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ABSTRACT

This paper, on the central and distinctive contribution of knowledge to teaching, combines philosophical analysis with a discussion of work in research on teaching, student conceptions, and curriculum. The hierarchical argument contains two main points: (1) that content knowledge is a logical precondition for the activities of teaching; and (2) that the firm grasp of subject matter has to be relaxed to allow for its pedagogical, fluid control, that is, the extent to which teachers hold knowledge with ease and flexibility and keep the door open to different points of view. Lacks in the depth and assurance of teachers' knowledge of content can act as conceptual and behavioral traps that lead teachers and students away from education to outward forms of achievement, misconceptions, and procedural concerns. However, factual and conceptual control of subject matter is not enough for teachers. Given the pedagogical requirement for flexible control of subject matter, knowledge of epistemology and history of science is a specific preparation for teaching. Knowledge of this kind deepens understanding of subject matter, encourages the mobility of teacher conceptions, and yields pedagogical knowledge in the form of multiple and fluid conceptions. Policy implications of this argument for the curriculum of teacher education, selection into the profession, and conventional modes of classroom induction are discussed. (Author/JMK)

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THE PRIORITY OF KNOWLEDGE
AND UNDERSTANDING IN TEACHING

Margret Buchmann

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Abstract

This paper on the central and distinctive contribution of knowledge to teaching combines philosophical analysis with a discussion of work in research on teaching, student conceptions, and curriculum. The hierarchical argument contains two main points: (1) that content knowledge is a logical precondition for the activities of teaching, and (2) that the firm grasp of subject matter has to be relaxed to allow for its pedagogical, fluid control, that is, the extent to which teachers hold knowledge with ease and flexibility and keep the door open to different points of view. Lacks in the depth and assurance of teachers' knowledge of content can act as conceptual and behavioral traps that lead teachers and students away from education to outward forms of achievement, misconceptions, and procedural concerns. But factual and conceptual control of subject matter is not enough for teachers. Given the pedagogical requirement for flexible control of subject matter, knowledge of epistemology and history of science is a specific preparation for teaching. Knowledge of this kind deepens understanding of subject matter, encourages the mobility of teacher conceptions, and yields pedagogical knowledge in the form of multiple and fluid conceptions. Policy implications of this argument for the curriculum of teacher education, selection into the profession, and conventional modes of classroom induction are discussed.

THE PRIORITY OF KNOWLEDGE AND UNDERSTANDING IN TEACHING^{1,2}

Margret Buchmann³

Who Cares for Content?

Let me begin by telling a story. At the beginning of one of my courses, I often discuss with the class--future teachers--Schwab's (1978) commonplaces of education. After arguing for the coordination of teacher, learner, content, and milieu (or environment) in educational theory, practice, and policy, I give students the task of rank-ordering these commonplaces. Which one, if rank-ordering were sensible at all, would you put first? For what reasons? Based on which assumptions? This exercise leads to group work in which thoughts, arguments, and evidence about the importance of the four commonplaces are discussed and presented to the class.

When I first ventured into teacher education, I assumed that four groups would sort themselves out by student loyalty to each of the commonplaces, and that each commonplace would get a fair share of the votes. Now I know better. In a class of about 30 students, content sometimes musters no partisan at all,

¹Sections of this work appeared in an earlier article, entitled "The Flight Away from Content" in Teacher Education and Teaching, in the Journal of Curriculum Studies, 1982, 14, 61-68. The author wishes to thank Charles Anderson, Jere Brophy, Sharon Feiman, Tom Good, Richard Pravat, John Schwille, and Ian Westbury for their criticisms and comments. She has drawn much profit from Robert Floden's suggestions, especially in writing the last part of the paper. Mary Mowry ably assisted in manuscript preparation.

²This work supercedes and replaces Occasional Paper No. 38 of IRT publications.

³Margret Buchmann is coordinator of the Conceptual Analytic Project and an assistant professor of teacher education.

milieu gets two votes, teacher three to six. The other votes go to the fourth commonplace of education, student. Groups of about equal size have then to be formed by persuasion and coercion.

After the group presentations, the class takes a second poll. There is always some shifting of votes away from student to teacher and milieu, but very few or no votes fall, again, to content. And there are other examples of content being ascribed little or no importance.

A recent book sponsored by the National Society For the Study of Education entitled, Improving Educational Standards and Productivity: The Research Basis for Policy (Walberg, 1982), covers in its three parts people, processes, and contexts involved in education. There is a chapter on extracurricular activities, but nothing on the content of education. In the 1983 call for papers for the meeting of the American Association of Colleges for Teacher Education, "Essential Knowledge for Beginning Educators," topics include the evaluation of learning and teacher evaluation, instructional planning and management, and the influence of context. Content knowledge is not listed. Who cares for content?⁴ This is a disturbing question.

⁴A few people do care. For instance, the Content Determinants Project, Institute for Research on Teaching, Michigan State University, investigates institutional and social influences on teachers' content decisions in elementary school mathematics. (See, for example, Schwille, Porter, Belli, Floden, Freeman, Knappen, Kuhs, & Schmidt in press; Floden, Porter, Schmidt, Freeman & Schwille, 1981; Freeman, Kuhs, Porter Knappen, Floden, Schmidt, & Schwille, Note 1). Currently this team of researchers is conducting studies at the state, district, school, and classroom level to find out how state and district policies influence content taught, as opposed to the influences of teacher convictions and the opinions of other teachers.

