)

3.2.7 Organising scientific skills

Stakeholders were divided over whether it is still useful to use biology, chemistry and physics as a way to organise the scientific skills and knowledge required in the Diploma.

Some suggested during the consultation that three separate disciplines do need to be *‘preserved’* and made *‘explicit’* within the Diploma to:

- a) enable continuity from Key Stage 3
- b) ensure the content is recognisable in comparison with the National Curriculum
- c) ensure that important areas of science are not omitted
- d) make teaching the Diploma *‘as easy as possible’* for deliverers
- e) ensure the Diploma is not perceived as generic *‘science studies’* rather than a *‘hardcore science’* option
- f) help learners understand where their interests lie and what to expect when they are progressing to, for example, A level study or a single science degree course
- g) help clarify potential progression routes onto HE courses

‘...people need to understand where their areas of interest lie if they want to go into further study or if they do a level two and then want to do specific A levels, they really need to understand how subjects contribute.’

- Pressure group working to promote science and engineering

For others, however, the separation of the three distinct disciplines of biology, physics and chemistry is *‘a rather nineteenth century view of science’* or *‘a barrier to more effective teaching.’* The main argument from stakeholders for a more holistic approach within the Science Diploma seemed to stem from the idea that this may better reflect the interdisciplinary nature of much scientific activity, or that the science industry is *‘often found in the areas between disciplines.’*

'Parallels between different sciences often offer better insights for students so we should focus on bringing all sciences together...We find in our business that we are often dealing with a combination of Physics, Chemistry and Biology. Why not get real world examples of this process into the curriculum?'

- Employer

3.2.8 Depth and Breadth of Learning

This was a difficult subject for many stakeholders to comment on in any detail, as it was felt to be too early in the development process to consider these sorts of issues.

However, where feedback was given, this generally indicated the need for assurance that the Diploma will be at least as rigorous in depth and breadth as current GCSE and A level offers in science.

'At level 2 and level 3 there has to be recognisable and comparable depth and breadth to GCSE and A level. At level 1 there is a big opportunity to create a 'technician' pathway.'

- Specialist science college

It was suggested by a couple of stakeholders that the Foundation level would need to remain fairly broad so as not to restrict learners in developing their interests. Relating to this, one workshop discussion group suggested that there should be increased levels of choice for learners, enabling them to specialise more as they progress through the three levels of the Diploma. The current applied GCSE in science was cited as being *'really supportive'* to learners in this respect.

'This [the Diploma] needs to have content equivalent to existing qualifications, especially at level 3 if it is to have currency...For Key Stage 4 students not to miss out on opportunities open to their peers following a GCSE path, there will need to be some flexibility across Principal and additional learning to accommodate content that would be found in combined, applied and triple science options.'

- School

Ensuring appropriate mathematics content was also cited as being very important by a number of stakeholders.

3.2.9 Categorisation

Diagram 1 in document QD1 was received somewhat cautiously by stakeholders. Although a few suggested that the diagram might be a *'good start'* to thinking about the way the content of the Science Diploma is organised, it was generally acknowledged that *'it needs a lot more unpicking.'*

One stakeholder did comment on how the diagram *'illustrates the need to cross boundaries created by the separation of science disciplines.'* Others suggested that it is currently *'rather narrow'* in scope, with one industry stakeholder commenting that *'businesses need (and we recruit against) a variety of competences which are not represented in this diagram.'*

Content identified by stakeholders as being missing from Diagram 1 (QD1 version 1.7)

- Chemistry
- Electronics/Electrochemistry
- Astronomy/Space
- Energy/electricity
- Psychology to appear within 'Science in the Human World' rather than in the 'Natural World'

The terminology used within the diagram was also questioned, and particularly the use of the term **'man-made'** which was suggested to be old-fashioned and open to accusations of gender-bias. One stakeholder suggested that if these themes were to be used then it should simply become the **'made'** world. Other concerns were also raised about the concept of a **'human world'**, that *'we are all part of the same world.'*

Others felt that the diagram focussed too much on vocational opportunities or the *'end procedures'* and that it does not appear to be *'fulfilling many of the goals of the vision.'*

3.2.10 'General science skills' in the Diagram

The central circle also provoked some debate, with 'general science skills' identified by stakeholders listed in the table below.

