IMPACT IN THE MATHEMATICAL SCIENCES IN REF2014

A discussion paper of the London Mathematical Society

Background

This paper has been produced by a working group from the LMS Research Policy Committee in order to stimulate debate, discussion and ideas on the Impact element of the REF. It is intended to be a "dynamic document", which will be edited periodically in the light of discussions, and as more details of the process emerge.

1. Introduction

There is a great deal of unease within the academic community in the UK about the "Impact Component" of the 2014 Research Excellence Framework (REF). The universal difficulties with assessing impact are compounded in the mathematical sciences by the facts that they are technically distant from the general public and that their impact is often necessarily achieved through other academic disciplines. There are major concerns, both for the well-being of our subject within the wider setting of higher education in the UK, and also for the position of individual departments in a context where a substantial part of future funding depends on a process about which so much is uncertain.

As explained in more detail in the next paragraph, our intention in preparing this document is to generate a constructive dialogue. Nevertheless it is better to be clear from the outset about the LMS's view:

the LMS believes that the concept of Impact as formulated for the REF fails to recognise the key mechanisms through which the mathematical sciences achieve impact on science, industry, the economy and culture. The measurement of impact is based on a largely untested methodology, and its implementation will have massive workload implications. For these reasons, its weighting in REF2014 of 20% is much too high.

We recognise, however, that decisions have been made, and that at this point constructive engagement is necessary to try to ensure the best possible outcome for our subject. In this context, this document has several purposes:

1. to generate discussion within the mathematical sciences community;
2. to share information, so that all mathematical science departments can have access to the same level of knowledge as to the operation of the process, as they prepare for the REF;
3. to encourage a dialogue and the flow of ideas from the mathematical sciences community to the REF team in general and the Mathematical Sciences Sub-panel (B10) in particular, on all aspects of the assessment of Impact as it affects the Mathematical Sciences;
4. to provide a published source of reliable information, which those preparing REF returns can use to convince their HEI that a proposed method of demonstrating impact is legitimate.

In order that this document contributes as much as possible and as accurately as possible to these aims, we intend this to be a live document, which will be updated regularly as more information becomes available

The REF Team held a meeting with the chair of the Council for the Mathematical Sciences, Frank Kelly, the chair of REF sub-panel B10, John Toland, and representatives of the learned

societies for mathematical sciences on 24th January 2011. One of the main outcomes was support for the strategy summarised in the third point, above.

2. Consultation process

There are two mechanisms for contributing to the discussion:

- via the dedicated blog which is available at http://lmsrefresponse.wordpress.com/.
- via the private email address, lmspolicy@lms.ac.uk

We hope that as many people as possible will use the first option, so that an open and stimulating discussion of these issues can take place. But we realise that some people may want to make comments or raise issues which they don't wish broadcast widely; hence the second option. "Private" above means that emails will be read only by LMS staff involved in administration, members of the LMS Research Policy Committee, and (unless specifically requested otherwise) John Toland.

To achieve maximum effect on the third aim listed in section 1, the LMS will provide comments to John Toland before the Subpanel 10 meeting on 6th June 2011, when the Guidance on Submissions will be finalised. Inputs will be collated from the above 2 sources and sent to him on 1st June. Given this deadline, we would ask for comments to be received by not later than **27th May**.

3. The rules

Most of the information in this section is from the HEFCE document "Decisions on assessing research impact"[1], released on 1st March 2011.

- "Impact" in the sense of the REF means "*all kinds of social, economic and cultural benefits and impacts beyond academia, arising from excellent research, that have occurred during the period 1 January 2008 to 31 July 2013*".
- The phrase *"beyond academia"* in the previous bullet is crucial – impact applying simply to another academic subject is *not* permissible for REF purposes.
- Notwithstanding the previous sentence, impact outside academia which proceeds in a chain, starting from specific mathematical sciences research, via some other academic fields, ending outside academia, *is* permissible. (This is sometimes called *"indirect impact",* in HEFCE's jargon. Clearly, many cases of impact arising from the mathematical sciences are of this type.)
- The research on which the impact is based must have been carried out at the submitting HEI at some point within the 20 years preceding 31st July 2013.
- *Public engagement* is acceptable as impact. There are, however, at least two problematic features relating to such items featuring as impact case studies[2]:

  (1) For an item of public engagement to be eligible as impact in the REF, it must be based *on original research* carried out within the HEI, within the past 20 years.

  (2) Evidence of actual *impact* must be provided – that is, substantial "passive consumption" is not enough.[3]
- Assessment of impact has two components: (i) an overall statement about how the UoA has supported the achievement of impact; and (ii) Impact Case Studies (ICSs).
- The required number *N* of ICSs for a submission[4] is 1 + (P/10) (rounded to the nearest integer), where *P* is the number of category A FTEs in the submission. The formula is overridden by the requirement that 2 is the minimum number of ICSs in a submission.

