

COLLABORATING WITH STUDENTS TO PRODUCE SUCCESS IN SCIENCE

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A tenet that appears to be accepted throughout the world is that effective teachers establish and maintain control over their students. This is an assertion that I challenge and deconstruct. In fact, for many teachers their well-intentioned efforts to establish and maintain control over students lead to their demise as teachers and for many more students, it opens pathways to failure. Emphasising control over rather than collaboration with is, simply put; a bad idea, and those in authority who offer control over as a recipe for success are giving bad advice. Furthermore, systems that build policies around hiring and rewarding teachers based on control over students may be producing forms of teaching and learning that reproduce failure and equity concerns based on categories such as ethnicity and native language. Categories like these are often referred to as meso structures and they are resources for agency within a field. However, structures do not determine culture and it is important not to stereotype based on any of these categories. For example, youth culture differs significantly from the culture of older educators, males and females have different cultural resources, and ethnicity and language often produce opportunities to create different forms of culture.

In this paper I propose collaboration with as a referent for producing effective forms of teaching and learning. However, as is the case with many one-liners and short phrases, there is much more to creating and sustaining productive learning environments than collaborating with others. To be glib, collaboration is a necessary but insufficient condition for effective learning and teaching.

Keywords: collaboration; cogenerative dialogues; student roles; urban youth; equity; sociocultural theory.

Teaching as Control Over?

In the literature emanating from the United States I sometimes come across the idea “Don’t smile until Christmas” (Ryan, 1970). What is meant by this advice is to establish distance between the teacher and student so that the teacher can claim the power that goes with the status of being a teacher. The rationale is that students will not have the social capital to negotiate with the teacher, who then can apply rules fairly and consistently and discipline students who infringe in some way. Being close to students before the teacher has established the power to enforce the rules is seen as a source of difficulty—hence, the advice of don’t get too friendly with students.

Good Teachers Control Their Students

What does it mean to have good control? When I began teaching in the early 1960s, to have good control meant that a teacher could leave his classroom and the noise level would not change from the absolute quiet or working buzz that was in effect when the teacher was present. The noise level never was excessive, even when there were moments of laughter or excitement when something of note occurred. It was not a case of an imposed silence as much as agreed-to values for learning environments in which distractions were minimised and the rights of others to learn were respected.

I began to teach in a small junior high school in rural Australia in 1964. As a 19 year old I was only a few years older than some of the students I taught. I am certain that I made many errors in my quest to establish and maintain effective learning environments, and yet I was regarded as an effective teacher with good control. In the classes I taught, I sometimes had to teach mixed grade levels (8-10) and occasionally, I taught science to one part of the class and mathematics to another. Hence, it was essential for all participants to learn to focus and work collaboratively in ways that did not disrupt others.

As I think critically on my two years in the rural school I am certain that one reason for my relative success was my understanding of youth culture, my willingness to coach sports teams at the school and in the town, and my efforts to build relationships in the local community through my participation in sports and other events. Although my science expertise was limited, I was fiercely determined that my students would learn and succeed on external examinations taken by tenth graders. I created a sufficient amount of symbolic and social capital to allow for steady production of capital in the classes I taught and the emergence of solidarity built around a shared work ethic.

When I moved to a high school in the suburbs of a large city I was regarded as a good teacher who could control his students. I was intrigued by the principal who would do a surveillance of the school throughout the day, eavesdropping at the windows and closed doors, judging the effectiveness of teaching from the noise inside. He maintained that he could discern a disruptive class from a productive working buzz—and I agree with him. However, the problem is not so much discerning the difference but in advising teachers with disruptive classes on what to do to create productive learning environments. Often the advice given reflects theories used to think about learning. How is a productive working environment established and maintained? I reject the premise that productive learning environments are created and sustained by a teacher establishing control over the students. In this paper I present theory and research associated with collaborating with students in endeavors to afford learning. In providing theoretical insights into alternatives for controlling students I explore what *collaborating with* means. In so doing I consider ways in which learning occurs by being-with others with a shared purpose. Also, I examine the possibility that researchers mistake *control over* with *receptivity to learn from*. How might teachers create situations in which their students are receptive to learning from them? My efforts to answer

this question accord with Wolff-Michael Roth's (2007) admonition that science educators have ignored the salience of radical passivity and, consequently, Emmanuel Lévinas's theoretical work on passivity, alterity and transcendence (Lévinas, 1999).

Early Experiences Set the Stage

Looking back on my life it seems as if I was successful in part because my family was upwardly mobile from the working class to the middle class and I was a white male. To emphasise the gender point—my father spoke to me about becoming an engineer or a scientist from about eight years of age onwards. He actively raised the possibility of accomplishing this goal by first becoming a teacher. In contrast, my three sisters were advised to pass junior high school and then seek a good job in a bank. Notably, throughout our schooling and into the workplace, each of us followed paths that aligned with his suggestions.

