Chapter 9
Following a Student into Her Science Classroom to Better Understand the Tensions of Science Education

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For many years, I have followed selected graduates of the Cornell University Teacher Education program, visiting them in their schools, observing their classes, and interviewing them about their work. Although these research projects were not designed as self-studies, what I have learned from the work has contributed substantially to my practice as a teacher educator. In this chapter, I analyze the story of a graduate who moved successfully into high school teaching in New York State. Of course a mere story, however good, is not enough. Berry and Kosnik (2010) stress the need for self-study to move "beyond the story," adding that "going beyond the story is not a cookie-cutter formula" (p. 218) and that it can be done in many ways. In the same issue of *Studying Teacher Education*, Loughran (2010) builds on Zeichner's (2007) challenge to ensure that self-studies contribute to the improved practice of the self-studier and other teacher educators and that self-studies also aim to influence policy. As Loughran points out, doing so requires that we "see beyond the story itself and push toward a sophisticated articulation of the knowledge that lies beneath the story" (p. 223). He notes the importance of "naming and framing the knowledge gained from self-study" (p. 223).

Naming and framing enable authors and readers to "seek the general from the particular" (p. 224), a conception of generalization developed by Donmoyer (1990) in his argument for the values of case study. Shulman (1986) made a similar point when he argued that "generalizability does not inhere in the case, but in the conceptual apparatus of the explicator. An event can be described; a case must be explicated, interpreted, argued, dissected, and reassembled" (p. 12). Of the studies Loughran mentions, Berry's (2008) explication of tensions inherent in teacher education best helped me to focus this story. The tension that I set out to explore in this self-study to explore is not new in teacher education, but it seems particularly salient

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in the USA. at this time: the tension between preparing new teachers able to enact reforms that are called for by leading bodies in science education and preparing new teachers able to succeed in the worlds of practice in today's schools.

I believe this new tension is exacerbated by current educational policy in the USA, where I am far from the only critic. Ravitch (2010), for example, makes a powerful case that the current emphasis on testing and use of test scores for making decisions about students and teachers is having negative effects: "Accountability makes no sense when it undermines the larger goals of education" (p. 16). Ravitch deplores the pervasive influences of a business mindset, with its focus on the bottom line, and explores how judging success only on results from single high-stakes tests narrows the scope of teaching and eliminates important curricular discussions. Wendy's story in this chapter illustrates some of the effects of such a focus. In her presidential address to the American Education Research Association, McDonnel argued that it is crucial to "reverse the causal arrow to examine what kinds of politics education policies create" (2009, p. 417). This story of Wendy illustrates unintended consequences of current education policies and current beliefs about education.

The story builds around a case study of one science teacher. Wendy (a pseudonym) majored in biology, completed the certification program with a master's degree, and moved into teaching. A former graduate student and I analyzed work that Wendy wrote during her time in the certification program. I visited her school in her third year of teaching, observed her classes, interviewed her before and after my observations, and talked with other teachers. This case study explores how Wendy understood biology content and teaching and her development of a teacher identity (e.g., Beijaard, Meijer, & Verloop, 2004; Beijaard, Verloop, & Vermunt, 2000). The case focuses on how Wendy's knowledge and views contributed to her identity and success as a teacher in a highly resourced and academically oriented high school. The cover story (Clandinin & Connelly, 1996) presented by the school describes a place that fosters student development and high achievement. Wendy's experiences reveal some of the secret stories (Clandinin & Connelly) about life in the school and how they constrained her development.

Pedagogical Content Knowledge as an Aspect of Learning to Teach

Since the initial work of Shulman (1986, 1987), much has been written about the particular kind of knowledge developed by teachers through teaching. One facet of this knowledge has been pedagogical content knowledge (PCK), which is an amalgam of knowledge of one's content area, knowledge of teaching approaches and strategies, and knowledge of students. Together, PCK enables a teacher to help her students master the important content in the discipline. PCK continues to be an elusive yet powerful construct for those of us in science teacher education; elusive because it is a form of knowledge enacted in actual practices requiring careful planning to elicit, and

powerful because, among other things, it provides a framework that helps integrate findings from the alternative conceptions research (e.g., Duit, 2004; Pfundt & Duit, 1994). The implicit argument in many studies seems to be that if beginning teachers know the alternative conceptions held by novices about key science ideas and recognize that novices indeed have formed alternative conceptions, then they will be much better able to respond to these nonorthodox ideas appropriately and also better able to recognize other alternative frameworks that interfere with development of the accepted science understandings (De Jong, Van Driel, & Verloop, 2005; Loughran, Berry, & Mulhall, 2006). The extensive research on alternative conceptions in science, then, provides a way to buttress beginning teachers' understandings of their content with understanding of how their students might think about that content and with teaching strategies to respond to student difficulties. A teacher education program, then, must foster in its developing teachers the propensity to take their students' ideas seriously, to seek to make sense of them, and to respond constructively.

