

Introduction

The Institute of Physics (IOP) Scotland welcomes the independent review and the opportunity to respond to the consultation.

We also welcome the extension to the consultation period, without which it would have been difficult if not impossible for many organisations which wish to engage with the process of education reform to respond to three consultations within the space of a few weeks (including those relating to the National Discussion on Education and the skills delivery review), and over a period which includes not only the Christmas and New Year break but also a period of industrial action within Scottish schools. The questions posed by the review are also profound and significant, and the consultation paper itself acknowledges that this builds upon significant other pieces of work during the past two years, so allowing sufficient time and space to respond is likely to generate more insightful and useful contributions.

Responses to consultation questions

Question 1:

- (a) Should information be gathered across all four capacities? No**
- (b) Please consider each of the capacities in turn. What kinds of information should be gathered on learners' progress and achievements in each capacity?**

No, we **do not** agree that assessing based on the four capacities would be practical or helpful.

It is fair and appropriate to consider each of the capacities as intended outcomes at various stages of the education system, including for planning and (especially) promoting pupil wellbeing, diversity and inclusion. But it is far less clear whether or how they should impact upon qualifications and assessment.

Some of the indicators are either not easily amenable to assessment (e.g. openness, self-respect, healthy lifestyle, responsible contribution to society), or it is hard to see how these could be assessed in a fair way which benefitted pupils, or which would be practical to administer or a reasonable burden to place on teachers. A fundamental principle of any system of qualifications and assessment is that the system should be workable.

Any kind of assessment can be stressful for pupils who are aware of the impact that obtaining qualifications can have for their careers, further study options and life chances. Any assessment beyond attainment could create additional stress, especially for those who might be performing well academically but suspect they might be negatively assessed in terms of

being considered a rounded individual across some or all the capacities. The four capacities may be useful overarching constructs to consider when curriculum planning, but we do not consider them a suitable basis on which to base assessment. For this reason, we are not considering each of the capacities in turn in this response.

Question 2: What, if any, information on learners' achievements obtained outside school and college should be gathered? Please explain your response.

We understand the potential appeal of recognising achievements outside of school or college. However, this should be balanced against attendant risks and unintended consequences.

Doing so could potentially – or be perceived to – create additional pressure on pupils to take on extracurricular activity, especially the kinds which can be measured and more easily lead to recognition. Opportunities for achievement may be unevenly spread between activities which suit different personality types, and bear limited or imbalanced relation to the skills and knowledge which schools and colleges are principally responsible for fostering.

Further, young people's ability to engage in the types of activity which could lead to recognition may be affected by other exclusionary factors. Those with caring responsibilities or who engage in part-time work for financial reasons would have less time to participate in activities which result in recognisable achievements. Although working and caring for others alongside education would reasonably be regarded as commendable actions, they would be less likely to lead to the types of achievement recognition envisaged here. Similarly, some activities might require financial resources to access them, which not everyone would have, and some activities might only be available in specific parts of Scotland. It is certainly possible, and perhaps quite likely, that children and young people from the types of social groups who traditionally struggle in educational environments might have this exclusion exacerbated by not being recognised for external achievements to the same degree as others, or at all. Schools would also be less able to affect these external environments to make them more inclusive. This could inadvertently undermine recent efforts to close the poverty-related attainment gap, and to make education inclusive and accessible for all, especially underserved groups, in practical ways.

It would also be worth considering this proposition against other factors, including:

- (i) evidence of how the recreational use of free time contributes to balanced lives and the healthy development of children and young people;
- (ii) how such achievements could be verified on a fair basis, and if this could become a source of complaints or disputes which schools would be poorly placed to resolve; and
- (iii) whether this place a significant bureaucratic effect on schools and teachers.

Question 3:

a) Should information be gathered on learners' skills and competencies as part of their senior phase? Unsure

b) If you have views on how this might best be done, please provide them here.

Although skills are important in studying and pursuing physics, we are unsure about this approach and have some scepticism about it.

