RANDY YERRICK, WOLFF-MICHAEL ROTH AND KENNETH TOBIN

FORUM: THE CULTURES OF SCHOOLING AND THE REPRODUCTION OF INEQUITY

THEORETICAL FRAMEWORKS EXPLICATING VITAL COMPONENTS OF SUCCESSFUL CROSS-CULTURAL SCIENCE TEACHING

Randy:Your characterization about intonation, pitch, and energy are reminding me that we have yet to create a cross-cultural way to capture successful teaching that transcends culture, science knowledge and pedagogy. We still seem to be in the mode of creating frameworks that work within situated cognition and within bounded contexts. Will there really ever be a way to do this? Is this a Holy Grail of sorts? Is science so different from students' home-based discourses that it cannot be done? I don't think so. I think the problems are less about the science and more about the implicit violence to learners in lower track.

Michael: In just this one paragraph, you raise what I consider to be a considerable number of issues. First, science educators have not, to a large extent, attended to all those other means of expressions that we use, including pitch, speech intensity, and rate of expression. In fact, we express ourselves through all of these forms, which in fact may be older from a phylogenetic perspective, than the expression through language, which we really need to think in terms of the production of sound that accompany what we do in particular settings.

Ken: My answer to Randy's question is no and yes. Teachers and learners have to start somewhere, presumably with what they know and can do . . .

Michael: This is really all we ever have to start with.

Ken: But what should be the focus? Traditionally the focus has been on canonical representations of science, usually arranged according to what some colleagues refer to as a teacher's pedagogical content knowledge.

Michael: While this makes perhaps sense from a subject matter perspective, it makes little sense from a learner perspective. This is just where the notion of solidarity, which you elaborate in the paper, is so important.

Ken: This research on pedagogical content knowledge suggests that an alternative focus might be on the success of interactions, paying careful attention to the entry points of learners and the extent to which active participation of all can be initiated and sustained.

Randy: I have long thought that the entry point to meaningful inquiry with children, especially those who have been alienated or have distanced

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themselves from school or science, is through understanding interactions that establish rapport, and invite students to introduce personally meaningful artifacts around which scientific discourse can be constructed. In this way, I think that Ken's cultural research here is an invaluable window into science and teaching—challenging the notion that the scientific canon comes first and we simply need to liven it up until we adequately motivate the unmotivated. Often the resistance or inability to see past content biases keeps teachers from reaching such children. There is emerging evidence that teachers abandon traditional views of science teaching more rapidly and adopt inquiry more readily when their introduction point to science is constituted by a focus on understanding children's interactions. Our challenge as teachers is first to find value in what students bring to the table and second to build upon it. However, as Ken can attest, this is far more difficult than it sounds when working with students with profound histories of school science failure.

Michael: This is why tinkering with this or that approach to teaching, teacher education, or curriculum does not, from my perspective, take us very far. The school as an institutional structure militates against certain students—those who are not White middle class—to be successful.

Ken: I agree, although it depends on what you mean by tinkering. If teachers and students work together they can accomplish a great deal, even within urban schools with their present inadequate resources. I adopt a both/and perspective. Changes should occur *both* inside *and* outside to support more appropriate curricula and achievements.

Randy: Ken, I am reminded of something you once wrote, where you argued leaving certain students out and teaching the interested ones in a separate corner of the class. If I recall correctly, a student/informer advised you this was an appropriate strategy given the constraints (Tobin, 2005). My point is, that it is a challenge to find value sometimes in the perspective of students who harbor enmity toward school authority figures and who have created a social system and hierarchy based upon the opposition to institutionalized learning. Yet, this is the real world for many urban teachers and we should be careful to qualify our claims.

Ken: When I speak of "aligning" cultures I expect urban teachers and youth to be adaptive to others and, in so doing, to produce new forms of appropriate culture. If this is to occur there will have to be shared commitments to factors such as goals, rules, roles and responsibilities for working toward successful interactions for enacting agreed to practices.

Michael: Let me change topic here and come to the second point I announced: In the opening paragraph, Randy talks about still being in the mode of situated cognition and bounded context, which I read as a complaint. If so, then I would have to say that we are always situated,

always concretizing possibilities in real, material and social settings. There is no other way of consciousness than in concrete contexts, which are therefore, in their very nature, always in *this* rather than *that* setting, and therefore situated. What our goal needs to be, however, is to deal with the diversity that we create and are subjected to when quite different people from different root cultures come together to engage in collective activity. At the national level and around the world, we have been successful to different degrees. I believe that Canadians are managing cultural diversity much more easily than other nations, which attempt to force everybody into the same straightjacket and thereby subject him or her to cultural violence—just consider the fact that girls and young women in France cannot wear the hijab at school, whereas in Canada, Punjabi students and police officers can wear their turbans at school or on duty. These garments are not just any clothing that human beings wear that could be replaced by something else: they are integral to who we are, aspire to be, how we behave, and so forth. Garments are central to our identity. Therefore, assuming that these are unimportant to learning is as silly and shortsighted as assuming that our past experiences or current experiences at home play no role in learning.