Identity

Becoming a teacher requires preservice teachers to develop a new identity, a new way of being. Bullough (2008) noted that teacher development is idiosyncratic, shaped by both biography and teaching context. His extensive collaborations with teachers have documented the myriad ways that contexts and individuals interact in development. Bullough used the work of Goffman (1959) and Harre and van Langenhove (1999) to describe the development process, noting that "through interaction speakers constitute and reconstitute one another in a kind of moving and often competitive symbolic dance with contextually set rules and established but ever-shifting boundaries" (Bullough, 2008, p. 54).

Beijaard et al. (2000) also used the notion of identity to understand teacher development. As befitting a symbolic interactionist frame, they describe how identity develops through interactions in social situations as individuals come to take on social roles and internalize them. In their explication, it is clear that these interactions involve individuals' interpretations of their experiences and others' reactions to them as actors in the setting. Identity changes as individuals reinterpret earlier experiences, have new experiences in new contexts, and evaluate these new experiences. Identity development is not a passive process; it requires self-evaluation and reflection on one's self and one's experiences.

Beijaard et al. considered that professional identity involves three areas: subject-matter expertise, didactic expertise, and pedagogical expertise. They cite the line of research initiated by Shulman's conceptualization of teacher knowledge as pivotal for the increased attention paid to teachers' subject-matter knowledge, particularly pedagogical content knowledge (Shulman, 1987). Didactic expertise refers to the skills that teachers use for managing: managing student actions, managing their presentation of material, and so on. Development in this area is, of course, crucial

for new teachers, but as Beijaard and colleagues make clear, it is only one aspect of professional identity, albeit the one to which novices most often attend. Principles, skills, and general techniques are all part of what Beijaard et al. (2000) refer to as didactic expertise. Understanding context, however, and responding with what is best for the persons involved correspond to pedagogical expertise.

Beijaard et al. pointed out that pedagogy, in contrast to didactics, constitutes the moral and ethical side of teaching. For example, the teacher's involvement with students is an aspect of pedagogical expertise. "This encompasses, among other things, what is going on in students' minds, ways of communicating with and speaking about other people, and personal or private problems students have" (p. 751). I believe a key aspect of pedagogical identity is the concern with students' understandings and willingness to take their conceptions seriously, as something more than mere wrong ideas.

Evidence Analyzed to Prepare the Case Study of Wendy

The Interview About an Instance (IAI)

For many years, I have used an assignment designed to demonstrate to preservice teachers that novices, not science or mathematics majors at university, hold ideas about everyday phenomena that are often quite different from orthodox disciplinary conceptions. The assignment was called the interview about an instance (IAI), based on the work of Bell, Osborne, and Tasker (1985). Preservice teachers had to interview novices to learn how they thought about some instance that instantiated some key notions from the discipline. The Instance could be a common scenario, an apparatus, or a demonstration.

In prior research, I examined how this assignment worked (Trumbull, 1991; Trumbull & Slack, 1991). There were several aspects of the IAI with which students had difficulties. Some had trouble thinking of concrete instantiations of key concepts, such as using the boiling of water to probe ideas about phase change and energy. Some had trouble identifying key conceptions in their disciplines, focusing instead on isolated facts. Some could develop good instances embodying key notions but had trouble eliciting an interviewee's ideas because they unconsciously (or perhaps consciously) turned the interview into an oral examination. Some, after being successful at all the preceding aspects, had trouble making sense of what their interviewees said, resorting to identifying correct and incorrect ideas rather than looking for an underlying framework that could explain the interviewee's conceptualization. My analyses of the IAI showed me that even though I was teaching an education course, I could not ignore students' content knowledge but had to work with them to articulate, refine, and perhaps revise what they understood. I had not thought of this assignment as fostering development of PCK, but I have come to use it as one way to initiate a deeper understanding of subject matter and foster the propensity to attend seriously to learners' alternative conceptions.

Observational Assignments

I developed other assignments to help preservice teachers observe more professionally in their fieldwork placements. Three different assignments asked them to describe the pupils they were observing, to characterize a pupil that intrigued them and explore what was intriguing about that child, and to interview one or two students after a lesson to explore what they had learned. These assignments, including the IAI, were all completed during the first pedagogy course in the teacher education program.

Student Teaching Portfolio

Students completed a portfolio during their student teaching. The final section of the portfolio asked them to analyze what they had learned about themselves, their pupils, their content area, and the system.