The study of physics requires and develops several key skills including: a grounding in mathematics and numeracy; understanding how we acquire and demonstrate knowledge; observation and analysis, including recording data; problem-solving and creativity; and the ability to use digital devices to data-log, analyse, communicate and collaborate. It rewards habits like logic, curiosity, open-mindedness, perseverance, and concentration. These skills are of wide, general application in other contexts and are important components for success in a wide range of rewarding careers. They also embody the democratic principle that the process of enquiry is part of learning as well as the acquisition of knowledge, and thus accessible to as many as possible.

Recording competencies works well in a limited range of subject areas, especially those which tend to progress into vocational education. Higher Still and Curriculum for Excellence (CFE) have already moved our system towards more skills-based approaches. However, as the OECD acknowledged, this has tended to de-emphasise the importance of knowledge in the curriculum and there is a risk that this approach would knock that further out of balance.

Some subjects, including physics, have benefited from high quality holistic assessments which assess the range of knowledge and skills developed; whereas atomistic, competency-based assessments can reduce assessments to bureaucratic "tick-box" exercises which can be detrimental to and distort teaching and learning processes.

It would also need to be considered how this could be done in ways which promote rather than challenge diversity and inclusion. There are also risks about atomisation and increased bureaucracy for schools, colleges, teachers, and lecturers. Any changes to assessment methods should be supported with appropriate professional learning for teachers and lecturers.

Question 4: Please share your thoughts on what a 'better balanced' assessment system would look like. As well as considering the balance between external examination and internal assessment you may also wish to comment on the frequency of examinations.

What is measured and assessed reveals what is valued in the education system. The purpose of school education should be learning, with class and home work designed to foment the knowledge and skills constituting attainment, these being observed by teachers and recognised throughout a school year. In subjects like physics, learning is cumulative, with progress dependent on securing and building upon sufficient levels of prior knowledge and skill. Learners should be able to build up recognition of their achievement through their education

rather than just in annual diets of examinations. A range of fit-for-purpose summative assessment methods should be used across the range of subjects in the curriculum rather than an overly prescriptive one-size-fits-all system, such as having an examination for all National Qualifications courses as is the case currently.

There clearly remains a role for independently assessed external examinations in any effective system of assessment. However, there should be a profound shift towards greater flexibility, a model which trusts teachers more to assess attainment, and away from what has been termed the “two-term dashes”. These are not conducive to effective learning.

There should also be flexibility within the assessment approach taken between subjects, since different subjects develop different knowledge and skills. Overly prescriptive assessment arrangements are inappropriate and have caused significant difficulties within the system, especially for more hierarchical subjects such as the STEM subjects, and especially physics. Interdisciplinary project units could be used to assess investigation and experimental skills, but these do not need to be built into every subject at every level. We have seen no persuasive argument or evidence for uniform approaches to assessment.

Greater trust in teachers and lecturers is required. Lessons should be learned from other systems such as the International Baccalaureate, developments in Wales, and from the FE sector, and as were described in the Stobart Report.¹ Good moderation and verification arrangements should be used to agree standards and allow for improved collaborative professional learning across the teaching workforce.

A good example of the current challenges is found in the National 5 and Higher physics assignments. The principle of such assignments is fair enough, but physics teachers are fiercely critical of these, which are not currently fit for purpose.

Further, the format of these reflects an overly rigid approach currently overseen by the SQA, in which each subject requires a distinct assessment. Pupils studying two and especially three science subjects invariably find these to be similar, leading to a good deal of overlap and duplication of effort for limited educational benefit, and this uses up a good proportion of class time comparatively unproductively. These drawbacks are accentuated by the requirement that assignments must be supervised in a classroom setting, with no feedback to students from teachers and lecturers allowed. This is not amenable to learning in later life, retraining, self-study or flexible routes for learning.

