Response to the consultation by the National Council for Curriculum and Assessment on the review of Junior Cycle Science

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RIA

The Royal Irish Academy ('the Academy'), Ireland's national academy for the sciences, humanities and social sciences, welcomes the opportunity to respond to the consultation by the National Council for Curriculum and Assessment (NCCA) on the review of Junior Cycle Science. The views expressed in this submission are not necessarily shared by each individual member of the Academy.

What is the purpose of junior cycle science?

Junior Cycle science should help to stimulate an interest in science and support better informed citizens as well as supporting the continued flow of future potential scientists. This need reflects the reality that within the Junior Cycle (JC) student population there will be students whose formal science education will cease following the JC as well as those who will continue with science to the senior cycle and beyond.

The new cycle should ensure continuity of progress building on prior experience obtained within the primary curriculum and developing sufficient skills to progress to the senior cycle.

To achieve these dual purposes, JC science should – to paraphrase the physicist Richard Feynman – inspire both wonder and doubt. Success in this regard could be assessed by the answer students would give when asked "what is science?" An answer that emphasises ways of doing, investigating, exploring and questioning would represent success in this context.

The content of the new science curriculum should ensure that students are:

- Provided with a basic understanding of the ideas and methods of science
- Equipped with the required learning outcomes to advance to the senior cycle
- Taught by specialist teachers within each discipline
- Given the opportunity to apply their knowledge through practical work
- Allowed to develop ideas within a range of contexts
- Familiar with different techniques for investigating scientific queries
- Given a solid grounding in critical thinking and problem solving skills.

The Academy supports the views of SCORE (Science Community Representing Education). SCORE is a partnership of science organisations in the UK which aims to improve science education in schools and colleges by supporting the development and implementation of effective education policy.

It states that student learning should engender an understanding that the sciences are characterised by the following: [1]

- Evidence – acquiring evidence is essential, as is the ability to undertake evidence-based thinking and logical reasoning;
- Experiments – scientific experiments and investigations are key to the clarification and consolidation of theories;
- Measurement – the sciences are about observing and measuring phenomena to make predictions to test theories;

[1] SCORE, June 2013, p.4, accessed online at: http://score-education.org/media/12525/ks4%20guidelines%20final%20version.pdf

- Prediction – using established models and laws to make predictions or creating new explanations in real world situations;
- Construction – using established laws to make things we know will work;
- Explanation – to get closer to a full understanding;
- Repeatability, reproducibility and validity and falsification – scientific claims are replicable and should be testable; it is important to understand why a particular interpretation of evidence may be inconsistent.

Promoting inquiry based teaching and learning

At the heart of the primary and second level school curriculum should be the idea of student engagement with *each* subject as an inquirer. The Academy supports greater use of Inquiry Based Science Education (IBSE) within primary and second level education.

The Academy believes that IBSE should be increasingly drawn upon to support the realisation of JC science learning outcomes. IBSE is a positive way to disseminate knowledge of and enthusiasm for science among young people. It reverses school science-teaching pedagogy from mainly deductive to inquiry/investigative-methods leading to a more interesting treatment of issues and subjects by students. Project Maths, the IBSE-focused change to the mathematics curriculum in Ireland is showing encouraging results.

Students declining interest in science as they move from one part of the education system to another represents a considerable challenge. The TIMSS (Trends in International Mathematics and Science Study) data indicate that motivational interest in science present at age 8 drops between the ages of 11 and 15. This also coincides with the shift from inquiry-based to knowledge-based learning – from doing to definitions or rote-learning.

In moving toward greater use of IBSE considerable challenges remain namely (i) How to embed changed methodologies in the classroom, (ii) How to develop assessment to support IBSE, (iii) Correcting model divergence between science syllabus at primary and lower second level, (iv) Applying standard testing for maths and science competence at age 14. In respect of the latter, the challenge will be to develop a test that adequately assesses if a student is able to extrapolate from what they have learned and apply that knowledge to a real world scenario.

The TIMSS 2011 study of trends in science achievement since 1995 found that teacher preparation and career satisfaction is related to higher science achievement. At both the fourth and eighth grades, students with more experienced and more confident teachers had higher science achievement.[2] Teachers themselves trained in the knowledge-based system require considerable support and additional professional development of enable them to confidently adopt and roll-out IBSE. This creates a significant continuous professional development (CPD) challenge. An Academy discussion forum in November 2013 on new approaches to science education noted that a key challenge to the embedding of IBSE is the provision of in-service training for one million teachers in the primary sector alone across Europe. There is also a case against making IBSE too prescriptive and an obligation on

[2] The *TIMSS 2011 International Results in Science* summarizes fourth and eighth grade student achievement in 63 countries and 14 benchmarking entities. It includes trends in science achievement over time for participants in the previous TIMSS 1995, 1999, 2003, and 2007 assessments, as well as student performance at the TIMSS International Benchmarks (Martin, M.O., Mullis, I.V.S., Foy, P., & Stanco, G.M., 2012, 16–17).

teachers. In France, for example, IBSE is optional for teachers. Now, more than 30% of teachers at primary level choose to carry out IBSE based science lessons.[3] The NCCA could look to foster links between teachers, via the internet, first within Ireland and, then internationally, taking advantage of the universal nature of the laws of science to establish direct contacts between classes in different countries on subjects of global interest (e.g. climate, ecology, geography) (IAP, 2003).

Choosing content

Science is fundamentally concerned with biology, chemistry and physics. The Academy would normally expect chemistry, biology and physics to be taught as separate disciplines with a clear outline provided of the core knowledge and understanding relevant to each.

The interaction between disciplines may be achieved by, for example, taking the example of energy as a possible thematic unit, requiring a fundamental understanding of physics, chemistry and biology to understand and explain what energy is and the importance of different energy sources.

Assessment

It is important to be realistic and recognise that the major present day goal and target by which performance is assessed for teachers, learners and parents are the learner's Junior Certificate results. Curriculum reform unaccompanied by reform of the assessment process will have little impact. There is little value in advocating for IBSE if the method of assessment remains based on the 'old curriculum'.

The Academy concurs with the views of SCORE that assessment of science at this level should meet a number of guiding principles namely:

- Assessment driven by the learning outcomes. Definitions of what students will be expected to know and do, lead to considerations of how these learning outcomes should be taught and assessed.
- Practical work is intrinsic to the teaching and learning of the sciences and this must be reflected in assessment.
- There should be an emphasis on demonstrating understanding.[4]

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[3] Report of the RIA-ALLEA Industry-Academia Alliance: Joint Efforts in Science Education, accessed online at: http://www.ria.ie/about/our-work/policy/science-education.aspx
[4] SCORE, June 2013, p.4, accessed online at: http://score-education.org/media/12525/ks4%20guidelines%20final%20version.pdf