Analysis of Wendy's Work

A graduate student (now a colleague) and I analyzed the work completed by over 20 students in three successive cohorts. We began our analysis of the new assignments using a constant comparative/grounded theory approach (Strauss & Corbin, 1990) but soon moved to the approach described by Charmaz (2000). Our analysis was an iterative process combining successive waves of careful reading and coding of data and reference to the wider research literature to refine initial codes and then movement back to the data. Three of us developed the early codes using one cohort of students, and then Fluet and I used these codes to develop categories linked more carefully to the literature. We checked our categorizing for consistency and then analyzed the work of preservice teachers in three subsequent cohorts. We looked at work completed in my course, the first of the pedagogy courses, and work completed in the portfolio that documented and analyzed their student teaching experiences (Trumbull & Fluet, 2007a, 2007b, 2008). We used these categories to analyze Wendy's work on the observational assignments and I used categories from prior research to analyze her work on the IAI. On the observational assignments, we identified two key categories: perspective and making claims.

Perspective

Preservice teachers wrote their assignments from different perspectives. Becker and colleagues used G. H. Mead's conception of perspective to understand differences they observed between the actions of medical students. A perspective is "a co-ordinated set of ideas and actions a person uses in dealing with some problematic situation, to refer

to a person's ordinary way of thinking and feeling about and acting in such a situation" (Becker, Geer, Hughes, & Strauss, 1961). Individuals' interpretations of their experiences contribute to, and are reflective of, the formation of identity, so it is important to look at how interpretations are made. The notion of perspective also helped to connect Wendy's story to the wider framework of education in the USA. Writing in the journal *Symbolic Interaction*, Luescher (1990) points out that Mead's notion of "the objective reality of perspectives" (p. 1) has not received the attention it should and goes on to explore how the notion can bridge micro- and macrosociology. "Ultimately, Mead made use of the concept of perspective in order to describe 'the world in its relationship to the individual and the individual in his relationship to the world'" (Mead, 1938, p. 115). Luescher noted that in using the notion of perspective to examine everyday experience, "perspectives are embedded in temporal relations, in short, in the context of action" (p. 3) and that there is "an unavoidable connection between action and its justification, including the constant necessity of ethics, be it only because ethical statements always anticipate a part of the future" (p. 3). I should note here that our use of the terms "teacher perspective" and "student perspective" has meanings opposite to the way Korthagen, Loughran, and Russell (2006) used those terms. We used perspective to characterize the ideas and actions the preservice teachers revealed in engaging with the assignments and how they responded to the opportunities the assignments were meant to provide, not whether preservice teachers considered the perspectives of the students with whom they were working.

Making Claims

We wanted to educate reflective teachers. For analysis, we operationalized reflection by noting if and how the preservice teachers used evidence to support claims they made and, when they used evidence, if they were able to regard their conclusions as tentative (Rodgers, 2002). This gave us three levels of reflection. Spontaneous interpretations were claims that provided no supporting evidence, revealing lack of reflection. Certain claims were made with supporting evidence but failed to consider any alternative interpretations. Tentative claims involved the use of evidence and included more than one possible interpretation of that evidence, which we considered the highest level of reflection. After several trials with coding, we soon came to agreement and could use these three categories consistently and with explicit justification. We counted the number of claims made by each preservice teacher and characterized each claim.

Doing the Interview About an Instance

In analyzing the IAI, I looked at knowledge of content, ability to elicit interviewee ideas, ability to relate an analysis of interviewee ideas to standard concepts, and ability to avoid turning the IAI into a session of teaching or testing.

Pedagogical Content Knowledge

For this case study, I also looked for evidence of Wendy's content knowledge and/or nascent pedagogical content knowledge across all the assignments.

Wendy as a Transitional Preservice Teacher

Wendy interested me because she seemed so transitional, and here I present extended quotations from her work to show this transitional status. Wendy generally made more claims than most of the other preservice teachers studied but rarely made any tentative claims. Wendy never wrote an assignment consistently from a teacher perspective; she mixed teacher and student perspectives in her work. Even her portfolio, the culmination of her student teaching, showed these shifts of perspective. Wendy's performance on the IAI showed many of the difficulties I had documented in earlier research, but she improved greatly when she did the IAI a second time. The following quotation from her first assignment illustrates a mix of both spontaneous and certain claims and also use of the student perspective:

> This student seems quiet, reserved, and appears to be studying notes intently whenever class is not going on. At the same time, she is often seen during lecture slumped over her desk with a sleepy expression in class that the teacher likes picking on, or she actually is asleep in class. (Wendy, A1)

It is not clear what "quiet" and "reserved" meant for a student in that classroom, although "slumped over her desk with a sleepy expression" provided explicit evidence of the student's behavior. That "the teacher likes picking on [this student]" is not only a spontaneous claim offered with no evidence but an illustration of Wendy's student perspective because the term "picking on" is such a loaded term—one that a student would use to describe a teacher she did not like—and Wendy failed to describe the teacher's actions or explore possible reasons for the actions.