Randy: My interest in inserting context and cognition is not so much a complaint as explicated constraint. As a discipline it would appear that science education has many different examples of making successful connections between accepted scientific knowledge, teachers' pedagogy, and students' culture. The work coming out of TERC with Haitian children (Ballenger, 2005), Rodriguez and Kitchen's (2005) and Okhee Lee's work with Latina/Latino populations (Lee, 2004), and Ken's work in urban Black contexts, as reported in the article we discuss, all indicate there are ways to weave successful science teaching into a plethora of contexts. However, these remain disjunctive and disparate in the larger picture of theoretical frameworks, which is of course, why I assume you two are beginning a journal to carry out the vital talks necessary to bring such frameworks together.

Michael: It takes more than these activities; it takes more than critique, too. It takes a radical rethinking and change of practice so that students other than those from the middle class can succeed in a culture that is inherently biased against them. Solidarity as praxis also means that we do more than make others successful in *our* institutions; our institutions have to change in interactions with others and with our institutions the practices that produce and reproduce them.

Ken: Social life is inherently macroscopic in the sense that, at any given moment, many fields structure praxis. Individual and collective agency are dialectically interconnected with the structures to which we have access. Relating this to an urban science classroom, all participants can act in ways

that produce culture (i.e., reproduce and transform) that changes the structures, affording the cultural production of all others. Within any collection of fields participants can reproduce and transform culture, hence structures, and potentially alter the possibilities for social life. In our research we have already examples of students who have produced forms of culture that have enabled them to proceed to university and succeed. Unfortunately, we also have students whose cultural production appears to have reproduced their disadvantage.

Randy: As a discipline, I think we often are too silent when organizations, individuals, or local and national policies promote a single successful way to support or celebrate diversity in science classrooms. Building respect and honoring both teacher and student perspectives in a classroom is arduous work and should be treated with the careful scrutiny you Michael and Ken give to thinking, speaking, and acting in classrooms.

Ken: Respect for self and others is such an important facet of social life within any setting. When participants experience disrespect, their primary goals may shift from learning science to earning respect or getting even with those who have "dissed" them. Whether or not disrespect is intentional, especially among urban youth culture, those who are disrespected have lost something of value. One of the most frequent ways to disrespect urban youth is to prevent them from using their capital to support their learning. Teacher-produced shut downs, which take very many forms, often occur unconsciously, reflecting a lack of awareness about those aspects of youth culture that can serve as a basis for active participation. There seem to be two major referents that create problems—a need to establish and maintain control over students and a tendency to view students' capabilities through deficit lenses.

Michael: Science educators have not attended to the fact that we experience as persons, immersed in everyday life, always connected and embedded in our lifeworlds, where we navigate like fish in the water. We do not re-present the world, make decisions about next moves, and then implement them. Rather, when we walk we walk; we do not implement a decision to walk or place one foot in front of the other. When we eat, we eat; we do not implement the decision to eat or follow an internal command, "Chew, chew, chew ..." When we comment, "What a nice day," while speaking to a neighbor, we no more think about speaking and using language as we think about placing a foot or making our jaws chew. This other conception of being, the one I reject, is one of the human as robot who implements the command of the little homunculus sitting somewhere in the recess of our minds. Science education by and large is still wedded to the Cartesian image of being as the implementation of a rational thought, the *eidos* of being, independent of our bodies, or merely forced to live in some

body. And this leads us to the differences in cultural experiences, which science educators cannot explain if knowing is a matter of thinking rational thoughts. One cannot understand a different kind of being—always culturally and historically mediated—with a very different sense of the relation to others and the world.

Ken: Part of the issue of aligning the cultures of the teacher and learner is to realize that dispositions to enact culture in a science classroom are structured by a dynamic system of resources—structures that include each participant's history of participating in similar structural contexts. That is, as particular interactions occur, practices are anticipated and dispositions to interact in particular ways resonate, usually allowing an appropriate interaction to occur in a timely way. Much of what happens during interaction chains is unconscious and there is considerable merit in examining classroom interactions to see what contradictions have been experienced by participants—in some senses making the fish aware of some characteristics of the water in which they swim.

Randy: I wish to state for the sake of the reader that none of us is actually speaking about teachers, administrators, or researchers acting out of malevolence or ill intent. It is their resilient worldviews that continually filter the events they observe, interact with, and impact in their daily instructional surroundings. It is not unlike the teacher who believes that students need to learn English before they learn science concepts—continuing to administer written English, text-based instruction and assessment with complex science vocabulary to demonstrate that the children are not yet ready for science learning until their English mastery is improved. Such teachers believe that they really are acting on behalf of students but are not the advocates children really need, simply because they are unmindful of the context (water in which they swim).

