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Review of: Re-examining Pedagogical Content Knowledge in Science Education

Editors: Amanda Berry, Patricia Friedrichsen and John Loughran

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Reviewer: Andrew Doyle

I came across this book in the same way that many researchers interested in the concept of pedagogical content knowledge (PCK) in technology education do – falling down a PCK shaped rabbit hole into science education. Despite having been conceived over 30 years ago, and the considerable attention given to this concept in the educational research community, there has been little consensus as to how PCK is conceived, explored, or applied. In 1999, this resulted in the PCK publication now commonly known as the *Purple Book* edited by Gess-Newsome and Lederman (1999). This book, entitled *Examining Pedagogical Content Knowledge: The construct and its Implications for Science Education*, sought to bring clarity and coherence to the use of PCK in the science education research community. Despite this effort, the use of PCK was still contended and with the lack of a shared agenda for the use of the concept, a PCK Summit was held in Colorado in 2012. The Summit, again specific to science education, was designed as a working conference whereby participants were challenged to move beyond their individual research agendas and work together to better understand the issues and concerns of PCK research and its impact and value to science teaching and learning. The *Blue Book* reviewed herein is a result of this Summit.

Re-examining Pedagogical Content Knowledge in Science Education is edited by Amanda Berry, Patricia Friedrichsen, and John Loughran. The structure of the book reflects the initial agenda for the Summit and is categorised into four parts: (1) Introducing PCK: Issues, ideas and development; (2) Research developments and trajectories; (3) Pedagogical content knowledge: Emerging themes; and (4) Provocations and closing thoughts.

Part one of the book contains three chapters, the first of which is written by none other than Lee S. Shulman, referred to in the book's preface as the father of PCK. Shulman's chapter outlines the historical roots of the concept and situates it in the work he was completing in the mid-80s. The chapter frames the potential for multiple perspectives on PCK research, and explains how there have been many legitimate, exciting, and fruitful ways of thinking about the construct. This may at first seem counterintuitive, given that the focus of the Summit was to move beyond individual research agendas. However, Shulman situates his argument in the assertion that the concept of PCK is context-dependant. Thus, once cognisance is taken of this, and elements are contextualised through linking PCK to the normative needs of a particular society, different factors come to the fore. It is from this perspective that perhaps the most significant contribution of the Summit (and subsequently the book) is developed, the model of teacher professional knowledge and skill presented in Chapter 3 by Gess-Newsome. Framed as the consensus model of PCK, this model is the result of discussions around the structure of the construct, in particular concerning its relationship with enacted practice. Critically, the model distinguishes between different types of teacher knowledge, and situates PCK as the result of planning *for* and reflection *on* teaching. Interestingly, instruments which have previously been used to aid teachers articulate the intricacies of their PCK are situated in the model as exemplars. Most notable among these is the Content Representation (CoRe) instrument developed by Loughran, Berry and Mulhall (2006). The model clarifies that PCK is derived from a particular instance of teaching, by comparison a CoRe is topic-specific and topic-wide, therefore a CoRe is categorised as teachers' topic specific professional knowledge. This new type of knowledge further aids in defining PCK as it distinguishes between knowledge that is canonical in nature and held by the profession, such as a CoRe, and knowledge that is personal – PCK. The second chapter in this part of the book, written by Carlson, provides an overview of the PCK Summit, the goals and supporting structures used. Although the content of this chapter may not be directly applicable to technology education, the format of the Summit in navigating the articulation of a messy construct may be useful.

Part two of the book consists of ten chapters which explore the research trajectories of individuals and research teams that attended the Summit. In these chapters the authors explore their starting point as PCK researchers, how their work progressed, the PCK model(s) guiding their work, insights gained and challenges encountered in their work, reflections on the influence of the Summit, and future research directions. The nature of this section therefore does not lend itself to an easy read. At the beginning of each chapter the reader must acknowledge the perspective from which the trajectory has been developed and the various agendas driving this perspective. This is framed very well in most chapters. As a reader, I was expecting to reach a section at the conclusion of each chapter detailing how the authors' research trajectory aligns with the consensus model presented earlier in the book. For me, this would have been most advantageous as it would

have outlined the process of navigating perspectives and different interpretations of the model. Despite this, part two of the book provides a timely stocktake of current practices in the science education research community.