In the assignment that documented student learning for a particular lesson, Wendy's student perspective was evident, as was her failure to speculate in ways that might have helped her develop her pedagogical content knowledge. She failed to explicate the key ideas students should be learning or speculate about whether high school students with no knowledge of chemistry could develop understanding of these key ideas. She interpreted the lesson from her own experiences as a college student:

> I noticed that the lesson was very diluted in detail, with no mention of leading and lagging strand definitions, Okazaki fragment formation when creating the complementary strand on the lagging strand, 5'-3' movement of DNA polymerase, and the name of the unwinding enzyme (helicase – even though it was described just as a general "enzyme"). Overall, it felt that this class understood the steps behind DNA replication as taught by the teacher. However, there were some concepts that were so overly simplified that they were conveying the wrong idea, and I wonder how this is going to affect their learning of biochemistry later on. [Wendy, A3]

As with her spontaneous claim that the teacher was "picking on" a particular student, Wendy failed to ponder why the teacher might have "diluted" the detail in this lesson or acknowledge that the level of understanding expected for a high school class should differ from that expected in her advanced college class. Wendy did not attend to student learning, noting only that it "felt" like the class understood. We see how her student perspective has curtailed speculation that might have helped her develop pedagogical content knowledge.

Although Wendy referred to interviewing several people before she was satisfied she had a good interview to write up and hand in, the IAI assignment she handed in had many problems. After consulting with me, she rewrote the assignment and submitted something much better. In fact, she revised and resubmitted three of the five assignments as she worked to keep her grade high. Each time, with guidance, she improved. A failure to speculate about content knowledge was apparent in her first interview about an instance. Wendy chose to interview novices about their experiences with the common cold. This Instance has worked well for many students because most people have had colds and developed ideas about how to treat them or avoid them. Conversations can reveal a novice's conceptions about key biological conceptions such as the germ theory of disease, the immune response and associated physiological changes, bacterial versus viral infections, spread of disease, and the like. Although Wendy listed many of these topics in her description of her Instance, she failed to provide detail about them and indicate how they related to the Instance.

In preparing the IAI, students develop an interview guide, a list of possible probes to explore interviewee's possible responses. Developing these probes should require thinking about what an interviewee might say. However, Wendy developed and used a strict interview protocol, which she followed rather closely instead of following up on what her interviewee actually said. Her first two questions were:

1. Explain how you felt the last time you had a bad cold.
2. Did you have a fever? [This question served as an opener because several later questions involve asking about technical details of the body's response to a fever.]

The first question, although it might invite conversation, could also easily move the interviewee's focus from simply describing the last cold to seeking to *explain* how he or she felt. (The difference is subtle, but Wendy was interviewing other Cornell students who have been trained to be sensitive to the difference between describe and explain.) The second question takes away any opportunity to follow up with what the interviewee actually said. Wendy's parenthetical remark showed her conception of the IAI as an oral quiz, which would allow her to "ask about the technical details." One segment from her assignment reveals the effects of her approach on her interviewee:

> When asked when the last time she had a cold was, she told me that it was almost a month ago, and described it as "I was extremely tired… and umm… my throat hurt… bad runny nose, sinuses were overreacting. Generally just felt bad, couldn't get over it." She was unaware of whether or not the sickness had involved a fever because she had never taken

> her temperature. She also mentioned that colds were caused by viruses, but sounded unsure. When asked about why fevers occurred, there was a great deal of uncertainty and slight impatience with the question – "I guess… the inflammatory response… I guess antibodies trying to fight off infection, I don't know!" She also was unsure of what cells were involved in fighting colds, and assumed they were B-cells.

This segment shows several missed opportunities to follow up on the interviewee's thinking. Wendy could have asked "What do you mean, 'your sinuses were overreacting'?" or "Did you do anything to try to get over it?" Instead, Wendy moved into her planned fever question. Although she noted that her interviewee had "a great deal of uncertainty and slight impatience," Wendy never attributed this response to her interviewee's intuition that Wendy was looking for orthodox answers. Wendy's evaluation of her IAI performance was:

> However, overall I believe that I was able to help my interviewees think about a subject in ways they had not considered before, and search for the reasons they act in specific ways to counteract a cold, which seemed they had not given conscious thought to in the past.

This sentence encapsulates Wendy's failure to understand that doing the IAI should enable her to elicit and explore an interviewee's conceptions, an important aspect of developing PCK and a professional identity. Her view of teacher as giver of information permeated her first attempt.

Wendy completed another interview and made significant progress. Although she did not develop the content section, she avoided blindly following her list of questions and did follow up on her interviewee's thinking. She wrote:

> From repeating this project, I learned that my abilities to elicit people's ideas and to understand them have improved with a better knowledge of what this project is actually asking of the interviewer and the purpose and necessity for natural conversation in the interview. From this interview and the previous two interviews I conducted, I have learned to improve my interviewing skills by not leading the interviewee into agreeing with me or manipulating him or her to say what I want to hear. My abilities to elicit people's ideas and understand them have improved since the last time I conducted the interviews because I am more aware of keeping myself from "leading" or "teaching" my own ideas about the topic, and I am leaving the opportunity open for them to express what they believe, what they are interested in, and what they want to elaborate in detail for me. I am also improving in my ability to probe the interviewee to tell me more when there is an idea that I am not clear about, so I am getting more than just a surface understanding of the meaning behind what the interviewee is trying to say.

