Educación Química (2017) **28**, 304–306

educación Química

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REPLY TO LETTER TO THE EDITOR

Is CER best considered a discipline or a field of study? Reply to Hannah Sevian's comment

¿Es el CER considerado mejor como una disciplina o un campo de estudio? Respuesta al comentario de Hannah Sevian

Dear Editor,

Thank you for inviting me to respond to Hannah Sevian's (2017) comments on my opinion piece in *Educación Química* (Taber, 2017). Dialogue on the nature of our work in chemistry education research (CER) is healthy, and a wider conversation is to be encouraged.

There are two aspects to Hannah Sevian's letter, which perhaps can most helpfully be considered separately. She asks (a) about the extent to which chemistry education research could be considered a discipline, and in doing so refers to Good's (2000) notion of disciplines (''ever-changing frameworks within which scientific activity is organised'', p. 260) forming through processes of assembly; and she also argues (b) against overly restricting the developing field (in her terms, discipline) of CER. The article she comments on was based around two recommendations, both of which could potentially be seen as restrictive: (i) that progress in CER should be achieved by focusing enquiry around the development of specific research programmes (RP) and (ii) that work carried out within chemistry teaching and learning contexts should not automatically be accepted as falling within CER.

RP are important for any area of work wishing to be considered scientific as they build traditions that allow knowledge to be developed cumulatively across studies and research groups. To suggest that we might expect a mature scientific field to be dominated at any time by a limited number of identifiable RP is not to be prescriptive about what in particular these programmes should be focused on. I am not sure that my suggestion that it is healthy for a good proportion of work in CER to be undertaken within progressive RP (i.e., i) is necessarily inconsistent with Sevian's own prescription for developing research specialisations, so I consider the main difference in our thinking to be between my exclusion of work that is not about the core foci of CER (i.e., ii) and her alternative description of the emergence of various different centres of consensus.

In the original *Educación Química* article, CER was described as a field rather than as a discipline. A field concerns the study of some particular range of phenomena, and it is suggested that the core phenomena explored in CER are the teaching and learning of chemistry. The precise nature of a discipline seems more problematic. Kuhn's (1974/1977) notion of the disciplinary matrix could be considered as requiring considerable commonality in those sharing a discipline: commonality in terms of ontological and epistemological commitments, methodological and communicative practices, norms in terms of standards of evaluation, etc. A researcher in physical chemistry today has not been inducted into the same set of paradigmatic examples as a researcher in synthetic organic chemistry and only partially shares intellectual commitments and methodological practices. From these considerations it might be suggested that modern chemistry is too broad to be considered a unitary discipline in this particular sense.

Sevian however draws attention to the alternative model of disciplines offered by Good which has much more flexibility: Good expects some ''degree'' of ''conceptual, methodological, institutional, and social'' consensus within a scientific discipline (p. 260), but admits scope for variation in how much consensus is expected within different sciences. Good sees disciplines as a higher level of structure above particular research schools, so connecting researchers at different places within a wider academic community, and does not feel there is any value in making absolute distinctions between what are considered sub-disciplines, disciplines and supra-disciplines.

Moreover, Good's model considers that disciplines are formed by the action of interested scientists who build an assembly from existing specialisms (such as ''the assembly of geophysics as a more widely accepted scientific discipline, separate from physics, geology, and geography'' p. 261) and then develop an identity for that discipline (as when ''campaigners for a unifying geophysics invented words, ways of thinking, journals, and institutions'' p. 261).

DOI of original article:
http://dx.doi.org/10.1016/j.eq.2017.06.002
Peer Review under the responsibility of Universidad Nacional Autónoma de México.

http://dx.doi.org/10.1016/j.eq.2017.06.003

He argues that the development of a discipline is ''the result of contention, consensus-building, and negotiation, some of it self-consciously pursued, some of it perhaps unintended'' (p. 263). Hannah sees CER as a discipline assembled from such areas as ''chemistry, science education research, learning sciences, education research, cognition, philosophy, psychology, sociology, informal science, biology, physics, geosciences, environmental science, and others''. I think this is an interesting perspective that potentially offers useful insights.

