

# Finding Meaning in Science: Lifeworld, Identity, and Self

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*Received 1 August 2002; revised 6 January 2003; accepted 2 February 2003*

**ABSTRACT:** Despite the many hours students spend studying science, only a few relate to these subjects in such a manner that it becomes a part of their essential worldview and advances their education in a larger sense—one in which they make a connection to the subject matter so that it becomes a source of inspiration and occupies a formative position in their life. Using the hermeneutic/phenomenological sense of lifeworld as our “being in the world,” we explore questions of identity in the teaching and learning of science. We suggest that by taking the notion of identity in science to include students’ identities in their collective, inclusive of an orientation toward both who the student is and who he wants to become, we can enable this broader educative process. Science’s link to lifeworld, identity, and self as well as the literature surrounding each are treated separately in the context of empirical case studies drawn from interviews with young college-aged migrant agricultural workers. This population of students is living within a distinct culture where ideological systems are spread across lines of ethnicity, class, and vocation that place this population of students at risk of dropping out of school. Given the nature of their circumstances and their desire to leave the life of migration behind, these students show how their perceptions of science are embedded within particular issues of lifeworld, identity, and self while illustrating their interrelationships. © 2004 Wiley Periodicals, Inc. *Sci Ed* 88:157–181, 2004; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/sce.10108

## INTRODUCTION

Years ago Eger (1992) described a difficult conundrum facing the science education community—the problem of meaning in science education. He articulated this problem as the trouble students have finding meaning in scientific concepts even though they may appear proficient in their knowledge of facts and theories. More recently Witz (2000) called this the math and science problem: Despite the many hours students spend studying math and science, only a few relate to these subjects in a manner that could be described as advancing their education in a larger sense—one in which students make a connection to the subject matter in such a way that it turns into a source of inspiration and occupies a

<sup>1</sup> K. G. Witz, self and fulfillment in mathematics, manuscript in preparation.

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Contract grant sponsor: The Spencer Foundation.

Contract grant number: 20000219.

formative position in the student's life. Witz<sup>1</sup> proceeded to describe this connection as part of a larger process, which includes students finding their place in society, direction in life, and establishing a deeper relationship with life and existence. In this sense involvement with math and science becomes part of the progression of more fully becoming one's self, independent and responsible, with the subject matter becoming a part of the student's essential worldview and understanding.

If we assume this is a connection that can be fostered in the realm of formal science education then, as science educators, we face a daunting task: one that is still inclusive of, but moves beyond, learning certain scientific concepts. Here our attention is focused upon the student knowing science as a perspective from which the world can be viewed (Belenky et al., 1997) and extends our concern to developing a relationship between students and their object of study through science. Traditionally, studying science has one learning or looking upon science from an abstract position that is distant from personal experience (Eger, 1992, 1993). Our hope is to offer some perspectives that may help overcome this distancing in science education.

To begin, we review literature that frames such distancing as the result of fundamental and distinct boundaries that exist between two disparate worlds—the student's world and the world of science. As this discussion runs its course, our argument turns into one of a need for opening and expanding science and nurturing its entrance into the worldview, or lifeworld, of the student if he/she is to know science as more than just another academic discipline. Using the hermeneutic/phenomenological sense of lifeworld as our "being in the world" (Heidegger, 1962), it emerges as a system of values and experiences that defines choices and ways of acting (Habermas, 1984, 1987). In other words, lifeworlds guide interpretations for both the individual and shared social world, thereby interconnecting these experiences and values that allow our identities, personalities, and social roles to materialize from within lifeworld knowledge. With identities linked to lifeworld, we turn next to an exploration of identity in the teaching and learning of science. Identity in practice is a way of being in the world, a layering of events and interpretations informing one another and produced from our participation in communal practices of lived experience (Wenger, 1998). Consequently, when we consider issues of identity in science education we need to discuss science, its learning and teaching, in a manner that includes students' understandings of self in relation to others and how science may provide experiences that contribute toward personal growth. In our final section, we suggest that there is room for expansion. Taking the notion of identity in science to include the student's identities in their collective, inclusive of both who the student is and who he wants to become (and thus the identities they want to transform and create), we enter the realm of notions or visions of the self. Here identity, embedded in individual and social circumstances, is created and recreated as a process of negotiation that science can mediate between the individual and other (Evans, 2002; Griffiths, 1995). If a union between science and the self is achieved, we can fully realize the potential science has to contribute toward this broader educative process.

Science's link to lifeworld, identity, and self as well as the literature surrounding each are treated separately in the context of our empirical case studies drawn from interviews with young college-aged migrant workers. This data is part of a larger study in which we examine the public education experiences of migrant worker students and how these experiences and the structures therein allow a minority of migrants to become successful in schools. This population of students is living within a distinct culture where ideological systems are spread across lines of ethnicity, class, and vocation and beliefs are associated with the poverty, mobility, and additional home and work responsibilities that put this population of students at risk of dropping out of school (Prewitt-Diaz, Trotter, & Rivera, 1989). Given

the unique nature of their individual and communal circumstances and experiences, their determination to leave the life of migration behind shows their understandings of who they are, who they want to become, and the role of schooling and their education in this process. This further involves coming to understand who they are with regard to science and these perceptions surface issues of science in relation to lifeworld, identity, and self while illustrating the common thread that exists between them.

These students have migrated with their extended families along particular and regular routes through northern Texas into Ohio and Iowa and then back through Tennessee and the southern states to Texas for the winter. In many instances this migration pattern has been followed for multiple generations. These students are academically successful in the sense that they graduated from high school and, with some financial assistance, have moved on to a postsecondary education. Further, their successful completion of high school and entrance into college makes them unique. Of the approximately 657,000 students eligible for migrant education services between the years 1993 and 1998, only 13% of teens were at grade level for their age compared to 67% of their nonmigrant peers, and 76% left school before completing the 12th grade while this was true for only 12% of nonmigrant students (Carroll, Gabbard, & Mott, 2000). These students' stories focus on their thoughts, feelings, and perceptions of science as part of broader recollections of their lives, school, and classes prior to entering college. But more importantly, the stories capture the visions and understandings these students possess of themselves within the learning and teaching of science. We rely on and refer back to the case studies that lead off each section to provide context to each section's argument and avoid what would otherwise be a completely abstract discussion.

In our final section we present Keith, a Jamaican American immigrant interviewed as part of a study on the construction and role of worldviews in the study of science conducted in anticipation of the migrant farmworker student research. Keith's story exemplifies how engagement with science can develop through experiences and understandings that are not-White, middle class, and Eurocentric. Science can become infused into the lifeworld of a student in an enriching and truly educative manner. Keith's story provides a specific image of what such a profound relationship to science subject matter might look like, which extends beyond his professional affiliations and aspirations within science. His relationship with science is personal and his perceptions of science, as part of his broader worldview, illustrate science's further link to his identity, self, and development. Keith's science experiences involve discovering "meaning" in a discipline, for it is through the discipline that Keith engages a larger and deeper notion of education.

## DATA COLLECTION

The data presented here are drawn from a larger body of work examining the public education experiences of marginalized students generally and specifically those of migrant worker children. We interviewed these students around the experiences and structures that allow minority students to become successful in science as well as those enabling migrant worker children to become successful in schools. The first of these two studies examined migrant students' personal and social development and in particular how they construct a "personal identity" in such a way that they can answer questions around who they are (and why), who they want to become (and why), and the role of schooling and their education in this process. We selected the participants for this study on the basis of their enrollment in a small, liberal arts college offering a program that provides migrant students with the financial and academic support to attend college. We found that of the five students willing to speak with us and participate in our study, for three of them articulating both who they are and who they want to become also involved coming to understand who they are with regard

to science, and this was embedded in implicit understandings of their lifeworld, identity, and self. None of the three migrant farmworker students presented here majored in science at the time of the study. Rather, their majors included political science (Hector), criminology (Clara), and theatre (Andrea). Our data collection for this study took place during the spring semester of 2001.

In the second of these studies we wanted to understand how science is confronted within the broader contexts and structures that comprise a minority student's life and how this translated into what we saw as their successful participation in science. Among the preservice secondary science teachers we came to know that year as either their methods instructor (Richard) or advisor (Margery), we found ourselves particularly attracted to Keith for several reasons. First was his background. Keith was born in Jamaica, immigrated to Canada, and then to the United States. He grew up in various areas around Chicago, eventually enrolling at a large state university in the Midwest. After earning his undergraduate degree in biology as a premedical student, he returned to Chicago and worked in a cancer research laboratory. With this work experience, Keith decided to return to school and obtain his master's degree in education and become certified as a secondary science teacher. Second, Keith's background seemed to separate him from the rest of his peers. At the time of our conversations with Keith, he was the only Black student among the 22 preservice teachers in his science cohort. Finally, we found that Keith's thoughts and feelings about science illustrated something deeper and, we think, more profound. Just as Keith has found a place to participate in science, science has found a place in Keith, for it seemed to resonate with multiple dimensions of his being and came to be integrated with and focal to his worldview. As such, Keith's relationship with science is simultaneously intertwined with and ties together certain elements of his lifeworld, identity, and self. Our conversations with Keith took place during the spring semester of 1999.

For both studies, we conducted a series of six 2-h semistructured interviews with the participants. All interviews were audiotaped for transcription and later analysis. We devoted our initial interview to gathering background information on the participants, and left the last discussion open to elaborate on relevant aspects of our conversations in prior interviews and member checks. Here we tested and discussed time-in-the-field ideas, interpretations, and conclusions with participants, allowing them to react, and thereby enhance the credibility of the study (Lincoln & Guba, 1985).