Suggested content for the central circle
<p>Widely cited:</p> <ul style="list-style-type: none"> - Mathematics/statistics - Communication (written, oral and aural)
<p>Additional suggestions:</p> <ul style="list-style-type: none"> - Manipulating/use of equipment - Dissection (Advanced level) - Handling live organisms (Advanced) - Report writing/literature reviewing - Making judgements and formulating arguments - Creative/critical thinking - Problem solving - Achieving reliable evidence/assessing validity - Testing predictions/hypotheses - Taking measurements and using appropriate language/terminology for these - Data literacy – analysis and interpretation, knowing how errors arise - Modelling - Experimental design , observation, recording - Research/investigative skills - Testing and evaluating - Team working - Presentation skills - Appropriate working practices (e.g. timekeeping) - Safe laboratory practice/Health and Safety - IT skills (e.g. text documents, spreadsheets, internet searches) - Leadership/people management (Advanced level) - Project planning (Advanced level) - Understanding that science embodies a 'network of concepts'

Finally, there were also suggestions of a different model:

*'It would be better to have in the centre **what scientists do**, a second circle then covering the programmes of study from the National Curriculum, or the areas from the subject criteria for A level, and then an outer circle which gives the additionality.'*

- Professional association

Another respondent suggested a very similar approach, with the central circle

including skills and knowledge areas such as maths and communication, the next circle representing the Principal Learning covering the National Curriculum themes, and then an outer circle adding *'experiences and topics beyond those covered in the National Curriculum.'* A third stakeholder again referred to the themes covered at Key Stage 4 during the workshop discussions, asking *'what's wrong with the existing model? ...If teachers are used to this set up, why start again?'*

3.2.11 Additional and specialist learning

A number of stakeholders felt that it is difficult to comment on how additional and specialist learning (ASL) will contribute to desirable pathways through the Diplomas without first of all knowing exactly what will constitute the Principal Learning.

Where suggestions were made these were mainly regarding mathematics and languages, or enabling students to specialise in particular areas of science in preparation for employment or Higher Education.

'For the Diploma to lead to working in science or Higher Education science study, students will need to study two science subjects to greater depth than the Principal Learning will probably allow.'

- Trade association

One stakeholder attending the workshop did suggest that the ASL is an opportunity for learners on the Science Diploma to *'be experiencing arts and culture so that they are a much more rounded individual, this is the area where languages, music, art and so on should be introduced'*. Another stakeholder responding to the consultation by email noted that it is *'important that there is also opportunity and encouragement for learners...to continue their mathematical studies.'* Further comment was received – again electronically – that at Advanced level, specialist ASL is *'likely to be of particular importance'* to enable entry onto science HE courses.

'By working with regulators, professional bodies and specific industries, it may be possible to incorporate existing professional qualifications, which are often at level 3, as ASL. This would make the course attractive as a general science course, with real opportunities to enter the workforce or to continue with education.'

- Professional society

The consideration of ASL did, however, provoke quite lengthy debate during the workshop discussions regarding how existing science provision – and particularly GCSE and A level – would fit with the Diploma. In particular, some stakeholders voiced concern regarding duplication of syllabus if learners taking the Advanced level Diploma in Science also opt to take an AS level science subject, for example, as part of their ASL.

'If you are doing a Diploma, and you are doing AS Chemistry, that means that the unitisation of the knowledge necessary for the Diploma...focuses on other areas and not the stuff they have done at AS level.'

- Inspection body

3.2.12 Coverage of Key Stage 4

Many stakeholders were unable to provide detailed comment on the extent to which Key Stage 4 science should be covered in the applied learning experience of the Diploma, and indicated the need for further debate about this issue before a firm view could be taken either way.

