

Responses to survey questions

1 What kind of education do you think children in Scotland will need in the future?

The Institute of Physics (IOP) Scotland agrees with the principles of Article 29 of the UN Convention on the Rights of the Child (that education should help the mind, body and talents of children and young people be the best they can, prepare them for responsible life in a free society, and promote respect for others and the world around them). We also believe that all children and young people would benefit from **a broad science education and the opportunity to study and pursue physics.**

Science education is vital to help children and young people learn about the world and how it works. Since science plays a crucial role in many aspects of daily life, including food, medicines, our environment and the technology we rely upon, a rounded education must have significant science content. Science education also teaches about the scientific method, which encourages critical thinking, asking questions, and seeking answers based on evidence. These approaches help children to develop the skills they need to solve problems and make informed decisions, as well as instilling values of openness, curiosity, imagination, integrity, fairness, and diligence.

Science knowledge and skills are highly valued and lead to successful, rewarding careers. They spark the innovation which grows the economy and creates opportunities for society beyond direct involvement in scientific research and its applications in industry; as the recent COVID-19 pandemic showed and as the threat of damaging climate change re-emphasises, science learning is also central to tackling our most vital social challenges. It is no exaggeration to say that lives, and the future of our planet, depend upon it. Since success in science relies comparatively less on status and personal connections than some other pursuits and professions, it also has the capacity to be a great social leveller.

All of these benefits are not only important, they are becoming significantly more so as our society relies ever more on technology and as the pace of change increases exponentially. Today's children will live through a fourth industrial revolution into a world where digital technologies like cloud-based data processing, the Internet of Things, artificial intelligence and robotics seamlessly integrate into daily lives, managing routines and information within homes, communities and workplaces but also increasingly becoming involved in creativity. Understanding and preparing for these changes will be crucial to maintaining social cohesion and humanity, and helping people to protect themselves against risks of exploitation and disinformation. Science knowledge and skills also help people distinguish between fact and opinion: as the COVID-19 experience also demonstrated, there is social

value in a broad understanding that scientific findings are derived from an elaborate, systematic process which leads to reliable knowledge, rather than simply what scientists believe.

IOP Scotland has been involved in promoting better science education, and physics education specifically, for decades. Since 2012, much of this has happened on a collegiate basis with other learned and scientific societies through the Learned Societies Group for STEM Education (LSG). The LSG has published a wide variety of reports and responses about the content and organisation of Scottish education, all of which are available online.¹ These include a manifesto for the 2021 Scottish Parliament elections and detailed responses to the OECD Review of the Curriculum for Excellence and the Ken Muir review. In a wide-ranging national discussion such as this, reference to the key elements of this previous work must necessarily be terse. We note that the LSG is submitting its own response to the survey and we endorse this. This response aims to amplify and supplement the LSG response in a physics-specific context.

This context underlies much of recent thinking which has shaped the modern Scottish education system. The Curriculum for Excellence was intended to develop personal capacities and flexible, interdisciplinary skills for life which were not tied to specific processes or careers which could be quickly replaced, rendering focused knowledge and skills obsolete. This is most clearly seen in the need and desire for a just transition out of the fossil-fuel based energy sector focused in North East Scotland. We will still need energy, and people working in that vital sector will need physics knowledge to design, manufacture and operate the technologies we need, whether they are renewable and/or if they incorporate far-reaching technologies such as fusion. The best approach is therefore to prepare young people for a changing world.

We endorse this approach and want to see it in effect throughout our system. However, we also believe that the current system does not fulfil the promise of the Curriculum for Excellence or pupils', our society's, or our economy's needs for the future, and that we should be prepared for radical change, not merely tinkering at the margins or the appearance of change, to make this a reality.

2 What do you think we can do to make that happen?

We propose a brave and radical review of the curriculum and its assessment. More flexible and responsive routes through the curriculum should be considered, as should moving to a form of exit assessments or at least reducing the need for pupils to be assessed in all subjects at the end of S4. Assessment is currently driving the curriculum and pedagogy to far too great an extent. Assessment is important, but it is not the primary goal of education. There is a risk that the distinct nature of the national discussion and the separate review of

¹ See <https://rse.org.uk/about-us/governance/standing-committees/learned-societies-group/>.

qualifications and assessment may cement rather than solve the dislocation between the BGE and Senior phases, which was highlighted by both the OECD and Ken Muir. A more connected, consistent approach would significantly assist with progression through the curriculum and avoids the current situation of schools effectively having to squeeze seven years of work into S1-S6.

There should be a proper review of the role of knowledge through the whole 3-18 curriculum and a redressing of the balance of knowledge and skills. This specific point was highlighted by the OECD and we believe it is of crucial importance. Much of science knowledge is cumulative, and developing science skills (and physics skills specifically) depends to a large degree upon a sufficient grounding of knowledge. The curriculum should specify this much more clearly so that teachers in subsequent years can more effectively rely upon pupils' prior learning and build upon it. This would also serve to promote the consistency we noted above.

We are deeply concerned about the narrowing of the number of subjects pupils in S4 can study in the time available. This has adverse implications for changes in choices in subsequent years, specifically including the ability to keep studying a group of STEM subjects alongside some other subjects, which in turn reduces the ability for interdisciplinary learning in the Senior Phase.

