

LEARNED SOCIETIES' GROUP:

FURTHER RESPONSE TO EDUCATION SCOTLAND ON THE CURRICULUM FOR EXCELLENCE SCIENCE BENCHMARKS

November 2016

Following the release of the draft *Science Benchmarks for Assessment*, the Learned Societies' Group submitted an initial response to Education Scotland in October which focussed on matters of principle underlying the Benchmarks¹. Coupled with that response, the group has now had the opportunity to review the content of the Benchmarks in more detail through a working party.

Summary of the review:

- We welcome the following aspects stated within the Benchmarks:
 - “The Benchmarks **support teacher professional judgement...**”
 - “Assessment is an **on-going process** to support learning.”
 - “They **support** professional dialogue, moderation and monitoring of progress in learning.”
- We agree strongly with the intention implied in the document that the Benchmarks should not be used to create “overly bureaucratic, or tick box, approaches to learning, teaching and assessment.” However, there is a risk that the Benchmarks, inadvertently, support such approaches.
- We note the 10th November version of the Benchmarks demonstrates refinement and improvement of the original draft. We are pleased that this later version makes clear the specific documentation that will be replaced by the Sciences' Benchmarks. We also welcome the fact that redundant guidance and assessment material is being removed from Education Scotland's website.
- We have identified several recommendations to minimise the risks of the document introducing inappropriate approaches to teaching and learning. Specific examples have been identified to give clarity to some of our recommendations.

Summary of Recommendations of the Learned Societies' Group

We recommend:

- 1 A review of the document focused on addressing misconceptions and correcting inaccuracies. This should be undertaken by Education Scotland as a matter of urgency and certainly before the Benchmarks are made available to schools.
- 2 Highlighting within the Benchmarks the importance of practical work in engaging learners in science and its role in supporting learners understand scientific concepts.
- 3 Including other forms of scientific enquiry in addition to fair testing.
- 4 The statements should be focused on outcomes. Suggested activities could be used to exemplify how outcomes can be evidenced.
- 5 While ensuring that learners have depth of learning is acknowledged, statements should be reconsidered to ensure depth of learning is outcome and evidenced-based.
- 6 Further consideration is given as to how the Benchmarks support progression of fundamental concepts.
- 7 Reducing the number of Benchmark statements and supporting teachers to use their professional judgement to identify when learners can be said to have reached the Benchmark.
- 8 The imperative verbs used to open the statements are reviewed and can be justified. The scientific language used should be consistent and appropriate.
- 9 Further clarity is added to the document on how schools *could* use the Benchmarks to support their assessments.

¹ LSG initial response on the Science Benchmarks, October 2016 https://www.rse.org.uk/wp-content/uploads/2016/11/LSG_science_benchmarks_final.pdf

Statement level comments:

- **Inaccuracies in content:** Some statements are factually incorrect and need urgent review. While we have highlighted a small number of prominent inaccuracies, Education Scotland will need to thoroughly check the document to identify and address others. E.g.:
 - SCN 1-05a: It is factually incorrect to state water boils, freezes and melts at set temperatures, as that is dependent on the purity of the substance. It is more accurate to say *pure* water boils at 100°C etc.
 - SCN 2-12a and SCN 3-12a: Use of the terminology “respiratory system” and “respirations” is inaccurate since respiration is a cellular process.
 - SCN 2-16a: “Explains that dissolved materials (soluble solids) cannot be separated by filtering but can be separated by evaporation”. As it stands it could imply that two soluble solids in the same solvent can be separated by evaporation of the solvent which is not the case. A better statement would be “Explains why a dissolved solid cannot be separated from the solvent by filtering but can be separated by evaporation”.
- **Misconceptions** – A misconception is based on scientific fact but there are issues with the explaining or understanding of said fact. We have identified several statements which could lead to misconceptions being reinforced or created. As for inaccurate statements, we have highlighted a small number of the misconceptions present and a thorough check is required to address others. E.g.:
 - SCN 2-18a: There are many issues with these statements that could lead to the development of misconceptions. The descriptions of “Waste water” and “clean” are particularly confusing.
 - SCN 3-18a: “Describes the pH scale as a continuous coloured number scale from below zero to above fourteen” can lead to misconceptions about what pH is.

We recommend there is a review of the document focused on addressing misconceptions and correcting inaccuracies. This should be undertaken by Education Scotland as a matter of urgency and certainly before the Benchmarks are made available to schools.

