Serial number 0221

Title Paper 2: Engaging with debates on curriculum reform: The case of Chemistry

Session Understanding Knowledge, Curriculum and Student Agency (UK-SA) in Chemistry and Chemical Engineering (Ashwin)

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Abstract

The current crisis in South African higher education has again focused the spotlight on the university curriculum, with some calls for radical reform. In this paper I draw on research in Chemistry Education and related fields, to be able to engage with these challenges. A starting point is a characterization of the distinct nature of Chemistry knowledge. The paper then draws on work in the sociology of knowledge to understand the recontexualisation of disciplinary knowledge into curriculum. Contemporary research on the Chemistry curriculum is reviewed and put alongside student learning research that explores not only student experience at university but also graduate outcomes and destinations. It is shown that South African universities are already producing graduates that not only make valuable contributions to economic development, but are also young people with thoughtful and critical perspectives on society.

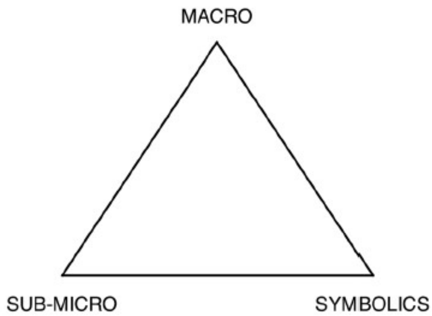
Extended abstract

Presently there is significant contestation about higher education both in South Africa and globally. There are debates around whose knowledge is privileged in the academy and what purposes does it serve. This paper engages these issues from the position of chemistry education in the South African university.

The starting point requires a position on knowledge, scientific knowledge, and specifically chemistry knowledge. To do this we turn to the chemistry education literature, which has grappled closely with this matter over the years. In fact, by contrast to education research in the humanities, where recent times have seen a 'reclaiming of knowledge', in science education there was never a move away from a central concern with knowledge (Marshall, 2009). This can be seen in a paper published in 1999 by the eminent chemistry education researcher, Dorothy Gabel (1999), looking backwards over a few important decades in which the field really emerged, and speculating about the forthcoming 21st century. Gabel gives an overview of the research on student misconceptions in chemistry which dominated the field from the 1980s. Gabel makes clear the reason for the prevalence of chemistry misconceptions:

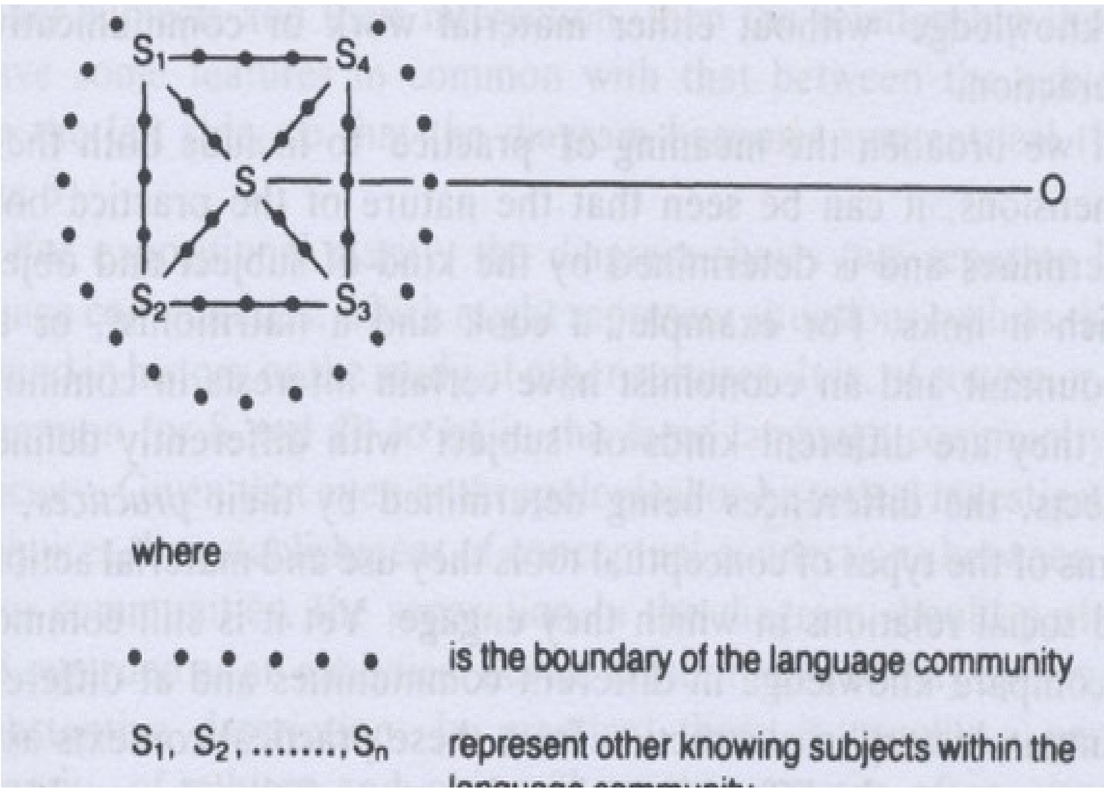
> Students possess these misconceptions and solve problems using algorithms because of the complex nature of chemistry concepts and because of the way the concepts are taught.