Here we see Wendy coming to realize, at least, the purpose of the IAI. It is less clear that she sees how listening carefully and probing ideas relate to teaching.

Another example of a mixed perspective appeared in her portfolio, written over a year after the earlier segments. She stated the goal that her students learn to think independently. However, her justification for this goal was not a concern that students develop as persons able to think independently outside classrooms or that biology knowledge was built by connecting ideas. Rather, her justification stemmed from her own experiences as a college student:

> Students moaned and groaned about having to think through what was given in notes and homework to figure out the answer on their own, and were not used to my habit of integrating inquiry into my teaching, but I was determined to make them think about "why."

> Personally, I have had a terrible experience with chemistry lab work in college because my high school chemistry classes were run the same way [as her cooperating teacher did] and I did not want to see my own students face the same fate in upper-level science classes due to a lack of understanding and expectation of being spoon-fed answers. [Wendy, Portfolio]

In summary, while in the teacher education program, Wendy failed to write consistently from a teacher perspective, did not attend carefully to key biology concepts underlying factual material and how they could be taught, and seemed to hold a strong view of the teacher as the giver of information. However, she worked hard and had moments of insight, as demonstrated in her revised IAI. I should make clear that Wendy did show confidence, organization, and good didactic skills in my observations of her, both in student teaching and in her third year of teaching. She adopted a persona that students teased her about, calling her "Dragon Lady," but she enacted this role with humor and an obvious willingness to help students perform well. She was business-like, made her expectations clear to students, and was well organized in the classroom. Students appeared to respect and like her, taking time to talk with her before, during, and after class.

Wendy as a New Teacher

A symbolic interactionist perspective holds that identity develops through interactions within particular contexts and with particular individuals. The school in which Wendy was teaching when I visited her was a highly acclaimed school in a well-to-do area of New York State. The median household income according to the 2010 census was $78,000, and the median family income was $98,700. More than 50% of the population over 25 years old held at least a bachelor's degree. Wendy's school was only a few blocks from the lovely old town center. When I pulled into the school parking lot, the guard helped me to find a parking spot but asked me to make sure, when I checked into the main office, that the car could stay there. The personnel in the main office cordially assured me that my car was fine where it was. I could hear a very good orchestra rehearsing when I went looking for the Science Department office. The hall monitors I passed were pleasant and helpful. The school has a reputation for being an outstanding public school. In the published data about student performances on the New York State Regents examinations, students at East High scored highly in all content areas. (For information on the examinations in biology, see http://www.nysedregents.org/livingenvironment/).

The methodologist in me cannot resist the opportunity to illustrate the iterative and on-going nature of this work. I had analyzed my observations and interviews with Wendy to highlight the conditions of practice that constrained or encouraged her development of PCK and professional identity. Her quotations revealed some of the secret stories (Clandinin & Connelly, 1996) of the school, aspects not unfamiliar to anyone who has worked in prestigious schools. Then I read an ethnographic study of a similar school (Demerath, Lynch, Milner, Peters, & Davidson, 2010) and realized that the categories in the findings in that study reflected many

aspects that Wendy had experienced: "The class cultural community achievement ideology, the schools' institutional advantaging of its pupils, … and parental intervention in school" (Demerath et al., 2010, p. 2935). My visit was far from an ethnographic study, and it was not my intent to develop the kind of analysis that Demerath and colleagues did. However, the similarities between their analysis and Wendy's experiences are striking, and so I use two of their main categories to frame the following sections.

Cultural Community Achievement Ideology and Advantaging Students

When I visited her classroom, Wendy introduced me as her former professor from Cornell. Usually, this introduction elicits very little response, but in this classroom in this school, there was a significant reaction from the students. Several students approached me with questions about applying to Cornell, what grades were expected, how many letters of recommendation were needed, and other related questions. I was clearly a resource from which they hoped to learn about the secrets for a successful college application. I later asked Wendy about her students. Her answer revealed her relations with students, her humor, and some of her expectations:

> They tell me all sorts of stories. Like this year I have one student, they're like, "Did you know he got hit by a car three times?" I'm like, "Well, you know what? He's got the top average in all three classes. He must be getting smarter every time." [We laugh.] So I think they're pretty comfortable with me. They know I care a lot about how they do. So I think that makes them want to try really hard. So like, before their midterm, I called—I must have called like four or five parents the night before the—two nights before the midterm. I told them, "You know, your kid has to come in for extra help." I'll give them extra help as long as they need it, as long as they come in, and I want to see a real improvement for their midterm. And I had them come in for like 4 hours maybe…. Those kids saw a big improvement, as long as they would buckle down and study.
>
> I put a lot of pressure on, like even the kids who are doing well, to do even better. Because the thing is, when you're doing well it's easy to kind of just, you know, "I'm going to glide by. I don't have to work that hard here. And I'll do O.K." But I think, you know, you could do better than that. So I push them all: "I ***know*** you could do better than that." It's like, "So what if it's 95? You could have a 97, right?"

