15

Merging Subjects and Students into Teaching Knowledge

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The viewpoints offered in these chapters present a dilemma: They are quite diverse, yet each by itself is credible. Since each is credible alone, it would be foolish to select one from each group and reject the others. Moreover, within every group, we learn something from the juxtaposition of these perspectives that adds to what we learn from the individual chapters. The differences between C. Anderson and Lawson in science, between Banks and Wilson in history, and between Romano and Hillocks in writing help us better understand these academic subjects. In most cases, these authors are not describing different phenomena, but rather different perspectives on the same phenomenon. For instance, Lawson describes science as a process of discovery of the nature of things via the creative generation of alternative hypotheses and their testing, whereas Anderson describes science as a process of collective sense making. Neither definition is contrary to the other; they merely emphasize different aspects of science. Similarly, Floden, Engelmann, and A. Anderson are not talking about different phenomena. All of them are talking about how students learn. Viewing these phenomena from multiple vantage points allows us to understand them far better than we could from only one vantage point.

Few outsiders of a discipline have such opportunities. And few teachers have such opportunities. If teachers had the kind of multifaceted, deep understanding of academic subject and of diverse learners that these authors describe, if they viewed their academic subject and their diverse learners from the multiple perspectives described here, we would not be worrying about education as we continually do in this country. Indeed, very few teachers hold the kind of knowledge that these authors described individually, let alone the ability to view either their subject or their learners from more than one perspective.
This is not to say that teachers have not taken courses in academic subjects or courses in learning or child development, but rather that they have not obtained through these courses the kind of knowledge that the authors of this volume describe. The term *liberal education* is often used to mean that students are exposed to multiple perspectives on various phenomena—that their education has broadened their perspective. But instead of the integrated knowledge and deep understanding that our authors advocate, college often simply helps students accumulate discrete pieces of subject matter knowledge. It is not only possible but likely that students will finish college with the impression that each subject consists of an agglomeration of numerous pieces of knowledge and that they will be unsure whether or how the pieces are related.

This disparity in outcomes between a liberal education and a college education occurs with respect to dispositions as well. Many of the authors of this volume described attitudes toward subject matter knowledge or toward learning that should arise from a liberal education but that do not necessarily obtain from a college education or from majoring in a particular subject. Clemens lists numerous attitudes he wants in a mathematics teacher: He wants a teacher to be humble, unafraid, reverent, opportunistic, and versatile, for instance. Indeed, Clemens defines his topic not as what teachers should know, but rather as what they should *be*.

The problem is multiplied for those college graduates who plan to teach, for they must not only integrate content within and across academic subjects, but must also integrate their knowledge of academic subjects with knowledge of diverse learners. If each teacher must have the full depth and breadth of understanding suggested here, and must have this quality of knowledge both about the academic subject and about diverse learners, and if, furthermore, these two aspects of their knowledge must be integrated into a body of knowledge about teaching academic subjects to diverse learners, then we have a serious problem: We are unlikely to educate more than a handful of teachers to have the full range of knowledge described here, let alone produce an entire teaching population that meets this standard.

The most prevalent solution to this problem is to reduce the knowledge burden of teaching by creating specialist positions. Secondary schools, and even many elementary schools, recognize academic subject specialties, and elementary schools often also recognize specialization according to the type of child the teacher works with. Thus we have remedial teachers, bilingual teachers, and special education teachers, as well as teachers of music, mathematics, or language arts. Sometimes teachers are specialists in both a type of child and a subject, so that, for instance, we could have a remedial reading teacher or a vocational special education teacher.

But specialization alone does not reduce the knowledge burden enough to make it manageable either for teachers or for teacher educators. The optimal package of knowledge and understanding, even within a given academic subject,
is still tremendous. The ideal specialist in teaching writing, for instance, is someone who is a writer, as Romano suggests; who knows the research on teaching writing, as Hillocks suggests; and who is familiar enough with the different schools of thought in writing that she or he can develop a coherent and defensible approach to writing instruction, as Gage suggests. In addition this person also understands diverse learners and how diverse learners learn to write, and can examine his or her diverse learners through the eyes of Floden, Engelmann, A. Anderson, Grant, and McDiarmid. And the social studies, as Wilson points out, themselves comprise numerous disciplines. Her suggestion is that teachers specialize in one of these subjects, but that they be required to know at least something about the nature of the other social studies subjects—about how economics differs from political science, for instance, and how history differs from anthropology. Such knowledge would, contends Wilson, at least enable teachers to learn more about these various areas of study. In the absence of such understanding, teachers may hold misconceptions that prevent them from learning.

