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'CoRes and PaP-eRs as a strategy for helping beginning primary teachers develop their pedagogical content knowledge

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ABSTRACT (CoRes y PaP-eRs como una estrategia para ayudar a los maestros de primaria principiantes a desarrollar su conocimiento didáctico del contenido)
While it is widely accepted that beginning teachers have little PCK, this paper attempts to explore whether two instruments, CoRes (Content Representations) and PaP-eRs (Pedagogical and Professional-experience Repertoires), might offer a means for articulating and portraying aspects of a beginning primary science teacher's developing PCK and how this might assist in developing his PCK. This has implications for all teachers of science including those of chemistry. Over a two year longitudinal study, a beginning primary science teacher developed his own CoRe and PaP-eR, accompanied by an analysis of his thinking behind his practice. On analyses, the study concluded that CoRes and PaP-eRs *can* portray explicit instances of PCK for a beginning science teacher but more importantly they help to highlight, build and scaffold knowledge of teaching and learning about science in new ways that extends beyond normal beginning teacher thinking. Therefore CoRes and PaP-eRs might be of potential interest to beginning science teachers in all disciplines (including chemistry).

KEYWORDS: Pedagogical Content Knowledge, teacher development, content representations (CoRes), pedagogical and professional-experience repertoires (PaP-eRs), beginning teacher development

Resumen
Mientras es ampliamente aceptado que los profesores principiantes tienen un reducido CPC (Conocimiento Pedagógico del Contenido), este artículo intenta explorar si dos instrumentos, CoRe (Representación del Contenido) y PaP-eRs (Repertorios de experiencia Pedagógica y Profesional) pueden ofrecer medios para articular y representar aspectos del desarrollo del CPC de profesores principiantes de ciencia en la primaria. Esto tiene implicaciones para todos los profesores de ciencia, incluidos aquellos de química. Mediante un estudio longitudinal de dos años, un profesor novato de primaria desarrolló su propio CoRe y PaP-eR, acompañado de un análisis de sus razonamientos detrás de su práctica. Del análisis, este estudio concluyó que CoRes y PaP-eRs sí pueden representar instancias explícitas del CPC para un profesor principiante de ciencia en primaria, pero más importante que eso, es que ayudan a destacar, construir y dar andamiaje al conocimiento de enseñanza y aprendizaje de la ciencia de nuevas formas que se extienden más allá del razonamiento de un profesor novicio. Por lo tanto, CoRes y PaP-eRs pueden resultar de interés potencial a los profesores principiantes de todas las disciplinas científicas (incluida la química).

Palabras clave: Conocimiento Pedagógico del Contenido, desarrollo del profesor, Representación del Contenido (CoRe), Repertorios de experiencia Pedagógica y Profesional (PaP-eRs), desarrollo de profesor principiante

Introduction

Content Representations (CoRes) and Pedagogical and Professional-experience Repertoires (PaP-eRs) have been extensively reported in science education literature as significant instruments which are claimed to be effective in articulating and portraying aspects of the tacit, intrinsic and individualized component of teachers' professional knowledge that has come to be known as pedagogical content knowledge (PCK) (*cf.* Kind, 2009; Hume and Berry, 2011; Loughran, 2012). In chemistry education, PCK has been researched with practising teachers (*cf.* van Driel, Verloop, and de Vos, 1998; Bucat, 2004), and much more intensely with preservice teachers (*cf.* Hume and Berry, 2011, Nilsson and Loughran, 2012, Rollnick, *et al.*, 2008). This research highlights the need for further studies into PCK and how it

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develops in teachers as they progress through their career. It has important implications for how chemistry is taught and learned.

Shulman (1986) offered PCK as a distinct domain of teachers' knowledge because it aimed to bring to the surface the understanding, reasoning, and underpinnings that a teacher develops in learning how to link content and pedagogy in meaningful ways in practice. In the absence of PCK (i.e., if the amalgam does not exist so that content and pedagogy are not linked) then it could well be that the teacher just happens to have a good activity. PCK, therefore, is the individual and unique knowledge a teacher possesses that marries knowledge of content and knowledge of pedagogy together in a way which enhances student learning (Loughran, *et al.*, 2012). It then becomes clear that PCK develops with teaching experience — that experience usually includes different pedagogical approaches for teaching particular content to different student groups over time. The act of teaching then adds a richness in building the teacher's PCK. On the converse, it has been commonly suggested that beginning teachers, therefore, have very little PCK (Baxter and Lederman, 1999; Gess-Newsome, 1999; Grossman, 1990; Magnusson, Krajcik, and Borko, 1999; van Driel, *et al.*, 1998). It would, therefore, be interesting to see whether CoRes and PaP-eRs are an appropriate framework that, in the first instance, might represent the (limited) PCK of beginning science teachers, and in the second instance, be a useful device in meaningfully supporting and scaffolding their developing PCK once they begin teaching.