Among those that did offer feedback on this, it appears to be generally felt that Key Stage 4 science does at least need to be acknowledged within the content of the Science Diploma at Foundation and Higher level. However, there is some disagreement among stakeholders as to the extent to which this should occur.

For the majority, it would seem important that the Key Stage 4 curriculum is covered within the Diploma:

'It is essential to incorporate the breadth of study that current GCSE qualifications offer if the Diploma is to both have the academic currency and the added value of a skills/applied approach. There should be enough flexibility in the Diploma to create pathways that attract students who would normally be expected to follow triple science.'

- School and science college

One attendee at the workshop event also suggested that not including the Key Stage 4 curriculum could potentially, even if inadvertently, undermine the current Programme of Study covered at GCSE. Another felt that it would be *'madness'* to make students cover the National Curriculum Programme of Study in addition to doing the Diploma.

However, for some others the idea of covering the whole of the Key Stage 4 curriculum may cause difficulties with overlap and duplication. There was also a suggestion among one discussion group at the workshop event that some schools are currently offering a condensed Key Stage 3 curriculum, meaning that students begin to cover Key Stage 4 during Year 9. It was therefore suggested that the results of the pilots for this approach will need to be carefully considered during development of the Diploma in Science. Queries relating to timetabling and school resources were also raised by some stakeholders.

Furthermore, one Awarding Body raised concerns regarding the coverage of Key Stage 4 at both Foundation and Higher levels.

'This is where the issue of including the KS4 PoS [Programme of Study] gets tricky, since it is the same for both level 1 and level 2 in GCSE, but the level 1 and level 2 Diplomas will need to be different. I think the PoS has to be included in its entirety at level 2, so that students can progress to GCEs in the sciences as well as to the level 3 Diploma. This will present huge problems in constructing the level 1 Diploma which cannot overlap with level 2, or with the KS3 PoS.'

- Awarding Body

Delivery and resource issues were also raised, with the consideration from one stakeholder attending the workshop event that since not all learners will take the Science Diploma, the National Curriculum will still need to be delivered, *'and that's a timetable and delivery issue that really does have to be taken seriously.'*

As one stakeholder put it, there may need to be *'more discussion of advantages and disadvantages'* before an approach can be agreed upon as to the coverage of the National Curriculum at Key Stage 4 within the Science Diploma.

3.2.13 The Foundation level Diploma

The Foundation level of the Science Diploma was an issue that sparked some debate during the workshop, and also received queries within the responses submitted electronically. One organisation, the ABPI, went so far as to say that they were not going to provide comment on the Foundation level *'as our industry does not have any interest in employing students who complete the Diploma at this level.'*

Others were worried schools involved in the delivery of the Diploma would be unlikely to want to offer the Foundation level Diploma in consideration of league table results and the proportion of students recorded as achieving GCSEs or equivalent at grades A* - C.

On the same note, some felt that if the Foundation level is going to be designed with learners unlikely to achieve Grade C or better at GCSE, there would have to be careful consideration of the reasons why some learners are only predicted the lower grades. In particular, there was concern that this approach to the design (although among some stakeholders there was support for it) could limit the potential for higher achievement levels among learners who respond well to the applied approach, develop further than originally anticipated and are consequently capable of achieving a higher grade than initially predicted.

'The difference with the applied science is that...where they might have got the D, a lot of them are getting C's or even B's because it is to do with the different approach. So they are actually moving them forward. Now the danger with this is you lock them into level 1 and therefore by sixteen they are a failure because they have only got the level 1 Diploma.'

- Professional association for science teachers

The result of this debate was a suggestion that the content within the Foundation and Higher level Diplomas in Science should be in some way linked so that a learner developing at a quicker rate than originally predicted is able to 'jump' from a Foundation to a Higher level Diploma and therefore achieve a higher equivalent grade than those available to them at Foundation level.