We developed our interview guides with several narrative points in mind: we prepared questions to elicit stories rather than reports, and always invited the participants to tell stories about their experiences. Our use of the term *narrative* refers to both the participants' life stories that examine life or certain segments therein (Bertaux, cited in Denzin, 1989) as well as their personal experience narratives, which include stories about specific events (Stahl, cited in Denzin, 1989). Both provided the opportunity for these students to make sense of their lives (Denzin, 1989). Further, we encouraged them to make the relevance of the storytelling clear in their own terms (Polany, 1985). Thus, during interviews whenever the participants made generalizations, we encouraged them to tell stories about past experiences that embodied their abstractions and would demonstrate how the abstracted meanings emerged through experience (Holstein & Gubrium, 1995). The participants are looked upon as constructors of knowledge in collaboration with the interviewer (Schwandt, 1999).

## DATA ANALYSIS

The design of the interview questions encouraged respondents to structure life stories around the topics that emerged as the interviews unfolded. These stories addressed particular facets of the participants' lives as they relate to their education and science (Wallace, 1994)

and situate their experiential stories in their larger cultural traditions (Rossman & Rallis, 1998). We did not impose any a priori categories that would limit the field of inquiry (Fontana & Frey, 1998). Instead, we probed the intentions, motives, meanings, contexts, situations, and circumstances embedded in the participants' stories (Denzin, 1988).

Postfield analysis involved a range of analytic procedures ranging from highly structured to the more open-ended (Rossman & Rallis, 1998). We analyzed the students' narratives structurally and thematically to uncover themes that articulate and illustrate the everyday meanings of the stories (Riessman, 1993) in a manner that maintains their integrity. Thus, we collaborated in analyzing transcripts to expose themes such as Hector's "resistance" to stereotypes, Clara's "determination" to succeed, Andrea's feelings of "isolation," and the presence of science in Keith's "everyday thoughts." Presenting their original accounts in a manner organized about themes allowed us to capture the richness and detail of their experiences, compliment the participants' individuality, and highlight themes that emerged through the reading of the data (Cole & Knowles, 1995). Following Coffey and Atkinson (1996) we used themes to explore how the social actors frame and make sense of particular sets of experiences, with these themes acknowledged as providing insight into cultural understandings. These themes constituted analytic points of departure from which we reread and explored the data in more detail, with attention paid to the characters, events, and happenings central in the participant's experiences. From both general and detailed readings, Kvale (1996) suggested that finding the plot or storyline within and between stories provides them with unity and coherence. Thus, the narratives develop the themes and the themes provide a coherence that acts to organize the individual stories into a richer, more condensed and coherent tale. It is these final stories, constructed from quotes and evaluative third person narratives drawn from the students' own words, that we present here.

## **HECTOR: SCIENCE AND LIFEWORLD**

Both of Hector's parents were born in a small border town in Mexico. They both also dropped out of school before completing grade school so that they could help support their siblings. After they met, married, and Hector's older brother was born, Hector's parents moved to another border town in the Texas valley to find work. Since his parents could not find the employment they expected in south Texas, Hector, like many others from his hometown, was born into a life of migrating between his home in the valley and Iowa to find work. Although his father eventually found a permanent job working on a turkey ranch in Iowa, Hector continued to split his time between Texas, where he lived with his grandparents, and Iowa. Returning to his parents for the summer months Hector found various migrant jobs, including employment on hog farms, turkey ranches, detasselling corn, and construction work.

The differences between Texas and Iowa went beyond job availability and financial security. First, Hector found that the students attending school in his hometown in Texas placed little importance on remaining in school.

Well school's not really important over there in Eagle Pass. There's a large dropout rate so they don't emphasize, they don't stress school over there. Students, they don't care about school. Most of them don't care. They're dropouts.

On the other hand, in Iowa, Hector saw most students approaching graduation as a foreseeable and routine part of going through school.

At my high school no one dropped out. In Iowa, so graduation, graduating was common. It was uncommon to not graduate. That's probably why . . . that was probably the big thing.

That was the big thing in Iowa. Everyone graduated. In Texas not that many people graduated so that's why I stood out in Texas because . . . not stood out . . . I just knew I wanted to graduate.

The people Hector saw dropping out of school were not nameless faces but friends and family members. Unlike his parents' decision to drop out of school so that they could help support their families, Hector found it frustrating that his friends and cousins had no apparent reason for quitting school.

They all just got tired of school and decided to dropout. Just for no reason. Just because they didn't like it. It's not as if they had to work to support the family or anything. They just didn't like it.

With all of these friends and family members dropping out of school it became so common that Hector became numb to its happening. "It's all the same. They all went through the same thing so I got used to it."

Hector described another difference between the two places he calls home. In Texas, Hector lived in a town with many other Hispanics and so no one gave his race or ethnicity a second thought. In Iowa, Hector resided in a predominately White, middle class community and, as a result, Hector felt subject to many biases and presuppositions based on nothing more than his racial and ethnic background. Hector explained that trips to the department store could involve the peering eyes of a salesperson following Hector and his sister as they wandered the store. One time in particular resulted in a confrontation between Hector's mother and a salesperson.

My mom said, "Is there any reason why you are following them around?" And she said, "No we're not following them around," and my mom told them, "I've been watching you for the past ten minutes and you guys haven't taken your eyes off them. You guys have been always following them," and they were denying it. And then my mom, she just pulled out her purse and said, "Look, if they want to buy something they can, look!" and she just showed them money, just to prove them wrong and they said, "We're not saying you can't pay for it but we weren't following your kids around," and my mom just got real mad and she just, I remember, she had some things with her that she was gonna buy and she just threw them in her face, in that lady's face. And we just walked out.

Although there was some difference of opinion between what his mother saw and what this employee claims she was doing, from Hector's perspective there was no question. This store employee followed them around to ensure they were not stealing anything simply because he and his sister are Hispanic. "Yeah, I'm sure if I was white they wouldn't be following me around. It's because of my color and my race." As another example Hector told us that while attending school in Iowa, the principal accused him and his brother of theft when another student's car stereo went missing.

And so he said, "Nice stereo. Where'd you steal that from?" And he was being serious and then my brother said, "No, I didn't steal it I just bought it." But then the principal said, "Whatever, because we just found out someone got their speakers stolen and all of the sudden here you are with a new stereo." So my brother said, "What? I've had it for a while now, I just haven't hooked it in," and so he was, he was saying that my brother stole it!

Rather than turning a blind eye to these events, Hector has a strong desire to disprove these stereotypes.

Well, it just shows me that, you know, they're ignorant or whatever. I know that I'm better than that and I don't have to go down to their level. But they've all influenced me. Like, to prove them wrong. [...] That's always what I've wanted.

Unfortunately, working the various jobs he and his family had to take, as well as seeing friends and family members drop out of school, Hector feels that he and others are playing further into these stereotypes.

Yea I want to prove that, you know, we all aren't like that... But, I don't know, I just don't want to fall into that stereotype. And just by dropping out of school I'd be giving up and be back into that stereotype and proving that it is there. Like, proving them right and proving myself wrong that I can't do something better... I just know there's a lot of stereotypes. They think all Mexicans are on welfare and they all have low paying jobs and they're uneducated and that's not true.

With these experiences in mind, Hector looks upon his education as a gateway to a better future. His education is a way out of poverty, prejudice, and the difficult life of migration. An education means there will be opportunities present to actualize a better future while proving these stereotypes wrong.

Well, it's a gateway to a better future I guess. It's a way out of poverty and suffering. It's an important role because without education you can't really do much. And then you won't be able to get any good jobs or anything. It's been really important to me.

As such, Hector approached school in a very businesslike manner. His job: to go to school and get good grades. Hector's strong dislike for math and especially science offset his fondness for the social sciences and subjects such as history and government. The latter, since he is a political science major, appeared to mesh well with Hector's plans for the future while the former did not.

Well everything that science has involved with it I didn't like. Chemistry, biology, all that stuff. I just always tried to avoid it. The things you do in chemistry like learn about the periodic table and all those stupid things. I don't see why I need it, I'm not gonna be a scientist or something. That's just the mentality I had. I don't need it in my life, for my future, so why do I have to take it.

More than science being something too difficult or something he simply dislikes, in Hector's estimation, there was and continues to be no reason to learn foreign concepts that remain irrelevant in their future utility. So when Hector could not avoid the science classes he needed to graduate any longer, he struck a balance between high scores on homework and failing test grades and this allowed him, in the end, to get through.

The argument could be made that if there is anyone who needs to know biology, chemistry, chemicals, and these "stupid things" it is a migrant agricultural worker. Although the reason for migration is almost always economical, decisions about when and where to move are in part based on knowledge about the length of the growing season, timing of crops, and changing agricultural conditions (Chavkin, 1991; Prewitt-Diaz, Trotter, & Rivera, 1989). Further, while in the fields or in migrant labor camps these agricultural workers are often exposed to pesticides and other chemicals, which can cause ailments such as skin rashes, eye irritation, flulike symptoms, and even death (Davis, 1997). Why is it that Hector, a mature, thoughtful, intelligent 18-year-old college freshman dismisses science categorically rather

than knowing that science may be a lens used to understand and control certain facets of his experiences migrating?