At the same university, a program for teacher preparation, begun by Jere Confrey and now led by Glenn Berkheimer, has been approved as a pilot program. It begins with a course combining study of children's understanding of subject matter with study of the epistemological foundations of four focal subject matters. The tentative foundation of subject-matter knowledge is a theme continuing through the program. The student-teaching component of the program is supervised by faculty with expertise in the particular academic content areas.

Why Should Anyone Care?

All professionals use knowledge. In teaching, knowledge enters into professional work in a unique fashion: Knowledge is what teaching is about. For teachers to act in a way that does justice to this intrinsic connection, they need to have content knowledge. To acquire, for example, delivery skills is pointless unless teachers know something they can deliver. Yet curriculum practices and developments in many colleges of education and schools can be interpreted as a flight away from content. Curricula include life skills, such as interpersonal communication. Preservice work for teachers emphasizes teaching strategies and skills. These skills may be useful, but they do not add to the content knowledge that is required for teaching. In fact, while no degree of mastery of teaching skills can overcome lacks in content knowledge, given content knowledge, something can be taught.

The flight away from content in education is a flight to the periphery: away from what is essential to the field, to what is of lesser importance to it. In this paper, I offer considerations, which, in their sum total, aim at advancing content to at least a position of equal rank among the commonplaces of education. My argument is hierarchical. After discussing content knowledge as a logical precondition for teaching, I examine the yields of different levels and kinds of content knowledge for the work that teachers do.

Content Knowledge as a Precondition for Teaching

Green (1971) analyses the activities of teaching in a way that allows one to detect and describe this flight to the periphery. Under his first category of activities of teaching, logical acts, Green subsumes activities such as explaining, concluding, demonstrating, and giving reasons. These logical acts relate to the element of reasoning in the practice of teaching. His second

category, strategic acts, includes disciplining, evaluating, motivating, and planning. These activities have to do with the direction and encouragement of students and the organization of lessons and classroom life. Teachers also collect milk money, patrol halls, keep records, and consult with parents, and specialists; these he calls institutional acts.

Green admits that the categories of logical, strategic, and institutional acts are imprecise. One can easily come up with additions to his lists of teacher activities, and it may be difficult to place some aspects of the work of teachers under these three headings. What is important and helpful about Green's categories is that they roughly describe what teachers do, while marking out clearly the activities without which teaching can still occur. The institutional activities of teachers "are in no way required by the nature of teaching itself. There is no inconsistency in the claim that teaching may go on even when the institutional acts of teaching are not going on" (p. 5, emphasis in the original). Socrates did not collect milk money. That, however, did not make him less of a teacher.

Strategic and logical acts, on the other hand, are required by the nature of teaching. Teachers who never explain or demonstrate anything, who neither answer questions nor question answers, may be engaged in some useful activity, but they do not teach. Classroom life that shows no evidence of teacher planning in instruction, where rules for behavior create no order, and where teacher interest in pupil learning is not discernible, would leave one puzzled. Where neither the logical nor the strategic acts of teaching occur, it is unlikely that teaching is going on.

I interpret Green's categories as going from the central to the peripheral, institutional acts being farthest off-center. To revert to what is closer to the center means to focus on the logical and strategic activities

of teaching. These activities, however, presuppose a content on which they can be exercised. Second, and more importantly, the logical and strategic activities of teaching presuppose subject-matter knowledge on the part of teachers.

The following question by a student illustrates this well. As a teacher reported in a study by Lampert (Note 2),

a ten year old boy asked his fourth grade teacher: "Does Dataman have eyes?" He was wondering about his hand-held computer game that looks like a robot. "If not, how does he know if my answers are right?" (p.1).

The teacher felt that this question was silly; she judged the boy as not very smart and worried whether he could learn what she would teach over the course of the year. Then, in what Lampert calls the role of teacher "as a provider of right answers," she told the child that Dataman was "programmed." However, in discussing the incident with other teachers she conceded that "she did not really know exactly how the machine works." (p. 6)

Unless they already know what being programmed means, to tell children that Dataman is programmed will not result in an increase of knowledge and understanding. However, without understanding the inward workings of Dataman, the teacher cannot answer student questions in a fashion that promotes learning.

Part of the meaning of "teaching" is an understanding of what is to be taught. It would be odd to expect a teacher to plan a lesson on, for instance, writing reports in science and to evaluate related student assignments, while admitting that the teacher is ignorant about writing as well as science and does not understand what student progress in writing science reports might mean. Through a case study of curriculum change, McKinney and Westbury (1975) show just what kind of planning--with what kinds of results--is to be expected where content knowledge is lacking. The work

they looked at on the science curriculum guide for grades 7-12 took two years; and here is its final result:

The committee members did the easiest thing they could do. They simply copied the chapter topics into the major areas column of the guide for each course from the primary textbook for that course. (p. 28)

Given lacks in teacher preparation and resources, there was no significant outcome of the work of the science curriculum committee. Nothing changed until 1960 when the science supervisor from Gary, Indiana attended a Physical Sciences Study Committee Institute. He was enthusiastic about their physics program, "but felt that before teachers should use it, they...should attend an appropriate institute." (p. 29) Tuition and materials were free and teachers attended with eagerness. After this substantive exposure, science education in the Gary schools started to change.

