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PEDAGOGY : TEACHING AND LEARNING

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Abstract

The myriad tasks of teaching, such as selecting worthwhile learning activities, giving helpful explanations, asking productive questions, and evaluating students' learning, all depend on the teacher's understanding of what it is that students are to learn. That teachers may hold such goals for student learning that grow out of their study of subject matter does not, however, dictate a particular pedagogy. In helping students develop such understandings, teachers may play a variety of roles and draw on a variety of knowledge and skills. Teaching styles and the manner in which teachers organize their classrooms may also vary. Wineburg and Wilson (1988) describe two very different but equally excellent high school history teachers, Mr. Price and Ms. Jensen, teaching their students about the American Revolution. The focus of this paper is the subject matter preparation of teachers: what subject matter preparation entails, where and when it occurs, and with what outcomes.

Introduction

The goal of teacher education is not to indoctrinate or train teachers to behave in prescribed ways, but to educate teachers to reason soundly about their teaching as well as to perform skillfully. Sound reasoning requires both a process of thinking about what they are doing and an adequate base of facts, principles and experiences from which to reason. Teachers must learn to use their knowledge base to provide the grounds for choices and action. . . . Good teaching is not only effective behaviorally, but must also reset on a foundation of adequately grounded premises.

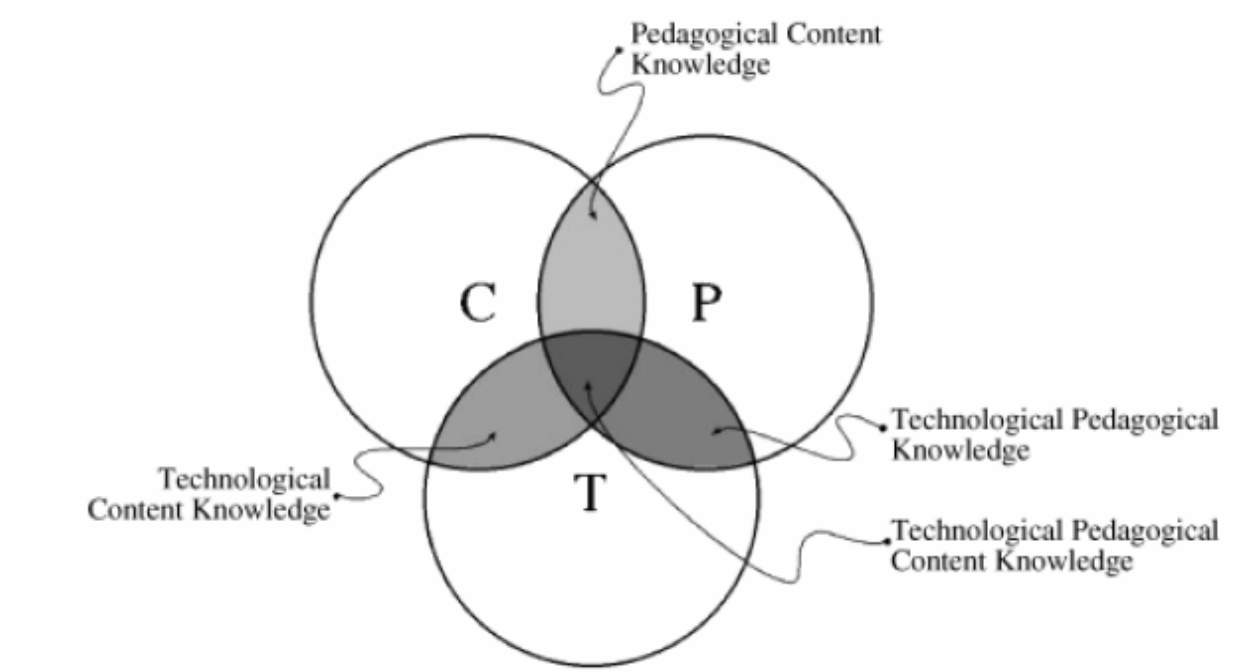
Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge

The important thing in science is not so much to obtain new facts as to discover new ways of thinking about them. —Sir William Henry Bragg.

The advent of digital technology has dramatically changed routines and practices in most arenas of human work. Advocates of technology in education often envisage similar dramatic

changes in the process of teaching and learning. It has become clear, however, that in education the reality has lagged far behind the vision. The TPCK framework allows us to tease apart some of the key issues that are necessary for scholarly dialogue about educational technology. Our model considers how content, pedagogy, and technology dynamically co constrain each other. Additionally, we show how the TPCK framework can be used to design pedagogical strategies and an analytic lens to study changes in educators' knowledge about successful teaching with technology.

We do not argue that this TPCK approach is completely new. Other scholars have argued that knowledge about technology cannot be treated as Figure. Pedagogical Technological Content Knowledge.



