

[4] Those Who Understand:

Knowledge Growth in Teaching

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"He who can, does.
He who cannot, teaches."

I don't know in what fit of pique George Bernard Shaw wrote that infamous aphorism, words that have plagued members of the teaching profession for nearly a century. They are found in "Maxims for Revolutionists," an appendix to his play *Man and Superman*. "He who can, does. He who cannot, teaches" is a calamitous insult to our profession, yet one readily repeated even by teachers. More worrisome, its philosophy often appears to underlie the policies concerning the occupation and activities of teaching.

Where did such a demeaning image of the teacher's capacities originate? How long have we been burdened by assumptions of ignorance and ineptitude within the teaching corps? Is Shaw to be treated as the last word on what teachers know and don't know, or do and can't do?

Yesterday's Examinations

We begin our inquiry into conceptions of teacher knowledge with the tests for teachers that were used in this country during the last century

This paper was a Presidential Address at the 1985 annual meeting of the American Educational Research Association, Chicago. Preparation of this address and of the research program "Knowledge Growth in Teaching" was supported in part by a grant from the Spencer Foundation.

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at state and county levels. Some people may believe that the idea of testing teacher competence in subject matter and pedagogical skill is a new idea, an innovation spawned in the excitement of this era of educational reform, and encouraged by such committed and motivated national leaders as Albert Shanker, President, American Federation of Teachers; Bill Honig, State Superintendent of Schools, California; and Bill Clinton, Governor of Arkansas. Like most good ideas, however, its roots are much older.

Among the most fascinating archives in which to delve are the annual reports of state superintendents of education from over a century ago, in which we find copies of tests for teachers used in licensing candidates at the county level. These tests show us how teacher knowledge was defined. Moreover, we can compare those conceptions with their analogues today. I have examined tests from Massachusetts, Michigan, Nebraska, Colorado, and California. Let us take as a representative example the California State Board examination for elementary school teachers from March 1875 and first look at the categories the examination covered:

1. Written Arithmetic
2. Mental Arithmetic
3. Written Grammar
4. Oral Grammar
5. Geography
6. History of the United States
7. Theory and Practice of Teaching
8. Algebra
9. Physiology
10. Natural Philosophy (Physics)
11. Constitution of the United States and California
12. School Law of California

13. Penmanship
14. Natural History (Biology)
15. Composition
16. Reading
17. Orthography
18. Defining (Word Analysis and Vocabulary)
19. Vocal Music
20. Industrial Drawing

The total number of points possible on this day-long essay examination was 1,000. The examiners were instructed to score for the correctness of responses and to deduct points for errors of composition, grammar, or spelling. What kinds of questions were asked on the examination? We shall review some from several of the categories.

- Find the cost of a draft on New York for \$1,400 payable sixty days after sight, exchange being worth 102 1/2 percent and interest being reckoned at a rate of 7 percent per annum. (Written Arithmetic, one of ten items)
- Divide 88 into two such parts that shall be to each other as 2/3 is to 4/5. (Mental Arithmetic, one of ten items)
- When should the reciprocal pronouns *one another* and *each other* be used? the correlative conjunctions *so as* and *as as*?
- Name and illustrate five forms of conjugation. Name and give four ways in which the nominative case may be used. (Grammar, two of ten items)
- Define *specific gravity*. Why may heavy stones be lifted in water when on land they can scarcely be moved?
- What is adhesion? What is capillary attraction? Illustrate each. (2 of 10 items from Natural Philosophy)
- Name five powers vested in Congress.

Educational Researcher

Just you think that all of the items on the 1875 California Teachers Examination deal with subject matter alone, rest assured that there is a category for pedagogical practice. However, only 50 out of the total 1,000 possible points are given over to the 10-item subtest on Theory and Practice of Teaching. Examples of those items are:

- What course would you pursue to keep up with the progress in teaching?

- How do you succeed in teaching children to spell correctly the words commonly misspelled?

- How do you interest lazy and careless pupils? Answer in full (!).

All the tests I have found from that period follow the same pattern. Ninety to ninety-five percent of the test is on the content, the subject matter to be taught, or at least on the knowledge base assumed to be needed by teachers, whether or not it is taught directly. Thus, aspects of physiology are apparently deemed necessary because of the expectation that teachers understand the biological functioning of their pupils.

How closely did the actual tests administered resemble these I have read? What was it like to take one of these examinations? A useful source for addressing such questions is the autobiographical literature by teachers, one of the most useful compendia of which is *Women's "True" Profession*, a collection of excerpts from the diaries or memoirs of women teachers. Among these, we find the following reminiscence of Lucia Downing (cited in Hoffman, 1981). She reported on the taking of her initial county examination in 1881, as administered by her family physician, who also served one day per month as county superintendent.

When my sister, already a teacher, went to take another examination, the spring I was thirteen, I went along too, and said to the doctor, who was only a superintendent that day, that, if he had enough papers, I should like to see how many questions I could answer. The doctor smiled at me, and gave me an arithmetic paper for a starter. It proved to be easy, for it brought in some favorite problems in percentage, which would be an advantage to a merchant, as they showed how to mark goods in such a way that one could sell below the

marked price, and still make a profit. I guess all merchants must have studied Greenleaf's *Arithmetical*! There was another problem under the old Vermont Annual Interest Rule... and then proudly started on Grammar. I knew I could do something with that, for I loved to parse and analyze and "diagram," according to Reed and Kellogg. In fact, my first knowledge and for many years my only knowledge of "Paradise Lost" was gleaned from a little blue parsing book....

Next came Geography. Though I had never traveled farther than Burlington, I knew, thanks to Mr. Guyot and his green geography, that Senegambia was "rich in gold, iron ore and gum-producing trees"... History and Civil Government were pretty hard for me, but next came Physiology, and I made the most of my bones and circulatory system, hoping to impress the physician. But it was in Theory and School Management that I did myself proud. I discoursed at length on ventilation and temperature, and knowing that "good government" is a most desirable and necessary qualification for a teacher, I advocated a firm, but kind and gentle method, with dignity of bearing. In giving my views of corporal punishment, I related a story I had read of the Yankee teacher who was asked his views on the subject. He said, "Wal, moral suasion's my theory, but hickin's my practice!"