Kant argues in the Critique of Pure Reason that it is already a sign of wisdom to avoid unreasonable questions and find the ones that are reasonable to ask. To this purpose, it is sometimes necessary to start with a statement of the obvious, namely, that teacher activities essential to teaching point beyond themselves to some content to be taught⁵--and known--by the teacher. The relationships between the logical and strategic activities of teaching and content knowledge follow almost by definition. Remote hypotheses--for example, that student achievement depends on which one of the necessary and invariant developmental stages the teacher happens to be at, on the teacher's mastery of taxonomies of educational objectives, on the formation of teaching (or, for that matter, learning) styles personal to the point of idiosyncrasy--

⁵In education, the obvious tends to be stated in less than homely ways. Consider, as a pertinent example, the "curriculum deficiency hypotheses: "Indeed, one of the more clear-cut results of the IEA studies is that the presence or absence of a topic in the curriculum is generally a crucial factor in determining whether students will 'know' it on a test" (Inkeles, 1977, p. 163).

may appeal to the initiates of various ideological camps. But they are often mistaken, misleading, and unnecessary. A problem with overlooking the obvious is that in the attempt to understand and remedy a puzzling or unsatisfactory state of affairs, such as lack of student learning, centrifugal tendencies are liable to be strengthened, thus creating more puzzlement and dissatisfaction.

When student achievement is disappointing, it is useful to recall that teaching is conditional upon the presence of educational content in teacher activities, and that essential activities of teaching are conditional upon the content knowledge of teachers. If command of content is insufficient teacher education has to address lacks in content knowledge. In this sense, content has priority in teacher education and teaching.

If anything is to be regarded as a specific preparation for teaching, priority must be given to a thorough grounding in something to teach. There are other things which a teacher must know well--about children, for instance, and the social conditions which shape their lives. But social workers, therapists, and juvenile employment officers must also know about these things. A teacher, in so far as he is concerned with teaching and not just therapy, 'socialization,' or advice about careers, must have mastered something which he can impart to others. Without this he would be like an actor who was exquisitely sensitive to the reactions of an audience, a master of gesture and of subtle inflections of voice, but who omitted to do one thing--to learn his words. (Peters, 1977, p. 151)

In the next section, I elaborate on the relationship of knowledge that is firm as well as plentiful to logical and strategic activities of teaching.

A Firm Grasp of Content

Dewey (1904/1965) argues that teachers at their best are observers and directors of the mental life of learners. The detachment presupposed in this role implies a shift of focus from the teacher's self to learners, and what they are doing, imagining, and thinking. As Dewey says, this point is of particular importance for teaching in the early grades when students learn how to

learn subject matter. On the part of the teacher it requires an idea of mental life, a firm grasp of content, and a conception of the student and the relationship between teacher and learner that revolves around content and learning. Contemporary British philosophers share this point of view (see first, 1974; Oakeshott, 1972; Peters, 1978), and Wilson (1975) has given it the following clear expression.

To be interested in education is to view him, the student, primarily, as a learner: to have in mind the process and benefits of learning and understanding . . . themselves, rather than other goods . . . and to view him under other descriptions only insofar as these descriptions are importantly relevant to him as a learner. (p. 44)

Learning can be a process of trial and error. But unless errors are recognized, the data they provide simply pass one by.

Knowledge of Learners Requires Knowledge of Content

When students seem to miss the point or are confused, the remedy is seldom just a provision of right answers. Students' understandings and misunderstandings have to be traced, fathomed, and responded to by the teacher to promote learning. Content knowledge helps the teacher to see what is the point from the perspective of the learner and to recognize the internal logic of student questions and answers. Responding to the concepts and mental activities of learners can be a process of considerable intricacy. It involves side-stepping and second-guessing; the resulting conversational exchanges can appear odd. Davis (1980) analyzes a pedagogical dialogue observed by Page that seems to come straight from the Mad Hatter's tea party:

(1) The teacher asks a question, (2) the student mistakenly answers a different question, (3) the teacher . . . identifies the question the student had in mind and asks that question, (4) the student does not answer the question just asked, but instead revises the answer to the first question. (p. 178)

This exchange is quite common and useful when students confuse addition and

multiplication; it does not seem as strange and elaborate in this context.

Teacher: How much is four times four?

Student: Eight.

Teacher: How much is four plus four?

Student: Oh! It should be sixteen. (Davis, 1980, p. 178)

Teachers' responses to student error require a firm grasp of pertinent concepts and relations. In this instance, one can usually assume it. In other instances, this is not so, and--under the surface of orderly instructional exchanges or progression on work book assignments--the mental reality of classroom life may be that of the Mad Hatter's tea party.