An influential framework for thinking about the complexity of chemistry concepts and which is cited by Gabel is that proposed by Johnstone, popularly named the 'Johnstone triplet' (1991). Johnstone proposed three 'levels' at which chemistry knowledge functions, the macroscopic, the submicroscopic, and the symbolic:



In a recent article, Keith Taber (2013) offers important elaborations on this model. He notes that it is not only the abstract nature of theory about the submicroscopic domain that causes difficulty to students, he also points out that the way chemists think about the macroscopic is also an abstraction, and a very special one. Regarding the symbolic, Taber makes the important point that this is not really a distinct 'level' of knowledge. It comprises forms of representation, the language of chemistry, that is used in communicating abstractions at the macro and submicro levels.

Further elaborations on this perspective can be developed using the work of the social scientist Andrew Sayer (Sayer, 2010)(Sayer, 2010)(Sayer, 2010)(Sayer, 2010)(Sayer, 2010)(2010). Sayer not only draws a clear distinction between object and subject as per a realist perspective, but shows that knowledge depends on a knowledge community, and a framework for thinking about the world that is shared in this community.



There are some key studies in South African chemistry education research that give us more details about chemistry knowledge and the challenge of teaching and learning in this discipline. Gail Green and Marissa Rollnick, focusing on second year organic chemistry, deal with the important issue of the subdisciplines in Chemistry, which have different conceptual structures even though there is some commonality in their core concepts and symbolic forms (Green & Rollnick, 2006). They draw a distinction between linear and nonlinear concept development in the subdisciplines of chemistry. Margaret Blackie from Stellenbosch University draws on some recent work in sociology of knowledge and applies this to chemistry education. Blackie works with the concepts of semantic gravity (SG) and semantic density (SD), developed by the sociologist Karl Maton, to describe two key aspects of knowledge, showing how building conceptual knowledge in Chemistry involves both weaking of SG and strengthening of SD.

Using these views on the nature of chemistry knowledge and of the challenges in teaching and learning in this space, the paper engages with arguments for decolonizing the curriculum that are currently in focus in South Africa. The serious scholars in this area do not propose to eliminate one set of knowledge and replace it with another, but they do propose to add on to the existing canon, knowledge that has, in this instance, African origins. It is very important to note that these claims are mostly made my scholars in the humanities, and in an epistemological sense build off a post-modern position into the postcolonial and the decolonial. We cannot say that the humanities has nothing to say to science or vice versa, but it is important to recognize that knowledge is differentiated and thus an argument in one field doesn't necessarily carry over to another. If we draw on the work of the sociologist Basil Bernstein it can be argued that science is an exemplar of a hierarchical knowledge structure, which unlike some disciplines in the humanities, develops in an integrated fashion and does not easily permit mutually exclusive conceptualisations to exist alongside each other.

Furthermore, the focus for humanities is the human condition, and thus the argument that some knowledges have focused on some humans and indeed dehumanized others, is certainly an argument that needs to be addressed.
Science does not in the first instance have as its object the human condition.
This is not to say that science is value free or indeed not linked to the humans who practice it and the objects that they focus on. We do need to teach much more on the processes whereby science is developed, and to talk about the people who are involved in this enterprise.

A useful framing to think about these issues has been made by the sociologist Leesa Wheelahan, who makes the distinction between 'knowledge of the powerful' and 'powerful knowledge' (Wheelahan, 2012). Because of the way power works in the world, at all levels of education it is those who are more well-off who tend to get better access to knowledge. These are the people with university degrees and the capacity to make a living in the world using this knowledge. To reject powerful knowledge per se because of its differential distribution is to shoot yourself in the foot, and actually to keep people in the ghetto. What we need are educational systems that can better offer broad access to powerful knowledge, and we do know of contexts which do this better than others. This is crucially important for science and thus a key focus for the collaborative research project that is the subject of this symposium.

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