Finally, one morning, there was an envelope addressed in Dr. Butler's scholarly hand... (and) out fluttered two yellow slips—two certificates, entitling the recipients to teach in Vermont for one year. And one was in my name! I cannot recall any subsequent joy equal to what I felt at that moment—even a college diploma and a Phi Beta Kappa key, in later years, brought less of a thrill (pp. 29-30).

The assumptions underlying those tests are clear. The person who presumes to teach subject matter to children must demonstrate knowledge of that subject matter as a prerequisite to teaching. Although knowledge of the theories and methods of teaching is important, it plays a decidedly secondary role in the qualifications of a teacher.

Today's Standards

The emphasis on the subject matter to be taught stands in sharp contrast to the emerging policies of the 1980's with respect to the evaluation or testing of teachers. Nearly every state is reexamining its ap-

proaches to defining what teachers must know to be licensed and subsequently tenured. Many states have introduced mandatory examinations, but these do not typically map onto the content of the curriculum. They are tests of basic abilities to read, write, spell, calculate, and solve arithmetic problems. Often they are treated as prerequisites for entry into a teacher education program rather than as standards for defining eligibility to practice.

In most states, however, the evaluation of teachers emphasizes the assessment of capacity to teach. Such assessment is usually claimed to rest on a "research-based" conception of teacher effectiveness. I shall take as my example a list of such competencies prepared by a state that I briefly advised during its planning for a state-wide system of teacher evaluation. The following categories for teacher review and evaluation were proposed:

1. Organization in preparing and presenting instructional plans
2. Evaluation
3. Recognition of individual differences
4. Cultural awareness
5. Understanding youth
6. Management
7. Educational policies and procedures

As we compare these categories (which are quite similar to those emerging in other states) to those of 1875, the contrast is striking. Where did the subject matter go? What happened to the content? Perhaps Shaw was correct. He accurately anticipated the standards for teaching in 1985. He who knows, does. He who cannot, but knows some teaching procedures, teaches.

Yet policymakers justify the heavy emphasis on procedures by referring to the emergent research base on teaching and teaching effectiveness. They regularly define and justify these categories by the extremely powerful phrase "research-based teacher competencies." In what sense can it be claimed that such a conception of teaching competence is research based?

The designers of recent ap-

proaches to teacher evaluation cite the impressive volume of research on teaching effectiveness as the basis for their selection of domains and standards, and in fact, this basis is valid. They base their categories and standards on a growing body of research on teaching, research classified under the rubrics of "teaching effectiveness," "process-product studies," or "teacher behavior" research. These studies were designed to identify those patterns of teacher behavior that accounted for improved academic performance among pupils.

Whether by contrasting more effective with less effective teachers, or by conducting experiments in which teachers were trained to employ specific sets of teaching behaviors and monitoring the results for pupil achievement, this research program has yielded findings on the forms of teacher behavior that most effectively promote student learning. The work has been criticized from several perspectives, both technical and theoretical, but for our purposes I would consider the research program a thriving and successful one (Shulman, 1986).

Nevertheless, policymakers' decision to base their approaches to teacher evaluation standards on this work is simultaneously the source of their greatest strength and their most significant weakness. What policymakers fail to understand is that there is an unavoidable constraint on any piece of research in any discipline (Shulman, 1981). To conduct a piece of research, scholars must necessarily narrow their scope, focus their view, and formulate a question far less complex than the form in which the world presents itself in practice. This holds for any piece of research; there are no exceptions. It is certainly true of the corpus of research on teaching effectiveness that serves as the basis for these contemporary approaches to teacher evaluation. In their necessary simplification of the complexities of classroom teaching, investigators ignored one central aspect of classroom life: the subject matter.

This omission also characterized most other research paradigms in the study of teaching. Occasionally subject matter entered into the re-

search as a context variable—a control characteristic for subdividing data sets by content categories (e.g., "When teaching 5th grade mathematics, the following teacher behaviors were correlated with outcomes. When teaching 5th grade reading..."). But no one focused on the subject matter content itself. No one asked how subject matter was transformed from the knowledge of the teacher into the content of instruction. Nor did they ask how particular formulations of that content related to what students came to know or misconstrue (even though that question had become the central query of cognitive research on *learning*).

My colleagues and I refer to the absence of focus on subject matter among the various research paradigms for the study of teaching as the "missing paradigm" problem. The consequences of this missing paradigm are serious, both for policy and for research.

Policymakers read the research on teaching literature and find it replete with references to direct instruction, time on task, wait time, ordered turns, lower-order questions, and the like. They find little or no references to subject matter, so the resulting standards or mandates lack any reference to content dimensions of teaching. Similarly, even in the research community, the importance of content has been forgotten. Research programs that arose in response to the dominance of process-product work accepted its definition of the problem and continued to treat teaching more or less generically, or at least as if the content of instruction were relatively unimportant. Even those who studied teacher cognition, a decidedly non-process/product perspective, investigated teacher planning or interactive decisionmaking with little concern for the organization of content knowledge in the minds of teachers. I shall have more to say about the missing paradigm and its investigation a bit later. Let us now return to the question with which we began.

Content and Pedagogy in the History of the Academy

Why this sharp distinction between content and pedagogical pro-

cess? Whether in the spirit of the 1870s, when pedagogy was essentially ignored, or in the 1980s, when content is conspicuously absent, has there always been a cleavage between the two? Has it always been asserted that one either knows content and pedagogy is secondary and unimportant, or that one knows pedagogy and is not held accountable for content?

I propose that we look back even further than those 1875 tests for teachers and examine the history of the university as an institution to discern the sources for this distinction between content knowledge and pedagogical method.

In *Ramus, Method and the Decay of Dialogue*, Father Walter Ong (1958) presents an account of teaching in the medieval university in a chapter with the captivating title "The Pedagogical Juggernaut." He describes a world of teaching and learning in those universities, where instead of separating content and pedagogy (what is known from how to teach it), no such distinction was made at all. Content and pedagogy were part of one indistinguishable body of understanding.