My ethnicity also was important in affording success, though I was unaware of white privilege at the time and it is only when I look back with a critical gaze that it now is visible to me. In my first appointment to teach in a rural school many of the students I taught were Australian aboriginal. I am ashamed to admit more than 40 years afterwards that I did not create close social bonds with many of these students, mainly because I did not understand their culture. For example, by growing up in a white, middle class home I learned to hold eye contact when being spoken to and to squeeze firmly with the hand and especially the thumb while shaking hands. In my lifeworld I had learned that to not look a person in the eye was to communicate you had something to hide and probably were not trustworthy. Also, to have a limp handshake was to imply that you were not reliable and could not be trusted. Most Aboriginal youth in my class avoided my gaze when I spoke to them and they had limp handshakes—hence, unconsciously I inscribed their identities as untrustworthy and not to be trusted! Notably, the Aboriginal

students with whom I created strong social bonds were those who participated in the sports teams I coached. With them the social bonds transferred over to the class and they did well in mathematics and science. In contrast, with the others my practices were focused on getting them to conform with the roles and practices of most students and overcoming deficits. I had little understanding of how their strengths could provide a foundation for learning science and mathematics. Accordingly, most of the Aboriginal students struggled to succeed and did not achieve as well as students from the white majority.

Teaching in a Strange Place

When I undertook my research as a teacher researcher at City High, a school in inner-city Philadelphia, I realised that the students would not allow me to establish control over them. I could not understand African American culture and my efforts to create productive learning environments frequently were unsuccessful (Tobin, 2000). The journey to success took time and presence—being with the students, especially coteaching with other teachers allowed me to create forms of culture that afforded successful encounters. Arising from success were positive emotions, social bonds with some of the students, and forms of symbolic capital produced from students getting to know me, and noticing that my primary goals were to help them learn. The production of social and symbolic capital set the stage for the production of cultural capital.

Once I realised the futility of trying to establish control over the students my goal shifted towards finding ways to successfully collaborate with them. As it happened, our work with students, on finding out from them *how to better teach kids like me*, led to the inclusion of students as researchers in most of our research designs and then to the development of cogenerative dialogues (hereafter referred to as cogens) in the teacher education programme. Later in

this paper I describe how cogens evolved in our efforts to improve the quality of teaching and learning in urban schools.

Perspectives on Teaching and Learning

This section contains six subsections in which I lay out a sociocultural framework I employ in my scholarship on learning to teach and teaching and learning science. Many constructs I use in this paper may be unfamiliar to readers and may even seem like jargon. It is not my intention to obscure what I mean. I regard specialised language as a tool for making sense of social life, illuminating patterns and contradictions, raising questions, and offering answers to them. As best I can, I explain the meanings of constructs as they appear in the paper. In addition, I provide a glossary of key terms in Appendix A.

Fields of Cultural Production

I adopt a view of social life in which culture is enacted in fields, which are structured sites that afford the conduct of social life. Agency, the power to conduct social life as intended, is dialectically related to structures—which are a dynamic flux of resources associated with a field. Space and time are part of structure, but like all structures can change. Activity and collective motives characterise fields, which are constantly being reproduced and transformed as culture is produced in a series of singularities, each never-to-be repeated. Like an electric field, there is no boundary around a social field, though a dynamic flux of structures affords characteristic forms of production, but not in a deterministic way. Because there are no boundaries, culture produced in another field can be enacted, thereby changing the structures and the potential for conducting social life. When a person enters a field she¹ accesses and appropriates structures to produce culture to meet her

¹ To avoid cumbersome constructions I use the female form for all pronouns throughout this paper. Hence, she stands for she or he, her stands for her or him etc.

individual goals and those of the collective. Some scholars, like my colleague Anna Stetsenko (in press), view identity as activity, involving actions in a field, and collaboration with others to accomplish individual goals and group motives.

Later in the paper I examine cogens as a field. Here I address an interesting aspect of fields through an example involving cogens. What defines cogens as a field is the activity of the cogen. For example, three students from Gillian Bayne's biology class in a school in New York City meet with their teacher in cogens in which the motive is to create structures to improve the quality of learning biology (Bayne, 2007). After an initial meeting the group decides to enact a buddy system when the class next meets.