Clearly, performance on the tests was important to Wendy and, by inference, to the parents of the students, if not to the students themselves. Wendy worked hard to ensure that her students would succeed and surpass. At this school, however, Wendy was not offering extra help simply because she personally felt it was important. "We're required to give extra help every day for at least half an hour after school. And then on the day before testing day to, like, I think, stay until 4."

In addition to providing mandated extra help, the school allowed students who were unhappy with their grades to do test corrections and improve their grades. Just when I wondered if Wendy were going to complain about all the extra work these expectations entailed, she said wistfully, "I wish we had that in high school."

> They're very competitive here. [laughs] I don't remember high school ever being like this, is the funny part. I was the weird kid 'cause I was so crazy about my grades and stuff, but I think I would have fit right in here. [laughs]. I wish this was my school.
>
> I feel like the kids are all very busy. They're very overbooked. Like they got a gazillion things going on, and just to catch them for like—. I know, with after-school activities, just to catch them for rehearsal [for a performance she directed]. They have like five things that they have lined up after school to deal with. The kids are there all the time. You'll find them there until like 8 or 9 at night, so—. *Doing school stuff?* Yeah. Like sports and clubs, and more clubs, and yeah. Extra help. Extra help's a big thing in my school.

The Biology Curriculum and Wendy's Understanding of Biology

Wendy planned extensively with the two other biology teachers, and their tests were always given on the same day. "We give the same test for all three teachers, and there really cannot be any changes between teachers… They're all based on the Regents questions that you can find in the published Review Books." *Do you compare scores [across classes]?* Yeah. *How are you doing?* It's a good record this time. The mean was 83 for my three classes, so I think we're good.

With a set curriculum and common tests that were designed to prepare students for the end-of-year Regents examination, there was little room for variation. Wendy mentioned feeling that she could not miss a day that she went in even when sick. I asked why, because with joint planning it seemed as though the other teachers could help a substitute teacher; Wendy revealed the pressure she felt and a concern that she had to be there to present the material:

> It's like I feel like no matter what, when there's a sub in the room I feel like the kids aren't—. Well, first of all, they can't really get lectured to. They can't get new material that well.

Although the curriculum was constrained by the State Examination and the joint planning, Wendy hoped to engage her students. She liked that some students considered that her class was fun. I asked her what made it fun:

> I like to talk about how bio is, like, applicable to regular life. And disease and stuff? Disease really gets kids. They love hearing about that. Things that go wrong with their bodies. Finding ways to give them a reason for why you're learning it. I mean, if you don't care about why you're learning it, you're not—there's no reason to pay attention. But if it actually matters, then I think you would pay more attention.
>
> So I try to get them into a lot of discussions and stuff like that, thinking about how things work, connecting the ideas. Because I feel like a lot of kids don't connect the ideas. They learn one isolated thing after another. They don't connect them. And then it makes it really hard for them to, like you know, put ideas together when you problem solve. Like the new bio state test is a lot more problem solving than—back before it was more like regurgitation of facts.

Wendy still used external factors (in this case, the requirements of the Regents exam) as the rationale for encouraging her students to put ideas together, rather than the importance of doing so to better grasp the nature of biology or to be better citizens after school life, illustrating "constrained professionalism" (Willis & Sandholtz, 2009).

To probe her view of biology as a field, I asked her what she wanted her students to remember in a year. She first replied with the standard "eight life functions," and we both laughed at this textbook response. She went on to present a human-centered approach to biology, not necessarily inappropriate for high school students, and one consistent with other statements, even her choice of topic for the IAI 5 years ago:

> You know, what you could use biology for. Things that go wrong with your body. Your body always tries to maintain a constant state. Your body doesn't ever try to get away from that constant state too much. If you're getting away from it, something's going wrong. So it's called "being sick." Um, what else? Oh, we're doing the reproductive unit right now. It's like, how not to get pregnant. [laugh] What the menstrual cycle is. And pregnancy is how the mother nurtures her young. All the human body systems, how those work together…. And how much more complex we are than, say, a one-celled organism. Like bacteria. They're considered a living thing, but that means they do all the same life functions, but they're a lot more simple than us. And even if something's small, it can still do a lot to hurt you. So it doesn't matter we're bigger than, say, a bacterium.