To this day, the names we give our university degrees and the rituals we attach to them reflect those fundamental connections between knowing and teaching. For example, the highest degrees awarded in any university are those of "master" or "doctor," which were traditionally interchangeable. Both words have the same definition; they mean "teacher." "Doctor" or "doctore" means teacher; it has the same root as "doctrine," or teaching. Master, as in school master, also means teacher. Thus, the highest university degree enabled its recipient to be called a teacher.

Ong's (1958) account of these matters is enlightening:

The universities were, in principle, normal schools, not institutions of general education. This was true of all faculties: arts, medicine, law, and theology; and it was most true at Paris and at universities modeled on Paris (rather than on Bologna), such as Oxford and Cambridge and, later, the German universities. Such universities were

in brief, medieval guilds, or were composed of four teachers' guilds or faculties with their associated pupils. The degree of master or doctor (the terms were equivalents, varying from university to university or from faculty to faculty) was the formal admission to the guild, just as the bachelorship which preceded it was admission to the body of apprentice teachers.

Officially, the bachelor of arts was an apprentice teacher on the arts faculty; bachelors of theology were apprentice teachers of theology, condemned to a long round of "practice" teaching; and bachelor butchers were apprentice butchers—for all these people were members of their respective trade guilds.

... A physician whom a university faculty certifies as a practitioner of medicine is called a "doctor" of medicine, as though he were going to teach medicine, just as in some countries, one trained to practice the law is also called "master" or its equivalent. Graduation, too, is still a "commencement" or *inceptio*—in theory, the beginning of a teaching career. (pp. 153-154)

The *inceptio* of which Ong writes was the ceremony of doctoral examination—the final stage of demonstration that one possessed the necessary capacities for the highest university degree. The basic structure of the examination has remained constant to this day in the final oral examination for the doctorate. The purpose of the examination is to demonstrate that the candidate possesses the highest levels of subject matter competence in the domain for which the degree is awarded. How did one demonstrate such understanding in medieval times? By demonstrating the ability to *teach* the subject (Ong, 1985):

Arrived at the cathedral, the licentiate delivered a speech and read a thesis on some point of law, which he defended against opponents who were selected from among the students, the candidates thus playing for the first time the part of a doctor in a university disputation. (pp. 227-228)

Consider the still current form of the oral exam. First, the candidate presents a brief oral exposition of the thesis. He then defends the thesis in dialogue with the examiners. These parallel the two modes of teaching: the lecture and the disputation. The oral examination is the ultimate test of subject matter expertise; it examines the can-

didate's ability to teach the subject by employing the dual method of lecture and discussion.¹

The universities were, therefore, much like normal schools: institutions for preparing that most prestigious of professionals, the highest-level of scholar—the teacher. The tradition of treating teaching as the highest demonstration of scholarship was derived from the writings of a far greater authority than George Bernard Shaw on the nature of knowledge. Aristotle, whose works formed the heart of the medieval curriculum, made these observations in *Metaphysics* (cited in Wheelwright, 1951).

We regard master-craftsmen as superior not merely because they have a grasp of theory and *know* the reasons for acting as they do. Broadly speaking, what distinguishes the man who knows from the ignorant man is an ability to teach, and this is why we hold that art and not experience has the character of genuine knowledge (episteme)—namely, that artists can teach and others (i.e., those who have not acquired an art by study but have merely picked up some skill empirically) cannot. (p. 69)

We thus find in Aristotle a very different view of the relationship between knowing and teaching than we find in either Shaw or in the criteria for certification and licensure in some of our sovereign states.

Last my readers conclude that the medieval university was a pedagogical utopia, to whose practices we need only return to redress the imbalances that plague contemporary teaching policies, permit me to provide a couple of counterexamples.

From the classic treatise on the medieval university, Rashdall's (1895/1936) *The Universities of Europe in the Middle Ages*, relates how problems of accountability were handled.

Punctuality is enforced with extreme rigour. The professor was obliged to begin his lecture when the bells of St. Peter's began to ring for mass, under a penalty of 20 soldi for each offence, though he has the privilege of beginning at an earlier hour if he pleases; while he is forbidden to continue his lecture one minute after the bell has begun to ring for hence. To secure the observance of the statute a more effectual means is adopted even than that of fining the doctor: his pupils are required under a penalty of 10 soldi to leave the lecture-room as soon as the bell begins.

Even in the actual conduct of his lectures the doctor is regulated with the precision of a soldier on parade or a reader in a French public library. He is fined if he skips a chapter or decretal; he is forbidden to postpone a difficulty to the end of the lecture lest such a liberty should be abused as a pretext for evading it altogether. In medieval as in modern times lecturers had a tendency to spend a disproportionate time over the earlier portions of a book, and so leave none for the rest. With a view to checking this practice, an expedient was adopted at Bologna which became universal in the law-universities of Southern Europe. The law-texts were divided into portions known as *parata*; and the doctor was required to have reached each *paratum* by a specified date. At the beginning of the academical year he was bound to deposit the sum of 10 Bologna pounds with a banker (the stakeholder was known as the *Depositarius*), who promised to deliver it up at the demand of the rector: for every day that the doctor was behind time, a certain sum was deducted from his deposit by order of these officials. . . . (pp. 196-197)

The medieval university was therefore hardly a paradise for its teachers, especially in Bologna, where the university was a guild of students that hired teachers (in contrast to the Paris model of a guild of teachers selling services to students). Moreover, it was also deeply flawed by an ultimate liability: it was open only to men and boys. This deficiency may account more than most others for the inability of the medieval university to accomplish as much as one would have hoped.

The Missing Paradigm

We have thus seen that the sharp distinction between knowledge and pedagogy does not represent a tradition dating back centuries, but rather, a more recent development. Moreover, identification of teaching competence with pedagogy alone was not even commonplace during Shaw's time. A century ago the defining characteristic of pedagogical accomplishment was knowledge of content.

The pendulum has now swung, both in research and in policy circles. The missing paradigm refers to a blind spot with respect to content that now characterizes

most research on teaching and, as a consequence, most of our state-level programs of teacher evaluation and teacher certification.