In our knowledge constructions there are presuppositions or preconceptions that constitute the conditions of our experiential possibilities. These derive from the lifeworld in which we are embedded, and are thus related to our basic way of being in the world (Bevilacqua & Ginnetto, 1995; Heidegger, 1962). The construct of preconceptions has caused researchers like Posner et al. (1982) and Nersessian (1991) to describe students' (scientifically) "wrong" understandings of phenomena as "misconceptions" embedded in alternative frameworks of understanding. In our explorations of meaning in science, however, the impact of such presuppositions are understood to be larger than the ones associated with conceptual change theory and misconceptions of how the natural world works. Rather, we are speaking of presuppositions concerning whether or not science has a place in our lives and whether or not science has meaning in our lifeworld, or world as it is experienced (Husserl, 1970). These are perceptions that relate to what science is, who it is that does science, and who needs science. Along these lines, our own biases with regards to science include how its mysteries, wonders, and ways of understanding the world may appear to have no connection to everyday life but are actually all around us. The joy and beauty we see in science is not in isolation but felt as we gaze at a phenomenon with others and look upon science as one way to understand our world and ourselves in the world. Hector's dismissal of science illustrates the opposite extreme of such preconceptions and how they have distanced him from science amid the larger contexts and structures that comprise his life. He has certain preconceived notions about what science involves as well as who needs it. As a result disciplinary particulars such as the periodic table become "stupid" or irrelevant within his life situation. It is these types of larger conceptions that form obstacles in the establishment of any relationship between Hector and what he calls science. After all, one can learn the ideal gas law without seeing it as having any real connection to the broader structures that constitute a student's life as a whole (Barton & Osborne, 1995). The same may be said if and when Hector ever memorizes the periodic table.

More than simply confronting the periodic table, its elements, and their atomic weights and numbers, for Hector to connect with science he needs to confront the tacit knowledge he uses to make sense of science and its contents. This involves acknowledging the general awareness, personal judgments, and emotional involvement Hector has with this certain thing that is science (Schwandt, 1997). To add another dimension to the idea of preconceptions, Gadamer (1994) might have labeled Hector's present thoughts on science as prejudices. These prejudices find their way into the horizons of all understanding and are how tradition and history orient us toward life in particular ways, allow us to form authoritative preconceptions that make the unfamiliar familiar, and thereby form a route for the past to play a role in the present (Gallagher, 1992). Given the negative connotations of the word prejudice, Bernstein (1985) warned that there is no understanding without them; we all inescapably possess and cannot fully shed them. Perhaps it is here that we find our educative undertaking, for Bernstein set the task as opening ourselves up to critically testing our prejudices when facing the alien, for such encounters are the only way we can determine which are prohibitive, which are facilitating, and in so doing continually reconstitute tradition in a manner that keeps it open and alive. Such a process is larger than the purely cognitive process of belief change in conceptual change theory (Gunstone & Mitchell, 1998). Here the learning of particular science concepts such as photosynthesis (Mikkila-Erdmann, 2001), heat and temperature (Harrison, Grayson, & Treagust, 1999), plate tectonics (Marques & Thompson, 1997), and thermodynamics (Lewis, 1996) is central, and particular misconceptions rooted in tacit understandings must be uncovered and addressed for robust understandings to be constructed. Rather, our attention here is larger

and involves a science pedagogy fostering encounters between the student and science that allows these prejudices to surface and be examined in the face of doing science. In the lifeworld, a world concerned with human encounters with phenomena as the objects and events of everyday life, these questions of meaning are primary, with such encounters being holistic, characterized by openness, and are where individual growth is engendered (Dahlberg & Drew, 1997). If so, for individual meaning to be found in science, what we need is for the student's world, Hector's world, and the world of science as a whole to broaden, open, and embrace one another so that the presuppositions both sides hold can come into intimate contact and be tested. Thus, we are arguing that the prejudices or preconceptions Hector uses to understand not just science but himself in relation to this science, which stem from the broader context of his life, need to be opened up, explored, and tested while he is learning particular science concepts such as the periodic table. These are the ones that cause Hector to fundamentally and holistically dismiss science.

Hector's predispositions regarding science establish formidable obstacles when we speak of infusing science into his lifeworld (Lijnse, 1990) or worldview (Cobern, 1994). Here we would wish to make science part of the shared culture and language with which Hector and other students interpret the world on both a conscious and unconscious level (Fairtlough, 1991). A more feminist orientation sets the difficulty in such an enterprise as one rooted in two different and disparate worlds. On the one hand there is science: a science that is often represented as an idealized world where such things as magnetic fields and cosmic rays are common entities (Ginev, 1995) and within which are stereotypical positions of objectivity, reduction of complexity, and detachment (Eger, 1993). Often, this objectivity is linked with both autonomy and masculinity, turning the goals of science into ones inclusive of power and domination (Keller, 1997; Merchant, 1980) and forming stereotyped expectations about who it is that should participate in science (Eisenhart & Finkel, 1998). For the student this represents a discontinuous break with the ordinary, everyday world of practical experience (Garrison & Bentley, 1990) and so, on the other hand, there is the student's everyday world. That world is influenced by class, culture, ethnicity, and gender (Atwater, 1996), which in turn lead to issues of power and discourse that foundationally construct the everyday world of the student's experience (O'Loughlin, 1992). These two worlds are in such conflict that to include one within the other would seem impossible and attempting to do so without critically examining the "prejudices" of each side ignores these disparities. Throughout his science courses Hector may have, in fact, learned about the periodic table. However, coming to a conceptual understanding of the periodic table and additional science topics does not address the larger predispositions with which Hector and other students holding similar feelings confront science. Without facing these there is little possibility of Hector finding any individualized relevance or meaning in science amid his broader concerns and interests. Science will remain solely for the scientist.

At this point we want to qualify that we do not deem Hector's conceptions of science unjustifiable, given his experiences with school science and the goals he has formulated for his life. Nor do we believe science to be beyond Hector's reproach, giving it the unlimited authority that Duschl (1988) articulated as one of the cornerstones of scientism. We are simply stating, just as Duschl argued for historians', philosophers', and sociologists' participation in the curriculum process, that in order to alleviate this authoritarian view of science whereby it is presented as absolute and in final form, Hector's involvement in school science is paramount. His participation in science can alter and change it from the irrelevant discipline he labels it, but his own dismissal impedes this from happening. This tension, however, generates possibility because any change that involves a reconfiguration of our lifeworld, although difficult, requires nothing less than a deconstruction of the horizon from where we know the world and ourselves (Roth, 2000), in other words, the deep

and fundamental growth engendered in finding “meaning.” With the student confronting this world, or subculture (Aikenhead, 1996), of science and his or her understandings of that world, we can embrace and accept this opportunity to make such changes. Although the understandings within each may be distinct and closed off from one another, there is nevertheless the possibility of opening them up through confrontations that, in the form of inquiry or recontextualization, would allow Hector to reconfigure science and in so doing his beliefs, desires, self, other, and world (Derrida, Rorty, cited in Roth, 2000). In short, the feelings with which Hector confronts science are a part of the way he understands both science and himself and can be reconfigured. But is there room in the program of science education for this type of phenomenological encounter—an encounter that allows science to become the foreground phenomenon of reflective analysis (Ihde, cited in Walters, 1995) while also confronting the individual perceptions that constitute the horizons from which students understand themselves (Roth & McRobbie, 1999)? Dahlin (2001) asserted that we need just this type of phenomenological complement to more mainstream, cognitive theories of science education. Doing so makes the transition from immediate lifeworld experiences to idealized scientific theories less difficult, contributes toward less alienation between individuals and nature, and avoids an inundation of epistemologies whose objectives are foreign to the larger goal of education—the overall development of the individual. As such, part of science education’s purpose must include the intrinsic worth of science as an interesting and exciting way of understanding our world and ourselves as opposed to its purely extrinsic value as preparation for work and the economy (Wellington, 2001). We can see the failures of this latter view in Hector’s words and the lack of extrinsic value he finds in science. He does not see himself needing science for his life, for his future. After all, he is not going to become a scientist. And so Hector avoided science until its confrontation was unavoidable and even then Hector remained closed off and effectively distanced from science.

How do we actualize such an enterprise within science education—one that pedagogically emphasizes encountering science amid the structures, phenomena, and understandings that comprise the student’s world as it is experienced while promoting encounters that open up the possibilities that exist between students and science? To do so, perhaps, the more usual turn is to examine the role of the history of science in science education (Bevilacqua & Giannetto, 1995), or to an examination of science’s epistemological and ontological (Abell & Eichinger, 1999) or sociological underpinnings as the means to promote such connections and thereby make the discipline more inclusive and authentic (Cunningham & Helms, 1998). But here we take a different route—one toward identity and thus to representation in science education. We do so because Hector’s understandings of science simultaneously illustrate the understandings he has of himself. *He* does not need science for his life or future. *He* is not going to be a scientist. These are the understandings that identities embrace in that they stand in relation to one’s past and potential future and emerge from participation in the world (Brickhouse & Potter, 2001). Thus, one way to look upon this being in the world is through the totality of roles we live in relation to specific others. Rosemont (1997) discussed these roles as interconnected where the relations in which we stand to some people affect directly the relations in which we stand to others. Taken this way he warned that it would be a mistake to say we play or perform these roles as if they were enacted in isolation. Rather, we are our roles that collectively create a distinct pattern of personal identity such that if a role changes, others will of necessity change, making us different people. It is here we turn to examining how incorporating more of these roles, or identities, into the science classroom opens up individual perceptions and self-understandings associated with science, which in turn encourage a connection to the subject matter beyond that of the detached science student.

