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CHEMISTRY DIDACTICS

Getting to the CoRe of it: A review of a specific PCK conceptual lens in science educational research

Louise Lehane[a,*], **Adam Bertram**[b]

[a] *University of Limerick, Limerick, Ireland*
[b] *RMIT University, Melbourne, Australia*

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Abstract Since its introduction, pedagogical content knowledge (PCK) has been widely written about in the science education research literature. It has served as an alluring concept amongst many of the discussions on the teaching and learning of science. This paper reviews and draws together empirical research on a specific PCK lens, consisting of two tools: a Content Representation (CoRe) and Pedagogical and Professional Experiences Repertoires (PaP-eRs). Both tools were originally developed by Loughran et al. (2006) and have since been used by a variety of educational researchers and practitioners within their own contexts. This paper seeks to present how CoRes and PaP-eRs have helped conceptualise and advance PCK research, including the impact this has had on the professional practice of teachers. This paper, in so doing, also demonstrates how this PCK lens can facilitate effective teaching and learning in science education.

PALABRAS CLAVE
Conocimiento didáctico del contenido;
Representación de un contenido;
Aprendizaje y enseñanza de las ciencias

Conociendo ''CoRe'': revisión de un concepto específico de investigación en ciencias de la educación

Resumen Desde su aparición, la expresión conocimiento didáctico del contenido (PCK, por sus siglas en inglés) ha sido ampliamente citada en la literatura sobre investigación en las ciencias de la educación, y ha protagonizado muchos de los debates sobre la enseñanza y el aprendizaje de las ciencias. Este artículo revisa y perfila con una mirada específica los PCK, que constan de 2 herramientas: una representación del contenido (CoRe), y un repertorio de experiencias profesionales y pedagógicas (Pap-eRs). Ambas herramientas fueron desarrolladas

* Corresponding author.
E-mail address: louise.lehane@ul.ie (L. Lehane).
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originalmente por Loughran et al. (2006), y desde entonces han sido empleadas por muchos investigadores y docentes en su contexto particular. El objetivo del presente artículo es mostrar cómo el uso de CoRes y PaP-eRs ha ayudado a conceptualizar y avanzar en la investigación del PCK, incluyendo el impacto que este ha tenido en la práctica profesional de los docentes. Al hacerlo, también se muestra cómo el PCK puede facilitar una enseñanza y un aprendizaje eficaz en educación científica.

Introduction

Pedagogical content knowledge (PCK) has served as an alluring theoretical construct since it was originally defined by Shulman (1986) as he attempted to grasp the knowledge bases that a teacher possesses. From his research he concluded that there were seven knowledge bases associated with teaching; one of these was PCK. Shulman defined PCK as:

> ''for the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations- in a word, the ways of representing and formulating the subject that make it comprehensible to others'' (Shulman, 1986, p. 9).

PCK would distinguish the knowledge that a science teacher has from that of a scientist, a scientist would have considerable knowledge of the subject but would not necessarily have the knowledge associated with the effective instructional strategies for teaching the subject (National Research Council, 1996). In other words, it is a knowledge that is unique to teachers and is the essence of teaching (Cochran, King & deRuiter, 1993). A scientist's knowledge is structured from a research perspective whilst a teacher's knowledge is structured for the purpose of student learning (Cochran et al., 1993).

Shulman (1986) describes PCK as an amalgamation between knowledge of content and pedagogy allowing for more effective teaching of a particular concept. PCK revolves around both a teacher's understanding and the enactment of their knowledge (Park & Oliver, 2008). PCK develops over time, through experience of how to teach a particular concept in a specific way so that there is enhanced student understanding (Loughran, Mulhall, & Berry, 2006). It is a result of the many classroom experiences that a teacher has with many different students (Cochran et al., 1993). It can be assumed that such varied experiences and understandings of what enhances student learning results in difficulties around how PCK can be conceptualised in the classroom.

In discussions at a worldwide PCK summit in 2012, an attempt was made in coming to a general consensus of a description and conceptualisation of PCK. The attendees, all of which had experiential and expert knowledge into the construct of PCK, believed PCK (personal PCK) to be representative of a teacher's knowledge of, reasoning behind, and purposeful planning for teaching a particular topic in a certain way for enhanced student learning (Gess-Newsome, 2013). Making the material comprehensible to others is crucial behind the effective teaching and learning of scientific ideas. Once such way that has become recently widely investigated is that of CoRes and PaP-eRs. This paper now draws together this research and presents a review and implications of these instruments and their impact on science teacher education. This conceptualisation of PCK and review of the literature encompasses research from around the globe and is not specific to any one country or region.

Capturing and measuring PCK

Perhaps the most important message in Kind's 2009 review of PCK (Kind, 2009) was the ''strong evidence that PCK is a useful concept and tool for describing and contributing to our understanding of teachers' professional practice'' (p. 198). She summarised the empirical studies that reinforced the idea that PCK is indeed important to science teachers as well as being crucial in science teacher preparation programmes. Moving PCK research forward then requires investigations into capturing and portraying PCK and then making this more explicit both with practising teachers and student–teachers.

A teacher's professional knowledge is difficult to categorise and because of this is very difficult to articulate and record (Loughran, Mulhall & Berry, 2004). Whilst Baxter and Lederman (1999) believe PCK to be a highly complex construct that is not easily assessed, in order to ''capture'' PCK, it requires a combination of approaches which can invariably portray a teacher's beliefs about what teachers know, what beliefs they hold, what they do together with their justification for what they do. The authors of this current paper believe that the complex nature of PCK requires instruments which can adequately portray instances of PCK.

Two instruments have gained significant attention in the science education research literature: these are a Content Representation (CoRe) and a Pedagogical and Professional-experiences Repertoires (PaP-eRs), both developed as complimentary tools by Loughran et al. (2006) from which PCK could be captured. Kind (2009) believed that the CoRe tool offers the most useful technique devised to date in science education research for eliciting and recording the PCK from teachers directly. Indeed both the authors in this current paper have used these tools in their own research and that is why the remaining discussion will focus on these and provide insight into how they have been used in various research contexts. The extent to which mainly the CoRe has been used in a variety of research contexts gives substance to the authors assumption that it is the most widely used instrument for PCK related purposes.