Immediately prior to the introduction of CFE, the Revised Higher Physics course included a ‘Researching Physics’ unit which was internally assessed by teachers and lecturers and externally verified by SQA. This provided a much more realistic assessment of the range of skills promoted by CFE than the current externally marked assignments which must take a restricted written format. Far better value and more reliable assessment could be achieved by

¹ *Upper-secondary education student assessment in Scotland: a comparative perspective* (2021), G Stobart. See https://www.oecd-ilibrary.org/education/upper-secondary-education-student-assessment-in-scotland_d8785ddf-en.

way of a more flexible range of assessment instruments, including appropriate exit assessments. Any new assessment arrangements must also consider the workload of teachers and lecturers and overall assessment burden of candidates.

With greater emphasis on a leaving certificate or exit assessments (see answer to Question 6, below) it will be important that appropriate assessment milestones are in place to motivate candidates to learn throughout the Senior Phase.

Physics particularly suffers from being associated with negative stereotypes about the nature of the subject and whom it suits. It can take a few years of development and experience for children and young people to obtain a more rounded view of it and be more aware of the career choices which it opens up: this is especially true for some categories of young people which are stubbornly underrepresented within physics (by factors such as sex/gender, disability, ethnic minority status, LGBT+ identity, and socio-economic status). The format of assessment makes this more difficult – especially the assignment element.

Yet, as well as individual life chances, there are also strong social and economic reasons to make these qualifications more accessible and flexible. In the next two or three decades, there will be increased demand for physics-based skills and knowledge – to cope with the increasingly digitised and automated age, the fourth industrial revolution, and especially the imperative of addressing climate change and achieving net zero. Recent research published by the IOP revealed that one-sixth of the entire Scottish economy is attributable to physics-based activities, and that this provides the equivalent of 220,000 full-time jobs, or 8% of the Scottish workforce: this the highest proportion of any nation or region within the UK and Ireland. Demand for these skills is growing, and there remain significant skills gaps to be filled. The sector is well-compensated: the average salary for physics-based roles is £47,000, which is 22% higher than the average in the transport and storage sector, 75% higher than the average in construction, and 2.5 times the average salary in retail. Over half of roles in the physics sector do not require a degree, so school-level physics qualifications offer a gateway to rewarding and productive careers.²

An overly structured or inflexible approach also reduces the opportunities to close the diversity and inclusion gaps beyond the age of 16. An assessment system which inhibits routes into physics would therefore have profound and far-reaching negative effects. On the flip side of the coin, a more flexible approach could improve articulation routes through into both further and higher education.

The ‘Researching Physics’ unit of the Revised Higher Physics course, mentioned above, is a good specific example of how more flexible assessment of skills has worked. There was no external course award: teachers assessed and graded against specified outcomes of planning, doing and reporting. The reporting element was flexible: by agreement with teachers, students

² See *Physics in Demand: The labour market for physics skills in the UK and Ireland* (2021), at www.iop.org/strategy/productivity-programme/workforce-skills-project, and *The Contribution of Physics to the Scottish Economy: executive summary* (2022), at <https://www.iop.org/strategy/productivity-programme/physics-and-economy>.

could choose to give a talk, demonstration or presentation, prepare posters, or complete formal reports. There were positive examples of science-fair type activities, and a range of good practices developed and were shared within the physics teaching community among those schools which took advantage of and embraced the possibilities of the format. This seemed to be entirely in keeping with the philosophy of the Curriculum for Excellence (CFE). However, a rigid and intransigent approach to the implementation of CFE meant that its replacement had to be externally assessed and marked, and written reports were deemed to be the only acceptable format. This extinguished much of the creativity in reporting, made the stakes higher for candidates, and has been ill-suited to some types of pupils. A different approach to assessment should recreate the positive elements of this experience, which would encourage students to flourish and could also generate more enthusiasm for physics as a subject. There is also a time-specific element to reintroducing or recreating this: there remains a sufficient body of knowledge available in the teaching community to capture and retain the positive elements of this experience, but that will not always be true. If the review recommends revisiting this type of opportunity, the IOP would be interested in working with others to identify and distil this knowledge into a useable format.