PCK, CoRes and PaP-eRs

Science teachers' PCK is often tacit and difficult to articulate, capture and portray because of its very personal construction (Gess-Newsome, 1999; Korthagen and Kessels, 1999; Loughran, *et al.*, 2012). Loughran and colleagues developed a Resource Folio — a framework which they contended could capture and portray these personal and idiosyncratic examples of PCK (*cf.* Loughran, *et al.*, 2012; Loughran, Mulhall, and Berry, 2004). A Resource Folio consisted of a Content Representation (CoRe) and any number of Pedagogical and Professional-experience Repertoires (PaP-eRs).

A CoRe is a table which sets out to represent science teachers' understanding of the content for a particular topic (see Table 1 in the Appendix for an example of a completed CoRe by the participant described in this study). It does this through asking teachers to consider the central or "Big Ideas" of the topic being taught — that is, what are the essential tenants of the content that students are to learn. These "Big Ideas" form the column headings. The rows consist of eight prompts which aims to reveal the teachers' reasoning behind pedagogical choices/activities, knowledge of their students (such as alternative conceptions, difficulties, and points of confusion) and ways of assessing student understanding.

PaP-eRs are linked to the CoRe. A PaP-eR attempts to draw out aspects of a teacher's PCK in action (see Table 2 in the Appendix as an example of a completed PaP-eR by the participant described in this study). They are a detailed description and reflection of a teacher's reasoning and thinking about one particular lesson based on a particular part of the content from the CoRe. A paper is commonly presented as narrative account of the lesson from the teacher's perspective: what did they do and why did they do it? A PaP-eR by itself does not represent the complexity or complete picture of that which makes up a teacher's PCK for that content, however a collection of PaP-eRs can certainly go further toward exploring the differing elements of PCK for that content (Loughran, *et al.*, 2004).

Loughran and colleagues, therefore, believed that through a combination of a CoRe and its associated PaP-eRs 'teachers' PCK becomes evident through making explicit the nature of their pedagogical reasoning and the associated decision making within the context of teaching particular science content' (Loughran, *et al.*, 2012, p. 21). In this regard, they believed that a Resource Folio represented solid, concrete portrayals of science teachers' PCK.

It is the purpose of this paper to examine one particular beginning science teacher's completed CoRe and PaP-eR and to provide an analysis of his thinking behind his practice. It should be noted upfront that the content area of the CoRe and PaP-eR presented in this paper is on Space. Although not a chemistry topic, the intent of this paper is to show how PCK can be developed with beginning primary teachers, and that it can be applied across all science domains. It is also an attempt at clearly elucidating explicit and concrete examples of his developing PCK as a beginning teacher, and in so doing validating whether CoRes and PaP-eRs achieve this end. If so, then CoRes and PaP-eRs have a significant contribution to improving how science (including chemistry) might be taught and learned.

Methodology

This paper reports on one specific, individualized case of a beginning primary science teacher (pseudonym of Gordon) in his first year of teaching. However, Gordon, along with five other practising science teachers (one primary and four secondary teachers) were involved in a much broader research study. This study explored how an understanding of PCK, as conceptualized through a CoRes and PaP-eRs approach, might develop science teachers' knowledge of their professional practice (*cf.* Bertram and Loughran, 2012; Loughran, *et al.* 2012). Gordon was the only participant in the study who was a beginning teacher and therefore the only candidate on which to report here in this paper. At the time of initial data collection, Gordon had only been teaching for six months. He was teaching a Grade Five and Six level composite class as a generalist classroom teacher in a government, co-educational, primary school in Australia. Previous to teaching, Gordon had gained a Bachelor of Arts, majoring in journalism and had just graduated with a Graduate Diploma of Education the year before. He had no formal training in science. When asked how confident he was when