Overarching document comments:

- **Practical work** – A key element of science teaching and learning is using practical work to support learners in understanding and explaining scientific concepts. However, the fundamental role of practical work in supporting the outcomes is not apparent in the document. This introduces the risk that teachers reduce practical science experiences. **We recommend highlighting the role of practical work** in supporting the Benchmark outcomes. This could be done by including a reference to practical work in the introduction.
- **Scientific enquiry** – There are various forms of scientific enquiry. Many of these are discussed in the Association for Science Education publication, *It's Not Fair – or is it?*² Currently, the document highlights fair testing but omits other forms of enquiry. To avoid teachers only exploring one form of enquiry with their students, **we recommend including other forms of scientific enquiry when describing the role practical work has in supporting the outcomes.**
- **Outcomes vs Activity statements** – There appears to be an inconsistency in the statements, with some being outcomes focused and some focused on a particular activity children should do or be observed doing. This could lead to teachers running an activity, regardless of the outcome. E.g.:
 - SCN 1-08a: “Applies knowledge of magnets to create a game or model with others.” Mixes the learning outcome of applying knowledge of magnets to a specific activity, which can possibly limit teacher choice.
 - SCN 2-02a: “Contributes to the design or conservation of a wildlife area” is an activity rather than a learning outcome.

We strongly recommend that the statements are focused on outcomes. Suggested activities could be used to exemplify how outcomes can be evidenced.

² *It's Not Fair – or is it?* A guide to developing children's ideas through primary science enquiry; Jane Turner, Brenda Keogh, Stuart Naylor and Liz Lawrence with contributions from the ASE Primary Science Committee Sandbach, Cheshire: Millgate House and ASE, 2011

- **Depth as well as breadth** – It is recognised in the document that a key focus of the Benchmarks is to ensure learners have achieved breadth of learning. It is also important that learners have sufficient depth of understanding about their learning. **We recommend that the statements are reconsidered to ensure depth of learning is outcome and evidence-based.**
- **Progression** – Individual teachers and schools will focus on certain levels within the document. It will be important to ensure that the Benchmarks provide for progression of fundamental concepts. **We recommend further consideration is given as to how the Benchmarks support progression of fundamental concepts.**

E.g good progression can be seen in:

 - SCN 2-18a, SCN 3-18a and SCN 4-18a. These provide for progression as they start with clean water at second level, move to acids, bases and pH measurement and then apply this to environmental monitoring at level 4.

E.g. poor progression can be seen in:

 - SCN 2-17a and SCN 3-17a. These have repetition of Benchmarks' statements. The first and second statements at level 3 repeat the second statement at level 2.
- **Quantity of statements** – There are often too many statements which gives the impression of a content-driven curriculum. This could adversely influence teaching and learning by unintentionally stifling teachers' creativity and professional autonomy, and potentially putting the Benchmarks in conflict with the ethos of the Curriculum for Excellence. E.g.
 - SCN 2-14a includes a large number of statements which could be condensed into fewer statements.
- **Use of language** – In some cases, there are concerns over the accuracy of the language used to convey a concept and/or outcome statement. This can lead to misconceptions where the science is factually accurate. There also needs to be clarification of the imperative verbs (Explain, state, name, describe) used to open the statements. Some of the imperative verbs support a tick box approach, which is not the stated intention of the Benchmarks. E.g.
 - There are many examples in level 2 of “explain that...” or “state that...” where “explain how” would be more appropriate (SCN 2-08a, SCN 2-10a, SCN 2-11b)

We recommend the imperative verbs used to open the statements are reviewed and can be justified. We recommend that the scientific language used is consistent and is appropriate.

- **Expectations on use** – While it is clear why the Benchmarks are being introduced, it is not immediately clear from the document how teachers will be expected to use them in their school or classroom. We do note there is a brief mention of how not to use the Benchmarks. Without guidance for how the Benchmarks should be used, some schools may not use them appropriately. For example, it is not clear how many times a teacher should observe a learner meeting a statement. **We recommend further clarity is added to the document on how schools *could* use the Benchmarks to support their assessments.**

As the document seeks to support teacher professional judgements, **we recommend reducing the number of statements and supporting teachers to use their professional judgement to identify when learners can be said to have reached the Benchmark.** Teachers could be supported in that judgement through exemplification, teaching resources and continued professional development.

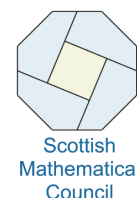
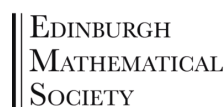
Questions for Education Scotland:

We have identified the following questions which we believe Education Scotland should consider before the Benchmarks are finalised.

- Has Education Scotland compiled a risk register for this document and considered ways to minimise the risks identified?
 - In preparing the Benchmarks has Education Scotland taken advice from those with expertise in curricular theory and design?
 - Will resource be made available to provide continued professional development support for teachers on using the Benchmarks?
 - How does this document link to other strategies and initiatives? E.g. the proposed STEM education and training strategy, the gender balance agenda, and the Literacy and Numeracy Benchmarks where there could be cross-supporting content.
- Given that the Benchmarks correspond to the Experiences and Outcomes, does Education Scotland intend to review the Sciences' Experiences and Outcomes to ensure that they are appropriate? We note that the Experiences and Outcomes for the Technologies have recently been reviewed.
 - Is there an intention to evaluate the way in which the Benchmarks are being used in schools and, if so, how will this be undertaken?

Additional Information

For further information about the Learned Societies' Group, contact its Secretariat,
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