Michael: Before we end this topic, let me articulate a fourth point that Randy raised in the beginning. It pertains to the question of whether everyone can navigate across the boundaries between their home culture and science. If you say that it can be done, you are making certain assumptions, which may be based on your implicit epistemology, grounded in knowing existing in the form of conceptions or language or some other form. If knowing is viewed in terms of participation, on the other hand, one might come to quite different conclusions. To take an analogy, you will not quickly jump to the conclusion that a blind person can or will participate in a Mount Everest expedition—not unless you radically rethink what it might mean to organize and realize an expedition to the top of the mountain. If you think culture as a form of being, including the way we relate to the world, perceive and articulate it, and if you accept that there are cultures other than the Western, White, middle-class based science, then you may

have to modify your ideas about the possibilities to do science in the way it is practiced or taught. There is also the question whether a student or person should be forced into a form of being—talking, thinking, doing—that is so very different from their everyday form of being that it constitutes a continual act of violence. In one of the studies that I conducted on the relationship of scientific and religious discourses, such experiences of daily violence between the home-based religious discourse and the school-based science discourses were salient (Roth and Alexander, 1997). One student in particular spoke of his experience as daily punches to his face, which were not just intellectual and intellectualized differences, but differences in the foundation of his identity.

Ken: In urban science classrooms, where teachers and students are assigned to teach and learn together as a class, the challenges are to create and sustain productive learning environments. As Michael suggests, we cannot expect all students to know all aspects of the teacher's culture or for a teacher to know all the details of the culture of each learner. Instead, what we require is a way to create a new culture based on successful interactions between *all* participants.

Michael: And that means we need new institutional resources to make such interactions possible, and we need to begin somewhere so that the all-too-common distrust and disrespect for the others can be overcome.

Ken: If this is to occur all participants will have to adapt their own capital too create successful interactions for all, minimize unsuccessful interactions, and create a bond by being with others in pursuit of a common set of goals. The creation of productive learning environments is not about cultural and social imperialism, but involves the production of new forms of culture that characterize this community, including forms of culture that allow for successful participation in a *culture of power* (Delpit, 1988). That is, all participants should learn to interact successfully in the mainstream, using their knowledge of science fluently to meet their goals in their lifeworlds, in which they may be racial and economic minorities.

DISENGAGEMENT, ALIENATION, AND IDENTITY

Randy: I am appreciative of Ken's characterization of teachers' responses as culturally adaptive and maladaptive interactions in that it doesn't assume that a teacher who is unsuccessful isn't doing anything relevant or invested in the students. Rather, Ken suggests it may feel to teachers as if they are trying their hardest, but their efforts are misaligned. I am convinced that a critical component of understanding the alignment of interactions resides in the tension Linda McNeil described as skepticism. In her book

Contradictions in Control McNeil (1986) argues that administrative and policy responses to students' skepticism in schools are "misaligned" or "maladapted" (mine and Ken's words) because they interpret these outward behaviors of resistance as the need for more control. In fact, such responses only help to define students' identity even more strongly as in the case of Fordham (1996) and the desire of children to not *"act White."* In this way discourses and student cultures are not simply defined from within but also from those interacting from the outside. We must consider the teachers' misaligned actions from the perspective of how their decisions to discipline and maintain order for the sake of learning plays into the larger student picture of alienation and identity as a part of their school experience.

Ken: For some years now I have collaborated with colleagues, including Michael, to develop cogenerative dialogues, as cultural fields in which teachers and students learn to collaborate to assume shared responsibility and develop complementary roles to support learning. Efforts by well-intentioned teachers to assert control over urban youth might lead directly to unsuccessful interactions, resistance, and dysfunctional learning environments. Conversely, collaboration can lead to participants learning about one another's culture, successful interactions, and a growing sense of belonging and contributing to productive learning environments.

Michael: These cogenerative dialogues, enacted with respect for the other, where all participants enact collective responsibility, and where a radical solidarity is practiced, have the potential to deal with some of the real problematic issues that plague our schools today. To better understand the problematic of learning in schools, we really need to take a step back.

Ken: These dialogues may be able to address the issues that I regard as a priority: teachers and students have to collaborate and learn how to successfully interact across boundaries that can be described in terms of factors such as class, race, gender and age.

Michael: To understand resistance—which I view as the objective, that is, object-centered counterpart to contradictions—we need take a cultural-historical look at the activity we are dealing with: schooling. And here, we have a precedent in the analysis Foucault (1979) provided of the role and function of schools to order students hierarchically, an order that can then be used to make decisions about access to limited resources such as a place at university or college, jobs, and so on. Michelle McGinn and I showed how grades and other rewards students can get if they function well within schools constitute forms of symbolic capital that can be converted into different forms of capital, including financial capital (Roth and McGinn, 1998). Of course, the whole process of gaining capital is slanted, because to do well in the culture of schooling, it helps when you bring substantial

amounts of cultural capital: because the culture of schooling is White, male, middle-class, those having been raised in such circumstances have accumulated much more than others and, inherently, succeed better than those with less of the most-valued form of capital as a quintessential case of "the rich get richer."

