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ScienceDirect
Teaching and Teacher Education 23 (2007) 885–897
TEACHING AND TEACHER EDUCATION
www.elsevier.com/locate/tate

A research model for the study of science teachers' PCK and improving teacher education

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Received 29 January 2006; received in revised form 7 May 2006; accepted 9 May 2006

Abstract

In this article, a new research model for the study of pedagogical content knowledge (PCK) is presented which aims to improve teacher education. This model called "educational reconstruction for teacher education" (ERTE) represents the framework for an integrative approach to the study of science teachers' topic specific PCK, which is a largely unexplored field. By integrating the PCK concept, originating in the American Curriculum tradition, into the German (*Fach*)*didaktik* tradition, this model adds a new perspective to (*Fach*)*didaktik*. This paper, therefore, also aims to clarify the PCK concept and its relation to *Fachdidaktik*.

Keywords: Pedagogical content knowledge; Science teachers; Teacher education; Research model; Teacher knowledge; Educational reconstruction

> Subject Didaktik and Curriculum research, as represented by [among others] Lee Shulman … are dealing with the same set of questions. What all these efforts have in common is the strong belief that we need an integrative approach … that can do justice to each corner of the Didaktik triangle: the teacher, the content, and not least, the learner (Hopmann & Riquarts, 2000, p. 10).

1. Introduction

The main purpose of this article is to introduce a new research model for the study of science teachers' pedagogical content knowledge (PCK). This model, which is called "educational reconstruction for teacher education" (ERTE), has been developed as the basis for a further research project on science teachers' PCK. It represents the framework for an integrative approach to the study of PCK which aims at improving and designing teacher education. This model can be used to explore secondary school teachers' (1) knowledge and beliefs of students'

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doi:10.1016/j.tate.2006.05.002

pre-scientific[1] conceptions, (2) knowledge and beliefs of representations of the subject matter, and (3) 'subject matter knowledge for teaching', in relation to (a) the design of learning environments or teaching–learning sequences, (b) the study of students' pre-scientific conceptions, and in relation to (c) a subject matter analysis. The ERTE model is based on an established research model within the German *Fachdidaktik*[2] tradition, the model of educational reconstruction (ER) (*Didaktische Rekonstruktion*). This latter model has been developed in the biology education group at Oldenburg University in cooperation with the department of physics education at the *Institut für die Pädagogik der Naturwissenschaften* (IPN) in Kiel (Duit, Gropengießer, & Kattmann, 2005; Kattmann, Duit, & Gropengießer, 1998; Kattmann, Duit, Gropengießer, & Komorek, 1997).

The ERTE model constitutes an example of how two traditions within educational research, the American Curriculum tradition and the German *Didaktik* tradition, can be mingled to the benefit of both. Therefore, we will begin this introduction with a very short historical, comparative description of the different roles that the teacher and the teaching content, two essential elements of this paper and within educational research, have played in the American Curriculum tradition and the German *Didaktik* tradition. We are not aiming to compare or even evaluate the two traditions as wholes. Rather we are aiming to identify two different ways of treating the role of the teacher and teaching content in educational studies. This limited and therefore necessarily simplified overview is meant to provide the context and starting-point for this paper. To understand the issues within the field of educational research it is important to be aware of the fundamental differences between the Anglo-Saxon Curriculum tradition and the Central and North-European *Didaktik* tradition. Until recently, there has never been a comparison of these two traditions. The first comparison was made in the project called "*Didaktik* meets Curriculum—Didactical and Curricular Theories and Patterns: An International Comparison (see Gundem & Hopmann, 1998, for a description of this project). This 'dialogue' has shown to stimulate international understanding and opportunities for cooperation. That such a comparative discussion can be useful can be concluded, for example, from the article by Gudmundsdottir and Grankvist (1992). According to these researchers the German *Didaktik* tradition is a well-kept secret within American educational research. Only recently leading researchers like Lee Shulman have rediscovered *Didaktik* and recognized the relationship with their own ideas.

Since the 17th century, the days of Comenius and Ratke, *Didaktik* has been the way to plan, to enact, and to think about teaching in most of northern and central Europe (Hamilton, 1999; Hopmann & Riquarts, 2000). In American educational research, which has its roots in the 19th century, the various themes within the *Didaktik* field are addressed in the two separate fields of Curriculum and Instruction (Hopmann & Riquarts, 2000). According to Westbury (2000, p. 21) the "most dramatic difference in viewpoint" between both traditions, the *Didaktik* and Curriculum tradition is "their respective views of the teacher, and the role the teacher is given within their theoretical and institutional systems." Lagemann (2000) observes that the relation between scholars and practitioners of education that has developed in the history of American educational research was hierarchical. It has been assumed that knowledge for teaching should be generated at the university and then used in the schools (Cochran-Smith & Lytle, 1993). Westbury (2000) even states that the teacher was seen as the passive 'conduit' in the school system who implements the system's, teacher-proof, curricula. He observes that in the German *Didaktik* tradition, in contrast, the teachers "are guaranteed professional autonomy, 'freedom to teach', without control by a curriculum in the American sense" (Westbury, 2000, p. 17). The state curriculum (*Lehrplan*) in Germany prescribes the content for teaching but is not meant to explicitly direct a teachers' work. The teacher works within

[1]We use the term 'pre-scientific conception' introduced by Good (1991; see also Wandersee, Mintzes, & Novak, 1994), instead of the commonly used term 'alternative conception'. In our view this former term better describes the place of these conceptions on the continuum of scientific understanding.

[2]Because of language differences and fundamental cultural differences the German terms *Didaktik* and *Fachdidaktik* are difficult to translate into English. The term didactics is not a good translation because "didactics has a negative valuation in the Anglo-American mind" (see Hamilton, 1999, also for an excellent description of the historical development of the terms: didactics and curriculum).

German *Didaktik* is characterized by a differentiation between the general *Didaktik* and the specific, that is focusing on specific teaching subjects (*Fachdidaktik*). *Didaktik* is a theory of learning and teaching that deals with the following questions: what is to be taught and learned? How and why is the content to be taught and learned? Traditionally *Didaktik* has been a more philosophical than empirical field (Künzli, 2000. pp. 43–44).