Another approach to reducing the knowledge burden of teaching consists of partitioning the task of teaching in some way that emulates the partitioning that occurs in other professions: Physicians, lawyers, and architects, for instance, rely not only on specialists but also on a variety of assistants. Though physicians make most of the important decisions about patient treatments, many of the diagnostic tests and actual treatments are provided by nurses, nurses’ assistants, and lab technicians. But teachers often do not want to delegate tasks, for even apparently mundane tasks can provide opportunities for teachers to learn more about their students. Moreover, teaching is a highly personal activity, and teachers often feel that their relationship with their students might be jeopardized if an assistant took over some of the teachers’ responsibilities. Because of these special characteristics of teaching, it has proved difficult to find satisfactory ways of partitioning the work.

Finally, an often-advocated solution to teachers’ knowledge burden is simply to declare that only one of these bodies of knowledge really requires formal education and that the other can be picked up on the job. Some people argue, for instance, that teachers need mainly to know their academic subject, and can learn about learners in the process of teaching them. Equally popular is the view that it is more important for teachers to know about diverse learners, either because they can rely on textbooks to take care of the subject matter or because they will actually come to understand the subject better through the process of teaching it.

But teachers do not teach academic subjects in the absence of diverse learners, nor do they teach diverse learners in the absence of academic subjects. The interdependence between these two objects of teaching is apparent in the chapters in this volume, for even though each author was asked to write about either an academic subject or an aspect of diverse learners, most actually wrote
about both academic subjects and diverse learners. It proved hard to discuss one without considering the other; academic subjects and diverse learners are the yin and yang of teaching—opposing and yet complementary forces. Teachers must respond to the demands of each, yet must do so within the constraints imposed by the other: An erudite portrayal of an important concept has no value if students can’t understand it, but neither does an engaging portrayal that is inaccurate.

MODELS OF TEACHING AND LEARNING

Many of the differences we observed among our authors derive from different assumptions about what teaching consists of, and these various models represent valid and probably enduring differences of view about the nature and purpose of teaching. The arguments are so prevalent, and have persisted for so long, that they warrant further examination. Below, I review some of the more prominent models of teaching and learning, and try to demonstrate that, regardless of the model one subscribes to, teachers still must know not only about subject matter, and not only about students, but also about the relationship between the two. The models of teaching that I describe do not differ in terms of whether teachers need most to know yin or yang; instead they differ in how these two objects of teaching are assumed to constrain and define one another.

The Additive Model

Probably the most popular model of teaching is the additive model. In this model, the main task of the teacher is to cover content—to give students as much specific content as possible. This view of teaching academic subjects to diverse learners is most apparent in Engelmann’s chapter. By content I mean the facts, concepts, principles, or laws that have been gathered through decades or centuries of inquiry into a subject. Academic subjects are usually presumed both to increase the volume of their content and to change the character of their content over time. Historical content, as Wilson points out, evolves with the discovery of new details about events and with the development of new interpretations of events; science content grows and changes with new research findings as well as new theoretical developments; and literary content expands with new pieces of literature and changes with new interpretations of existing pieces.

Just as an academic subject can be defined by the content it contains, learners can be defined by the content they contain. Indeed, under this model, the most critical dimension of learner diversity has to do with the content learners know and do not know. Moreover, the difference between what learners know, on the one hand, and what is available to be known in the subject, on the
other, defines the teacher’s task: The teacher tries to reduce the gap between what students know about a subject and what they could know.