For some stakeholders, it would be necessary to ensure that those learners taking the Foundation level Diploma remain enthused about the experience – for example, that the qualification was *'billed as smaller rather than lesser...a taster'* – so that perceptions of the qualification remain positive.

'The level 1 Diploma should motivate and excite students so that lower ability students have the opportunities to achieve a positive outcome. We need to ensure that the level 1 qualification is not seen as a qualification that is aimed at potential GCSE 'failures' as this may damage the reputation of the level 1 qualification.'

- Awarding Body

3.2.14 Techniques-led approach

The appropriateness of a techniques-led approach to Principal Learning in the Advanced Diploma was met with some degree of uncertainty by stakeholders unclear as to what a 'techniques-led' approach entails. Concerns were also raised by one stakeholder that for such an approach to be meaningful, adequate facilities would have to be available within educational institutions to ensure that the techniques used were genuinely relevant to current workplace practice.

Many did agree however, that a practical approach to learning at Advanced level was appropriate, combining skills, processes and contexts with the theory required for progression onto Higher Education courses.

Much of the discussion at the workshop event, and some of the responses received electronically, digressed from this point however, to consider the three different types of Diploma available at Advanced level. It is clear from the questions raised, that stakeholders require further clarity on the *'point'* and role of the different sizes of Advanced Diploma.

'People will think 'oh the little one is for those who aren't very good' and so more means better. And that's often a trap that people fall into, so it needs to be stated why there needs to be three.'

- Charity supporting development of vocational education in science, engineering and technology subjects

Document QD1 also mentioned debate over the extent to which specialism is desirable in the Principal Learning, or whether this should be achieved through ASL. Some participants in the consultation took up this point.

'I agree that specialism should come through ASL whereas underpinning scientific knowledge should come through Principal Learning and include techniques such as testing, observation, analysis, conclusions and reporting which are the foundations for all areas of science.'

- Sector Skills Council

3.2.15 Lessons from the past

There was limited feedback on this aspect of the consultation but stakeholders contributing to the debate on lessons and challenges from the past suggested that there is *'much to be learnt'* from the GCSE in Applied Science and the previous GNVQ in terms of enabling learners to develop practical and generic skills, as well as reviewing the possible lack of this within the current science curriculum at GCSE.

'The Applied Science has produced courses with a much greater emphasis on developing practical skills and less on purely science knowledge... With the greater science content being tested with external examinations [in current GCSE 'triple science'], what time is there for hands on practical work?'

- Retired science teacher/examiner

A number of stakeholders suggested the need to trial the Science Diploma before it is rolled out nationally. Although it was accepted that timescales will not allow for this, concerns were raised that there should be *'enough time for development'* and consultation processes.

Much of the focus during the brief time it was given at the workshop event was given to delivery issues and the professional development science teachers will need to undergo, not only to enable them to deliver the applied approach proposed within the Diploma, but to dispel negative perceptions of qualification innovation still lingering from GNVQ days.

'Look back at the history of GNVQ and a lot of people invested a lot of time and effort into that and quite a lot of them liked it and thought it was quite good. It disappeared and I think there may be a certain portion who might think well, it is just another one of those....'

- University

This was generally agreed among the members of the same workshop group, with another going on to suggest there would be *'a lot of angst'* among teachers who have never needed to develop the skills to deliver a *'more flexible curriculum'* such as that proposed through the Diploma. As a result, it was thought by stakeholders to be important that teachers are shown *'what you do with this freedom when you are given it'* and that they are able to deliver the subject in a relevant *'work-related'* context, rather than just the academic theory.

'We need to use industry standard approaches to working with data. GCSE has invented a whole lot of vocabulary which is not used in the industry. Subjects like accuracy, resolution, errors and so on need to be described in a way which is common between industry and schools.'

- Employer

SCORE has advocated the commissioning of specific research on the successes and failures associated with the development of previous science qualifications. This will be borne in mind during the secondary research for the Science Diploma.