Ken: This pattern will only persist for as long as we allow schools to privilege what you refer to as White, middle class forms of capital. Our research points to something quite different in high poverty, inner-city schools. Through adaptive forms of teaching and learning, as I describe in my paper, I expect to see all learners producing forms of capital that will allow them to participate, succeed, and thereby make changes to mainstream society.

Randy: I agree that we need to have students producing forms of capital that allow them to participate in society. However, it is a substantive challenge to impact the societal structures into which engaged learners' products will be introduced. I recall engaging students in water quality studies to confirm or refute the hog farmers' responsibility for the *pfisteria* outbreaks in North Carolina and contributing to the knowledge that golf courses used by the wealthy were dumping more nitrates in the rivers than poor farmers. The golfers had better lawyers and more control over the media than poor hog farmers so the public view was that the problems were attributable to farming practices. There is a societal structure in which students can and should contribute to the scientific knowledge but this structure cannot always be easily changed. We cannot ignore the societal expectations set upon schools that they sift and sort students. Not only that, but when they sort students differently so that the privileged students continue to succeed, political pressures representing these privileged children arrive in the principal's or superintendent's office demanding explanations.

Michael: Eckert (1989) showed how the very forms of interacting with others led to the differentiation of students into different groups not only in school but out of school as well. Each of the two cultures—middle class, working class—reproduced itself in the very moment of being produced, leading to the fact that working class kids remained out of alignment with the middle class culture that you have to adopt to be successful. This middle class culture is not just a piece of clothing that you put on, but constitutes who a person is—including the way we produce and reproduce time and temporality, the ways in which we speak or do not speak, the way we walk and move about. Culture is not just a habit that we put on, or a building that we can walk in and out of, that is, a container: culture is constitutive of who we are, it is the plural part in the *singular plural* that I am. This has serious consequences for how we think about the transitions between home culture and school culture, and whether it is possible to adapt. My hunch

is that unless we open and reconfigure schools, collectively, involving all students and cultures, schools will simply be the means of oppression.

Ken: You present an interesting perspective that highlights some of the well-known studies of social reproduction. As is often the case with perspectives, they illuminate some aspects of social life while obscuring others. I accept your explanations and examples as compelling and somewhat reminiscent of a study I did with Gale Seiler and a student researcher, Ed Walls. In this study we highlighted the potential for urban schools to reproduce myriad forms of disadvantage and oppression (Tobin et al., 1999). As we have continued with our research in urban classes we have used different theoretical frames to assist us to understand how classroom environments can be understood within agency |structure and individual| collective dialectics . . .

Michael: an instance of which I just termed the *singular plural* . . .

Ken: I believe we have compelling examples of teachers and students in urban science classrooms expanding collective agency and producing learning environments in which science education can flourish. Carambo's (2005) description of students dissecting a frog's heart is one example of what can be accomplished and Olitsky's (2005) research identifies some pathways that can be followed to sustain solidarity and high levels of emotional energy in urban science classes.

Michael: You know that I am not just thinking about social reproduction, because reproduction is possible only through production. I can only have hope when the future is indeterminate, not if it is prefigured because of continual reproduction of social structure.

Ken: As is often the case, I do not believe that urban science education can be transformed solely by paying attention to structures within the science classroom, as if they were immune to macroscopic structures. Obviously, efforts of others to change macrostructures also will mediate social life for students inside and outside of classrooms. As indicated before, I prefer to adopt a both/and perspective in which the agency of all participants is interconnected with all structures, at every instant. Having acknowledged this, any individual can appropriate structures to meet her goals in the fields in which she is participating, and as she lives her life her possibilities for action are not predetermined by macrostructures, though they are mediated by them. Participants, acting individually and collectively can change structures, thereby changing the agency of all participants.

Michael: But we never just act because of *our* own intention; our actions are already and inherently social, or rather societally mediated. So we not only face macrostructures, but the unconscious operations that constitute our actions also are inherently sociocultural and cultural-historical in nature.

Ken: As we have written together, when culture is enacted, it is structured and structuring. If certain forms of enactment tend to reproduce disadvantage, participants from a classroom can identify them and, through cogenerative dialogues, the community can act together to eliminate them.