From a conceptual standpoint, this is probably the simplest model of the teaching process. In it, both academic subjects and diverse learners are defined by the specific pieces of content that can be known or that are known by a particular learner. Yet even in this relatively straightforward, additive model of teaching, subject matter and learner are yin and yang to each other. What makes subject matter content relevant is determined not by the subject alone, but rather by what learners do not yet know. University literature teachers, for instance, rarely consider elementary grammar as part of their content, nor do college calculus teachers include long division in their definitions of mathematics. These aspects of their respective subjects are not relevant because, presumably, their students already have learned them. Similarly, the most relevant aspect of learners is inherent not in the learners themselves, but rather in what they do and do not know about the subject. Neither subject nor learner has teaching significance alone, but each gains significance when juxtaposed with the other.

The Process Model

An alternative to the additive model is the process model. Under this model, the main task of teaching is to help learners develop skill in the processes and methods of inquiry that enable people to function within a given academic subject. This view of teaching academic subjects to diverse learners is most apparent in Lawson’s chapter on science and in Romano’s chapter on writing. By process, I mean methods of operating, strategies, rules of evidence, and forms of argument that are or can be employed by those who contribute to the development of the academic subject. Some of these processes are tacit—a novelist may engage in a number of writing processes, such as brainstorming, drafting, revising, and so forth, and may “use” rules of sentence structure or story structure routinely, yet not be able to describe these processes and rules to someone else. Others are explicit—the historian who challenges another’s findings must be able to articulate her rules of evidence. Whether tacit or explicit, though, these processes provide practitioners with the means of contributing to their field: to evaluate new ideas, challenge or defend them, interact with one another and with the subject-in general, to function within their field.

Students, too, favor certain processes and methods of inquiry, reject others, and may be unaware of still others. To the extent that diverse learners use processes that differ from those considered fruitful within a particular academic subject, the teachers’ task is to reduce the discrepancy between these two sets of processes.

Though this second model of teaching places a different demand on the teacher than the first, and introduces a different form of relationship between...
subject matter and learner, it does not alter the essential interdependence between subject matter and learner. For the significance of a subject’s particular processes derives not from the academic subject alone, but instead from the processes used by the learners; and the significance of the learners’ processes is determined not by the learners alone, but instead by the difference between the learners’ processes and those deemed appropriate to the subject.

The Conceptual Change Model

A third model of teaching is the conceptual change model. In this model, the main task of the teacher is to help students form concepts that are like the concepts formed by experts in a field. This model is particularly apparent in both chapters on science and in Floden’s chapter on student learning. By concepts, I mean the models, hypotheses, impressions, and other mental images of phenomena, all of which constitute an important part of academic subjects. Academic subjects do not, after all, come to us prefabricated, but are instead formed by human beings. Growth in a field comes not only from the accumulation of more content, but by reformulating our understanding of the content we already have.

Students, too, form such images, but because they are novices in these fields, their images often differ from those of experts in the fields. When this occurs, the teacher’s task is not to add more content to the learners, but instead to alter the concepts and images students have already formed in their attempt to make sense of the content they have encountered.

This model of teaching offers a substantially different challenge to the teacher than either the additive model or the process model presents, in that the first two models both suggest that teachers add to students’ store of knowledge, whereas the third model suggests that the teacher alters the student’s store. Notice too that this model increases the difficulty of many ordinary teacher tasks, such as the evaluation of student progress. Under the earlier models, teachers can evaluate by asking students to recite back the information they have acquired or to demonstrate the skills they have learned. Under the conceptual change model, teachers must somehow learn how students think about a phenomenon, perhaps through interviewing the students or examining student sketches. If students are not particularly articulate, it may be difficult for teachers to see students’ thoughts well enough to know how they compare with the prevailing ideas in the field.

But although the third model introduces a different relationship between subject matter and learner, it does not eliminate the interdependency between them. Both academic subjects and diverse learners are still defined in relationship to one another. The most significant aspects of the subject are those concepts that are not understood or that are misunderstood by learners. And,
conversely, the most significant aspect of the learner is the particular concept or image he or she has generated instead.