## CLARA: FROM LIFEWORLD TO IDENTITY

Clara's parents met on the busses that took people across the border from Mexico to work in the fields picking carrots and cotton. After they married and moved to the Texas valley, Clara's father found carpentry jobs that eventually allowed her parents to stop migrating. But eventually the jobs Clara's father could find turned scarce and he faced a 6-month period where he could not find work. So during her freshman year of high school Clara's parents informed her that she, her brother, and her sister had to accompany them on the journey north to find the work and money that would sustain the family.

Although her parents had become accustomed earlier to migrating, Clara had not. As they packed their truck and began their first trip to Ohio to join others in the cucumber and strawberry fields, Clara's fears began to set in. "I was, like, I was scared. I was thinking what are we gonna do? Where are we gonna go? Where are we gonna live?" But on her first day at the migrant camp Clara saw all the little houses where she and the others would live, and at a general meeting the rancher explained to Clara and all the strangers surrounding her where they would work and when they would get paid. From there Clara was thrown into something she had never done before. Clara learned, with the help of her parents, what cucumbers to gather and how to treat the plant while harvesting the crop. Although Clara eventually made it through her first day, while she and her parents walked down the road to their house Clara's physical and emotional exhaustion emerged.

I remember that first day . . . I just sat down right in the middle of the road and I started crying. And to my mom, I told her, "I was not born to do this." I remember telling her, "I was not made to do this, I don't deserve to be here." And I remember that she started crying and she said, "And you think I was?" She goes, "You think all these people were made, were born to do this?" She goes, "It's we don't have a choice." . . . And I remember I told my dad, "What did we do for you to make us come?" And I felt really bad because my dad, I know my dad felt bad for taking us but I mean we had no other choice. That was the only way that the whole family could work and provide some money for the family.

That summer, and the subsequent summers Clara spent migrating before entering college, reinforced the importance of school and her education.

So, I remember that that day was when I told my mom I was, like, "Man if I thought school was important before now I think it is super important. I know that I have to go to college, finish school, and go to college cause I don't want to be here."

With Clara's experiences migrating, in addition to the ones she had growing up in poverty and living in a community whose residents are thought of as drug dealers and thieves, she embraced the concept of her education. "Well I knew that if I wanted to make something of myself and not work in the fields I had to continue my education." "Making something" of herself does not involve money or a particular vocation. Rather, it means finding the opportunities distinctly lacking in a life of migration.

If you come from a minority group migrating you don't really have that many alternatives if you don't have an education. So when you have an education you have so many doors open to you and you can do whatever you want with that education.

But before Clara ever began migrating, she completely devoted herself to school. Her classes, along with athletics, clubs, and academic competitions consumed Clara and her time.

... I would just go to my practices, go to my meetings, come home do my work, and that's it. During the weekends I would have my meets, like, my competitions or my community service or whatever. Afterwards I would just sleep, like, all day. Sunday would be the same thing. Go to church and then I would go home and I would sleep. All day! So I had no, no life really.

Clara often reaped the rewards of her hard work, going to the regional meet in San Antonio for track and a conference in San Diego for submitting a winning essay in a national writing contest for migrant students. And in class Clara eagerly accepted the challenges that pushed the limits of her knowledge, provided her with new experiences, and prepared her to move on academically, such as writing a 10-page research paper in her English class.

[The paper] was just gonna be, basically, all my own opinions. Everything was gonna be my opinion and a couple of facts and quotes and, I mean, I had never done a paper like that... [But] see, at least I found out I could live up to [the teacher's] standards you know?

On the other hand, Clara scoffed at the mundane activities that consumed class time with looking up vocabulary words in government class or copying notes and assignments from the board in geometry. But even with the success Clara attained in school she tended to shy away from math and science, for they appeared as subjects that intimidated her. When Clara's counselor brought up the idea of taking calculus the very prospect of the class surfaced her insecurities. "So I told her, like, I don't think I can handle calculus because I'm not that good in math." Further, Clara placed science upon the same plane as math and regarded it as difficult. "And I mean science is not a very good subject for me... I have trouble just grasping the whole concept of science." Despite her feelings about science, Clara found herself in a chemistry class and with a teacher that altered the perspectives with which she approached the subject.

But that teacher she would make it sound so easy. We would do experiments in class and she would work with you and she would make it fun. Oh, and I remember one time we had a science project and my friend and me did a report on landfills. On landfills and we actually went to a landfill there in Brownsville. And we interviewed the paper there and we walked around the landfill. We even got on top of the trash and then we came back and presented it and she loved it so much that we got to present it on this major event that goes on in school called Earth Day where you present several things that try to save the environment. So that was pretty fun. And I actually got to be in Earth Day! Me, who's not a science person!

Here Clara found herself being complemented for the creative manner in which she and her partner completed their project and, if nothing more than for a brief moment, Clara saw science as a discipline she could grasp, participate in, and understood herself as a "science person."

In educational discussions it is not uncommon to speak of identity as fractured, contradictory, and shifting in such a way that accounts for the student's inner and outer diversity (Hird, 1998). Thus, we have a rejection of sameness with identity best understood as fluid and changing depending upon the surrounding circumstances and mode of discourse therein (Heilman, 1998). These identities, as oppositional to one another and contingent or shifting, shape participation and resistance in school, definitions of success, and visions held for the future and would suggest the importance of listening to youth as we reformulate educational policy and practice (Schultz, 1999).

Keeping our eye on circumstance in particular, we have markers of identity that denote categorically which we emphasize or are emphasized for us, correctly or not, and which

change according to circumstances (Smolicz, cited in Grant, 1997). Thus, we have what Taylor (1991) noted as the conception of identity as situated in some sort of space. These spaces can be drawn around familial or professional lines but are also inclusive of those depicted around race, class, gender, and ethnicity. We can see that Clara's identity, as a migrant agricultural worker, is located in the vocational practice that took her and her family from Texas to the fields in Ohio. But her particular experiences working in the fields, the many miles traveled, and difficult labor involved have led Clara to her own individual understandings of her identity as a migrant farmworker. Clara is not meant to be an agricultural laborer and by the same token it is not an identity or space she wishes to occupy. Therefore, Clara looks upon her education as the means by which she can leave this identity behind.

Looking at all of these spaces that encompass Clara as an individual, which include her identity as a migrant farmworker but also consist of her roles as a daughter, sister, Hispanic, female, and student, we must move away from pure circumstance and keep in mind what Taylor further discussed as identity being linked to who we are. To do so, we look to self-understanding as the foundation of identity, and as the source of multiplicity and conflict. As Kerdeman (1998) explained, as a mode of practical involvement and experience, this type of understanding is never disinterested but requires recognition of situational parameters and possibilities. She attested that we raise such questions as what is it that this situation is asking of me? How do I stand in light of what needs to be done? Am I willing or able to respond? Why or why not? Whether or not these questions are formalized and conscious, Kerdeman pointed to them as ones shaping and reflecting all understanding. Clara's experiences migrating involve just this type of self-understanding. But if we examine Clara's identity as a student relative to science we can see Clara has come to some broader understandings that concern not only the topic of science but also the type of self-understanding Kerdeman referred to.

Amid Clara's determination to succeed in school and the many hours spent working toward this in science as well as other subject matters, Clara came to broader understandings of science. Science has never been a very good topic for Clara and she has had trouble grasping many of its concepts. Clara carried these understandings with her as she faced further situations in school science and these meanings necessarily constitute another understanding of herself not only as a student but also as a person. She is not a science person. Thus, situationally the contexts Clara brings to any event of understanding that may involve science not only include her cognitive perceptions but also her emotional predispositions, her sensibilities, and her ever-emerging sense of personal identity (Hogan, 1998). In this manner Clara's identity in relation to science is grounded in culturally normative and changing views of self, which encompasses the implicit values and understandings about what it means for her to be a person (Hoffman, 1998).

It is important to note that conflict is not a necessary feature of multiple identity but arises when the forces, the understandings, behind some demand a greater degree of loyalty over others, causing us to prioritize amongst these spaces (Grant, 1997). To ease this tension between social identities and identities implicitly promoted in science we look upon science as a set of knowledges constructed through discourse that can act as an expression of identity (Osborne & Barton, 1998). Allowing our emotions, values, beliefs, and essentially our broader self-understandings to become a starting place for the teaching and learning of science we do more than ease conflict or tension. We enact what Barton (1998) called a decentering process or a process that dissipates the lines separating the worlds of student and science. But, in our opinion, this process can just as easily be seen as one that encourages the opening and broadening of these two positions. We open up representation in science, or what science is and can be, as well as

identity in science, or who we think we must and can be to engage in and encounter that science.

In Clara's story we can see how a particular set of circumstances involving one teacher, one science class, and one specific science project alleviated some of the tension existing between how she understands science and herself and allowed Clara to open herself to science. Clara pursued a project on landfills where she and her partner did not just read about the topic, looking up facts and figures. She visited a landfill site, talked to and interviewed others as part of her inquiry, and returned to class so that she and her partner could present what they had learned to their peers. As a result of her project, Clara participated in something she would never have imagined herself doing, continuing with the project and presenting it on Earth Day. This appears to have been a very memorable experience for Clara. After all, she is not a science person. But for that one class, that one project, Clara caught a glimpse of herself creatively pursuing and succeeding in a science that, if only briefly, contradicted the larger presuppositions Clara uses when approaching science and opened up the possibilities that exist between science and herself.