3.2.16 Practical skills

When asked to comment on the laboratory practical skills frequently highlighted by science companies as being important, stakeholders generally agreed that the list provided in QD1 is *'very narrow'* or *'incredibly limited'* as it stands. Several were also concerned that the list appears biased towards chemistry.

'Those are the skills of an analytical lab that wants to analyse various bits and pieces but...What if you are a palaeontologist, or a geologist? What if you are an astronomer...What if you want to measure animals and plants? None of those are mentioned...We could put hundreds of them down.'

- Inspection body

Practical skills suggested for inclusion

- IT skills
- Measurement of mass, volume, distance, pressure, length, height, area and depth, measurement of human behaviour and mental processes
- Observation
- Handling laboratory equipment
- Dissection of animal organs
- Handling live organisms
- Tissue culture and collection
- Aseptic techniques
- Sampling techniques
- Plant identification
- Drawing
- Constructing electrical circuits
- Working knowledge of Health and Safety issues
- 'Calibration techniques' rather than specifics such as calibration of pH meters

Some stakeholders suggested that concepts need to be widened – so 'weighing out of materials' would include, as in the box above, the measurement of mass and distance for example – and metric measurements should also include different types of **unit** such as joules and watts. The reference to imperial measurements was queried by some stakeholders, and others felt that '*non-lab practical skills*' should also be included within this section, with skills such as data collection in the field and report writing offered here.

'Laboratory skills are only one aspect of being a scientist, and an over-emphasis on this area will lead to the Diploma being seen as a purely vocational option. Scientific methodology incorporates the understanding of how to set up experiments or fieldwork, the mathematical skills to interpret data (which are important practical skills) and the imagination to theorise and extrapolate.'

- School

A small number of stakeholders suggested the inclusion of distinct 'unit(s)' focussing on practical skills, covering the use of equipment, quality control and Health and Safety.

'There is a case for having specific units in practical work that complement the theoretical learning.'

- Intelligence agency

One respondent also suggested having specific units for safe practice and

correct use of weights and measures at Foundation level, but then embedding these skills throughout the Higher and Advanced levels to ensure that their application becomes routine.

3.2.17 Overlap with other Diplomas

Several suggestions of where overlap may occur between the Science Diploma and other Lines of Learning have been put forward by stakeholders during this short consultation, commonly citing the links between science and engineering, but also seeing overlap between the Science Diploma and:

- **Manufacturing and Product Design:** materials science and topics on process chemistry, pharmaceutical practices and bioscience
- **Sport and Active Leisure:** sports science
- **Land-Based and Environment:** research methods and skills
- **Humanities:** possibility of psychology being included as a social science

For the majority of stakeholders, this overlap is thought to be an inevitable result of the application of science within a broad range of sectors, and is generally regarded as being permissible and potentially desirable within the Science Diploma *'as long as it makes sense.'* Subsequently, the proposition within QD1 that this overlap would *'not duplicate content'* was also queried by some, as the content may be relevant for more than one Diploma, and learners will only be undertaking one of the Lines of Learning at any given time.

'Learners will study one Diploma only and therefore there is no risk of a learner covering the same material twice. Excluding a topic that appears in another Diploma may deprive a learner who is following the Science Diploma from gaining important skills, knowledge and understanding.'

- Awarding Body

In addition, an e-mail response from an SSC's education and qualifications team pointed out that some duplication was *'both permissible and desirable if progression between Diplomas is to be achieved successfully.'*

Only one stakeholder, the New Engineering Foundation, raised strong objections to overlap between Diplomas, perceiving this to potentially be *'very dangerous.'*

'The idea of the Diploma is to teach in context. Now, if we take something like Mathematics for Engineers, which is being developed for the Engineering Diploma, the whole of the contextualisation of that course is very much in engineering. If you take the same syllabus and put it into science, all the context will be engineering context.'