Randy: I wholly agree that the notion of restructuring schools independent of attending to ongoing social practices that exacerbate differences is misguided. You are aware of my accounts of overt racism in counseling and science instruction in the rural South and the social construction of differences in such contexts (Yerrick, in press). I think that the two of you offer successful accounts that all point to the challenge of bringing the right agents to the table and providing them the empowering resources (time, equipment, knowledge, pedagogy, insight) to make change on a grander scale.

ALLOWANCE FOR MULTIPLE EXPERTISE

Randy: I was encouraged to read that there is more than one model you present for survival in this context. It is good to balance the approaches with essential differences in pedagogy, history, and identity. All too often the report of teaching that is engaging reads as if, "You just do what this person did . . . and you will be successful." It is an important message that I walk away with after reading this article that should be stressed. Instead of good and bad, or successful and unsuccessful teaching, we really ought to be focusing on the outcomes of specific choices. When one sets out to teach in this way . . . it is informed by this set of goals . . . is biased for this kind of assessment . . . and will yield a certain kind of outcome. It is then incumbent upon all ethnographers, outsiders, teachers, and other experts wishing to apply the analysis, to decide if it is a good set of choices for the population I teach.

Ken: It strikes me as almost self evident that each person has to use the capital he has in order to enact the culture of teaching and thereby change structures within the class, and expand the opportunities for students to act and learn. To be a successful teacher, it is essential that teaching practices can be appropriated by learners and for this to be the case there will inevitably need to be adjustments that reflect at a collective level what others can do and need to do in order to meet their goals. Hence, the ideas of alignment that I address in the paper seem appropriate.

Michael: I think we need to go still further than balance and make allowances. We need to reconfigure schools, which, as I suggested earlier, are tools in and for the reproduction of middle class culture.

Ken: I am not advocating balancing and making allowances. I am advocating serious cultural brokerage whereby all participants learn about ways in which to successfully interact with others, to accomplish individual and collective goals. I am not suggesting this is all that needs to be done. What I do feel very strongly about is that for any class that is created, the teachers and students can achieve success. I should point out too that because of the porosity of the borders to fields, the class is not a closed field and structures associated with other fields, including human resources, can be a vital part of the solution to improved science education.

Randy: I think that your notion of cultural brokerage, which reminds me of Apple's "cultural capital," comes into sharp focus when we consider who is typically teaching in the contexts you (Ken) are speaking from. Typically teachers in these contexts are not the most trained, best supported, or even open to alternative strategies. Lower track classrooms, especially in diverse cultural contexts, are typically awarded to the most inexperienced and overloaded novice teachers, or teachers who have been involved in "schooling" (a Deweyian perspective here) so long that they already have a system in place to "deal with" unmotivated students. Neither of these appointments are ones that foster a teachers' shift in roles to understand and respond to students' needs. If change is to be made on a larger scale, other changes must be made as well so as not to reproduce reward systems and self-fulfilling prophecies teachers hold for children of color. For example, the department chair, who is likely the most experienced and knowledgeable about the content should not take the Advanced Placement Biology class for him or herself and farm out the "lower" classes to new or burned-out teachers based upon their position of power and authority in the school.

Michael: Even many or perhaps most of those teachers who have come from the generally excluded and oppressed cultures—African Americans in the US, Arabs in France, working class around the world—forget where they have come from and act White. They as their peers from White middle-class backgrounds then consider helping students to assist them succeed in their world, White middle class, rather than in changing the world. The discourses in educational journals show that allowing students to succeed always means making them change so that they fit the mold and succeed in the culture as it is rather than working collectively to change the status quo. Schools and the exploitation of people through capitalist forms of labor and markets are seldom questioned. Thus, allowing everyone to succeed is a dream, an ideal, which inherently cannot be realized. More than 30 years ago I read that in order for the markets to function, a structural unemployment rate of five percent is necessary; I think the number is much higher now. This means that we inherently need people without work, which means living in poverty—unless we change our culture and

make the collective responsible for allowing people without work to live decent lives. That is, schools are designed to shake certain students and individuals out of the system, to mark them so that they can become part of the structurally unemployed and unemployable. All talk about equal access, equal opportunities are smoke screens to cover very simple facts of capitalist markets: the need to have structural unemployment and the need to have people in low-paying jobs.

Ken: I choose to adopt a more optimistic stance. Even in New York City, where high school teachers feel highly constrained by a need to prepare students for success on the Regents' examinations it is possible to focus a curriculum on a plethora of markers of attainment and success.

Michael: I do not know what is optimistic about the fact that a considerable number of people *have to be out of work*—therefore be without earned income and depend on the state and welfare system—for capitalist markets to function. And a curriculum and the Regents' examinations already constitute societally mediated structures, the results of cultural-historical processes that favored the middle class. They constitute constraints rather than possibilities for students from particular race, class, or socio-economic backgrounds.