[1] http://www.hefce.ac.uk/research/ref/pubs/2011/01_11/01_11.pdf

[2] At least, according to current guidance.

[3] For example, in the English Literature Pilot exercise, an ICS featuring a poetry contribution to a BBC Radio 4 programme, which listed the audience figures for the programme as impact evidence, was criticised on the basis that the audience numbers were no higher than (and possibly slightly lower than) the normal audience for Radio 4 at that time.

[4] There is some uncertainty about this formula: it is different from that proposed in earlier HEFCE documents, but is based on the best available information at present.

- The research on which an ICS is based should be of at least 2* quality.
- Each ICS is presented in a word-limited template[5], with
    (1) A short summary,
    (2) An account of the underpinning research,
    (3) References to the research,
    (4) An account of the impact
    (5) References to corroborate the impact.
- ICSs are not expected to be spread evenly across the UoA, but just to be the strongest available examples.
- The criteria for assessing ICSs are *"reach"* and *"significance".*
- Impact is weighted 20%.

4. Examples

Before going on to discuss aspects of the above, we give a couple of examples of difficulties that can arise with possible candidates for ICSs. There are of course a number of sample ICSs on the HEFCE website showing the type of case that fits well into the HEFCE model. The following examples are chosen to illustrate the challenges of providing evidence for Impact in difficult cases relevant to the Mathematical Sciences. We hope that more illustrative examples of difficult cases will be added here, (or simply examples of a type which might be overlooked), to help focus discussion of the questions which follow, and to help colleagues around the country as we collectively try to ensure that mathematical sciences are not damaged by this exercise. Ultimately, we need good examples that exemplify what can be done in the creation of viable mathematical sciences ICSs.

Please *do* contribute ideas for ICSs to the blog!

Example 1. Imagine that an RA employed by HEI X writes a certain piece of software for the project, implementing an algorithm due to the PI. At the end of the contract the RA gets a job with Company Y. It turns out that the software is useful, so the company rewrites the software and incorporates it into a larger piece of software, which it then sells. Is this impact? Certainly it is hard to document, since Company Y probably won't be publishing anything that describes the dependence on the earlier work. Of course, this type of problem is not specific to mathematics.

Example 2. Mathematician Mary meets engineer Edward to discuss some work that Edward is doing with a large manufacturing company, involving an existing numerical code that doesn't work and Edward can't fix. Mary realises that Edward is trying to use the wrong numerical algorithm, and that another approach (which is equally well-known) should work well. They try it out and it does work, and is so efficient it saves the company a large amount of money in its design process. Because this is the first time this sort of numerical approach has been used for this particular engineering application it is regarded as interesting in Edward's research area, so Mary and Edward write a joint paper and publish it in a respectable engineering journal. It would be regarded as 2* work in engineering, it isn't 2* research in mathematics (or really mathematics research at all), but it has had a substantial economic impact. Question: Can Edward and Mary both use this as a REF case study for their respective departments, or only Edward?
Addendum: Regarding this example, we are reliably informed that the published research would be viewed as applied mathematics of a sufficiently high standard, on the (sufficient) basis that it had been published in a reputable academic journal.

Example 3. More straightforward perhaps is the case of Mathematician Z who publishes a paper developing ideas that are then used in GCHQ. Even to reveal that the ideas are relevant to GCHQ may be an unacceptable breach of security. In a less extreme case, it may be reasonable to know the work had impact, but not to describe the impact.

[5] The template is not yet in final form, but many samples are available from http://www.hefce.ac.uk/research/ref/impact/

Richard Pinch (a Subpanel member from GCHQ) is having discussions with HEFCE to attempt to find ways to give credit for this type of impact, without sacrificing transparency or undermining confidence in the process.

Question 1: What other types of ICSs, not previously discussed, might be appropriate for the mathematical sciences?

A number of case studies, some of which fit the REF's Impact agenda can be found at http://www.ima.org.uk/i_love_maths/mathematics_matters.cfm. The Royal Statistical Society and the American Statistical Association also jointly publish a magazine called Significance (http://www.significancemagazine.org/details/section/868399/Magazine-Articles.html) which includes case studies.

5. Robustness

Noting that the weighting for Outputs is 65%, and that each person submitted will return about 4 inputs, we see that a single ICS counts about ten times as much as a single Output. One paper of (say) 20 pages has been through a rigorous refereeing process, the language is objective and precise, and contains most of the information to allow an informed reader to verify and assess its contents.

One ICS is about 4 pages of descriptive text which attempts to capture the entire process from the underpinning research to the impact, and to make a convincing argument about the connection between them. There is no space to establish directly either the quality of the underpinning research or the extent of the impact. All must be based on secondary indicators (references to published papers, newspaper articles, media reports) that assessors will generally not have seen.