Here science changes from being the man in the white lab coat peering through a microscope in his laboratory using and examining the many concepts of science that have given Clara so much trouble in the past. Instead it could be the young girl feeling the breeze across her face as she marvels at the kite she and her father are flying climbing higher and higher. Or the boy running around amongst the trees with his friends while they wonder how in the world the rocks they are throwing can make those multiple skips across the lake. In this case it was Clara standing atop a pile of garbage, not repulsed but thinking about it, and sharing what she and her partner had learned in class and at Earth Day. Atop that pile of garbage the language, material practices, perceptions, theories, and beliefs that for Clara constitutes science as a troubling and difficult subject, or world, in its own right momentarily changed (Roth & Lawless, 2002). From within these perspectives science is also found in these numerous spaces and as part of these numerous identities, with the interests of one flowing into those of the other. Science becomes a part of these interests, understandings, and ways of knowing the world. Can we say that during Clara's project on landfills she was clearly and strictly a science student? It appears that her other identities, the interests they represent, and the understandings they involve also emerge as she reflected on this project—ones that also include the way she knows her world, her community, and herself.

It is these ways of knowing and the identities they involve that allow Clara and other students to enact a science that alters and reshapes the enterprise of science itself from an unapproachable, difficult, or irrelevant subject, as well as the larger educative process in such a way that includes the perspectives and needs with which Clara looks upon her education (Osborne & Barton, *in press*). Thus, we are increasing the possibility of the student opening up and questioning the prereflectively acquired meanings that concern both themselves and science (Simpson, 1983). For Clara these include her understandings of science as troubling, herself as not being a science person, and thus herself within and not distanced from science. In short, science instruction that begins amid the students' larger interests, concerns, and ways of knowing the world allows students to encounter science in such a way that it opens up the horizons from within which science and self are understood and contributes toward the evolution of both.

Allowing the individual in his or her entirety, and not just what is understood as a scientist or science student, to engage in and encounter science through these multiple opportunities and pathways makes way for the aesthetic, emotional, and social elements whereby science, self, and other interact (Barton & Osborne, 1999). With these elements we can begin the necessary task of broadening identity from pure self-interest and understanding. The hesitation and insecurities that arise as Clara continues to approach science are not solely

rooted in isolated understandings of science and self. They surface amid a larger negotiation between life at home, in school, and how her achievement in school translates into Clara's view of her education as the way to become "somebody" and leave the life of migration behind. Thus, with the self-interests and understandings that identity involves, in addition to the aesthetic, emotional, and social elements that play a part in a larger interaction between self and other, we can move from identity in science to certain broader visions of the self. Helms (1998) discussed self as not solely rooted in what a person does, in his or her affiliations, but also in what a person values, believes, and wants to become. Here the self was an experienced self in context from where the search for meaning in science begins with identity, allowing it to become a part of the way we know ourselves, our world, and thus our being in the world, and ends in a central sense of self as individuals negotiating the structures and contexts amid this larger world.

### **ANDREA: FROM IDENTITY TO SELF**

Andrea moved from Mexico City to Texas with her family at the age of four. The rationale for their move was to seek a better life in the United States. But the jobs needed to secure this better life were few and far between and the little work available required skills that Andrea's father did not possess. Moreover, neither of Andrea's parents spoke English, which compounded the difficult task of finding work. So Andrea and her family began to migrate. Although migrating never took Andrea and her family outside the state of Texas, it did take her to different towns, and schools, scattered across Texas. With every approaching move questions flooded Andrea's mind.

Then I would always think, what is gonna happen? What's gonna happen? What's gonna happen next year am I going to be in the same school? Am I gonna change schools? Do I have to go back and withdraw?

Growing up amid all of this uncertainty, Andrea began to look ahead to an education. An education would stifle the feelings of instability that she had never quite become comfortable with or accustomed to in her life. A life that she described as "temporary."

Yea, because I knew that the only way to get out of that life that I didn't want because it was so unstable was to study. Was to get an education. I knew that that was my, my only ticket to being happy.

Andrea described coming to the United States from Mexico as if someone had thrown a big puzzle in front of her to figure out. First she had to learn English, which she had to do on her own "just by seeing and by listening", because she did not have any bilingual teachers. Even though Andrea eventually learned English she had a more difficult time mastering school life, which extended beyond academics and extracurricular activities. Suddenly Andrea needed to pay attention to how she dressed, to music, and to who was popular opposed to who was not—all things that Andrea was not used to focusing her concentration upon. Andrea explained it as though she had entered a different world where unusual things were expected of her. Within this world Andrea had trouble making friends since it seemed she could be excluded from the group on the grounds that her shoes were not Reebok or Nike. Often times, Andrea sat alone in the cafeteria because every attempt to join one of the many cliques in the lunchroom ended in denial. Even the few friends Andrea made and could have "light conversations" with quickly pointed out that she did not quite fit in. "My friends really thought I was weird and they would say, 'Andrea you're weird,'

because I didn't know about all those things they would talk about you know?" Andrea had the strong sense of being an outsider looking in upon all the groups that comprised the school's student body. "I would just be sort of hanging around you know? Not really in with them just there." The traveling Andrea and her family did as migrant farmworkers only compounded these difficulties since, "It was difficult finding friends because they wouldn't see me that long."

Andrea felt extremely uncomfortable in school, always carrying the fear that someone would point out that her outfit was not color coordinated or she was not up to date with the latest music releases. Andrea expected that she would become friends with everyone in school, with the freedom to talk and sit with anyone she chose. Unfortunately, Andrea discovered she was neither the friend nor person her peers expected and felt like an outsider looking in.

Yea definitely and I used to be so happy and open-minded and you know? I wanted to help everybody and talk to everyone. And it changed me a little because it made me more shy. And it made me think that I should never be comfortable. Never express what I feel or what I think because they made me think that I was weird.

As a result Andrea dedicated herself entirely to the one aspect of school lacking judgment and criticism. Andrea studied.

It was horrible that I was still into this, well I'm just gonna study, I don't come to school to party, I don't have friends I'm just here to study. I want to learn and then hopefully go to college . . . Everything I do is wrong because they tell me or they laugh at me. They say, "Ha ha look at her," you know? Or they whisper at me or, this is even funny, but even the Hispanic people that were there, they would also do that to me for some reason. I don't know.

Despite the high marks she was receiving in school, Andrea still felt isolated. "Lonely. Completely lonely. Lonely. From school lonely, from the people I knew, lonely, from not having friends, lonely . . . Completely lonely, frustrated, and scared. And to think that, I guess, I still have a little queasiness."

With her feelings of loneliness and isolation, Andrea looked to her classes, school, and her education to do more than teach her the material that would help her get the grades necessary to move on to college and leave a life of migration behind. She also wanted them to provide spaces where she and her classmates could learn from each other, where they would be colleagues, and in so doing come to know each other amid relationships based on who Andrea was and not what she was wearing and knew about music.

It made me feel that I definitely had to educate myself to be able to find a place. Find a place to live and to find myself. And to be able to make others understand where I stand. You know? Because when I was younger I didn't know what to say. I just said, "Well I just don't feel like doing that. I just don't feel like that you know?" I think that there are other things to do but I didn't know. Well I think that if I get educated I'll have other ways of showing them my views. And they might even take me seriously. You know? If I'm educated.

And in science, Andrea found a class that provided just that.

Oh yes! I love science, anything that has to do with nature. Science is always a lot of group work, a lot of coming together and getting results from other people you know? "What did you see? Well I observed this. What did you observe, you know?" A lot of interaction and I like that. Through science I got to know a few people.

Where do we begin to locate science in relation to the self? To do so, we must begin with the broader discussion of what exactly constitutes the self. Here we rely on Fay's articulation of the two distinct manners with which matters of the self may be divided (Fay, 1996). First, we can speak of atomism and the self as a single isolated entity that, as the subject of consciousness, persists through time and is the source of all our activity. Individuals are distinct and only externally related to others, something to be confronted in an encounter and dealt with, where the self is the underlying entity of these conscious confrontations with any changes of state comprised of alterations to this underlying substance. The self is located in the substantial unity of this hard, closed-off, and integrated entity. But substantial unity of this type does not explain how the individual can be comprised of multiple identities and the fact that we can be different in different settings, circumstances, and dialogues. How then, may we go from identity to self in science?

We can answer this question when we shift to the second manner self may be envisioned. Here the self is porous, dialectically interacting with others, and relationally rather than substantially unified. The self is created in the very process of interacting with others and the environment. Taking into account the individual standing in relation to certain others there is no need for an underlying thing, a true self, required for unity. Instead the self comprises certain states of proper relations. Suggesting this alternative view of self accounts for both a unity of self and the way we are fragmented and fluid. Ultimately, from this perspective the self can be conceived as an ongoing activity dedicated to self-creation where others are not separate from but a necessary part of us. So quite clearly, others have an integral role in this process. Without an intimate connection between self and other, authentic experience could not exist and thus it is here that we can move from identity to self. More than pure self-understanding and self-interest identity is, in part, to be related to others in particular ways and to understand ourselves as related. In these understandings we become aware of ourselves as objects to others, thereby become aware of ourselves as selves, and acknowledge the beings of self and other as interrelated to the extent that they effect everything about us including our aesthetic and emotional views.

Johnson (1985) considered this latter view of self to be where the consensus lies. We can no longer regard self as a unitary phenomenon or structural entity comprised of factors and traits that add up to the total person. Rather, we should consider self as a social construction created through interactions and transactions between and among social beings. Our more autonomous self-interests intermingled within these relationships strike a balance between the autonomous individual and pure collectivity. In this case self is grounded in a dialectical understanding of individuality comprised of our self-interests and self-understandings and the ensemble of social relationships that constitute our being in the world (Lykes, 1985). This view of self-in-relationship stresses our essential connections to others, recognizes interdependence in the form of relationships, and acknowledges continuity and difference embedded in relationships with distinct others inclusive of human relations with person and place (Plumwood, 1998).