We support greater use of online assessment, especially for knowledge recall, while recognising that there may be issues with how pupils approach such assessments. We also support for more open project style assessments for higher level skills. We will make these points to Professor Louise Hayward's review.

High quality moderation and verification of teacher assessment will be required to ensure trust in teacher assessment and this must be workable in practice, and not result in an increase in teacher workload, or reduce the process to a 'tick-box' exercise.

National 5 and Higher Assignments are not fit-for-purpose and not good use of class time, although the Advanced Higher Project is well-regarded. Alternative methods of assessment of practical work should be considered in the future, including appropriate questions in examination papers. We would strongly prefer experiment report writing assessment similar to previous Outcome 1 or Outcome 3 assessments rather than current Assignments. This could be certificated separately to subject course assessments.

Schools must also be supportive learning environments which welcome all learners and which encourage them to be whatever they want to be. Inclusion and equity should be embedded as guiding principles for not only schools but all organisations involved in organising and delivering education. Specifically, we wish to see whole-school equity approaches formalised and adopted across schools and clusters, throughout all years and settings. Experience shows that focused action is necessary to overcome ingrained stereotypes and eliminate unconscious bias, allowing all pupils to feel they can genuinely

follow any education and career path. This level of planning should also be considered within school inspections, and teachers should be supported via career-long professional learning opportunities to examine their own practices and assumptions. The **Improving Gender Balance and Equalities (IGBE) programme**, currently located within Education Scotland following a pilot programme run by IOP Scotland, is a first-class example of this. During evaluations, virtually every participant in the programme reports finding the learning they obtain as valuable, related to their own practice, and worth recommending to others.

Enabling all this to happen requires professional teachers with responsibility to do and direct their jobs, provided that there are sufficient frameworks in place to provide some level of certainty, that there are appropriate and understood professional standards which inform teaching practice, and support available.

3 How can we make sure we understand and meet every child's individual needs in the future?

No answer to this question.

4 What is one thing that needs to stay. Why do you think it needs to stay?

Picking only one element to be retained is too restrictive. There are several elements which are essential in delivering high-quality physics education, including:

- **Practical laboratory work.** This allows pupils to consolidate and apply theories in a practical setting. Learning by doing engages pupils better, is more motivating and promotes better knowledge retention. The COVID-19 pandemic showed that the absence of practical work during virtual learning adversely impacted experiences for teachers and learners and led to poorer outcomes.
- A **curriculum framework** which specifies more clearly what children and young people should be expected to know, to do, and to understand. This added certainty should ensure there is a knowledge-based, skills-oriented curriculum² which has spin-off benefits for pupils, teachers and ultimately employers and tertiary education providers.
- A **well-qualified and committed teacher workforce** who have qualifications requirements, professional standards and career-long professional learning opportunities, and (for teaching physics at S3 and beyond) a relevant degree-level qualification. The main driver of the experience school pupils have is the quality of teaching they experience. Two specific factors which inhibit this are, firstly, the comparative lack of science experience among primary teachers and the variability of provision for STEM learning within primary initial teacher education, and secondly,

² See <https://theteachingdelusion.com/2021/10/09/a-5-minute-guide-to-knowledge-vs-skills/>

the low level of teacher recruitment in physics. On the latter point, recruitment has consistently fallen below Scottish Funding Council targets for many years.³ To address this, we should explore flexible entry routes, flexibility based on high-quality accreditation to allow existing teachers to gain GTCS registration in an additional STEM subject, and a national programme of high-quality subject-specific professional learning.

IOP Scotland strongly believes that widespread **subject-specific professional learning** is an essential element of high quality teaching and learning.⁴ Specifically, we believe there should be a systematic approach to developing teachers' subject knowledge, including a consistent national system of subject-specific professional learning within each subject which is integrated within the system, appropriately resourced, based on evidence-based practice, properly evaluated and which allows schools and teachers to plan for years ahead. As a driver towards this, teachers should be entitled to have at least half of their allocated time for professional learning dedicated to subject-specific options. This should also form a significant part of any increase in non-contact time introduced in the current parliamentary session. We believe only a strong commitment across the system and the combination of these push and pull factors will spur the culture change needed across the sector which increases understanding of the value of subject-specific professional learning for pupils, teachers and the entire system.

The **Improving Gender Balance and Equalities programme** should certainly be retained, notwithstanding reform of national agencies. We welcome the addition of Social Justice as a professional value in the revised professional standards for teachers, but it is important to ensure proactive steps are taken to embed equity, diversity, and inclusion throughout the education system and every reasonable opportunity is taken to promote this to practitioners. For generations, physics as a subject has suffered from perceptions as being unsuited to girls and women, and pupils with disabilities, who are LGBT+, or from some ethnic minority groups are also underrepresented, as are those from poorer socio-economic backgrounds. There is evidence that many of these groups are dissuaded from continuing physics study or careers because of perceptions that physics is not for them or people like them. This is why the IOP across the UK and Ireland is running a **Limit Less campaign**⁵ not only to change perceptions of physics, but ensure that everyone who surrounds and interacts with young people also reinforce those messages and do their part in providing a supportive and welcoming environment.