In a classic study of a sixth-grade student, "Benny," Erlwanger (1973) showed that the creation and use of a complicated set of idiosyncratic concepts and rules is consistent with the appearance of student learning. Benny's mathematical world is strange and a bit frightening. Learning mathematics is "a 'wild goose chase' in which he is chasing particular answers." (p. 16) And the rules of mathematics, though invented, work like magic "because the answers one gets from applying these rules can be expressed in different ways, 'which we think they're different but really they're the same'" (p. 18). Benny progressed as one of the best pupils through programmed exercises in adding fractions and multiplying decimals; he typically got his answers right. But in his habits of learning and views of subject matter, arbitrary rules rather than reasons were dominant. Nevertheless, Benny's system of rules--inflexible and wrongheaded--was certified as achievement.

Evidence on student conceptions and misconceptions is accruing for different subject areas and age levels (Novick & Nussbaum, 1978; Nussbaum, 1979; Tamir, Gal-Choppin, & Nussinovitz, 1981). Whether one calls these cognitive structures "frames," as Davis does, or "schemata" in the language of

cognitive science, Anderson's (1977) observations hold and have implications for teaching and teacher preparation:

the schemata by which students assimilate their lessons may not be the ones certified by some discipline or other. This fact can easily escape detection since the student will often be able to repeat segments of the text and lecture even though he/she understands them in terms of an incorrect, incomplete, or inconsistent framework. Indeed, students may develop specialized frameworks for maintaining the particular identity of lesson material in order to cope with the demand for veridical reproduction. (p. 429)

Erlwanger (1973) as well as Lampert (Note 2) point out that what is involved in pedagogical responses to children's thinking is more than a change of teacher behavior. Both authors stress that teachers' attention to the child as a thinker requires a change in role conception. The teacher as a "provider of right answers" changes to a person intent on understanding and directing the mental life of students. Erlwanger, in particular, would like this mental life to be of a kind that enables the learner to participate with others in the experience of mathematics as a particular form of the life of the mind.

Knowledge Legitimizes Teacher Authority

The term "creative spelling" is sometimes used to describe deviations from accepted usage. No doubt many spelling errors show creative minds at work. The point of teaching, especially in the elementary grades, is, however, not the cult of idiosyncrasy, but the induction into frames of reference with standards for what is appropriate, true, and right. The common stock of reason contains, for example, historical lore, elementary arithmetic, and the Golden Rule, as well as the basics of grammar and spelling. It is equally removed from idiosyncratic rules and untutored beliefs and the alternative, specialized conceptions of theorists. Even at this level, the life of reason is in an important sense impersonal; it is intersubjectively rather than subjectively validated. An expansion of the common stock of reason and conceptual change within it come when individuals know what they are doing and

are not arbitrary in their deviations.

Partnership in understanding presupposes mutual respect and a real interest in the thought processes of others. However, in the classroom, teachers are in authority. They determine what is to count as an appropriate assumption and which answers or rules are to be discounted as wrong. Thus they have not only social control, but epistemic control as well.

Unfortunately, teachers act with authority, whether or not they are an authority on subject matter. It is unlikely that youngsters will be able to distinguish between social and epistemic control--or, if they do, that they can act on this distinction--even where the latter is exercised, not by right, but by power (see Freeman, Note 3).

The merger between social and epistemic authority in schools makes knowledge to the best of the teacher's capacity, again, a requirement with moral dimensions. I have discussed pedagogical responses to student error. But student inventiveness that is not wrongheaded must not be penalized simply because it deviates from the teacher's way of arriving at a solution, or the results and procedures laid out in the textbook. Where teacher authority is legitimate and exercised to benefit the student as a learner, it rests on a thorough grounding in something to teach.

Dewey (1904/1965) held that the "delicate and far-reaching matter of intellectual responsibility" (p. 147) is too frequently ignored by the teaching profession. This concern bears restatement. The teacher's experience, thoughtfully explored, can yield knowledge and insight that can help in teaching and understanding children's thinking. However, no amount of reflection, observation of students, general information, and personal experience can overcome lacks of knowledge in areas such as mathematics and chemistry. On the other hand, content knowledge delimits the significance of management concerns and affects the very occurrence of management problems.

Given Content Knowledge, Management Problems May Disappear

Knowing something allows us to go ahead and teach it; and knowing a subject thoroughly means to be mentally organized about it and well prepared to teach it in a general way. Getting ready to teach a lesson means to think about what teacher and students will be doing--in substance, grouping, sequence, and so forth. And having youngsters do things in reasonable order ~~will relate to instructional tasks. If the teacher presses forward to new~~ content or responds with care to student understandings, teacher and students will be busy enough with teaching and learning. Under normal circumstances, management is nested in instruction and requires no separate techniques.