Ken: I am too much of a realist to imagine that science teachers could ignore Regents' examinations. My research on social class, race and science achievement highlights the folly of focusing too narrowly on achievements on high stakes tests and high school graduation. Even when students succeed they may earn what amounts to counterfeit currency when they are unable to use their knowledge to succeed at university or even gain admittance to higher education or get a good job. I advocate that interactions between the teacher and students which, in urban high schools, inevitably occur across boundaries of race, class and age focus on success and the building of solidarity. Within the framework of collective goals and associated curricula, changes in roles can be negotiated and enacted, possibly with transformative possibilities that expand the horizons for the social lives of all participants.

Randy: I do appreciate your optimism Ken and I hope that you continue to encourage me to rethink my own cynicism which dates back to a critical analysis in the 1970s (Bowles and Gintis, 1976) and to the Coleman report which argued schools "at best" make no difference at best for socioeconomic mobility for children of color and at worst assure the propagation for inequity. I think it is evident that high-stakes testing and the narrowing of the vision for science proficiency are heavily influenced by this history of inequity in school. I believe it may be something that will survive as a relic in future reforms that we will continue to operate at odds with; serving as a reason not to change for

many reticent powerful individuals (teachers) and collectives (publishers, ETS, policy makers). I only speak as a teacher/researcher working in specific classroom contexts where it is needed and I am getting weary because I have not done a more careful job of crafting larger reform within the school district to support broader views of science expertise. It has made me apprehensive and very careful with whom I link arms to make change.

THE SEARCH FOR CONTENT THAT IS INTRINSICALLY MOTIVATING

Randy: Much of the common talk about science teaching is making the content "exciting," "inviting," "hands-on/minds-on," and "engaging." These constructs (which fail miserably to explicate what is truly meant by their use) are often used in practical contexts, where teachers are asked to change or are trying to convey what they know to a common audience. These constructs *must be avoided* in any serious search for a resolution to the problem of bridging content, discourse, and culture. It is a major flaw and difference in the way organizations like NSTA and their publications treat the problem and publications like your own. Practitioners who have been in classrooms and have subjected themselves to trying to change a discourse in a lower track, cultural setting are keenly aware of their own efforts to make things more "engaging" or "interesting" and how students do not recognize the value of such efforts. I am reminded of dozens of my own examples but even of the paper Ken wrote about how he would use students in a corner for teaching until others were interested. He was told by his student to teach those who wanted to learn and leave the rest. Having to make such a difficult choice seems like abandonment to the teacher, but brings into light a more fine-grained look at the job it takes for transformation. I don't think that you, Ken, would recommend that all teachers do this, but bringing such real anecdotal struggles to the table to debate the appropriate application of our larger theoretical learning frameworks we apply helps better inform what we are up against with systemic school reform. It will make for far better progress than the pedantic recommendations of making science more "exciting." I suspect that Ken's notion of mesospheres of understanding social life will likely promote a useful lens through which to examine successful science reform in classrooms.

Ken: The example you chose of a student researcher advising me to teach those who want to be taught brings back a flood of emotions. I was teaching in the low track of the same high school involved in the present paper. At the time I was so unaware of the students' culture and

tended to treat and judge them according to my own White, middle-class culture. I did not do this consciously and made every effort to treat the students with dignity and respect. The problem was that I just did not know how to do it. When the student researcher made his comment I simply got it wrong. I figured out what he meant, but what I did was not at all close to what he had in mind. It is acceptable to make errors such as the ones I made in this instance as long as I am on the lookout for contradictions and how to resolve them. In this instance the student researcher was frustrated that I was spending way too much time dealing with students who "did not want to learn," making efforts to get them involved. Inadvertently, that struggle prevented me from spending enough time with the students who wanted to interact with me. The student researcher was offering advice with a collective goal of using the teacher resource productively to improve learning. His comment about students "coming to you when they want to learn" shows deep insights into agency and the desirability of allowing students to access and appropriate the structures as they unfold without monitoring performance and endeavoring to coerce particular forms of participation from all learners.

Randy: I was quite encouraged by your article and the attendance to the students' voices for informing appropriate pedagogy and it continues to demonstrate your consistency in forging new discussions for the discipline regarding the transformation of inequitable science learning contexts. All in all, I think that these kinds of discussions demonstrate that the most important and overlooked resource for lasting change in diverse contexts is the students' voices themselves.