Each ICS will normally be assessed by at least 2 people (and probably more), including both academics and Research Users.

A short calculation makes plain (especially bearing in mind the number of research outputs to be read) that assessors will not have time for substantial background reading.

Question 2: Are there any mechanisms which would assist reliability of the assessment of Impact profiles?

One important factor will be the use of appropriate Research Users. It is likely there will be an opportunity to make further recommendations.

Question 3: Who should be recommended as Research Users for Subpanel B10, Mathematical Sciences?

6. What counts?

The impact must be beyond academia. This is fixed at the heart of HEFCE's approach to impact, and there is unfortunately no hope to overturn this component of the definition now. Other than that massive exclusion, the definitions are rather inclusive and non-proscriptive. Impact may be on the economy, society, public policy, public services, health, the environment, international development or quality of life. The impact may be to any person or group outside academia. Risk reduction, cost reduction, prevention of negative processes or outcomes, public engagement are all allowed. Impacts on HEI education are permitted, provided numerous institutions are impacted.

Despite the inclusive form of the definitions, there are clearly severe difficulties for the mathematical sciences in fitting the contribution which we make into the straitjacket of the Framework. Many questions present themselves. We give a couple here, expecting more to be added, and perhaps even to gain answers to some, in due course.

Question 4: Should subpanel B10 argue for an extension of the permitted time period for impact, beyond 20 years?

Pro extension: in many cases the time between research and payoff is much longer than 20 years. Contra: the longer the time gap, the more difficult it is likely to be to make the case for a close connection.

Question 5: For public engagement, can the "based on original research" requirement be weakened?

Question 6: How can a public engagement activity in the mathematical sciences be shown to have significant impact?

Under the rules for public engagement as presently formulated many cases with highly significant impact will have to be excluded.

7. Evidence and assessment

Of course, in the present fandango the above two abstract nouns are performing an intimate dance: the nature of the assessment will determine what evidence is required, while the quality and accuracy of the evidence provided will influence the robustness of the assessment. Returning to "first principles" and in particular to the second last bullet in Section 3:

Question 7: In the Mathematical Sciences what should be the meaning of the two descriptors *'reach'* and *'significance'*, so as to ensure the correct features are valued?

Reach and "significance" are undefined terms. Reach might refer to the breadth of the applications, the number of people affected by the impact, geographical or conceptual range. Significance can be measured in a variety of different categories, conceptual, cultural, social as well as financial and political. Other interpretations have also been suggested.

Question 8: Once these two concepts are assigned satisfactory definitions, what evidence is appropriate to demonstrate their presence and their strength in a specific ICS?

Reach is what mathematics does best. One idea is developed in a more abstract setting, and it applies in many specific settings, in many applications. The proof of the Poincare conjecture applies to three manifolds everywhere, whether in the structure of the universe or in solution spaces of equations or the configuration space of a robot arm. However there is a tendency for spreading waves to lose height. Worse still, when the spreading wave of impact has come round an obstacle, it is harder to track its course or prove its origin. Writing about philosophy although his words apply equally to mathematics, David Hume put it better, anticipating the REF by 270 years[6]:

"Though the philosopher may live remote from business, the genius of philosophy, if carefully cultivated by several, must gradually diffuse itself throughout the whole society, and bestow a similar correctness on every art and calling."

Perhaps, then, the next question is a rephrasing of parts of the previous two:

Question 9: What compelling objective evidence could establish indirect impact in the space available?

[6] David Hume, 'Enquiries Concerning the Human Understanding and Principles of Morals', 1737.

A strong case for impact would have a clearly defined genesis, and a single direct line of influence leading to a focused impact. Many of the impacts we think of for mathematics do not have this form. They have many beginnings, develop though many different routes and have a pervasive conceptual impact.

> **Question 10:** Leaving aside the timescale over which the impact was achieved, how could Darwin establish the impact of the idea of evolution by natural selection?

At least we have the clearly identifiable publication of The Origin of Species. It is hard to imagine a greater conceptual upheaval, but not so easy to isolate a single impact of evolution. Genetics is much easier, but that isn't the problem. One published sample ICS from the English studies pilot suggests that the number of copies sold, the impact on employment in printing houses, the impact on tourism in the Galapagos Islands might be counted. Whilst it is good to find ways to recognize merit, there is a danger that the use of such arguments will undermine the credibility of the assessment of Impact.

8. Other questions

The third last bullet in Section 3 will no doubt prove to be something of a lifeline for those preparing many mathematical sciences submissions to the REF, since, for a large and diverse department, it permits the ICSs to be taken from the more directly applicable part of the research portfolio. But not all departments have this form.

> **Question 11:** How can a relatively small department, focussed on more pure parts of the subject, be assisted to achieve a good impact return?