The occurrence and severity of management problems depend on what the teacher believes to be the point of classroom life and that belief, in turn, is often shaped by the degree and assurance of teachers' content knowledge. Sheer lacks of content knowledge will be a powerful factor in predisposing teachers toward a process view of classroom life, while thorough knowledge in itself may tip the conceptual scale in favor of student learning. If learning is seen as the practical end of teacher and student activities, student questions and remarks that show engagement, bewilderment, and thoughtfulness will be taken by the teacher as instructional occasions. When we look at the child as a learner, there is no independent value in order, prompt obedience, and taking turns. But if process is a primary concern, "teachable moments" may go unrecognized or be tackled as challenges to teacher authority. Thus, some management problems are made; they appear due to teacher conceptions about the nature of school work and lacks of content knowledge. Of course, learning conceptions of classroom life alone won't do the job. For their realization they depend on teachers' substantive capacity to act on them--on content knowledge that is deep and abundant.

Smith and Anderson (Note 4) have found that procedure is a key category as teachers interpret curriculum guides in science. The 18 fifth-grade teachers they studied constructed "story lines" from textbooks; "For many teachers this story line is primarily procedural in nature: a chapter is thought of as a sequence of pages to be read or activities to be done" (p. 17). The learning goals of activities often become invisible when activities are edited and re-arranged to accommodate procedural considerations.

Anderson (Note 5) identified a matching phenomenon in the thinking of first-graders about school work. Thirty-two students were observed as they completed their seatwork assignments. These children understood their work in terms of content coverage rather than learning. On the spot interviews document this phenomenon; what follows are excerpts:

Researcher: Tell me about this work you're doing (as student is working in math workbook.)

Student: This is my math. I'm almost done with a unit! Only two more pages. (Said with excitement)

Researcher: What was this unit about?

Student: Well, when it's done I get to take it home.

Researcher: What were you learning about when you did this unit?

Student: (brief pause, slightly puzzled expression) Oh, I learned how to work hard.

The following exchange occurred with several students:

Researcher: What are you learning about when you do this page?

Student: (shrugs) I don't know.

Researcher: Why did the teacher give you this page to do?

Student: This is just our work (said as if the question seemed very odd.) (Anderson, Note 5, pp. 8-9)

The researchers report that teacher presentations to these first-graders focused primarily on procedure and rarely touched on the content-related

aspects of assignments. Their hypothesis, namely, that students' perceptions of the point of their work may be related to the information they receive from teachers about it, is supported by the findings of Smith and Anderson (Note 4) regarding teachers' procedural reconstruction of science texts.

During instruction, the surface responses of teachers who have "learning" as opposed to "process" views of classroom life may look similar. But it is likely that the bent of thoughts during and after teaching will be affected by differences in the conception of the point of teacher and student work. For, while lacks of subject matter preparation or a concern for the robustness of a lesson may make teacher responses to "teachable moments" minimal under both conceptions, a process or management view of teaching will give the teacher a sense of success and accomplishment where interruptions--whatever their source and potential--have been contained or suppressed in the flow of activities. However, the teacher who has a learning view of classroom life will be more likely to see where teacher action falls short of promoting student learning, and less likely to develop a sense of success and accomplishment that is somewhat deceptive.⁶

Where teacher thinking during instruction is problem-oriented (see Morine-Dersheimer, Note 6), decisions that take instructional difficulties

⁶These observations are supported by research on elementary-level mathematics lessons (Shroyer, Note 8) and by findings from studies (Peterson, Marx, & Clark, 1978; Zahorik, 1970) that link teachers' planning to subsequent instruction. Shroyer found that of the three teachers she studied the teacher who was most concerned about promoting pupil understanding did the most exploiting of "teachable moments," and the teacher who was most bound to lesson plans and to obtaining correct answers to preset questions did the most avoiding. The larger studies of teacher planning cited indicate, among other things, that teachers who planned thoroughly but perhaps overly rigidly, were less sensitive to pupil needs and less likely to encourage or develop pupils' ideas than teachers who were less rigid or more comprehensive in their planning.

into account are often postponed. They may not be made in flight, but then they are not made by flight either.

Given that teacher approaches to classroom life authoritatively influence students' beliefs about its point, it can furthermore be argued that data which do not fit teacher conceptions are not only liable to pass teachers by, but are less likely to be forthcoming in the first place. The effects of these conceptual traps may be particularly unfortunate for low achievers. Anderson (Note 5) analyzed the strategies of low achieving students as they completed difficult assignments; she believes that the following conditions detract from content learning and the development of skills in learning to learn:

First, low achievers (or anyone, but it happens most frequently to them) are given work that is not easy enough for them to do quickly, automatically, and with a clear sense of whether they are correct. Second, these assignments are given in a setting where working independently and finishing in the time allotted is valued and encouraged by the teacher. Our present hypothesis is that when these two conditions are frequent, students do not learn to ask whether their work makes sense to them. However, they develop other strategies that allow them to get the answer and get finished. (p. 11)

Low achievers are more likely than high achievers to find themselves with assignments that are difficult for them and less likely to expect their work to make sense. But the rewards for developing strategies in getting work done, anyhow, are clear, with predictable effects on student learning.

Two different claims have been made so far in this argument. First, content knowledge has some payoffs for the logical and strategic activities of teaching, while training people in the moves of teaching does not teach them its content. Second, knowledge and understanding are distinctive points of teacher and student work. If the first claim is conceded, the route to teaching strategies and management skills through content knowledge is reasonable because it is economical. Given the limited time available for the education

of teachers, this point is important. If the second claim is granted, the route through content is desirable because it maintains, maybe restores, the proper attention of teachers and teacher educators to educational content and student learning. Oakeshott (1972) lists teaching activities in mingled profusion to highlight this relationship.