Herein we can find science's meaning—its power, significance, relevance, and authenticity to all students regardless of who they are and whoever it is they want to become. Science's meaning lies in its ability to become a part of everyone's process of this self-in-relationship with others. The "ongoing project of constituting and reconstituting selves that are more developed, less alienated, more ethical and humane, less oppressed and exploited, more sensitive and conscious, more free, more creative, and more in harmony with nature and other human beings" (Allen, 1997, p. 22). We can see how this might look in Andrea's sentiments. Her connection to science does not lie in a certain scientific discipline or its topics. In her statement nothing of the sort is mentioned. Her "love" of science lies first in the connection she has found between science and nature, thereby

redirecting science toward this larger object of study (Witz, 1996). Science is grouped among those things that have a connection to nature for which Andrea has a love in its own right. Second, Andrea's fondness for science also lies in science's ability to connect her with other people. It was one way in which she and others came together, conversed in the sharing of ideas, and thereby interacted in such a way that Andrea overcame some of her feelings of loneliness and isolation. Science became part of Andrea's process of getting to know and recognizing others as well as a means by which others could more authentically come to know and establish relationships with her. In this process of interaction, sharing, and coming to know others, Andrea connects science to these larger wholes and so science appears to facilitate Andrea's process of interacting and forming relationships. Andrea knows science and as a knower of science we must necessarily refer to these relationships between herself as a knower and the objects or subjects of her knowing, which, in the realm of science, come in the form of both person and place (Belenky et al., 1997).

For science to become part of such a process for all students, it cannot be portrayed and approached as a set of unchanging facts, laws, and theories that, part by part, constitute the way of understanding the whole of nature and the natural world. Then science is a world in its own right that, upon entering, the student can join membership with those select few that alone possess such knowledge, setting them apart. Rather, if science is to have any individualized meaning it must become one way of understanding our relationship to these others, thereby increasing, substantiating, and authenticating our relationship with people, nature, and the natural world. Connecting science to self transforms it into an intermediary through which the student can find and establish a stronger relationship to people, nature, and society and where we find self living among instead of disconnected and distanced from others. To change science education in a manner that facilitates this for all students we must allow these connections to people and place, or lack there of, to become the starting place of scientific teaching and learning.

As an intermediary of this type, science becomes a part of the holistic relationship between the student, other people, and the natural world. This whole contains the social, humanistic, aesthetic, and spiritual elements constituting a subjectively personal relationship between a passionate, dependent, and intuitive self and others (Cobern, 1989). In this union between science, self, and other we have a stronger foundation to overcome the link between science and the modernist attitude that embraces production and control in order to conquer nature and we can return to the historical vision of "scientist" as a part of nature (Schumacher, 1991) or natural philosopher if we wish. This firmer grounding in the self can help realize science's individual and societal benefit by reorienting scientific objects and concepts toward a larger object of study, the phenomenon of nature or the natural world. This in turn encourages a strong relation to this larger object of study as a source of deeper personal development (Witz, 1996). To do so, we must more seriously consider a dialectical perspective on science, one that Merchant (1992) described as emphasizing change, historicity, and social construction, and where the whole of reality is taken as an interpenetrating relation among parts whose properties and divisions depend on the particular problem of study. With this merger between science and self we can move back up the terrain through identity and end in a less reductionist scientific world conception (Tamas, 1991).

To conclude we introduce Keith. Keith's involvement with science goes beyond any professional affiliation. It is a deeply personal and holistic relationship that begins and ends outside of school and is further illustrative of how opening up to science, allowing science to enter the realm of everyday thought, coheres elements of his lifeworld, identity, and self.

### **KEITH'S RELATIONSHIP WITH SCIENCE: LIFEWORLD, IDENTITY, AND SELF**

What would such a profound connection to science subject matter look like? Much is said about these connections, or the infusion of science into the lifeworld of the student, with little exemplifying it. So to conclude we would like to describe Keith. Keith is a Jamaican American immigrant interviewed as part of a study on the construction and role of worldviews in the study of science. Keith was born in Jamaica, immigrated to Canada, and then to the United States. He grew up in various areas around Chicago, eventually enrolling at the University of Illinois. After earning his undergraduate degree in biology as a premedical student, Keith returned to Chicago and worked in a cancer research laboratory. With this work experience, Keith decided to return to school and obtain his master's degree in education and become certified as a secondary science teacher. Keith's story exemplifies how engagement with science can develop through experiences and understandings that are not White, middle class, and Eurocentric. Science can become infused into the lifeworld of a student in an enriching and truly educative manner. Keith's story provides a specific image of what such a profound relationship to science subject matter might look like. His perceptions of science, as part of his broader worldview, illustrate science's further link to his identity, self, and development.

During our conversations Keith would talk at length about his experiences of nature and the natural world in Jamaica and how those experiences infused and enriched the science he was learning in his college classes. As a child with his brother and cousins he would play with hermit crabs, anoles, and exotic insects:

There's a bench that we would always sit on [in Jamaica]. But there's like a tree right next to it and there's these ants that just chew up the wood and their lair is a tunnel. It's just basically a tunnel. They'd build a tunnel and you could see the tunnel going along the tree. Going up the tree or down a branch or something like that. And it's made . . . I guess what, what they did is they chewed up wood and then they process it into this paper-like material and they just build that whole tunnel. We'd go out there and mess with those. And it's funny, I just found this out in my entomology class, when the ants are like that, if somebody breaks into their house, they send out these pheromones and they'd call all the, the army ants, the soldier ants. And that, I mean that was what would happen. You'd break a hole and just instantly a whole bunch of these big ants would come out and they'd come through that hole and try to see who was there. I mean, I got a bunch of bites from them!

Often Keith would exclaim how much he enjoyed the classes he was taking in entomology and plant sciences and the classes he had taken in the past (like epidemeology). We asked Keith what he was getting out of his science classes that caused him to like them.

I like being able to explain common things. I like it when the classes are relevant. I mean I'm not talking about going down to what's in a cell, just why things happen the way they do. I really enjoy that, and in very, very simple way. I'm taking this entomology class now and I really enjoy it. I have not missed one of those lectures. Just because it is, it's just interesting. I mean I'll probably never do anything with bugs or anything like that but just learning and seeing those new things . . . O.K. this is Batesian mimicry, this Mullerian mimicry, you know what I'm saying? Here it is, here is an insect that's showing it. I mean you've seen it, it exists. You've felt it you've touched it, you've tasted it, you've been in it.

It seemed obvious to us that the things that Keith found so interesting in his science classes connected to the "science" he had been doing as a child with ants and other creatures in

Jamaica. It connected with them and took them further, explaining things he had seen and giving him a deeper understanding. Keith called this “confidence” and he claimed that his classes gave him confidence in his knowledge of the things he had observed by giving him explanations and multiple perspectives. His knowledge became more specific in the facts he could now recite and broader for now he could relate his observations to larger theories and concepts.

Now I think about the whole thing. I can definitely see how [theories from classes] would change my perceptions on nature. I was thinking about this when I was talking about confidence, about how if you look at a picture, people get different views from the picture. [School] has given me more information that I can piece together. [Classes] might give me a broad understanding in one area and I turn around and go to another class that gives me a broad understanding of another area and to make a bigger thing, like nature, I have to put them together. Like this psychology class, it’s psychology of personality and why people are the way they are and why they do things the way they do. And it’s given me different perspectives even with insects! I took the entomology exam last week and I put in psychology terms. And those terms were underlined. He gave them back to me, I don’t think I can remember him mentioning those terms. He mentioned the ideas in a broad way, like, he was talking about selectivity of birds. Birds as selective agents of co-evolution. He was talking about that, “O.K. birds go around and pick out things or leave them alone.” This butterfly needs to look a lot like this butterfly, this other poisonous butterfly, or just a little bit like that other poisonous butterfly depending on the predator. So he’s asking a question about that.

I was thinking about something in psychology, I think it was classical conditioning. You can be conditioned in something and certain things like, say, to the bell or whatever. Now hear the bell and you’re salivating. Now are all bells going to make you do that? Is a doorbell going to make you do that? So it came down to talking about generalization and discrimination. And I was sitting there taking that entomology test and I’m like . . . that’s exactly what it is! It comes down to the birds’ level of generalization or discrimination. And he underlined those things and he said “exactly”! And I can’t remember him ever saying that! It’s just because I’ve started to just notice things a lot more and I’ve started to think about things a lot more. I just make connections I’ve never thought of before.

This in turn gave him different perspectives to theorize his own relationship to nature.

I mean it all goes back down to just knowledge. You look at things, different things, from different angles. O.K. say for instance I was talking about nature. I could look at things from a statistical view based on this class. I can look at things from a psychological view, you know, or whatever and then kind of come to a conclusion as to how do you attack this situation, how do you deal with that situation. If I look at it from an ecological view, I can ask, “How is this, which direction is this area headed toward?” Cause knowing that you start off with a pioneer species or whatever and then you start moving up the ladder and then you end up going this direction or that direction depending on, say, latitude or water—that type of thing. Which direction is this forest headed in? Where did this tree come from? Was this one of those trees that that was carried here by the wind? Was it carried here by a bird? A bird that ate a seed some place down here and the droppings fell here and, and the tree, the tree grew? What’s in this tree knowing that there are wood boring insects, there are stem-boring insects? What’s in here that I can’t see? What’s underneath this tree based on what type of nutrition does this tree need? And is it getting it? Then you can look at things from like a completely different perspective but still bring it back to just the natural thing. Like maybe from a statistical view, how much does this tree represent this forest?