Open-book assessments would also reflect this flexibility and recognise an ability to process and apply information with less of a focus on memory and rote learning, which modern assessments are less likely to need to focus upon.

There should also be flexibility within the assessment approach taken between subjects, since different subjects develop different knowledge and skills. Overly prescriptive assessment arrangements are inappropriate and have caused significant difficulties within the system, especially for more hierarchical subjects such as the STEM subjects, and especially physics. Interdisciplinary project units could be used to assess investigation and experimental skills, but these do not need to be built into every subject at every level. We have seen no persuasive argument or evidence for uniform approaches to assessment.

A shift towards this kind of flexibility would require acceptance of teacher professionalism and its implications. It also means adjusting our system – including resourcing it appropriately – to ensure there is sufficient accessible and good-quality CLPL to empower and equip the teaching community to be more directly involved in assessment in ways which meet the overall objectives and principles of the system. We endorse the sentiment that “**all curriculum development rests on teacher development**”, expressed by the noted educational and curriculum theorist Lawrence Stenhouse in 1975.³

Question 5: Please share your thoughts (advantages/disadvantages) on the idea of introducing an achievement, award or qualification at the end of the BGE.

There is support among some IOP teaching members for some form of recognition of achievement at the end of BGE in S3. Only literacy and numeracy are formally assessed at this

³ *An Introduction to Curriculum Research and Development*, (1975), L Stenhouse, p. 26 (Heinemann)

stage currently. In particular, it is hoped that this would increase consistency of approach and articulation between the BGE and Senior phases. This should not necessarily mean that the Senior Phase should be seen as simply an extension of the current BGE: both elements should be revised, especially to ensure that they both adequately reflect the proper development of knowledge, as was highlighted in the OECD's review of CFE, and is especially important for the development of conceptual knowledge in subjects like physics. The importance of the role of knowledge should be better acknowledged, and the BGE and the Senior Phase should be better linked with each other to facilitate a smoother learning progression throughout schooling. This would also make exit assessment more relevant and important (see response to question 6 below).

A positive example of how this might be done is the Junior Cycle assessments (replacing the Junior Certificate) taken at the end of S3 in the Republic of Ireland. The IOP is aware of this because, unusually, as a professional body and learned society we support teachers and represent the discipline of physics across both the UK and Ireland. As the Cycle has replaced the Certificate, this now includes a classroom-based assessment element as well as a written examination. Junior Cycles are available in broad science, engineering, and applied sciences such as technology, materials technology (i.e. wood and metal work) and graphics. The science part includes the ability for students to demonstrate achievement by creating scientific research reports. There are also digital records of progress and examples of work which can be accessed by students themselves, parents and teachers. Crucially, reports following classroom-based science assessments may be presented in a variety of formats (see the response to Question 4 above): these cover both the formulation and testing of a scientific hypothesis, but also recognising the place and potential of science in wider society. The National Council for Curriculum and Assessment produces detailed assessment guidance for teachers.

In Scotland, we would benefit from clear curriculum and assessment guidance throughout BGE which makes it explicit what pupils are expected to know, to do, and to understand, as was highlighted in the OECD's review of CFE. This is essential if any award or qualification is to be made at the end of BGE. This would have the additional benefit of providing a sounder foundation for learners to transition to further study in the Senior Phase.

Question 6: Please share your thoughts (advantages/disadvantages) on the idea of introducing a type of leaving certificate in the Senior Phase.

There is support among IOP physics teacher members for a major assessment point at age 18, which for most young people would represent an exit assessment and school leaving certificate, which reflects progress in learning to this point, and which includes graded examinations in appropriate subjects at appropriate levels when required. However, the assessment point could also occur within employment-based courses or FE colleges, which would further encourage the flexibility we believe is essential. This would help to ensure that assessment is flexible, fit for purpose, and moves beyond the three "two-term dashes" which are unproductive and in many

instances counter-productive for learning, increase candidate and teacher stress, and encourage learning to the exam rather than reflecting broader understanding.