To explore her ideas about more general biology conceptions, I asked her about evolution. Her answer still emphasized a human-centered approach to biology but also reveals the school community and how she has adapted to it:

> We'll be teaching evolution later on. Now the thing with my school is, there's a lot of kids that are very, very religious in the school. I talk about evolution, I'm like, "O.K., if you don't want to believe it I'm not out to change whatever you have, O.K.? But I'm just trying to tell you what scientists have found. And that this—there's this stuff out there that scientists have found. And this supports what they believe is evolution. And, you know, if you don't—if this bothers you, I mean, you learn about other religions in social studies. You learn about Christianity in social studies. You learn about Buddhism in social studies. Are we asking you to convert to it? No. O.K." But they have their beliefs too. And with evolution I always stress that, "You know, you see microevolution happen very easily. Like with disease, you can see that stuff changes very rapidly. That's how you get mutations, right? So this is how you see a disease changing. But with macroevolution, you know, there's stuff out there that scientists use to prove that they think it exists." But whether or not they believe it in the end—I mean, that's up to them. So, I don't want to press it too much, because I feel like we'd get a gazillion phone calls on that.

Wendy did not acknowledge that evolution is a conception that unites all of biology; it is not something taught in one isolated unit. At this point, my self-study took an unexpected turn, forcing me to consider how I had failed to help this future biology teacher conceptualize the importance of evolutionary theory to biology.

Parental Intervention

Wendy's description of changes the teachers made to the honors program made it clear that the staff wished to avoid parental displeasure. The school integrated honors students into the regular classes but expected the honors students to do more work. Wendy described the evolution of the current structure. Previously, the honors students were required merely to pass in short book reports about a recent newspaper article concerning biology. Wendy said that had found that many students submitted poorly written reports or nearly direct copies of the articles. The only criterion they

were meeting was submitting something on schedule. When the teachers raised the standards for these reports, students then resorted to sharing articles, so that one article could be used by three students and submitted to the three different biology teachers. The teachers soon realized that the students were sharing reports. In the year I visited, the honors students were required to do additional reading. She explained:

> Every time the kids have a quiz, they [honors students] take two quizzes in that time period. They take the same regular quiz. They also take an honors quiz with, like, questions that have five choices instead of four…. I take my questions out of the SAT Two books. I modify it a bit for them. And then on their regular tests they have an extended honors section…. Now this year it's done a much better job of rooting out who belongs in the honors program and who doesn't, but we got a lot of parent backlash on it. I don't know if we're going to keep it for next year…. At the beginning I got all sorts of backlash. It's like "You can't make them take an extra quiz. You can't make them do this. Why is it different from last year?" We got that question about 60 times. So, I mean it's hard to make a change.

Clearly, the teachers' expectation was that honors students should be able to complete extra independent work, which would reveal their abilities to perform successfully in the next year's science class. However, Wendy avoided at least some possible parental complaints by not holding honors students accountable for independently studying and learning material:

> To cover my bases, I cover everything. Like even the honors stuff, I'll water it down. This way the honors kids can understand it, this way the regular kids get some extra knowledge. I'll put a star at the top of the PowerPoint. I'll be, like, "Look, this is all honors stuff. If you don't understand it, O.K., just listen. It's probably for your own good anyways. But if you're in honors, O.K., this is the watered-down version of it, all right? Take whatever you saw in your honors packet, I'm going to make it easier for you to understand."

Wendy also accommodated parents by handing out weekly homework packages, not nightly homework, to review material and practice state examination questions. The packets provided flexibility and helped the support teachers:

> This way it gets around like, say, absences and also like religious holidays, because there's so many of them….And it also makes it so the ESL teacher and the special education teacher, they have all the work in advance. I give them like targeted vocabulary. Like words that they actually—words that would be useful for them to solve a problem on this topic on the state exam. Because I feel like the State Exams word certain things in very particular ways. Like "Restore chromosome number." I mean, that just means when a sperm and egg get together, it brings the chromosome number back to 46. I also give them multiple-choice practice, which is based on the real State Exam questions. Short-answer questions, too. And also some, like, standard textbook assignments, like actual reading comprehension from the textbook.

The Context of East High and Wendy's Development as a Teacher

Wendy seemed comfortable in the identity she is developing in East High. Wendy's opportunities for further development of pedagogical content knowledge and pedagogical identity were constrained by the "middle class logic of individual

advancement" (Demerath et al., 2010, p. 2946) and also by the structure and importance of the end-of-year Regents examination. Wendy seemed not to view these factors as limiting. Many of her initial beliefs and values were strongly reinforced; as she said, it is the school she wished that she had attended, with its strong emphasis on grades and competition. The intense focus on doing well on examinations, imposed both internally and externally, and the large number of activities in which her students were engaged, limited how well Wendy could come to know her students. In her descriptions of her students, she focused nearly always on how they performed: were they organized students, did they do their work well, how freely did they talk in class, how did they explain things, and so forth. Only rarely did she mention a more personal connection with the students. Rather than spending time exploring their ideas, getting to know them as people and improving her PCK and pedagogical identity by attending carefully to their thinking, she worked to prepare them for success on the Regents examination.