In reading the literature of research on teaching, it is clear that central questions are unasked. The emphasis is on how teachers manage their classrooms, organize activities, allocate time and turns, structure assignments, ascribe praise and blame, formulate the levels of their questions, plan lessons, and judge general student understanding.

What we miss are questions about the *content* of the lessons taught, the questions asked, and the explanations offered. From the perspectives of teacher development and teacher education, a host of questions arise. Where do teacher explanations come from? How do teachers decide what to teach, how to represent it, how to question students about it and how to deal with problems of misunderstanding? The cognitive psychology of *learning* has focused almost exclusively on such questions in recent years, but strictly from the perspective of learners. Research on teaching has tended to ignore those issues with respect to teachers. My colleagues and I are attempting to redress this imbalance through our research program, "Knowledge Growth in Teaching."

What are the sources of teacher knowledge? What does a teacher know and when did he or she come to know it? How is new knowledge acquired, old knowledge retrieved, and both combined to form a new knowledge base?

We assume that most teachers begin with some expertise in the content they teach. (This may be an unfounded assumption, and the consequences of varying degrees of subject matter competence and incompetence have become a serious topic of our research as well.) Secondary teaching candidates, in particular, have typically completed a major in their subject specialty.

Our central question concerns the transition from expert student to novice teacher. How does the successful college student transform his or her expertise in the subject matter into a form that high school students can comprehend? When

this novice teacher confronts flawed or muddled textbook chapters or befuddled students, how does he or she employ content, expertise to generate new explanations, representations, or clarifications? What are the sources of analogies, metaphors, examples, demonstrations, and rephrasings? How does the novice teacher (or even the seasoned veteran) draw on expertise in the subject matter in the process of teaching? What pedagogical prices are paid when the teacher's subject matter competence is itself compromised by deficiencies of prior education or ability?

Our work does not intend to denigrate the importance of pedagogical understanding or skill in the development of a teacher or in enhancing the effectiveness of instruction. Mere content knowledge is likely to be as useless pedagogically as content-free skill. But to blend properly the two aspects of a teacher's capacities requires that we pay as much attention to the content aspects of teaching as we have recently devoted to the elements of teaching process.

In our research, we have focused on the development of secondary teachers in English, biology, mathematics, and social studies. Our participants are all in California, thus each has already completed a bachelor's degree in the subject to be taught or has earned a waiver by examination. We are devoting at least one year, and often two, to the study of each novice teacher. We begin with their year of teacher preparation (which is nearly three-quarters completed as this paper is written) and, whenever possible, we will follow them into their first year of full-time teaching.

Our initial goal has been to trace their intellectual biography—that set of understandings, conceptions, and orientations that constitutes the source of their comprehension of the subjects they teach. This approach to assessing their content knowledge is quite different from the methods typically used to measure teacher content knowledge in the research literature: namely, administering an achievement test and employing a total test score as the index of teacher knowledge.

We follow them closely during this teacher-education year, conducting regular interviews, asking them to read and comment on materials related to the subjects they teach, and observing their instruction after having engaged them in a planning interview. We also gather data on the teacher education program in which they are prepared and the impact of both formal and informal preparation experiences on their pedagogy. Most of these references emerge naturally in the course of frequent conversations during the year.

A number of strategic research sites and key events are particularly illuminating for our understanding of how knowledge grows in teaching. Often a young teacher will be expected to teach a topic that he or she has never previously learned. For example, the biology major encounters a unit on levers and simple machines in a general science course. The English major must teach a novel or play never previously encountered. The political science major with strong preparation in Central America confronts a unit on India or the Middle East. Even the math major encounters such occasions, as when teaching introductory topics in algebra or geometry, topics he or she has not encountered since high school or even earlier. How does the teacher prepare to teach something never previously learned? How does learning *for* teaching occur?

Another strategic site occurs in conjunction with sections of textbooks that the teacher finds problematic, flawed in their conception of the topic, incomplete in their treatment, or inadequate in explanation or use of examples. How are these deficiencies in curriculum materials (which appear to be commonplace) apprehended and dealt with by teachers? How do teachers take a piece of text and transform their understanding of it into instruction that their students can comprehend?

We are not alone in our interest. Prominent among other investigators who are pursuing such questions are Gaeta Leinhardt at the Learning Research and Development Center, University of Pittsburgh, and Charles Anderson and

Edward Smith of Michigan State's Institute for Research on Teaching.

A Perspective on Teacher Knowledge

As we have begun to probe the complexities of teacher understanding and transmission of content knowledge, the need for a more coherent theoretical framework has become rapidly apparent. What are the domains and categories of content knowledge in the minds of teachers? How, for example, are content knowledge and general pedagogical knowledge related? In which forms are the domains and categories of knowledge represented in the minds of teachers? What are promising ways of enhancing acquisition and development of such knowledge? Because I see these as among the central questions for disciplined inquiry in teacher education, I will now turn to a discussion of some ways of thinking about one particular domain—content knowledge in teaching—and some of the categories within it.

How might we think about the knowledge that grows in the minds of teachers, with special emphasis on content? I suggest we distinguish among three categories of content knowledge: (a) subject matter content knowledge, (b) pedagogical content knowledge, and (c) curricular knowledge.

Content Knowledge. This refers to the amount and organization of knowledge *per se* in the mind of the teacher. We already have a number of ways to represent content knowledge: Bloom's cognitive taxonomy, Gagne's varieties of learning, Schwab's distinction between substantive and syntactic structures of knowledge, and Peters' notions that parallel Schwab's.

In the different subject matter areas, the ways of discussing the content structure of knowledge differ. To think properly about content knowledge requires going beyond knowledge of the facts or concepts of a domain. It requires understanding the structures of the subject matter in the manner defined by such scholars as Joseph Schwab. (See his collected essays, 1978.)

For Schwab, the structures of a subject include both the substantive

and the syntactic structures. The substantive structures are the variety of ways in which the basic concepts and principles of the discipline are organized to incorporate its facts. The syntactic structure of a discipline is the set of ways in which truth or falsehood, validity or invalidity, are established. When there exist competing claims regarding a given phenomenon, the syntax of a discipline provides the rules for determining which claim has greater warrant. A syntax is like a grammar. It is the set of rules for determining what is legitimate to say in a disciplinary domain and what "breaks" the rules.