Such certificates, if introduced, should also be properly integrated into the Scottish Credit and Qualifications Framework, so as to create clarity and ready comparison between pupils in Scotland and those from elsewhere in the UK and Ireland when determining admissions to colleges and universities, and so they can also be readily understood by potential employers.

Question 7: How should Scotland's qualifications and assessment system make best use of digital technologies?

There are both opportunities and risks in using digital technologies within assessment. This is likely to be increasingly necessary in an environment of more flexible assessment, which we support. It may be more inclusive to allow students with special educational needs to use digital devices to give their answers rather than traditional paper-based examinations. Electronic assessment is increasingly prevalent in working environments for professional development such as HR requirements, so there would be a potential benefit for candidates in familiarising them with experiences and demands they will encounter beyond school. Physics-based knowledge and skills increasingly depend upon familiarity with IT and assessment may be an opportunity to demonstrate that.

However, we should also be aware of the limitations of digital assessment at this time, which lends itself towards formats where answers can be more readily marked and analysed, such as multiple-choice style rather than essay questions. These can restrict the breadth and therefore quality of the assessment in its ability to discern the candidate's full understanding of the subject, rather than techniques such as memorising answers and "teaching to the test".

It should also be noted that schools will have a responsibility to ensure that equity and access issues are catered for, so that pupils with access to more resources and support at home are not disproportionately advantaged.

A more pertinent concern relates to the increasing sophistication of machine learning/artificial intelligence authoring tools. As these become more widely available, they are also becoming sufficiently advanced to reflect individuals' writing styles, which would make their use increasingly hard to detect using currently available anti-plagiarism software. At this time there is limited public awareness, and this extends to schools and teachers, about the capabilities of AI and its potential to mask itself.

If AI becomes sufficiently adaptive to become difficult or impossible to detect, then digital assessment would have to be designed in such a way as to protect academic rigour and integrity and ensure that submissions were the candidates' own work. This is not a straightforward task, but it would be an important one not only to ensure assessment accurately reflected attainment but also to retain public and employer confidence in the outcomes. We would welcome a wider conversation about the role of AI and how it impacts on digital

assessment, especially because this type of activity could also help to increase public awareness and boost science capital.

Question 8: How can we make sure that proposals for a future qualification system will uphold the rights of all learners to demonstrate their achievements?

Diversity and inclusion are particularly important to the IOP. In response to a comparative lack of diversity among the sciences, since 2020 we have been running a **Limit Less campaign**⁴ to support young people to change the world and fulfil their potential by doing physics. In our experience, many young people are put off studying physics from age 16 both by misconceptions about what physics is and stereotypes about the type of person who becomes a physicist. This has negative impacts on young people themselves and our society.

Studying physics provides young people with a way to understand the world and is a gateway to a wide range of fulfilling and rewarding careers, both within physics itself and in other fields. But we will also need access to this talent to tackle some of the biggest challenges we face, including climate, public health and poverty, and capitalising on the opportunities of the fourth industrial revolution, including innovative physics-based technologies as varied as artificial intelligence, quantum computing, big data, the Internet of Things, photonics, robotics, advanced manufacturing, nanomaterials, 3D printing, gene sequencing, fusion, and further space exploration.

It is fair and appropriate to recognise that the national bodies, Education Scotland and the Scottish Qualifications Authority, have acknowledged and reacted to the need for equality and diversity for decades. However, this has led to a centralised, command-and-control model, in which there is a pervasive belief that equalities and equity can only be guaranteed under a system of uniformity. The concern about diversity and inclusion is understandable, but we believe the approach is misguided. A system which acknowledges teacher professionalism has to be based on trust in the workforce to conduct assessments in ways which recognise equalities and reflect inclusion. There is a responsibility to embed equalities, diversity and inclusion (EDI) throughout the system, and the key elements of doing this are professional teaching standards which set the benchmarks for good equalities practice and access to career-long professional learning (CLPL) which supports teachers to attain and refresh those levels of practice.