The third part of the book contains three chapters, which are clearly written in response to issues raised at the Summit, focusing on exploring themes and collaborations. The role of PCK in policy-making, the challenges of learning progressions, and the measurement of PCK are all considered. In their chapter exploring learning progressions, Friedrichsen and Berry contemplate how much of the PCK research to date has identified that PCK development is a non-linear process, and that it can be very different from teacher to teacher, according to context, situation or on a personal level. They theorized the potential of learning progressions in highlighting the gaps in the PCK literature about how the construct develops across topics, but also caution against their elaboration as they may become attractive to testing agencies and policymakers. Instead, it is advocated that learning progressions offer the potential to support the specific needs of individual teachers. In a chapter concerning PCK research and policy initiatives, Sickel, Banilower, Carlson and Van Driel expand on the cautions presented by Friedrichsen and Berry. Here it is advocated that policies should not appropriate PCK, and that they should rather afford structures and supports to facilitate teachers' ongoing PCK development. Then, in what appears to be a somewhat counterintuitive turn, a chapter concerned with the measurement of PCK is presented. Kirschner, Taylor, Rollnick, Borowski and Mavhunga's chapter offers an extensive critique of existing methods and their inappropriateness for validly capturing the construct. Driven by the agenda of exploring a relationship between PCK and student outcomes, the chapter provides an ever-expanding list of variables and validation criteria that must be considered in the measurement of PCK.

Concerns about the measurement of PCK are further highlighted in the final part of the book. This part contains a single chapter written by Richard F. Gunstone and the chapter serves as a reflection on the successes of the Summit. Within his chapter, Gunstone highlights two concerns with the evolving research agenda. First, from the definition of PCK provided at the conference, issues surrounding the use of language in PCK research are cited as critical. The multitude of pathways that PCK researchers have dived down over the past 30 years are ultimately viewed as serving to further complicate an already messy construct. In this light and advocating precision in how language is used to describe PCK and its various relationships, the clarity afforded by the definitions developed are also commended. The second issue raised in this chapter is the use of the term measurement when concerning PCK. It is noted that measures of teacher knowledge in the normative form needed to explore quantitative relationships with student outcomes tend to lead to simple and gross data forms, and that it is harder to quantitatively conceive of the subtlety, fine distinction and fine discrimination between differing forms of teacher knowledge that one might hypothesize would lead to differences of substance in student

outcomes. This concern mirrors my own reading of the book and previous PCK research – as soon as numbers are applied, the construct appears to become somewhat unstuck.

I had initially thought my contention with measuring PCK stemmed from the nature of technology education. My thinking was that the various decisions about what to teach afforded in technology negated the application of PCK frameworks as this would mean that all PCK is personal. This is mostly informed by attempts to apply the CoRe instrument to technology education (Williams, Eames, Hume, & Lockley, 2012). However, in defining PCK as personal and situational, the attendees at the Summit have situated PCK across all disciplines in a place where it cannot be measured in a conventional sense.

It is perhaps most beneficial to consider the model presented at the Summit, as not a model of PCK but rather as a model of teacher practice/knowledge/beliefs/skill *including* PCK. The question that stems from this conception is: How would a model of teacher practice/knowledge/beliefs/skill *including* PCK look in technology education?

It is from this perspective that I would recommend reading the book, in particular the chapter written by Gess-Newsome and consider the application of this frame of reference to technology education, as I believe the fruitfulness of PCK stems from understanding its relationship with practice. Developing our understanding of this relationship will evolve PCK research past the stale metaphor status (Settlage, 2013) it has attained in recent times.

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