Michael: I am glad you brought up the topic of motivation, about which my graduate students and I talked at length after our weekly research seminar. Motivation is one of those concepts that psychologists and educators claim to know but really are relics of a pre-scientific age, as the sociologists Pierre Bourdieu and Dorothy E. Smith might say; and it is a concept that is used as an instrument of oppression, as the analyses of critical psychologists in Germany showed (e.g., Holzkamp, 1993). It is one of those concepts that are recorded as datum, as empirically given facts "independent of the act of knowledge and the science that performs it" (Bourdieu, 1992, p. 236). Fundamentally, the concept is invoked to understand and to plan instruction such that students do on their own what *someone else* wants them to do. Students are said to be unmotivated when they do not do what someone else wants them to do; teachers or psychologists are then called in and called to work to come up with strategies to make students do what they do not inherently want to do but do what the teacher, school, or other institution wants them to do. At times, so the argument goes,

students do not know what is best for them, so instruments are required to make them do what someone else considers to be best. I have yet to see a person—student, worker, or anyone else—fail to engage in learning activity when they anticipate an increase in their room to maneuver at the end. There is a positive emotional valence associated with having more control over your life conditions, which comes with greater agency. Greater room to maneuver and therefore greater control over my life conditions means higher emotional valence, I am less subject to the conditions than I was before. I am therefore not surprised to see that anyone is "unmotivated" if there is no payoff from their activity in terms of expanded agency, possibility to act. Why would I engage in doing something if there is no payoff?

Ken: Your comments on motivation fit well with my experiences in the study I just described and also in this study in regards to Mirabelle. She had figured out how valence worked and wanted to put her ideas to the test—to give them a good shot. Victoria was more focused on getting it right and making sure that students learned what was right and not what was wrong . . .

Michael: . . . and it does not take much of doing so that students get turned off.

Ken: Even though the students figured it out for themselves there is often a preference to teach only canonical forms and privilege them over other ways of figuring out what is going on. In social life, is it more important to know how to figure out which elements have a valence of one, or two or three or is it more salient to know that sometimes theories will work well for limited data but fail when additional data are considered? I am certain I oversimplify by creating a dichotomy here and the case to know both can clearly be made. However, to make a point, in this study many of the students listened attentively to Mirabelle's model for valence and having considered it, recognized its limitations and could say that "it doesn't work for all of them."

Michael: Motivation therefore becomes a theoretical tool for thinking about how to subject people to conform to middle class culture and its values, and therefore to subject themselves to the values of the capitalist markets. Motivational psychology becomes an instrument of bourgeois power, of class, a means of reproducing schools, and therefore of reproducing social structure. Schools and teachers are not reluctant to use the most base of human needs as targets—there are only differences in degrees between candy, stars, stickers, and grades for rewarding particular performances and inherently distinguishing these from other ways of acting and engaging. The motivation concept and the practices it is used to legitimate and justify are

among the most insidious instruments of power and subjection I know of.

Ken: Underlying your dealing with motivation is the idea that coercion is often needed to elicit perceived-as-desirable practices. So, for me, I am curious about how to create learning environments in which coercion does not occur and that structures such as roles, goals and rules are negotiated between all participants in such a way that there is a shared responsibility for what happens and the resolution of contradictions that are identified through regular analyses of what is happening. If collective agreements can be arrived at then a focus on successful interactions could provide a means by which teachers and students can research learning environments with the goal of making it possible for individual and collective goals to be attained.

THE ENORMOUS CHALLENGE OF CHANGING TEACHERS' WORLDVIEWS

Randy: The vast majority of the struggles I have faced in my teaching at the university level and facilitation of grants for school reform is convincing grown-ups that what worked for them in school is hardly relevant to the population we may face in our classrooms today. I was reading about the "Net Generation" recently and reflected upon how far from the mark schools are from meeting the needs of students we deem as successful.

Michael: This point has been latent in what I have been saying earlier. Present and future teachers are caught in the middle-class, bourgeois ideology, of which they are unaware in much the same way as the proverbial fish is unaware of the water it swims in. This is the insidious part of schools, and the very mechanism by means of which an inequitable society built on the capitalist market and middle class culture reproduces itself. Those who were more successful themselves become teachers. And if any teacher once struggled to learn something, she tends to forget about it.

Ken: Teachers often bring an adult perspective to their teaching. If they remember their histories as youth, the images they bring back may not represent accurately what actually unfolded, but even if those representations were in some ways viable, they may fail to take account of the changed times. It is not just that culture is different across the boundaries of social class and race, but also that youth culture today is radically different than the youth culture of even five years ago. Randy's use of the term net generation is but one aspect of the profound reshaping of social life that has occurred in a digital age of cable, text messaging, and hypermedia. Learning to connect with youth culture, especially across the

boundaries of race, class and age are imperatives for effective science education.

EQUITY IN SCIENCE CLASSROOMS

Randy: How much more are we missing the mark with these children of your study? We need to find ways to dive in and expose teachers' espoused beliefs and actual practices if we are to break from the egocentric and self-serving notions of cultural deprivation of African American or Latino students. As Ladson-Billings (1999, p. 242) stated so eloquently, " We may want to believe that this different group of students requires some extraordinary type of teaching because if we do not believe it, it calls into question all the teaching we have endorsed heretofore. Suzanne Wilson wrote of these private spaces teachers hold as if they were private gardens—ones that are nurtured and protected and sheltered from effects of the outside world. My question is, "How can we change the private notions of teaching in ways that promote equity in science classrooms?" Until we can do this, I think our progress will be slow and perhaps only one classroom at a time for those invested in advocating for under-represented students.