As well as using this knowledge to reflect on his past experiences, Keith used it to analyze and understand the present. Living at one of his old residences on campus Keith

would always take the same route home. Now there was a house on one of the corners Keith had to go around so that he could get to his apartment. This house had a nice green lawn that Keith and others would cut across to decrease their walking time and eventually the heavy foot traffic wore a short dirt path across the lawn. In order to put a stop to this, the owners of the house decided to put up a wire fence.

After that fence had been put up, obviously people didn't walk on it any more, and grass started to grow there. Now me walking by, I'm looking at this and I'm seeing two different grasses. I'm seeing that this grass over here has been here, this grass hasn't been walked on, this is grass that's gotten here. Now I'm seeing a pioneer species come in that's been there this whole time but hasn't been able to grow because people have been walking over it. But this, this grass can grow a lot quicker than the other grass so now it's there you know. So you could see, you can still see exactly where the line was even though it's not dirt any more that whole line there is a different type of grass! But me thinking about it, having a class about that pioneer species and things like that—I think that's probably why I noticed it even more. But even now just the fact that it's still in my head if I walk past, I look down just to see what's there now. You know, has this other grass moved in now? Is there a different type, something else growing there now before this other grass can make it? So I mean I can definitely see how [the class] would effect my perception because I wouldn't even look at it normally, if I didn't think about it. I mean it isn't something that I would walk by and point out to somebody because they'd probably be like well, who cares, you know.

But Keith did notice and showed a personal satisfaction in his ability to look down and simply notice this phenomenon. It was “science in action.” Keith carried this connection, constructed from understanding how the pioneer grass species would grow and his own propensity to observe and question, into the classroom with him. Further, Keith is going to take it with him into his future science classroom. Keith has found a meaning in science that is embedded within a relationship that exists between himself, science, and the world around him as well as other people existing in this world who both have and do not possess such a scientific outlook. We asked him about such a perception:

I think that's the driving force you know. It's like you have this picture that probably will never be finished and you don't know what it's of. But maybe if you look at the *whole* picture, you'll see what it's *about*. I mean I just feel that that's been driving me. I want to, I want to get the complete picture. I know that I'm not going to get the complete picture but I want to get the complete picture. So I want to get as many pieces of that puzzle as I can. I really want to know more. I want to know more about that grass, I mean even though I, I don't want to have anything to do with that grass! I enjoy knowing why that grass grew there. And that I think that has been just the driving force. Just knowing that I got another piece of the puzzle, and I see something else that somebody may not see you know.

In such a connection, Keith's understanding of science is simultaneously an understanding of himself relative to others. It is part of his identity as a student, scientist, preservice teacher, and, most importantly, as a person who notices, cares about, and understands such a phenomenon. Science is just one way that Keith can confront and understand the realm of everyday phenomenon. Keith's ability to use science in order to bring together disparate contexts in order to make sense of his experiences, and further connect these experiences to other aspects of his life, provides science with meaning and a place in his lifeworld. Keith employs his entomology class to understand the ants he observed in Jamaica, and his ecology class to understand the grass growing in someone's yard. Further, when Keith speaks of these connections he also refers to his own feeling of confidence and caring. When

talking about the science he has done in school and home these feelings are made sensible and accessible against the backdrop of science and turns science into part of both the person Keith is and wants to become (Taylor, 1994). As part of his identity, science is one way Keith negotiates a deeper and more harmonious existence with the people and places constituting the world around him. He can look upon the world from different angles and perspectives and this takes him closer to the whole picture Keith is so driven to complete.

In many ways Keith epitomizes a student making meaning of science, learning and using science in ways that are truly educative and that enlarge his self and his self in the world. Despite the many hours students spend studying science, only a few relate to it as Keith does—in a manner that could be described as advancing their education in a larger sense, one in which they make a connection to the subject matter in such a way that it turns into a source of inspiration and occupies a formative position in their lives. Keith seems to use his study of science to help him find his place in society, direction in life, and establish a deeper relationship with life and existence.

Keith's story suggests that a pedagogy fostering connections to science across contexts can cohere aspects of a student's lifeworld while including the self-understandings associated with identity and the negotiation of these understandings amid various relationships that constitute the self in the practicing of science. In so doing science turns into a source of inspiration: one motivational starting place not only for those students who want to become doctors or science teachers but those who desire the confidence, caring, and knowledge to face the world in such a way that would help Hector overcome the stereotypes he has faced, assist Clara in achieving the success she seeks in school so that she can become someone in life, and aid Andrea in finding the place and understanding in life she is looking for. In this sense involvement with science may become a part of this developmental process of more fully becoming one's self, independent and responsible, with the subject matter becoming a part of the student's essential worldview and understanding.

The research reported in this article was made possible by a grant from the Spencer Foundation. The views expressed are solely the responsibility of the authors.

## REFERENCES

- Abell, S. K., & Eichinger, D. C. (1998). Examining the epistemological and ontological underpinnings in science education: An introduction. *Journal of Research in Science Teaching*, 35(2), 107–109.
- Aikenhead, G. S. (1996). Science education: Border crossing into the subculture of science. *Studies in Science Education*, 27, 1–52.
- Allen, D. (1997). Social constructions of self: Some Asian, Marxist, and feminist critiques of dominant western views of self. In A. Douglas (Ed.), *Culture and self: Philosophical perspectives*, East and West (pp. 63–82). Boulder, CO: Westview Press.
- Atwater, M. M. (1996). Social constructivism: Infusion into the multicultural science education research agenda. *Journal of Research in Science Teaching*, 33(8), 821–837.
- Barton, A. C. (1998). Teaching science with homeless children: Pedagogy, representation, and identity. *Journal of Research in Science Teaching*, 35(4), 379–394.
- Barton, A. C., & Osborne, M. D. (1995). Science for all Americans? Science education reform and Mexican Americans. *High School Journal*, 78, 244–252.
- Barton, A. C., & Osborne, M. D. (1999). Re-examining lived experience: Radical constructivism and gender. *Cybernetics and Human Knowing*, 6(1), 47–59.
- Belenky, M. F., Clinchy, B. M., Goldberger, N. R., & Tarule, J. M. (1997). *Women's ways of knowing: The development of self, voice, and mind*. New York: Basic Books.
- Bernstein, J. R. (1985). *Beyond objectivism and relativism: Science, hermeneutics, and praxis*. Philadelphia: University of Pennsylvania Press.

- Bevilacqua, F., & Ginnetto, E. (1995). Hermeneutics and science education: The role of history of science. *Science and Education*, 4(2), 115–126.
- Brickhouse, N. W., & Potter, J. T. (2001). Young women's scientific identity formation in an urban context. *Journal of Research in Science Teaching*, 38(8), 965–980.
- Carroll, D., Gabbard, S. M., & Mott, A. F. (2000). Workforce investment programs for migrant farmworker youth. U.S. Department of Labor. <http://migration.ucdavis.edu/rmn/cfra/ucdapr2000/carroll.html>. (Accessed September 6, 2000)
- Chavkin, N. F. (1991). Family lives and parental involvement in migrant students' education. Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools. (ERIC Document Reproduction Service Number: ED 335 174)
- Cobern, W. W. (1989, March). Worldview theory and science education research: Fundamental epistemological structure as a critical factor in science learning and attitude development. Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Francisco.
- Cobern, W. W. (1994). Point: Belief, understanding, and the teaching of evolution. *Journal of Research in Science Teaching*, 31(5), 583–590.
- Coffey, A., & Atkinson, P. (1996). Making sense of qualitative data: Complementary research strategies. Thousand Oaks, CA: Sage.
- Cole, A. L., & Knowles, J. C. (1995). Extending boundaries: Narratives on exchange. In R. Josselson & A. Lieblich (Eds.), *The narrative study of lives*, Vol. 3: Interpreting experience (pp. 205–251). Thousand Oaks, CA: Sage.
- Cunningham, C. M., & Helms, J. V. (1998). Sociology of science as a means to a more authentic, inclusive science education. *Journal of Research in Science Teaching*, 35(5), 483–499.
- Dahlberg, K., & Drew, N. (1997). A lifeworld paradigm for nursing research. *Journal of Holistic Nursing*, 15(3), 303–317.
- Dahlin, B. (2001). The primacy of cognition—or of perception? A phenomenological critique of the theoretical bases of science education. *Science Education*, 10(5), 453–475.
- Davis, S. (1997). Child labor in agriculture. Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools. (ERIC Document Reproduction Service Number ED 405 159)
- Denzin, N. K. (1988). *The research act* (Rev. ed.). New York: McGraw Hill.
- Denzin, N. K. (1989). *Interpretive biography*. Newbury Park, CA: Sage.
- Duschl, R. A. (1998). Abandoning the scientific legacy of science education. *Science Education*, 72(1), 51–62.
- Eger, M. (1992). Hermeneutics and science education: An introduction. *Science Education*, 1(4), 337–348.
- Eger, M. (1993). Hermeneutics as an approach to science: Part I. *Science and Education*, 2(1), 1–29.
- Eisenhart, M. A., & Finkel, E. (1998). *Women's science: Learning and succeeding from the margins*. Chicago: The University of Chicago Press.
- Evans, K. (2002). *Negotiating the self*. New York: Routledge Falmer.
- Fairtlough, G. H. (1991). Habermas' concept of "lifeworld". *Systems Practice*, 4(6), 547–563.
- Fay, B. (1996). *Contemporary philosophy of social science*. Oxford, UK: Blackwell.
- Fontana, A., & Frey, J. H. (1998). Interviewing: The art of science. In N. K. Denzin & Y. S. Lincoln (Eds.), *Collecting and interpreting qualitative materials* (pp. 47–77). Thousand Oaks, CA: Sage.
- Gadamer, H. G. (1994). *Truth and method* (2nd ed., J. Weinsheimer & D. Marshall, Trans.). New York: Continuum.
- Gallagher, S. (1992). *Hermeneutics and education*. Albany, NY: State University of New York Press.
- Garrison, J. W., & Bentley, M. L. (1990). Science education, conceptual change and the breaking with everyday experience. *Studies in Philosophy of Education*, 10, 19–35.
- Ginev, D. (1995). Between epistemology and hermeneutics. *Science and Education*, 4(2), 147–159.
- Grant, N. (1997). Some problems of identity and education: A comparative examination of multicultural education. *Comparative education*, 33(1), 9–28.
- Griffiths, M. (1995). *Feminisms and the self*. New York: Routledge.
- Gunstone, R. F., & Mitchell, I. J. (1998). Metacognition and conceptual change. In J. J. Mintzes, J. H. Wandersee, & J. D. Novak (Eds.), *Teaching science for understanding: A human constructivist view* (pp. 133–163). San Diego, CA: Academic Press.