Thus, teaching is a variegated activity which may include hinting, suggesting, urging, coaxing, encouraging, guiding, pointing out, conversing, instructing, informing, narrating, lecturing, demonstrating, exercising, testing, examining, criticizing, correcting, tutoring, drilling and so on--everything, indeed, which does not belie the engagement to impart an understanding. (pp. 25-26)

In what follows, I will advance a third claim. It links knowledge about knowledge to a particular form of classroom life and a species of pedagogical knowledge.

Letting Go of Certainty

Why does thunder follow lightning? Why does Johnny always hit Mary? Teachers who attempt to answer such questions in ways that are satisfactory to themselves, while being clear and understandable to their audience, benefit greatly from scholarship (Scheffler, 1968). This is the case not only because scholarship lends depth and clarity to their answers, but because scholarship brings awareness of the fact that groups of phenomena can be understood, and, indeed, perceived in different ways. If not always appropriate as a source of instructional content, learned uncertainty is a pedagogical asset. It helps the teacher to look and to listen in a simple and direct fashion and without an epistemic arrogance for which the history of science gives no warrants.

The knowledge that allows teachers to come up with answers that they find compelling to themselves is the knowledge that opens the door to uncertainty. It makes a relationship of equal respect between teacher and learner possible. Hawkins (1974) cites an example in point:

One of the nicest stories of this kind that I know comes from a young physicist friend who was very learned . . . My wife was asking him to explain something to her about two coupled pendulums. He said, "Well, now, you can see that there's a conversion of . . . Well, there's really a conservation of angle here." She looked up at him. "Well, you see, in the transfer of energy from one pendulum to the other there is . . ." and so on and so on. And she said, "No, I don't mean that. I want you to notice this and tell me what's happening." Finally, he looked at the pendulums and he saw what she was asking. He looked at it, and he looked at her, and he grinned and said, "Well, I know the right words but I don't understand it either." This confession, wrung from a potential teacher, I've always valued very much. It proves that we're all in it together. (p. 62)

Teachers and students can meet on the common ground of uncertainty. But uncertainty comes in learned and untutored versions. In the Republic, Socrates leads--with a good deal of guile--a group of adults to a common, reasoned understanding of the ideal structure of society. But Socrates' truest teaching comes at the end, when he teases the people who have become his followers with a line that amounts to saying "yes, it is thus. But is it so?"

In teaching, the aim is "to give the child reason" (Duckworth, Note 7).

As I see it, this means to treat youngsters as persons with a mind and to teach them with a will. In respecting the mental integrity and force of children, one honors their quest for understanding. And their understandings need not be about matters that are innocuous, vapid, and trivial. Banalities "about the home, then the friendly postman and trashman, then the community . . . are, a poor way to compete with the child's own dramas and mysteries" (Bruner, 1968, p. 160). (See also Bettelheim & Zelan, 1982.) Thus Thomas (1982), the chairman of the board of the Scientists' Institute for Public Information suggests

that the introductory courses in science, at all levels from grade school through college, be radically revised.... At the outset, before any of the fundamentals, teach the still imponderable puzzles of cosmology. Describe as clearly as possible, for the youngest minds, that there are

some things going on in the universe that lie still beyond comprehension, and make it plain how little is known.

Do not teach that biology is a useful and perhaps profitable science.... Teach instead that there are structures squirming inside each of our cells that provide all the energy for living. Essentially foreign creatures, these lineal descendants of bacteria were brought in for symbiotic living a billion or so years ago. Teach them we do not have the ghost of an idea how they got there, where they came from. (p. 91)

Teachers interact with students as the first and often only representatives of the life of the mind. The empirical fact that different sorts of content are taught at different levels of schooling (e.g., learning about uncertainty and the conceptual foundations of knowledge occurs primarily at the doctoral level) amounts to a radical equity problem in the distribution of educational opportunities (Bernstein, 1975; Meyer, 1980).

Respect for Student Integrity

From the point of view of theory of knowledge, there is a weak and a strong version of the principle of respect for student integrity (Petrie, 1981). The strong version casts all knowledge claims as in principle on a par; Niels Bohr was just fond of his opinions about atoms. However, as Petrie points out, "it might be urged that most if not all of the time, the reasons contained in the disciplines are simply better than the student's reasons" (p. 29). The weaker version of the principle of respect for student integrity that is argued here requires that students, like anyone else, be treated and regarded as the potential source of thoughts and behavior that make sense. This equality of respect does not commit the teacher to a relativistic stance that reduces what is true or right to whatever youngsters happen to believe in, thus depriving them of the benefits of accumulated knowledge and good sense (see Kohlberg & Mayer, 1972).