The Learning Community Model

Yet another model of teaching emphasizes the formation of a *learning community* in the classroom. This model of teaching academic subjects to diverse learners is most apparent in C. Anderson’s chapter on science, Ball’s chapter on mathematics, and A. Anderson’s chapter on student learning. By learning community, I refer to such norms as the kind of scholarship that is valued or shunned, the kinds of findings that are considered important as opposed to routine, the kinds of issues that are considered worth pursuing, and how members of the group are expected to interact with one another. Such norms, which are often tacit, can nevertheless influence learners’ perception of, and interest in, particular academic subjects. When James Watson (1968) tells the story of discovering DNA, he describes, among other things, the competitiveness he felt toward other biologists and reveals some disparaging views of women colleagues. Without realizing it, he gives us an insider’s view of a highly competitive, male-dominated social norm in biology. C. Anderson argues that the European male social origins of science may alienate some students from this area of study.

Teachers may not want to enculturate their learners into this particular learning community, and may choose instead to form a learning community of their own that is less competitive and more pluralistic, while at the same time encouraging a respect for argument and for empirical evidence. In that event, the teacher’s task becomes one of simultaneously using learners’ norms to improve on the norms of the scholarly community, and using the norms of the scholarly community to improve on the norms of diverse learners. Thus, C. Anderson suggests that teachers have an obligation to nurture scientific values and habits of thought among all groups of students, even those for whom these values and habits of thought are more alien. Similarly, Banks argues that a major goal for social studies teachers is to help students become reflective decision makers and civic actors. These authors want students not only to learn the subject matter, but to become members of a community of individuals who draw on substantive ideas and use them to influence social and scientific progress.

This model of teaching introduces yet another form of relationship between subject matter and learner, one that may require teachers to alter not just the students, but the subject as well, in their effort to reduce the differences between students and subject matter. Teachers may choose to blend the two sets of norms, creating a new norm that respects both subject matter and student. Under this model of teaching, what is relevant about academic subjects are those norms
that deviate most strongly from student norms, and what is relevant about student norms are those that deviate most strongly from subject matter norms.

The Transformational Model

A fifth model of teaching is the transformational model. It suggests that the teacher’s task is to render academic content relevant and meaningful to diverse learners. It recognizes that students’ relations with subject matter are not only substantive, but social and emotional as well. This model of teaching is suggested in both chapters on social studies, Gage’s chapter on writing, Grant’s chapter on diverse learners’ cultural backgrounds, and McDiarmid’s chapter on the relationship between students and subject matter.

Academic subjects are pursued because they are thought to be relevant and meaningful to a variety of human endeavors, yet the relevance and meaningfulness of a subject may not be apparent to students. Or different aspects of different subjects may seem valuable to different students. Or students may misunderstand the relevance of different subjects. If students do not perceive particular content, processes, or concepts to be relevant or meaningful to their own lives, they are not likely to strive to understand that material, let alone to master it.

One conclusion that can be drawn from this is that the teacher’s task is to render the content, processes, or concepts meaningful by choosing analogies or metaphors that are understandable to the student and enable the student to better grasp these ideas. The teacher who can draw an analogy between the dilemma Brutus faces in Julius Caesar and dilemmas that students face (Wilson, Shulman, & Richert, 1987), who can illustrate the principles of electricity in relationship to the relative risk of carrying a battery-operated radio versus an outlet-powered radio into the shower, or who can use mathematical probabilities to interpret a weather forecast, is rendering academic subjects relevant by drawing analogies between the subject and the problems and issues diverse learners face in their daily lives.

The transformational model assumes that teachers must attend not only to students’ cognitive relationships with academic content, but to their social and emotional relationships as well. In his review of Vygotskian theory, A. Anderson suggests that new psychological functions appear twice, once on a social plane and later, within the individual child, as a cognitive process, and and Clemens emphasizes repeatedly the importance of students’ emotional relationship with mathematics. Moreover, academic subject helps us understand or resolve certain personal and social problems, each also contributes to or even creates other such problems. This aspect of the relevance of academic subjects is highlighted by Banks when he points out that history tends to be about white European males, whereas anthropology tends to be about third world and minority cultures. And just as learners can be taught how white historians have
Merging Subjects and Students into Teaching Knowledge

examined and portrayed the history of white settlers and Native Americans, so can they be taught how biological knowledge not only has led to improved medical care but has also introduced a host of new ethical issues in medicine.