³ See www.gov.scot/publications/teacher-workforce-planning-advisory-group-initial-teacher-education-intake-figures-2021/ and www.gov.scot/publications/initial-teacher-education-2020-student-teacher-intake-statistics/pages/pgde-secondary-and-alternative-route-intake-figures/.

⁴ See www.iop.org/about/publications/subjects-matter

⁵ See www.iop.org/limit-less

5 What things do you think should be done first?

This question is partly addressed by our responses to questions 1, 2 and 4 above.

To some extent, the ordering as well as the outcomes of the reform programme are being driven by the Scottish Government's announcement of organisational change and the nature of the simultaneous reviews of both qualifications and assessment and also skills delivery. It would be preferable to approach this question from the point of view of determining the aims of the system as a whole and then deciding what factors are needed to give effect to it, and how these are to be integrated, resourced, evaluated, and kept up-to-date. The process of reform itself has raised questions about whether that cohesive approach is likely.

6 How do we make sure everyone involved in Scottish education has their say about its future?

We endorse the approach suggested by the LSG in its response, and in particular the suggestion that pupils and their families themselves should be actively involved in discussions about what the education system delivers.

7 How should we support and care for young people in the future? This includes their physical and mental health.

Better educational achievement is itself a major factor in promoting lifelong health, wellbeing and resilience. Those with the highest levels of education tend to live longer and be healthier than those with the least. Good educational outcomes increase the likelihood that students will develop positive, supportive and sustainable social connections and relationships; access good working opportunities and a fulfilling career; be adaptive to change, have problem-solving skills and value lifelong learning; and feel empowered and valued and more effectively advocate for their needs and interests. In turn, these foundations tend to lead to developing more healthy habits and lifestyles (e.g. diet, exercise, alcohol intake and smoking); managing life challenges and moderating risk (including of mental risks such as isolation, stress and depression); working in safer and healthier environments; and affording a better quality of life.

More educated people are also more likely to be able without assistance to identify and seek out sources of advice and support when needed. This produces wider social benefits, since they are more likely to volunteer, which in turn produces benefits both for themselves and others, and more likely to see value in participating in democracy. There are also circular effects, as people with these advantages as adults tend to pass on and reinforce these benefits to their own children. Good educational outcomes therefore lead to not only healthier, happier, and wealthier people, but also stronger families, communities and businesses. We would welcome decision-making and evaluation mechanisms within

Government and public bodies, but also the educational system as a whole, which acknowledge and promote these factors.

A specific series of risks facing young people in the modern world is the risk of cyberbullying and misuse of personal, especially sensitive, information. In an increasingly digital age, more information about everyone is shared and stored – this can lead to more customised services, but it can also be damaging. Better science education specifically is more likely to inform pupils and students about the risks of sharing information on digital platforms and how to manage this to minimise the risks; it is also more likely to produce an educated workforce who appreciate and can work to protect against misuse of data in professional contexts involving data collection, use and management and an educated population who can contribute to informed debates about regulation.

8 Every child has the right to reach their own potential. How should we make sure they get the chances to do this?

The forthcoming revised version of the Scottish Government's STEM Education and Training Strategy reinvigorates Scotland's commitment to closing equity gaps in STEM participation. As detailed in the LSG response, data constraints mean that it is difficult if not impossible to conclude the extent to which this target has been realised. The breakdown of male and female entrants does, especially in physics and computing science, however suggest enduring disparities. The difficulties in achieving the stated target of increasing the number of girls taking physics at Higher by 15% should not lead to a rowing back of ambition, but instead should encourage all to examine what more can and needs to be done to make increasing diversity a reality, and take into account lessons of those schools and programmes which have produced encouraging results.

Young people should also be provided with comprehensive and accurate careers advice to illustrate the wide array of careers available in physics and to raise their aspirations as to what may be possible.

9 How should we help children to understand the changing world and take part in those changes?

Our response to this is dealt with under section 1 above, and in the LSG response.

10 Is there anything else you would like to say about Scottish education?

We have one concluding comment on the consultation and reform programme itself. The large number of parallel consultation exercises currently taking place raises the issue of whether all stakeholders have the capacity to fully engage with these and respond in a considered manner and whether sufficient time is allowed to enable a well debated consensus to form as to the priority issues. In its review of CfE, the OECD recommended moving to a cyclical curriculum review model of perhaps eight or ten years. This would have

the benefit of providing curriculum stability between reviews allowing teachers and other practitioners to concentrate on improving pedagogy, and resource and other support providers to invest in work knowing this will be worthwhile, and consistent data to be gathered over several years to evaluate progress made. However, such a cyclical process gives the opportunity to have well planned and transparent consultations to determine issues to be addressed when it comes time for the next review. These reviews should offer both opportunities for wide consultation but bring those with appropriate knowledge and experience together, drawing from classroom teachers, school leaders, academics with appropriate research, curriculum, and pedagogical knowledge, as well as other stakeholders, to ensure curriculum and assessment reviews result in changes of a high but realistic standard.

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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