The Three Circles, Content, Pedagogy, and Technology, Overlap to Lead to Four More Kinds of Interrelated Knowledge. context-free and that good teaching requires an understanding of how technology relates to the pedagogy and content. In practical terms, this means that apart from looking at each of these components in isolation, we also need to look at them in pairs: pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and all three taken together as technological pedagogical content knowledge (TPCK).

Content Knowledge

Content knowledge (CK) is knowledge about the actual subject matter that is to be

learned or taught. The content to be covered in high school social studies or algebra is very different from the content to be covered in a graduate course on computer science or art history. Clearly, teachers must know and understand the subjects that they teach, including knowledge of central facts, concepts, theories, and procedures within a given field; knowledge of explanatory frameworks that organize and connect ideas; and knowledge of the rules of evidence and proof (Shulman, 1986). Teachers must also understand the nature of knowledge and inquiry in different fields.

Pedagogical Knowledge

Pedagogical knowledge (PK) is deep knowledge about the processes and practices or methods of teaching and learning and how it encompasses, among other things, overall educational purposes, values, and aims. This is a generic form of knowledge that is involved in all issues of student learning, classroom management, lesson plan development and implementation, and student evaluation. It includes knowledge about techniques or methods to be used in the classroom; the nature of the target audience; and strategies for evaluating student understanding. A teacher with deep pedagogical knowledge understands how students construct knowledge, acquire skills, and develop habits of mind and positive dispositions toward learning. As such, pedagogical knowledge requires an understanding of cognitive, social, and developmental theories of learning and how they apply to students in their classroom.

Pedagogical Content Knowledge

The idea of pedagogical content knowledge is consistent with, and similar to, Shulman's idea of knowledge of pedagogy that is applicable to the teaching of specific content. This knowledge includes knowing what teaching approaches fit the content, and likewise, knowing how elements of thecontent can be arranged for better teaching. This knowledge is different from the knowledge of a disciplinary expert and also from the general pedagogical knowledge shared by teachers across disciplines. PCK is concerned with the representation and formulation of concepts, pedagogical techniques, knowledge of what makes concepts difficult or easy to learn, knowledge of students' prior knowledge, and theories of epistemology.

Technology Knowledge

Technology knowledge (TK) is knowledge about standard technologies, such as books,

chalk and blackboard, and more advanced technologies, such as the Internet and digital video. This involves the skills required to operate particular technologies. In the case of digital technologies, this includes knowledge of operating systems and computer hardware, and the ability to use standard sets of software tools such as word processors, spreadsheets, browsers, and e-mail. TK includes knowledge of how to install and remove peripheral devices, install and remove software programs, and create and archive documents. Most standard technology workshops and tutorials tend to focus on the acquisition of such skills. Since technology is continually changing, the nature of TK needs to shift with time as well.

Technological Content Knowledge

Technological content knowledge (TCK) is knowledge about the manner in which technology and content are reciprocally related. Although technology constrains the kinds of representations possible, newer technologies often afford newer and more varied representations and greater flexibility in navigating across these representations. Teachers need to know not just the subject matter they teach but also the manner in which the subject matter can be changed by the application of technology.

Technological Pedagogical Knowledge

Technological pedagogical knowledge (TPK) is knowledge of the existence, components, and capabilities of various technologies as they are used in teaching and learning settings, and conversely, knowing how teaching might change as the result of using particular technologies. This might include an understanding that a range of tools exists for a particular task, the ability to choose a tool based on its fitness, strategies for using the tool's affordances, and knowledge of pedagogical strategies and the ability to apply those strategies for use of technologies.

Technological Pedagogical Content Knowledge

Technological pedagogical content knowledge (TPCK) is an emergent form of knowledge that goes beyond all three components (content, pedagogy, and technology). This knowledge is different from knowledge of a disciplinary or technology expert and also from the general pedagogical knowledge shared by teachers across disciplines. TPCK is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content;

knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones.

The Role of Subject Matter Knowledge in Teaching

Helping students learn subject matter involves more than the delivery of facts and information. The goal of teaching is to assist students in developing intellectual resources to enable them to participate in, not merely to know about, the major domains of human thought and inquiry. These include the past and its relation to the present; the natural world; the ideas, beliefs, and values of our own and other peoples; the dimensions of space and quantity; aesthetics and representation; and so on. Understanding entails being able to use intellectual ideas and skills as tools to gain control over everyday, real-world problems. Students should see themselves, either alone or in cooperation with others, as capable of figuring things out--of using mathematics to define and reason through a problem; of tracking down the origins of current social policy; of interpreting a poem or story, of understanding how physical forces operate; of recreating in writing a feeling, idea, or experience. They should both be able and inclined to challenge the claims in a politician's speech, to make sense of and criticize presentations of statistical information, and to write an effective letter to the editor. A conceptual mastery of subject matter and the capacity to be critical of knowledge itself can empower students to be effective actors in their environment.