- New Engineering Foundation

It should be noted that another stakeholder responded by arguing that *'we cannot remove these mathematical requirements from the Science Diploma on the basis that Engineering has the same content...we should identify the requirements of the Science Diploma in isolation from the other Diplomas without worrying about overlap.'*

The concern regarding contextualisation has been raised by other stakeholders, with one suggesting that units from other Diploma Lines of Learning could be included within, for example, the ASL element of the Science Diploma as long as the assessment criteria *'reflect a strong focus on science rather than the sector themes.'*

The issue of psychology being included within the Humanities (and possibly Social Sciences) Diploma was also raised by one stakeholder, but using a point that seems to encapsulate the views of many on the issue of overlap with other Diplomas – i.e. that it is permissible for such overlaps to occur, but that *'it is important that a scientific approach is maintained.'*

3.2.18 Critical success factors

There was very little time available to discuss the critical success factors of the Science Diploma during the workshop event, and only a small amount of feedback has come through other responses. Where comments have been made it would appear that the list of bullet points included in QD1 has been generally well received. However, some stakeholders did indicate areas to add:

- Maintaining the relevance of the Science Diploma to a broad range of employment sectors
- Stronger emphasis on supporting opportunities for progression into Higher Education, and creating strong links with HE institutions during the development process
- Ensuring that delivery and assessment give the learner 'ownership' and enables progression towards independent learning
- Improving the media profile of science, taking care to communicate the benefits of the Diploma as widely as possible

In addition, there were some suggestions that the success of the Science Diploma will be dependent upon funding and resources available to consortia

to provide innovative and practical, work-related learning experiences, appropriate work placements, as well as for the professional development of the teaching workforce.

'The knowledge and expertise of teachers is critical to the success of their students... Opportunities for teachers to visit science workplaces to see how science is used in industry, hospitals and other scientific workplaces would be valuable and should be sought. Employers willing to offer visits to teachers should be identified during the development of the Diploma.'

- Trade association

The use of the term '**the Science Diploma is a preferred alternative**' in this section of QD1 has been queried by a couple of respondents, suggesting that this should be amended to a 'rigorous', 'attractive' or 'equally valued' alternative route. It was also suggested by one that **teachers and learners** also need to see the Diploma as a valuable alternative route, rather than just parents, employers and Higher Education.

An Awarding Body also suggested that the factors listed in this section of QD1 should be reviewed if and when amending the vision and purpose statements, as *'it gives much more flavour'* to what the Diploma in Science is about.

4 RECOMMENDATIONS

The recommendations that follow are based on the feedback received from stakeholders, and have taken into account the fact that the latter set of the nineteen questions were answered to a much lesser degree:

Vision & Purpose

- ★ As a starting point, and of the vision statements offered, it seems that the recommendation is to combine 1 and 4, and emphasise the learner and the unique selling point of the Science Diploma.
- ★ There is also a need within the vision and purpose statements to define more closely and precisely what the Diploma is supposed to add to the existing qualifications landscape.¹

Categorisation

- ★ The messages from stakeholders at this early stage seem to be to emphasise “what scientists do” and the principles behind why they do what they do.
- ★ Add in much greater detail about *applied learning* in the science context. This could provide the basis for a new/enhanced diagram and ensure missing aspects are covered.

Content

- ★ Further detailed review needs to be undertaken regarding the treatment and coverage of Key Stage 3 and Key Stage 4. This should include, if and where available, the results of a pilot condensing KS3, so that learners take three years (9 – 11) to complete KS4.²
- ★ Further work on, and consideration of the meaning, in reality, of
 - ‘authentic workplace practice’ and,
 - a ‘techniques-led approach’

This is to ensure that clear definitions of these terms (if used) are developed and understood by stakeholders.

Coverage for all types of learners

- ★ In terms of the design of the Foundation and Higher levels – consideration should be made to the possibility of linking the two to enable learners to “jump” up a level, and/or encourage them to aspire to achieve higher grades or a higher level than anticipated.

Progression

- ★ Further work and information needs to be researched into progression from the Science Diploma into employment opportunities, and other qualifications and training programmes, to enable meaningful feedback from stakeholders on these proposed routes.

¹ The Market View research planned as a later activity will be an important source for this

² As above