Question 9: Is there anything else in relation to the reform of qualifications and assessment which is not covered in this consultation which you would like to raise?

Although we have sought to reflect this point in responses to other questions, it is worth emphasising that a brave and radical review of the curriculum and assessment is necessary to obtain the most effective outcome, and this relates as much to the BGE phase as it does to the Senior Phase.

⁴ See www.iop.org/limit-less.

We also wish to record some comments on the nature of the approach to education reform which the Scottish Government has taken. We acknowledge that this is not principally the fault of Professor Hayward or the independent review group. Regrettably, the approach taken to public engagement and consultation on the wider programme has seemed disconnected and confused. In his own independent review, Professor Ken Muir recommended a national discussion on education, two decades after the preceding one, to seek to establish some consensus about the purpose, value and principles of the Scottish public education system. This discussion is ongoing, with the public consultation having closed just a few weeks ago, half of which was a holiday period. The real value of this would have required the consultation responses and analysis to be published and time allowed for these to be digested and discussed by those in and with a stake in the system, before proceeding to consider distinct elements and concrete steps for change. This has not happened here. There is no opportunity for learning or reflection from that exercise before embarking upon this one. Although every element of the reform process has acknowledged the existence of the others, it is not apparent that there has been a logical order or proper consideration of the most effective way to reach good and informed decisions. It seems self-evident that a rational process would have involved agreeing the purposes of the system as a whole and then considering distinct elements leading to those intended outcomes, including qualifications and assessment, and only then considering the institutional and resource implications necessary to deliver it. Yet decisions about institutional reform were announced early last year, and then in November the Cabinet Secretary for Education and Skills announced that accreditation and regulation functions would be retained by the qualifications body, contrary to the recommendation of Ken Muir. This approach impacts on the confidence teachers and the public have that the reform programme is as genuinely consultative as the ambitions which have been stated for it, and that it will lead to real and effective change.

In the past, decisions have been made about curriculum and assessment which have had unintended consequences. For example, the replacement of a four-year Senior Phase with a three-year Senior Phase with the introduction of CFE without proper knowledge and skills development in BGE and adequate transition arrangements from BGE to the Senior Phase has had significant unintended consequences on the breadth of curriculum and subject choices of pupils, particularly in S4 but also beyond, and an increase in multi-course teaching to the detriment of pupil learning and teacher workload. Also, the overly bureaucratic and not-fit-for purpose CFE unit assessments introduced by SQA in many subjects resulted in increased teacher workload and stress for candidates who ended up sitting several unit assessments most weeks during S4-S6. This resulted in the decision to remove the requirement for unit assessments as part of National Qualification courses at National 5, Higher, and Advanced Higher, and the introduction of externally assessed exams in subjects which did not previously have an examination such as Practical Electronics. There was little consultation of the teaching profession or consideration of alternative solutions to either of these fundamental changes.

A better solution to the workload problems with the unit assessments would have been a revision to ensure we had manageable fit-for-purpose unit assessments, something being sought by many physics teachers at the time, and which resulted in IOP funding and organising

the development of a suite of tests for teachers to use. With hindsight, it is easy to see that if this alternative course of action had been followed, as was desired by many teachers, it would have resulted in a national assessment system much better prepared for the COVID-19 pandemic and the lockdown of schools than was the case with the move to external examinations. It is important that future assessment and qualification changes involve genuine input from stakeholders, especially the teachers and lecturers that are responsible for the delivery of the education of our children and young people, and those practitioners and academics with relevant curriculum and assessment knowledge and experience.

About us

The Institute of Physics is the learned society for physics and professional body for physicists across the UK and in Ireland. We seek to raise public awareness and understanding of physics, inspire people to develop their knowledge, understanding and enjoyment of physics and support the development of a diverse and inclusive physics community. Our mission as a charity is to ensure that physics delivers on its exceptional potential to benefit society.

About this response

We are content for this response to be published. If you wish to follow up the issues raised in it, please contact:

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