- Habermas, J. (1984). *The theory of communicative action*, Vol. 1: Reason and the rationalization of society. Boston: Beacon Press.
- Habermas, J. (1987). *The theory of communicative action*, Vol. 2: Lifeworld and systems: A critique of functionalist reason. Boston: Beacon Press.
- Harrison, A. G., Grayson, D. J., & Treagust, D. F. (1999). Investigating a grade 11 student's evolving conceptions of heat and temperature. *Journal of Research in Science Teaching*, 36(1), 55–87.
- Heidegger, M. (1962). *Being and time* (J. Macquarrie & E. Robinson, Trans.). London: Routledge and Kegan Paul.
- Heilman, E. E. (1998). The struggle for self: Power and identity in adolescent girls. *Youth and Society*, 30(2), 182–208.
- Helms, J. V. (1998). Science and me: Subject matter and identity in secondary science teachers. *Journal of Research in Science Teaching*, 35(7), 811–834.
- Hird, M. J. (1998). Theorising student identity as fragmented: Some implications for feminist critical pedagogy. *British Journal of Sociology of Education*, 19(4), 517–527.
- Hoffman, D. M. (1998). A therapeutic moment? Identity, self, and culture in the anthropology of education. *Anthropology and Education Quarterly*, 29(3), 324–346.
- Hogan, P. (1998). The politics of identity and the experience of learning: Insights for pluralism from western educational history. *Studies in Philosophy of Education*, 17, 251–259.
- Holstein, J. A., & Gubrium, J. F. (1995). *Qualitative research methods*, Vol. 37: The active interview. Thousand Oaks, CA: Sage.
- Husserl, E. (1970). *The crisis of European and transcendental phenomenology* (D. Carr, Trans.). Evanston, IL: Northwestern University Press.
- Johnson, F. (1985). The western concept of self. In A. J. Marsella, G. DeVos, & F. L. K. Hsu (Eds.), *Culture and self: Asian and Western perspectives* (pp. 91–138). New York: Tavistock.
- Keller, E. F. (1997). Feminism and science. In R. Boyd, P. Gasper, & J. D. Trout (Eds.), *The philosophy of science* (pp. 279–288). Cambridge, MA: The Massachusetts Institute of Technology Press.
- Kerdeman, D. (1998). Hermeneutics and education: Understanding, control, and agency. *Educational Theory*, 48(2), 241–266.
- Kvale, S. (1996). *Interviews: An introduction to qualitative research interviewing*. Thousand Oaks, CA: Sage.
- Lewis, E. L. (1996). Conceptual change among middle school students studying elementary thermodynamics. *Journal of Science Education and Technology*, 5(1), 3–31.
- Lijnse, P. (1990). Energy between the life-world of pupils and the world of physics. *Science Education*, 74(5), 571–583.
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage.
- Lykes, M. B. (1985). Gender and individualistic vs. collectivist bases for notions about the self. *Journal of Personality*, 53(2), 356–383.
- Marques, L., & Thompson, D. (1997). Misconceptions and conceptual changes concerning continental drift and plate tectonics among Portuguese students aged 16–17. *Research in Science and Technological Education*, 15(2), 195–222.
- Merchant, C. (1980). *The death of nature: Women, ecology, and the scientific revolution*. New York: Harper Collins.
- Merchant, C. (1992). *Radical ecology: The search for a livable world*. New York: Routledge.
- Mikkilia-Erdmann, M. (2001). Improving conceptual change concerning photosynthesis through text design. *Learning and Instruction*, 11(3), 241–257.
- Nersessian, N. J. (1991). Conceptual change in science and science education. In M. R. Mathews (Ed.), *History, philosophy, and science teaching: Selected readings* (pp. 151–165). New York: Teachers College Press.
- O'Loughlin, M. (1992). Rethinking science education: Beyond Piagetian constructivism toward a sociocultural model of teaching and learning. *Journal of Research in Science Teaching*, 29(8), 791–820.
- Osborne, M. D., & Barton, A. C. (1998). Constructing a liberatory pedagogy in science: Dilemmas and contradictions. *Journal of Curriculum Studies*, 30(3), 251–260.

- Osborne, M. D., & Barton, A. C. (in press). The love we call science: Constructing a womanist science from observations of practice. New York: Peter Lang.
- Plumwood, V. (1998). Nature, self, and gender: Feminism, environmental philosophy, and the critique of rationalism. In M. E. Zimmerman, J. B. Callicott, G. Sessions, K. J. Warren, & J. Clark (Eds.), *Environmental philosophy: From animal rights to radical ecology* (pp. 291–314). Upper Saddle River, NJ: Prentice Hall.
- Polanyi, L. (1985). *Telling the American story: A structural and cultural analysis of conversational storytelling*. Norwood, NJ: Ablex.
- Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education*, 66(2), 211–227.
- Prewitt-Diaz, J. O., Trotter, R., & Rivera, V. A. (1989). *The effects of migration on children: An ethnographic study*. State College, PA: Centro De Estudios Sobre la Migracion.
- Riessman, C. K. (1993). *Qualitative research methods, Vol. 30: Narrative analysis*. Newbury Park, CA: Sage.
- Rosemont, H. Jr. (1997). Classical Confucian and contemporary feminist perspectives on the self: Some parallels and their implications. In A. Douglas (Ed.), *Culture and self: Philosophical perspectives, East and West* (pp. 63–82). Boulder, CO: Westview Press.
- Rossman, G. B., & Rallis, S. F. (1998). *Learning in the field: An introduction to qualitative research*. Thousand Oaks, CA: Sage.
- Roth, W. M. (2000). Learning environments research, lifeworld analysis, and solidarity in practice. *Learning Environment Research*, 2, 225–247.
- Roth, W. M., & Lawless, D. (2002). Science, culture, and the emergence of language. *Science Education*, 86(3), 368–385.
- Roth, W. M., & McRobbie, C. (1999). Lifeworlds and the 'w/ri(gh)ting' of classroom research. *Journal of Curriculum Studies*, 31(5), 501–522.
- Schultz, K. (1999). Identity narratives: Stories from the lives of urban adolescent females. *The Urban Review*, 31(1), 79–106.
- Schumacher, E. F. (1991). The problem of production. In A. Dobson (Ed.), *The green reader* (pp. 29–33). San Francisco, CA: Mercury House.
- Schwandt, T. A. (1997). *Qualitative inquiry: A dictionary of terms*. Thousand Oaks, CA: Sage.
- Schwandt, T. A. (1999). On understanding understanding. *Qualitative Inquiry*, 5(4), 451–464.
- Simpson, L. C. (1983). Science, language, and experience: Reflections on the nature of self-understanding. *Man and World*, 16, 25–41.
- Tarnas, R. (1991). *The passion of the western mind: Understanding the ideas that have shaped our world view*. New York: Ballantine.
- Taylor, C. (1991). The dialogical self. In D. R. Hiley, J. F. Bohman, & R. Schusterman (Eds.), *The interpretive turn: Philosophy, science, culture* (pp. 304–314). Ithaca, NY: Cornell University Press.
- Taylor, C. (1994). The politics of recognition. In C. Taylor (Ed.), *Multiculturalism* (pp. 25–73). Princeton, NJ: Princeton University Press.
- Wallace, J. B. (1994). Life stories. In J. F. Gubrium & A. Sankar (Eds.), *Qualitative methods in aging research* (pp. 137–153). Thousand Oaks, CA: Sage.
- Walters, A. J. (1995). Technology and the lifeworld of critical care nursing. *Journal of Advanced Nursing*, 22(2), 338–346.
- Wellington, J. (2001). What is science education for? *Canadian Journal of Science, Mathematics and Technology Education*, 1(1), 23–38.
- Wenger, E. (1998). *Communities of practice*. New York: Cambridge University Press.
- Witz, K. G. (1996). Science with values and values for science. *Journal of Curriculum Studies*, 28(5), 597–612.
- Witz, K. G. (2000). The 'academic problem'. *Journal of Curriculum Studies*, 32(1), 9–23.