Sources and Outcomes of Teachers' Subject Matter Learning

Critics of teacher education tend to overlook the fact that prospective teachers take most of their courses not in much-maligned colleges of education but in liberal arts departments. The professional training they receive in colleges of education is also not centrally concerned with their subject matter knowledge. Elementary teachers take half or more of their courses in the liberal arts; recent policy initiatives--in states such as New Jersey, California, Illinois, Texas, and Virginia--have drastically curtailed or have eliminated the education courses that intending teachers can take. Secondary teachers have, for many years, taken as few as four or five teacher preparation courses in addition to student teaching. Yet, few critics or researchers concerned with teachers' ability to help their pupils learn subject matter knowledge have shown a broad philosophical interest in the liberal arts component of teacher education (see, for example,

Bigelow, 1971).

Outcomes of Subject Matter Learning

What is learned through studying a subject, whether at the elementary, secondary, or college level? On one hand, this may seem an obvious question. Math classes teach students to add and subtract fractions, factor equations, construct deductive proofs, and solve story problems; social studies classes provide them with information about our nation's past, cultures different from their own, and world geography. In English, students learn to write the five-paragraph essay, to construct grammatical sentences, and to spell and punctuate correctly; in science they learn about electricity, gravity, and about the ecosystem. An abundance of evidence belies these easy assumptions about what students learn from subject matter study. On the other hand, what is learned from studying a subject entails much more than what can be inferred from examining course syllabi or curriculum goals and objectives.

Substantive knowledge of the subject

The first dimension is what is conventionally thought of as subject matter knowledge. Every subject matter field, although continually changing and growing, includes specific information, ideas, and topics to be known. This information and these ideas and topics may be subject to disagreement and different interpretation based on competing perspectives within the field. Still, no conception of subject matter knowledge can exclude attention to substantive knowledge. The very stuff of the subject, its components and the terms used to classify it differ from one subject to another. Knowledge of mathematics includes specific concepts, definitions, conventions, and procedures (e.g., what a rectangle is, how to find the maximum value of a function). Historical knowledge focuses on differing accounts of people, societies, and events, and on explanations of factors that influence the course, sequence, and relationship of events (e.g., what contributed to the Great Depression or to the suffrage movement in the United States and in other countries).

Knowledge about the subject

Substantive knowledge--knowledge of the ideas, facts, and theories of a subject--is but one aspect of subject matter knowledge. Subject matter knowledge also includes a host of understandings *about* the subject--for example, the relative validity and centrality of different ideas or perspectives, the major disagreements within the field (in the past as well as current), how

claims are justified and validated, what is entailed in doing and engaging in the discourse of the field. Whether or not such understandings are explicit goals of instruction, students develop ideas about the subjects they study. Beers (1988) argues that while epistemological issues are rarely made explicit in classrooms, they are implicitly represented in the organization and content of curriculum, in the interaction between teachers and students, and in the nature of classroom activity and discourse.

Dispositions toward the subject.

In addition to understandings of the substance and nature of the subjects they study, students also develop dispositions toward those subjects. They acquire tastes and distastes for particular topics and activities, propensities to pursue certain questions and kinds of study and to avoid others. Students develop conceptions of themselves as good at particular subjects and not at others. For example, 65 percent of third graders think they are good at mathematics; by the end of high school this proportion has dropped to roughly half (Dorsey, Mullis, Lindquist, and Chambers, 1987). And, college students tend to juxtapose being good at mathematics with being good at writing (Ball, 1988). Such dispositions towards subject matter, while well known, are often overlooked in considering what students learn from studying subject matter.

The Precollege Curriculum and Teachers' Subject Matter Preparation

Prospective teachers have been studying mathematics, science, social studies, and writing long before they enter a university. Their precollege education forms a much bigger chunk of their formal education than does the relatively brief period of college study. Not only is the precollege phase of subject matter study longer than the college period, but the content studied in elementary and high school classes is also often closer to that which prospective teachers will actually teach. The subject matter preparation of English teachers reveals perhaps the closest correspondence between what is studied in college and what teachers teach in elementary and high school. High school English teachers study literature in their college courses; the works they read and what they learn about literary interpretation may contribute to the understandings upon which they draw in teaching.

Conclusion

Until a few years ago, the subject matter knowledge of teachers was largely taken for

granted in teacher education as well as in research on teaching. Recent research, focused on the ways in which teachers and teacher candidates understand the subjects they teach, reveals that they often have misconceptions or gaps in knowledge similar to those of their pupils. This paper argues that as teachers are themselves products of elementary and secondary schools in which, research has shown, pupils rarely develop deep understanding of the subject matter they encounter, we should not be surprised by teachers' inadequate subject matter preparation.

The complexity of teacher knowledge makes it extremely difficult to represent it within one overarching framework or theory (Fenstermacher,1994). In particular, any representation of teacher knowledge needs to reflect its socially constructed and dynamic nature.

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