It is crucial to understand that lacks of factual or conceptual control over subject matter can lead the teacher to an unconscious application or a

conscious endorsement of the troublesome strong version of the principle of student integrity. B. Othanel Smith (1972) gives an example in point. During a biology lesson the question came up how "thoroughbred" could be defined;

One of the pupils insisted that his definition was true and that all the others were false; "A thoroughbred race horse is a flat race horse originating in England," he said. After some discussion, an observer in the room asked if the following would be acceptable, "a flat race horse originating in England we choose to call a thoroughbred." The pupil replied, "No, you do not choose to call him a thoroughbred. That is what he is." (p. 128)

Students confused definitions with facts; they identified statements about words with statements about the world. The teacher did not know the meaning of "definition" and did not correct this misconception.

Mistaking definitions and classification schemes as simple statements of facts has repercussions in social perception. Terms such as "angora rabbit" and "thoroughbred racehorse" are logically equivalent to terms that designate people as members of groups that are seen as different in society. Bias in matters of class, sex, culture or race is impossible to combat unless people understand the conventional and valuative aspects of terms such as "girl" and "boy" or "poverty-stricken" and "advantaged." Such words do not just describe what is the case, but they make a case that implies hypotheses and prescriptions about the different behaviors and characteristics of members of social groups.

Teachers have civic responsibilities which they can take on to the extent that they are educated persons. As the history of science and the theory of knowledge show, even statements about the world describe facts as we know them, and are open to revision on the basis of new evidence and alternative ways of seeing things.

Flexible Control of Subject Matter

Where knowledge is well understood it will not be confused with the comforts of settled opinion. Knowledge about how and why a set of propositions comes to be called knowledge encourages the willingness to be surprised by new evidence (Scheffler, 1977). The history and theory of knowledge can shape teachers' dispositions so that thoughts and beliefs are entertained seriously, but as hypotheses held lightly. The mobility of teacher conceptions--more than their logicity, clarity, and, to a certain extent, their truth--is a safeguard of thought that is free to live up to the commitments of teaching (see Brophy & Good, 1974). It is here that the subject-matter expert pure and simple and the teacher part company. For, although mobility as a habit of mind is central to the work of both, the point of this mobility marks out different enterprises (Wilson, 1975; Gustin, Note 9). And though communication is central to what scientists as well as classroom teachers do, their principal audiences can be distinguished as universal, often remote in time and place, versus concrete, particular, and inescapably there.

Scientists, mathematicians, and poets strive toward integration and parsimony in doing things with symbols so that they can approximate more closely what is true and beautiful. Teachers strive toward clarity in order to increase knowledge and understanding in youngsters. A great part of the difficulty rests with mastery of subject matter. But another part lies in the difficulty of understanding and communicating with other minds--minds of people divided from the teacher, certainly by age, and often by sex, race, culture, and language (Soltis, 1981). In his classic book on teaching, Hight (1966) clarifies what teachers have to think about if their aim is to give students reason:

You must think, not what you know, but what they do not know; not what you find hard, but what they will find hard; then, after putting yourself inside their minds, obstinate or puzzled, groping or mistaken as they are, explain what they need to learn. (p. 280)

The pursuit of student achievement often results in simplification given "the sense of 'pruning' or 'stepping down to a lower level'" (Kirsch, 1976).

Teaching that does not dilute or distort knowledge from the disciplines while reaching a variety of students requires a wide and theoretically differentiated knowledge of subject matter. This flexible understanding can provide multiple entry points for students who differ in outlook and capacities (see Hawkins, Note 10; for geometry, Vollrath, 1976; for physics, Karplus, Note 11).

In learning, ontogeny sometimes is phylogeny: What individuals learn or unlearn may repeat episodes of growth and conceptual change in the common stock of reason. As research on subject-matter specific, student conceptions has shown (Novick & Nussbaum, 1978; Nussbaum, 1979; Tamir, Gal-Choppin, & Nussinovitz, 1981), youngsters are divided and creative in their beliefs about, for example, the nature of matter (e.g., continuous versus particulate), the earth as a cosmic body (e.g., flat versus spherical), or the principle of life (e.g., animism vs. biological attributes such as nutrition and reproduction). History does, of course, neither necessarily nor completely repeat itself. But the evolution of scientific understanding in general and the history of the disciplines provide the teacher with a collection of examples of conceptual change. And,

by looking both at individuals' cognitive schemes and how they have developed and at the development of intellectual disciplines we may be able to see the crucial points of conceptual change, compare them and see how they might justifiably be made congruent. (Petrie, 1976, p. 129)

In teaching, requirements for the depth and breadth of content knowledge shade into moral imperatives.

Telling the Story of Knowledge

Telling the story of knowledge is to give an account of how knowledge comes into being; it is to reveal the ways and means of coming to knowledge that lie concealed in knowledge as an end result. Telling a story is associated with a powerful pedagogy; it means to include the dimensions of time and change and, with that, of variation and choice. The story of knowledge shows to both teachers and students that great scholars in other ages have thought in ways that we now dismiss, too readily, as childish. Thus astronomers have written a sound and enchanting curriculum for children organized historically around themes like "Charting the Universe" and "The Universe in Motion;" the latter theme,

centers on accounting for common observations like the daily apparent motion of the sun, moon, and stars, and most particularly the apparent motion of the planets. We embark in considerable detail about geocentric and heliocentric models of the solar system and point out that in the seventeenth century the finest observational astronomers, like Tycho, preferred the geocentric model. A few, with exactly the same data at the same time, preferred the heliocentric. (Atkin, Note 12, pp. 6-7)

Here the point is not so much the parallelism between the growth and change of knowledge in a domain of enquiry and conceptual change in children, but the fact that data alone can't tell a story.