The circumscribed curriculum constrained Wendy's opportunities to continue to explore and learn more biology. Instead, she is becoming an expert on what is likely to be on the Regents examination and how she can ensure her students do well on this high-stakes test. She made an effort to make the content interesting and useful to her students, which she felt would motivate them to learn. But I could not get a sense that there were some things that she included because they were just so intriguing and central to biology as a field of study. As Demerath and colleagues found, students in schools like East High tend to have a highly instrumental view of content knowledge; they need to learn what they will need to get a high score on the high-stakes examinations. Wendy's effort to build on their interests enforced an instrumental view of biology and deemphasized some of the content central to biology. Generally, though, Wendy seemed to feel little tension between school expectations and her own. Pressure, yes, but not tension. The fit between Wendy's initial beliefs and the climate at East High was a good one.

However, it is not a fit that supports Wendy's growth as a teacher. The strict focus on academic achievement, as indicated by performance on the Regents examination and reinforced by the departmental testing policy of joint tests across teachers, limited the freedom Wendy has to explore her content. The concern with parental pressure limited the biology teachers' opportunities to let at least their honor students explore content because there was a need to justify possible poor grades.

Tensions of a Science Teacher Educator: Idealism Versus Realism?

When I began the case study of Wendy, I hoped to illustrate the ways in which current conditions in schools, with heavy emphasis on test results, limit the opportunities for teacher and student growth. The tension I framed for myself left me asking: As a teacher educator hoping to recruit and educate bright and energetic new teachers, what mention do I make of current conditions? How much do I explore these conditions and how practice might be constrained by them?

As I have analyzed this self-study, I see that I have erred in the way I framed the tension, because I was presenting it far too rigidly as an either-or situation. I could nurture new teachers eager to go out and change the system and enact all the current reforms stressing inquiry teaching and student-centered approaches, or I could try to ensure that new teachers know all about the format of typical standardized examinations and the kinds of standards in place in the states in which they are likely to teach. I can now see that by framing this tension in this way, I limited my possible responses. I thought back to a book that was very influential for me, Berlak and Berlak's (1981) *Dilemmas of Schooling,* in which they describe key dilemmas in education: "Each dilemma captures contradictions that are simultaneously in consciousness and in society" (p. 124). The dilemma language thus links the individual and society. What was most important for me to consider was that Berlak and Berlak also presented the possibility that a dilemma could be resolved transformationally.

Instead of viewing state-mandated tests as inherently evil, I should help preservice teachers understand them as a cultural condition of practice and learn how to use them productively by linking the test content to the broader content area, for example. Thus, Wendy could have been prepared to see not just that the state exam required students to link specific content but that the field of biology is linked by certain key ideas. Homeostasis is certainly one key idea, and she did use her knowledge of that idea to organize her teaching about human biology. She might have used others. So once again, as in 1991, I realize the centrality of content for my teacher education work. A productive teaching move with Wendy could have involved asking her to consider why a high school teacher might present a simplified version of a complicated process or why a high school teacher might not provide the detail that would be required in an advanced university class. Since working with Wendy, I have emphasized pedagogical content knowledge through readings and discussions and explicated the role of my assignments in helping students to develop their own pedagogical content knowledge.

A student such as Wendy, who is transitional in terms of taking a teacher perspective or making tentative claims, could also benefit for a more careful analysis of dilemmas, to understand more fully the complex relations between individual and social-cultural assumptions. Such consideration could help new teachers better analyze the pressures of the situation in which they practice and develop their identity. As Berlak and Berlak wrote:

> Each dilemma captures not only the dialectic between alternative views, values, beliefs in persons and in society, but also the dialectic of subject (the acting true "I") and object (the society and culture that are in us and upon us.) It does so by formulating in each act both the forces which shape teachers' actions (those forces that press toward particular resolutions to a dilemma) and the capacity of teachers not only to select from alternatives, but to act to create alternatives. (pp. 124–125)

Finally, I close on a somewhat ironic note, given my previous emphasis on explicit analyses. Two years ago we asked graduates if the program had helped them to research their own teaching and to use student responses to revise their approaches. Many students said the program had not done so, and I realized that by focusing on

my resistance to mandated high-stakes testing, I had not attended carefully to the use of formative assessments of a range of types in the classroom. My thinking about teaching had been subtly manipulated by the national testing policy; my personal resistance to the policy had shut down my consideration of the importance to excellent teaching of regular and rich assessments of student learning. I found that students were quite responsive when I increased the emphasis on assessments, particularly formative assessments, and that they were better able to see how they could both prepare students for high-stakes tests and facilitate achievement of their own goals for their students' learning. What so often intrigues me about my work as a science teacher educator is that I began changing my practice before I had fully articulated the tension in my practice.

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