In this model of teaching, subject matter and learners are still dependent on one another, but they hold yet another form of relationship with one another. According to this model, what is relevant about diverse learners is not only what they perceive to be relevant about a subject but also what they fail to perceive as relevant. And what is relevant about a subject is not merely what diverse learners perceive as relevant but also what diverse learners fail to perceive as relevant. Moreover, the transformational task itself is bidirectional. On one side, the teacher must transform academic content into something that is meaningful and relevant to diverse learners; but the teacher’s success in this can be measured by the extent to which students are transformed into people with an active interest in these academic subjects, people who seek out further knowledge in this area and who draw on this knowledge as they interpret events around them.

How the Models Differ

Each of these models of teaching requires teachers to reduce the difference between subject and learner, but each does so in a different way. In the additive model, the teacher reduces the discrepancy by adding content to the learner. In the process model, the teacher reduces the discrepancy by helping learners add new processes and methods of inquiry to their repertoire, processes that more closely approximate the way experts in the field conduct their work. In the conceptual change model, the teacher reduces the difference by provoking learners to revise their models, hypotheses, or images of fundamental ideas in the subject. In the learning community model, the teacher reduces the discrepancy by creating in the classroom a learning community that draws on the norms of scholarship from the academic subject and on the norms of collegiality and equal participation that learners tend to prefer. Finally, in the transformational model, the discrepancy is reduced by rendering subject matter more relevant and meaningful to students, and by transforming students’ cognitive, personal, and social relationships with academic content.

The differences among these models are especially apparent in the illustrations offered by chapter authors. In these chapters, for instance, four authors use photosynthesis to illustrate their points. The first author, C. Anderson, describes Ms. Copeland’s teaching of photosynthesis. His description is illustrative of the learning community model of teaching and learning: Anderson claims, on the one hand, that Ms. Copeland’s job was to “transform the children, to make them somehow more like scientists than they were before they came to her.” But to do that, he continues, Ms. Copeland first had to transform science, to “create a body of scientific knowledge and a version of the
scientific subculture that were accessible to her students." He further argues that the interactions we observed in her classroom were not unique to this topic, but instead reflected a *pattern of practice* that the teacher and students had developed together over time, one that enabled students to engage in a process of collective sense making. Copeland’s students, then, were members of a learning community. One could argue that Copeland taught more about scientific processes and argumentation than about photosynthesis per se, but Anderson also argues that, for students to understand photosynthesis, they must go through a rather involved process of restructuring and integrating their personal knowledge of food.

Lawson recommends a *process* model to teach photosynthesis. He suggests that Ms. Copeland should have first asked students to generate hypotheses about the sources of food for plants and should have then helped them test those hypotheses with a series of formal experiments. If they contrast plants living in the sunlight with those living in the dark, for instance, they will discover that sunlight is important to plant life. Similar contrasts, comparing the presence and absence of water and the presence and absence of soil, will enable students to determine which of these various conditions is necessary for plant survival. Such experiments enable students to determine which environmental conditions are necessary and which sufficient for plant life, but do not necessarily lead to the conclusion that plants actually make their own food. Lawson suggests that Ms. Copeland could introduce the idea of photosynthesis after students have done some of these experiments, and then help them test the photosynthesis hypothesis by testing for starch in the leaves of plants living in different environmental conditions. In Lawson’s model, students learn both about the natural phenomenon and about the processes of generating and testing hypotheses.