Teachers must not only be capable of defining for students the accepted truths in a domain. They must also be able to explain why a particular proposition is deemed warranted, why it is worth knowing, and how it relates to other positions, both within the discipline and without, both in theory and in practice.

Thus, the biology teacher must understand that there are a variety of ways of organizing the discipline. Depending on the preferred color of one's BSCS text, biology may be formulated as (a) a science of molecules from which one aggregates up to the rest of the field, explaining living phenomena in terms of the principles of their constituent parts; (b) a science of ecological systems from which one disaggregates down to the smaller units, explaining the activities of individual units by virtue of the larger systems of which they are a part; or (c) a science of biological organisms, those most familiar of analytic units, from whose familiar structures, functions, and interactions one weaves a theory of adaptation. The well-prepared biology teacher will recognize these and alternative forms of organization and the pedagogical grounds for selecting one under some circumstances and others under different circumstances. The same teacher will also understand the syntax of biology. When competing claims are offered regarding the same biological phenomenon, how has the controversy been adjudicated? How might similar controversies be adjudicated in our own day?

We expect that the subject matter content understanding of the teacher be at least equal to that of his or her lay colleague, the mere subject matter major. The teacher need not only understand *that* something is so; the teacher must further understand *why* it is so, on what grounds its warrant can be asserted, and under what circumstances our belief in its justification can be weakened and even denied. Moreover, we expect the teacher to understand why a given topic is particularly central to a discipline whereas another may be somewhat peripheral. This will be important in subsequent pedagogical judgments regarding relative curricular emphasis.

Pedagogical Content Knowledge. A second kind of content knowledge is pedagogical knowledge, which goes beyond knowledge of subject matter *per se* to the dimension of subject matter knowledge *for teaching*. I still speak of content knowledge here, but of the particular form of content knowledge that embodies the aspects of content most germane to its teachability.²

Within the category of pedagogical content knowledge I include, 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. Since there are no single most powerful forms of representation, the teacher must have at hand a veritable armamentarium of alternative forms of representation, some of which derive from research whereas others originate in the wisdom of practice.

Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons. If those preconceptions are misconceptions, which they so often are, teachers need knowledge of the strategies

most likely to be fruitful in reorganizing the understanding of learners, because those learners are unlikely to appear before them as blank slates.

Here, research on teaching and on learning coincide most closely.

The study of student misconceptions and their influence on subsequent learning has been among the most fertile topics for cognitive research. We are gathering an ever-growing body of knowledge about the misconceptions of students and about the instructional conditions necessary to overcome and transform those initial conceptions. Such research-based knowledge, an important component of the pedagogical understanding of subject matter, should be included at the heart of our definition of needed pedagogical knowledge.

Curricular Knowledge. If we are regularly remiss in not teaching pedagogical knowledge to our students in teacher education programs, we are even more delinquent with respect to the third category of content knowledge, *curricular knowledge*. The curriculum is represented by the full range of programs designed for the teaching of particular subjects and topics at a given level, the variety of instructional materials available in relation to those programs, and the set of characteristics that serve as both the indications and contraindications for the use of particular curriculum or program materials in particular circumstances.

The curriculum and its associated materials are the *matéria medica* of pedagogy, the pharmacopeia from which the teacher draws those tools of teaching that present or exemplify particular content and remediate or evaluate the adequacy of student accomplishments. We expect the mature physician to understand the full range of treatments available to ameliorate a given disorder, as well as the range of alternatives for particular circumstances of sensitivity, cost, inconvenience, safety, or comfort. Similarly, we ought to expect that the mature teacher possesses such understandings about the curricular alternatives available for instruction.

How many individuals whom we prepare for teaching biology, for example, understand well the materials for that instruction, the alternative texts, software, programs, visual materials, single-concept films, laboratory demonstrations, or "invitations to enquiry?"

Would we trust a physician who did not really understand the alternative ways of dealing with categories of infectious disease, but who knew only one way?

In addition to the knowledge of alternative curriculum materials for a given subject or topic within a grade, there are two additional aspects of curricular knowledge. I would expect a professional teacher to be familiar with the curriculum materials under study by his or her students in other subjects they are studying at the same time.

This lateral curriculum knowledge (appropriate in particular to the work of junior and senior high school teachers) underlies the teacher's ability to relate the content of a given course or lesson to topics or issues being discussed simultaneously in other classes. The vertical equivalent of that curriculum knowledge is familiarity with the topics and issues that have been and will be taught in the same subject area during the preceding and later years in school, and the materials that embody them.

Content Examinations. What might the expectation that our teachers possess these varieties of content knowledge entail for the assessment of teacher competence?

If such a conception of teacher knowledge were to serve as the basis for a subject matter content examination for teachers, that examination would measure deep knowledge of the content and structures of a subject matter, the subject and topic-specific pedagogical knowledge associated with the subject matter, and the curricular knowledge of the subject. We would have a form of examination that would be appropriate for assessing the capacities of a *professional*. It would not be a mere subject matter examination. It would ask questions about the most likely misunderstandings of photosynthesis among preadolescents, for example, and the strategies most likely to be use-

ful in overcoming those difficulties. As such, it could distinguish between a biology major and a biology teacher, and in a pedagogically relevant and important way. It would be much tougher than any current examination for teachers.³

Forms of Knowledge

A conceptual analysis of knowledge for teachers would necessarily be based on a framework for classifying both the domains and categories of teacher knowledge, on the one hand, and the forms for representing that knowledge, on the other. I would like to suggest three forms of teacher knowledge: *propositional knowledge*, *case knowledge*, and *strategic knowledge*.

Recall that these are "forms" in which each of the general domains or particular categories of knowledge previously discussed—content, pedagogy, and curriculum—may be organized. (There are clearly other important domains of knowledge as well, for example, of individual differences among students, of generic methods of classroom organization and management, of the history and philosophy of education, and of school finance and administration, to name but a few. Each of these domains is subdivided into categories and will be expressible in the forms of knowledge to be discussed here.)