My own view is that the sheer range of components in this assemblage probably mitigates against any easy evolution into a recognisable discipline. Even given some latitude in how much ''conceptual, methodological, institutional, and social'' consensus one might reasonably expect within a single discipline, it is difficult to see enough consensus emerging (even allowing for ''various different'' centres of consensus) for CER to acquire a strong disciplinary identity. What Good's account does seem to imply, however, is that the development of CER as a discipline – that is, as something that would occur through contention, consensus-building, and negotiation – would necessarily reduce the eclectic nature of work currently admitted into CER.

CER presently includes work which draws upon a wide variety of perspectives originating in diverse disciplines such as anthropology, psychology, sociology, economics, philosophy, and others. The suggestions made in my original article would by no means exclude any such perspective from CER as long as it informed research related to the teaching and/or learning of chemistry. Moreover, CER encompasses experimental research, case studies, ethnographies, and many other methodological strategies. A wide range of data collection techniques is employed, and different modes of analysis are used. This should all be admissible subject to coherence within a particular study: the research questions should be framed in a way consistent with any theoretical perspective adopted; and the methodology should reflect that framing and offer a design combining compatible research techniques (Taber, 2013). Some CER studies offer inferential statistics based on comparing random samples 'of large N'; some make comparisons within a modest sample of purposefully selected diverse instances; some others offer thick description reporting in detail highly triangulated accounts of single cases. All these kinds of studies potentially offer useful insights, and indeed as I have argued elsewhere (Taber, 2014), given the complex and contextually-embedded nature of teaching and learning as phenomena, complementary perspectives and approaches are indicated within such a field.

It seems to me that Hannah Sevian and I agree on much: certainly that CER is currently eclectic and interdisciplinary. I think we both agree that CER will evolve. I recognise Good's process of ''contention, consensus-building, and negotiation, some of it self-consciously pursued, some of it perhaps unintended'' (p. 263), and would argue that it is preferable to self-consciously and intentionally seek to shape what CER becomes. In Good's example, geophysics formed as an assembly of components from physics, geology, and geography - however it was not simply an aggregation of these existing disciplines: in forming its identity it not only took from these areas, but also formed new boundaries around the fledgling science. So not everything that had been part of physics (including ''theories, instruments, and research problems'', p. 263), for example, became part of geophysics, only those things relevant to the focus of the new science.

In the same way CER clearly should not admit everything from the disciplines that it draws upon, but rather needs to have some kind of boundary condition to allow it to have a distinctive identity. As an editor I regularly see submissions to *Chemistry Education Research and Practice* that are about aspects of chemistry, but which make no reference at all to teaching or learning. I cannot imagine any colleague who considers they are working in CER would see these articles as within the scope of the field (or, if preferred, discipline) simply on the basis that CER is interdisciplinary and chemistry is one of the disciplines it draws upon.

Some other submissions do make reference to educational contexts, but offer no insights into educational processes. A study that is based on motivation theory, or feminist standpoint theory, or cultural-historical activity theory, or any of a great many other perspectives, may offer valuable new knowledge about teaching and learning of chemistry. However, it is not sensible to consider any study based on one of these perspectives and carried out in a chemistry classroom as necessarily part of CER rather than some other field of scholarship. A sensible boundary for CER is not based upon theoretical perspective, methodological approach, or even the type of research site where data might have been collected – but whether the research questions are enquiring into issues of central concern to the field.

This is why I identify some studies carried out in chemistry classrooms (or other chemistry learning contexts), but motivated by questions that are not strongly linked to chemistry teaching and learning, as outside the field (and so better reported in journals with other foci). I think there have to be demarcation lines: the question is where we draw them, and to what extent we make that decision in a deliberate and principled way. My own view is that defining this boundary in terms of core foci of interest (i.e., teaching and learning chemistry) allows us to delimit CER whilst admitting any theoretical perspective and methodological approach which does allow us to learn about those foci.

It also follows from this line of argument that CER is better conceptualised as a field that remains interdisciplinary, than a discipline that would be expected to move towards greater ''conceptual, methodological, institutional, and social'' consensus. Kuhn's (1996) model would consider a field that lacked disciplinary structure as immature - but Kuhn was discussing the natural sciences. When dealing with complex, emergent, multifaceted phenomena such as teaching and learning such an identify may not apply (Taber, 2014). In a field such as CER it seems desirable to retain diversity at both conceptual and methodological levels as the field matures, and instead delimit the field by only admitting work focused on its characteristic concerns. That allows the flexibility for new RP to be initiated and developed in accord with the interests and concerns of community members, drawing upon a wide range of intellectual and research tools deriving from a diverse set of disciplines.

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