No one lives in reality. People think and act by perceptions and intentions that construe and reach beyond the immediately given. Schooled imagination is disciplined imagination. But schools can be places where the discipline of thought can be liberating. Initiation into the history and theory of knowledge helps teachers and students to see the human mind at work, shaping itself, and the conditions of its existence. This knowledge brings with it the understanding that freedom is one part of the human condition, while the other part is determination. Every student has the right to be initiated into what is baffling about the social and natural world: the

sunset, the ocean, family life, and the social organization of labor.

Epistemology, ethics, and pedagogy converge in content.

Summary and Conclusions

In this hierarchical argument, I have examined the place of content knowledge in teaching, such as it logically is, and such as it could and should be. Content knowledge is a logical precondition for the activities of teaching; without it, teacher activities such as asking questions or planning lessons hang altogether in the air. This reminder about the meaning of the term "teaching" does not set minimal or desirable levels of content knowledge.

It simply clarifies the intrinsic connection between content knowledge and teaching as a distinctive form of professional work.

When we consider under what conditions a teacher can legitimately be the intellectual leader of a group, we find that a firm grasp of content and abundant knowledge are required. Lacks in the depth and assurance of teachers' content knowledge can act as conceptual and behavioral traps that lead teachers and students away from education to outward forms of achievement, misconceptions, and procedural concerns.

Studies in research on teaching suggest that the teachers' orientation toward matters of process affects students' opportunities to learn directly through teacher behavior and, indirectly, through shaping student conceptions of the nature of school work. There is some evidence for the notion that teacher orientation toward process may come by default (i.e., that it stems from lack of content knowledge). But an orientation toward process as opposed to content can also be an expression of teacher beliefs (Carew & Lightfoot, 1979). Here a straightforward concern for responsible action requires that future teachers gain awareness of the historical and personal sources of their

beliefs, and of any empirical and conceptual consequences for students that these beliefs might have.

If we do not want to miss the practical and ethical mark of teaching, the idea of teachers' intellectual responsibility has to be taken seriously. But for teachers, factual and conceptual control of content is not enough. The firm grasp of subject matter has to be relaxed to allow for its pedagogical or "fluid" control, that is, "the extent to which the teacher holds knowledge flexibly and easily, incorporating new or conflicting information, tolerating dissonance and ambiguity, and keeping the door open to alternate points of view" (Joyce & Harootunian, 1967, p. 40).

Given the pedagogical requirement for flexible control of subject matter, knowledge of epistemology and history of science is a specific preparation for teaching. Content knowledge of this kind and, at this level deepens understanding of knowledge and subject matter, encourages the mobility of teacher conceptions and yields pedagogical knowledge in the form of multiple and fluid conceptions. It also contributes to a form of classroom life in which all participants are seen and treated as the potential source of thoughts and actions that makes sense. Thus, as the stringency of content-knowledge requirements is increased, the yields of content knowledge for teaching are increased and diversified: Content knowledge lends substance, strength, and rightness to the activities of teaching.

So What Follows?

It is no good having teachers who are ill-informed. Few people will disagree with this. But to act on this simple insight, it is necessary to look dispassionately at beliefs and institutional realities that dilute or crowd out content in teacher education and teaching.

The fascination of educators with things and techniques is troublesome, no less so than unexamined beliefs in "learning by doing," and the unreal goals that seem to come with the territory. The philosophy and social sciences of education compass much that is dry theory and energetic folly.

Thus I submit three pleas for discussion.

No more learning by doing. Student or practice teaching should either be dispensed with as a frill (and an often miseducative one at that), or be institutionalized in earnest after graduation. In this case, subject-matter experts should supervise all beginning teachers, regardless of levels of schooling. The obvious model is the training of physicians with its emphasis on knowledge and appropriate action in the face of uncertainty (Coser, 1979; Fox, 1957).

Use all time allotted to conventional forms of classroom induction for the study of the history and conceptual foundations of a specialized academic subject.

No more soap operas in learning to teach. It is not evident that university curricula ought to reflect the problems of new professionals or be geared toward the psychological adjustment of beginners. In taking on the teacher role, transitional problems are normal and should not be made much of. People who have fantasies about their effects as teachers or who cannot settle down to do their work with the necessary persistence and attack should not become teachers. Instead of interpersonal skills and parent-teacher relations, teach about the subject-matter specific conceptions and misconceptions of learners.

More inspirational education. The teacher's calling a dignity. It requires a good mind and heart and a sense of obligation. The teacher's work gives people access to the life of the mind. Don't be afraid to tell future

teachers so. Instead of so-called educational theories and the foundations of education, let them study the lives of people who took teaching seriously.

None of this is surprising. But for the requisite mix of sophistication and common sense, we will have to draw on sources outside of schools and colleges of education.

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