Much of what is taught to teachers is in the form of propositions. When we examine the research on teaching and learning and explore its implications for practice, we are typically (and properly) examining propositions. When we ask about the wisdom of practice, the accumulated lore of teaching experience, we tend to find such knowledge stored in the form of propositions as well.

The research-based principles of active teaching, reading for comprehension, and effective schools are stated as lists of propositions. The experience-based recommendations of planning five-step lesson plans, never smiling until Christmas, and organizing three reading groups are posed as sets of propositions. In fact, although we often present propositions one at a time, we recognize that they are better

understood if they are organized in some coherent form, lodged in a conceptual or theoretical framework that is generative or regenerative. Otherwise they become terribly difficult to recall or retrieve. (The experimental studies of teaching effectiveness have been guilty of presenting lengthy lists of research-based behaviors for teachers to practice, without always providing a rationale or conceptual framework for the set.)

I will argue that there are fundamentally three types of propositional knowledge in teaching, corresponding to the three major sources of knowledge about teaching: disciplined empirical or philosophical inquiry, practical experience, and moral or ethical reasoning. I will refer to these three types of propositions as *principles*, *maxims*, and *norms*.

A principle typically derives from empirical research. One of my favorites is "Ordered turns are associated with higher achievement gains than are random turns in first grade reading groups" (Anderson, Evertson, & Brophy, 1979). The teaching and school effectiveness literatures contain many examples of useful principles for teaching.

The second kind of proposition makes not a theoretical claim, but a practical one. In every field of practice there are ideas that have never been confirmed by research and would, in principle, be difficult to demonstrate. Nevertheless, these maxims represent the accumulated wisdom of practice, and in many cases are as important a source of guidance for practice as the theory or empirical principles. "Never smile until Christmas" would qualify as such a maxim, as would "Break a large piece of chalk before you use it for the first time, to prevent squeaking against the board."

The third kind of proposition reflects the norms, values, ideological or philosophical commitments of justice, fairness, equity, and the like, that we wish teachers and those learning to teach to incorporate and employ. They are neither theoretical nor practical, but normative. They occupy the very heart of what we mean by teacher knowledge. These are propositions

that guide the work of a teacher, not because they are true in scientific terms, or because they work in practical terms, but because they are morally or ethically right. The admissions to provide each student with equal opportunity for turning, or not to embarrass a child in front of peers, are examples of normative knowledge.

The representation of knowledge in the form of propositions has both a distinct advantage and a significant liability. Propositions are remarkably economical in form, containing and simplifying a great deal of complexity. The weakness of propositions is two-fold. First, they become very hard to remember, especially as they aggregate into long lists. This is where theoretical frameworks as intellectual scaffolds become indispensable. Second, they gain their economy precisely because they are decontextualized, stripped down to their essentials, devoid of detail, emotion, or ambience. Yet, to be remembered and then wisely used, it is precisely the detail and the context that may be needed.

Although principles are powerful, they are not particularly memorable, rendering them a problem to apply in particular circumstances. *How* does a teacher apply, for example, the principle "check for understanding," certainly among the most important in the direct instruction and the active teaching research bases? For these reasons, I am proposing that we look seriously at the usefulness of a second type of knowledge, a necessary complement to knowledge of propositions, *case knowledge*.

The roots of the "case method" in the teaching of law in this country, certainly the best known approach to employing cases as vehicles for professional education, lie in their value for teaching theory, not practice. Christopher Columbus Langdell, who became Dean of the Harvard University Law School in 1870, was responsible for advancing the case method of legal education. His rationale for employing this method was not its value as a way of teaching methods or approaches to practice. He believed that if practice were the essence of law, it had no place in a university. Instead, he ad-

vocated the case method of legal education because of its effectiveness in teaching law as science—in teaching legal theory through cases.

A case, properly understood, is not simply the report of an event or incident. To call something a case is to make a theoretical claim—to argue that it is a "case of something," or to argue that it is an instance of a larger class. A red rash on the face is not a case of something until the observer has invoked theoretical knowledge of disease. A case of direct instruction or of higher-order questioning is similarly a theoretical assertion. I am therefore not arguing that the preparation of teachers be reduced to the most practical and concrete; rather, using the power of a case literature to illuminate both the practical and the theoretical, I argue for development of a case literature whose organization and use will be profoundly and self-consciously theoretical.

Case knowledge is knowledge of specific, well-documented, and richly described events. Whereas cases themselves are reports of events or sequences of events, the knowledge they represent is what makes them cases. The cases may be examples of specific instances of practice—detailed descriptions of how an instructional event occurred—complete with particulars of contexts, thoughts, and feelings. On the other hand, they may be exemplars of principles, exemplifying in their detail a more abstract proposition or theoretical claim.

Parallel to my argument that there are three types of propositional knowledge of teaching—principles, maxims and norms—I shall propose three types of cases. *Prototypes* exemplify theoretical principles. *Precedents* capture and communicate principles of practice or maxims. *Parables* convey norms or values. Naturally, a given case can accomplish more than a single function; it can, for example, serve as both prototype and precedent.

We are probably most accustomed to thinking of cases as precedents. Knowledge of how a particular teacher taught a particular lesson, or the way a teacher brought a classroom of misbehaving youngsters under control sticks in

our minds. These remembrances of teachings past are valuable in guiding the work of a teacher, both as a source for specific ideas and as a heuristic to stimulate new thinking. But other kinds of cases exemplify, illustrate, and bring alive the theoretical propositions that are potentially the most powerful tools teachers can have. These are the prototypes within case knowledge. For example, when pharmacology is taught, specific drugs are often used as illustrations. The drugs selected for that purpose are not necessarily the most frequently used in practice. Instead, prototypes are selected that exemplify in their performance the mechanisms of action most characteristic of the class of drugs they represent. They are thus theoretically interesting cases for teaching purposes.