Ken: At the heart of equity issues is affording agency by ensuring that the structures of a science classroom facilitate all participants to use their capital to meet their goals and in so doing contribute to collective goals. As social life unfolds, for example, in a science classroom, culture is enacted in patterns that have coherence and at times are contradictions to those patterns. Much of what happens in a classroom happens at a level of unconsciousness. Hence it seems central that participants from a classroom meet to identify the patterns that are desirable and worth retaining, patterns that are deleterious to the learning of some or all, and contradictions that either should be deleted or strengthened so that they become patterns. If this is to occur the participants from a class may need to do more than talk about their recollections of what happened. Perhaps they should use the tools I used in this study and undertake similar analyses so that patterns and contradictions can be presented along with evidence in chosen vignettes and transcripts, selected from digital video taken in the class. I am advocating an expansion of the roles of teachers and students to include researching and teacher education.

Michael: But I do not have much hope that the notion of equity will get us any further, as long as curricula are preset and as long as students such as Mirabelle or Gavin have to accept the goals and standards someone else sets for them. Equity, for me, also means that the students frame what they need to expand their room to maneuver, their possibilities of acting; and to

do so, they need to have a say at the stage of setting the goals for what is to be done, and what needs to be learned to reach the goals.

Ken: I am not basing an argument on equity. I do not argue that Mirabelle should leave chemistry with flawed understandings or that she should leave with only her street ways of argument. My argument is that learning environments should afford her uses of the capital she has, such that she can produce, that is reproduce canonical forms and transform them to benefit her in meeting her goals. I do not essentialize her goals either, advocating negotiation and agreement around the goals for a class, so that, over time students' interests and values are constituted in enacted curricula along with those of the teacher and stakeholders from the school, school district, state and nation. Participation and collective action is at the essence of what I consider to be necessary changes in urban schools. Productive curricula will not be enacted for as long as the conventional wisdom is to define effective teaching in terms of establishing and maintaining control over students and holding individual teachers accountable for successful teaching. Two things are very clear—no teacher will successfully establish and maintain control over the youth I have taught in urban schools and no teacher could claim to be successful in teaching science in an urban school without the students acknowledging the right for this person to act as their science teacher. Effective teaching is a collective activity.

Randy Yerrick is a professor of science education at San Diego State University. After leaving the field of chemistry he entered education and earned is Ph.D. from Michigan State University in 1993. The focus of his research has been intervention ethnographies of enacting science education reform, specifically targeting underachieving students and lower track classrooms. Since his selection as an Apple Distinguished Educator much of his work has focused on the preparation of teachers entering diverse sociocultural contexts and the role technology can play in promoting equitable science learning contexts.

Wolff-Michael Roth is Lansdowne Professor of Applied Cognitive Science at the University of Victoria. His research focuses on knowing and learning science and mathematics across the lifespan and from kindergarten to professional practice. His recent publications include *Toward an Anthropology of Graphing: Semiotic and Activity Theoretical Perspectives* (Kluwer, 2003), *Talking Science: Language and Learning in ScienceLaboratories* (Rowman and Littlefield, 2005), *Doing Qualitative Research: Praxis of Method* (SensePublishers, 2005), and, with A. C. Barton, *Rethinking Scientific Literacy* (Routledge, 2004).

Kenneth Tobin is Presidential Professor of Urban Education at the Graduate Center of City College. In 2004 Tobin was recognized by the National Science Foundation as a *Distinguished Teaching Scholar* and by the Association for the Education of Teachers of Science as *Outstanding Science Teacher Educator of the Year.* Prior to commencing a career as a teacher educator, Tobin taught high school science and mathematics in Australia and was involved in curriculum design. His research interests are focused on the teaching and learning of science in urban schools, which involve mainly African American students living in conditions of poverty. A parallel program of research focuses on coteaching as a way of learning to teach in urban high schools. Recently Tobin completed an edited volume on urban science education (with Rowhea Elmesky and Gale Seiler) and another on coteaching (with Wolff-Michael Roth). In 2002 Tobin's book with Wolff-Michael Roth, *At the Elbows of Another: Learning*

to Teach through Coteaching, received the Choice award in the category of *Outstanding Academic Titles.*

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RANDY YERRICK
San Diego State University
E-mail: ryerrick@mail.sdsu.edu
Tel.: +1 (619) 594-4753

WOLFF-MICHAEL ROTH
University of Victoria
E-mail: mroth@uvic.ca
Tel.: +1 (250) 721-7885

KENNETH TOBIN
The Graduate Center of the City University of New York
E-mail: ktobin@gc.cuny.edu
Tel.: +1 (212) 817-8284