Floden, on the other hand, uses photosynthesis to illustrate a *conceptual change* model of teaching and learning. He points out that if students believe water and soil provide food and that plants obtain food by absorbing it from the soil, they will miss the significance of the fact that plants actually *make* food from the materials they absorb. For Floden, the teacher’s role is one of pointing out to students that their conceptions about the source of nourishment for plants cannot account for plant growth. If students believe plants absorb food from the soil, for instance, the teacher might consider doing an experiment in which plants are placed in the dark. The point of this experiment would be to raise questions about why plants need sun if it is possible for them to obtain food directly from the soil. Once students realize that their theories are inadequate, the teacher can introduce photosynthesis as an alternative hypothesis and can present arguments for why this is a better theory of accounting for plant food. Floden’s method of teaching is more directive than Anderson’s, and less procedural than Lawson’s, and focuses more tightly on the goal of altering students’ conceptions of food and its origins.
Finally, Engelmann uses photosynthesis to illustrate an *additive* model of teaching and learning. His ideal teacher presents the subject matter in a logical, rather than a psychological, sequence. He begins by pointing out that all organisms need both raw materials and energy. He then teaches the major forms of energy, and that energy from one form can be converted to another form. He gives students practice identifying forms of energy and conversions from one form to another. Then he introduces the rule that raw materials enable organisms to convert energy from one form to another. Animals use oxygen, a raw material, to convert higher-energy chemicals to lower-energy chemicals. “The game organisms play is to go from higher-energy chemicals to lower-energy chemicals, which are the ones we end up with when something burns.” Finally, he tells them that plants obtain energy from the sun, not from food, and that they convert their raw materials, soil and water, from lower-energy chemicals to higher-energy chemicals.

These models differ in several ways. One difference, for instance, lies in what students actually learn. Through the additive model, students appear to learn more specific content than they do through the conceptual change or learning community models, but they do not learn the processes of science as they do in the process model or the process model or the learning community model, and they may not appreciate the significance of what plants do, as in the conceptual change model. And none of these models of teaching and learning attends much to the significance of photosynthesis to human beings, as a transformational model would. None examines the ecological relationship between animals and plants in the production and consumption of food, nor prompts students to consider where they would get food if plants ceased to make it.

Taken together, these five models of teaching demonstrate five forms of interdependency between subject matter and learner and constitute five reasons why we cannot reduce the knowledge burden of teaching by declaring that teachers can get by without knowledge of one or the other side of the interdependency—why neither knowledge of academic subjects alone, nor knowledge of diverse learners alone, will do teachers much good.

Indeed, this is the enduring dilemma of education. We know that good teaching requires highly sophisticated, multifaceted understandings not just of subject matter, not just of students, not even of both, but of the relationships between the two as well. We know that few teachers have, or have access to, such knowledge. And we know that the work cannot readily be partitioned in a way that genuinely reduces the knowledge burden.

One way out of this box is to revise our goals as teacher educators and policy makers, so that we define our task not as solving a particular problem of teacher knowledge, but rather as managing a particular dilemma (Lampert, 1985). We do the best we can, knowing that we will never attain the ideal we seek. If we view teacher knowledge as a problem to be solved, we seek-vainly,
I would argue that handy solutions that will ensure that teachers learn all the things defined in these pages. If, instead, we view teacher knowledge as a dilemma that must be managed, we do not pretend that there are handy solutions, but instead use these pages as a guide for thinking about this enduring dilemma of learning to teach. Indeed, their greatest value may be in helping us do as little harm as possible when we design teacher preparation programs, teacher assessment devices, and school regulations.

Another way out of this box is to alter our model of learning to teach, so that teacher learning is not assumed to be finished when students graduate from college, but instead is considered to evolve continually throughout a teacher’s career. We might envision teachers gradually expanding their repertoire of teaching techniques, so that they become more adept and more sophisticated over time. Several of these authors suggested that this was a more appropriate view of learning to teach. This solution to our dilemma allows us more leeway in thinking about how to help teachers gain the kind of knowledge they need. Rather than pretending that teachers really do not need to know about learners or really do not need to know about subject matter, and rather than trying to design preservice teacher education that will provide the full range of knowledge and skills described in these chapters, we can search for ways to facilitate continuing development, for school structures that enable teachers to learn more from their peers, for incentive systems that encourage teachers to experiment in their own classrooms as they continue to develop their teaching repertoires, and for extended in-service programs that stretch teachers upward and that help them practice new and more demanding techniques.

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