As part of an extensive interview study with teachers reputed to be excellent managers of classroom behavior problems, J. Brophy (personal communication, 1981) has reported the following case: A teacher was confronted with repeated incidents of students coming to class without pencils. Rather than either supplying them with replacements (thus making it possible for them to keep up with their work, although running the risk of reinforcing their poor habits) or forcing them to sit through the lesson without benefit of participation, the following strategy was reported. The teacher kept a box of very short pencil stubs in his desk. Whenever a student approached who had forgotten to bring a pencil, the teacher produced the shortest stub available and lent it to the student, who was then expected to use it in completing all of that day's work. In addition to serving as a fine classroom management precedent, this case can also serve as a memorable prototype for the principle of avoiding the inadvertent reinforcement of maladaptive behavior.

Parallel to the theoretical use of prototype cases and the practical use of precedents, we also encounter the moral or normative value of parables. A parable is a case whose value lies in the communication of values and norms, propositions that occupy the very

heart of teaching as profession and as craft. Moreover, if we look at the recent literature on effective organizations and what keeps them working well and their members collaborating enthusiastically, we discover the importance of myths in organizations—tales about heroic figures or memorable events that somehow capture the values of those organizations and communicate them to everyone working within them. Those myths, I would argue, or their case equivalents—pedagogical parables—would be equally important in the socialization of teachers into their general professional obligations as well as into the special ethos of particular schools or districts as organizations.

The identification of case knowledge, a case literature, and case-based teacher education as central elements in our discussions and inquiries produces a rich and vital agenda for research. What is involved in the elevation of an event into a case? How are cases aggregated into case knowledge, or alternatively, how does knowledge of cases become case knowledge? How does one learn from and use cases in teaching? If the conception of propositional knowledge is deductive, where applications are deduced from general propositions, how is the analogical reasoning from cases learned, practiced, and tuned? Can we learn from other disciplines or professions such as law or architecture, where analogical reasoning from cases is much more typical, how to conceive of and use case knowledge in education? Why are cases memorable? Is it because they are organized as stories, reflecting the grammar of narrative forms of discourse, that makes them more readily stored, ordered and retrieved than their expository or propositional analogues?²⁴

Another reason that these conceptions of case knowledge may be timely is the shift of research paradigms currently underway in our field. We are developing well-reasoned, methodologically sophisticated, and logically argued approaches to the use of qualitative methods and case studies to parallel our already developed approaches of correlational and experimental inquiry. These newer approaches in-

produce both a new kind of data about which to reason and new modes of reasoning themselves. As Geertz (1983) has observed, "Inquiry is directed at cases or sets of cases, and toward the particular features that mark them off. . . ." (p. 22). As these approaches grow in their educational applications, we will begin to develop a more extensive case literature, as well as a pool of scholars and reflective practitioners capable of preparing and interpreting cases.

Cases are documented (or portrayed) occasions or sets of occasions with their boundaries marked off, their borders drawn. What a given occasion is "a case of" is not immediately apparent from the account itself. Generalizability does not inhere in the case, but in the conceptual apparatus of the explication. An event can be described; a case must be explicated, interpreted, argued, dissected, and reassembled. A case of Budweiser is marked off from other cases (or non-cases) by physical attributes that are immediately visible. But a case of direct instruction, or of teacher expectations, or of student misconception, is a theoretical construction. Hence, there is no real case knowledge without theoretical understanding. What passes for atheoretical case knowledge is mere anecdote, a parable without a moral.

I am not offering herein an argument against the conception of teaching as skill. I am instead arguing for its insufficiency—its incompleteness as an account of teaching ability and performance. We are only half way toward understanding the knowledge base of teaching when characterizing a research-based conception of the skills of teaching. This account must be complemented by a conception of teaching in which the principled skills and the well-studied cases are brought together in the development and formation of strategic pedagogical knowledge.

I have referred to *strategic knowledge* as the third "form" of teacher knowledge. Both propositions and cases share the burden of unilaterality, the deficiency of turning the reader or user toward a single, particular rule or practical way of seeing. Strategic knowledge comes in-

to play as the teacher confronts particular situations or problems, whether theoretical, practical, or moral, where principles collide and no simple solution is possible. Strategic knowledge is developed when the lessons of single principles ~~contradict one another, or the precedents of particular cases are incompatible.~~ From Rowe's (1974) research on wait-time, for example, we learn the principle that longer wait-times produce higher levels of cognitive processing. Yet Kounin's (1970) research on classroom management warns the teacher against slowing the pace of the classroom too severely lest the frequency of discipline problems increase. How can the principle of longer wait-times and that of quicker pacing both be correct?

It is in the very nature of the practical or policy fields that individual principles are fated to clash on particular occasions. Knowledge of the relevant propositions and cases is needed to form the underlying knowledge base. Strategic knowledge must be generated to extend understanding beyond principle to the wisdom of practice. We generally attribute wisdom to those who can transcend the limitations of particular principles or specific experiences when confronted by situations in which each of the alternative choices appears equally "principled." Novice bridge players rapidly learn the principles of the game, embodied in such maxims as "Lead fourth highest from your longest and strongest suit," and "Never lead away from a king." But when you must lead away from a king to lead fourth highest, then propositional knowledge alone becomes limited in value. Strategic knowledge (or judgment) is then invoked.⁵

I envision the use of case method in teacher education, whether in our classrooms or in special laboratories with simulations, videodisks and annotated scripts, as a means for developing strategic understanding, for extending capacities toward professional judgment and decision-making. These methods of instruction would involve the careful confrontation of principles with cases, of general rules with concrete documented events—a dialectic of

the general with the particular in which the limits of the former and the boundaries of the latter are explored (Shulman, 1984). What happens when cases are applied to principles or principles to cases? What happens when two principles are in conflict, or when two cases yield contradictory interpretations?

When strategic understanding is brought to bear in the examination of rules and cases, professional judgment, the hallmark of any learned profession, is called into play. What distinguishes mere craft from profession is the indeterminacy of rules when applied to particular cases. The professional holds knowledge, not only of how—the capacity for skilled performance—but of what and why. The teacher is not only a master of procedure, but also of content and rationale, and capable of explaining why something is done. The teacher is capable of reflection leading to self-knowledge, the metacognitive awareness that distinguishes draftsman from architect, bookkeeper from auditor. A professional is capable not only of practicing and understanding his or her craft, but of communicating the reasons for professional decisions and actions to others (see Shulman, 1983).

This sort of reflective awareness of how and why one performs complicates rather than simplifies action and renders it less predictable and regular. During the eight years that I attended the University of Chicago, I often took classes near Swift Hall, the theology building. On the side of that hall, facing me as I left my classroom building, a saying was carved in the stone: "You shall know the truth and the truth shall make you free." I suppose I never really understood those lines until I realized the implications of knowledge, of deep understanding, for the predictability and uniformity of behavior.

Reinforcement and conditioning guarantee behavior, and training produces predictable outcomes; knowledge guarantees only freedom, only the flexibility to judge, to weigh alternatives, to reason about both ends and means, and then to act while reflecting upon one's actions. Knowledge guarantees only grounded unpre-

dictability: the exercise of reasoned judgment rather than the display of correct behavior. If this vision constitutes a serious challenge to those who would evaluate teaching using fixed behavioral criteria (e.g., the five-step lesson plan), so much the worse for those evaluators. The vision I hold of teaching and teacher education is a vision of professionals who are capable not only of acting, but of enacting—of acting in a manner that is self-conscious with respect to what their act is a case of, or to what their act entails.

The implications of our discussion are several. First, we can begin to conceive differently of how professional examinations for teachers might be organized and constructed. I firmly believe that we must develop professional examinations for teachers, though their existence will constitute no panacea. They must be defined and controlled by members of the profession, not by legislators or laypersons. They must reflect an understanding that both content and process are needed by teaching professionals, and within the content we must include knowledge of the structures of one's subject, pedagogical knowledge of the general and specific topics of the domain, and specialized, curricular knowledge. Ultimately, that knowledge must be informed by a well-organized and codified case literature. Those tests will be useful when only those who have been professionally prepared as teachers are likely to pass them because they tap the unique knowledge bases of teaching. We are already well on our way to defining such a knowledge base.

I envision the design of research-based programs of teacher education that grow to accommodate our conceptions of both process and content. These programs will articulate with and build upon instruction in the liberal arts and sciences as well as the specialty content areas of each candidate. Instructions in the liberal arts and content areas will have to improve dramatically to meet the standards of understanding required for teaching. If these are special sections of such courses for teachers, they will entail evaluation of subject-matter treatment, not watering down.

Such programs will draw upon the growing research on the pedagogical structure of student conceptions and misconceptions, on those features that make particular topics easy or difficult to learn. They will extensively employ a growing body of case literature, both to represent a far wider and more diverse range of teaching contexts than can possibly be experienced within any one teacher education program, and to provide teachers with a rich body of prototypes, precedents, and parallels from which to reason.

The fact that we do not possess such a case literature at this time suggests new agendas for research in teacher education. In addition to the obvious task of encouraging the continued growth of disciplined case studies of teaching by scholars, another alternative suggests itself. Fred Erickson has noted that one of the exciting features of case studies is that you don't necessarily have to be a PhD social scientist or educator to learn to prepare useful case materials. Given proper preparation and support, teachers and teacher educators can contribute to the case literature themselves. As they do so, they will begin to feel even more membership in the broader academic guild of professional teachers.

We reject Mr. Shaw and his calumny. With Aristotle we declare that the ultimate test of understanding rests on the ability to transform one's knowledge into teaching.

Those who can, do. Those who understand, teach.

Notes

¹There is, in fact, a delightful ambiguity surrounding use of the word *methodology* in educational circles. It can refer to methods of teaching as well as methods of research. A person introduced as a specialist in methodology might these days be claiming competence in either. But before the days of Descartes, the concept of methodology was far more unitary. Methods of inquiry did not typically involve elaborate empirical procedures and concomitant statistical analysis. Indeed, scholars did something far more revolutionary as the heart of method. They thought about their problem and organized a coherent, logical analysis of

its structure. This analysis not only served as the structure of inquiry, it also constituted the structure of pedagogy. The scholar's explications and disputations reflected the applications of the same method.

²There is also pedagogical knowledge of teaching—as distinct from subject matter—which is also terribly important, but not the object of discussion in this paper. This is the knowledge of generic principles of classroom organization and management and the like that has quite appropriately been the focus of study in most recent research on teaching. I have no desire to diminish its importance. I am simply attempting to place needed emphasis on the hitherto ignored facets of content knowledge.

³Although in this paper I discuss aspects of content knowledge (including content-specific pedagogical knowledge and curricular knowledge) exclusively, a proper professional board examination would include other equally important sections as well. These would assess knowledge of general pedagogy, knowledge of learners and their backgrounds, principles of school organization, finance and management, and the historical, social, and cultural foundations of education among many more. Exams would also tap teaching performance and other capabilities unlikely to be adequately assessed using conventional paper-and-pencil instruments. Discussion of the character of a professional board for teachers and its desirability, however, is appropriate for another paper.

⁴I must also acknowledge some potential disadvantages of cases as sources of teacher knowledge. Kahneman, Slovic, and Tversky (1982) have pointed out the potentially misleading character of cases. They refer to the memorable quality of vivid cases as significant sources of bias in reasoning. Both availability and representativeness are characteristics of cases that make them readily retrieved from memory; they also bias the decisionmaker's estimates of the frequency of their occurrence. The important test of a case is its contrast with other cases and its examination in the light of principles. Such disciplined evaluation of cases can temper the inappropriate inferences that might be drawn from cases without diminishing their other virtues.

⁵It may well be that what I am calling strategic *knowledge* in this paper is not knowledge in the same sense as propositional and case knowledge. Strategic "knowing" or judgment may simply be a process of analysis, of comparing and contrasting principles, cases, and their implications for practice. Once such strategic processing has been employed, the results are either stored

in terms of a new proposition (e.g., "Smiling before Christmas may be permissible when . . .") or a new case. These then enter the repertoire of cases and principles to be used like any others. In that sense, it is possible that strategic analysis occurs in the presence of the other forms of knowledge and is the primary means for testing, extending, and amending them.

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