After leaving the meeting each student continues to think about the thought objects created during the meeting and especially the different ways the buddy system could be put into effect. Even though participants from the cogen have gone their separate ways, those who continue to think about the meeting and try to make progress towards the attainment of the motives, are participating in the field. The culture being enacted, even though individuals are not with the others, is still germane to the activity and is an example of a field having no boundaries. The potential for action varies within a field, depending on place and time, and other structures such as who is present and what they do. Hence, an individual thinking about possibilities is still socially connected with others through what has been done in the past and the potential for what can be accomplished in the future when others are present. Also, because fields are nested, a person participating in the cogen field through inner actions can, in the outer-world, seamlessly enact culture initially produced in cogens. As a student enters her home she might still be participating in the cogen field, appearing "pre-occupied" to her family members who are pursuing other "home" activities. If the student engages family members about some of the contradictions she has attempted to solve in the cogen she may enact

culture from the cogen in the home field. Hence, culture produced in cogens is reproduced and transformed in another field and changes the potential for what can be done in that field as the structural flux affords actions.

Dialectical Relationships

I regard constructs as dialectically interrelated, not as independent or as dichotomous choice points. There are several ways I think about dialectical relationships. If A and B are patterns applicable to social life in a field, a dialectical relationship can make sense in terms of recursion; a continuous flow from A to B and back to A. In our work in cultural sociology we soon came to realise that for any assertions there would be contradictions, not due to measurement error, but because in social life there always are enactments that do not conform to patterns of (thin) coherence. Often these contradictions are cultural resistance to norms or transformative culture that reflect the practices of newcomers. That is, when considering a dialectical relationship between A and B there are patterns to support A, patterns to support B, and patterns that support neither A nor B. Within the theoretical framework I have used in my research on teaching and learning to teach I explore many seeming dualisms in terms of dialectics. An example is the agency | structure² relationship, which I regard as central to our work (metaphorically described as Newton's second law). Agency and structure presuppose each other and coexist, meaning that without structure there can be no agency and without agency there can be no structure. The dialectical relationship between reproduction and transformation, which defines production, is best thought of as the parts constituting an inseparable whole, that is, a both/and relationship. In any act of production, both reproduction and transformation are involved. Finally, there is the example of

² Consistent with research undertaken within our research squad and by colleagues such as Wolff-Michael Roth (e.g., Roth, Hwang, Lee, & Goulart, 2005), I use a vertical stroke (|) to denote a dialectical relationship between the constructs shown on either side of it.

opposites. If it can be argued that there is a trend towards A, then radical doubt suggests I consider that the trend might also be towards B, and a possibility of the trend being towards both A and B. Hence, a dialectical relationship can be considered as a “both/and” kind of an arrangement between entities otherwise thought to be in an “either/or” relationship. Roth (2007) identified agency and passivity as opposites being dialectically related. Later in this section I discuss the agency | passivity relationship in a context of teaching and learning.

Learning as Cultural Production

I view learning as cultural production, theorising that culture comprises practices and schema in a dialectical relationship, in which each construct presupposes the existence of the other (Sewell, 1992). What the relationship means is that in making an argument about schema and /or practice neither can be considered as coming first, or at any time existing without the presence of the other. Culture is experienced as patterns, which have thin coherence, and contradictions to those patterns.

Alfred Schutz (1967) spoke about stocks of knowledge at hand to support action. What is at hand reflects many factors including the structures of the field and the capital an individual has produced in the past. Structural resonances can occur, bringing to hand a particular supply of capital to be enacted within the dynamic structure that is the field of production. Bourdieu refers to a similar situation as habitus, dispositions to act in particular ways in a particular arrangement of structures. As Bourdieu noted, and Roth and I reiterated (Roth & Tobin, 2002), habitus is structured and structuring—structured because of the resonance which brings to the fore (or to hand) particular dispositions to act, and structuring because enactment is production; always reproductive and transformative, supplying all participants with a stream of resources for action.

In regards to teaching, what has been learned about teaching “comes to hand” depending on the structures available at the moment at which an operation is enacted. Roth has referred to *Spielraum* and we have used cultural fluency for much the same idea when, at a given time, knowledge is enacted that is appropriate, anticipatory, and timely. Hence, as Bourdieu says of habitus, to be fluent a person needs to have a sense of the game—to have done something similar before. For example, during student teaching, the idea is to gain experience at teaching so that the stocks of knowledge needed to teach well are to hand as they are needed. Teaching is responsive in that a teacher appropriates structures that are continually emerging and anticipatory in the extent to which prior experience allows her to know “intuitively” what students are likely to do at any given time as the lesson unfolds. Hence, teaching is not a case of reflecting in action and in some conscious way deciding to do this rather than that. Such an approach to teaching would hardly be timely and is not at all like habitus, which is enacted without conscious awareness. As Bourdieu explained, habitus reveals itself in its breakdown—a lesson I was to learn at first hand when I undertook research on my own learning to teach in an urban high school (Tobin, 2000).

My habitus was in radical breakdown as I taught at City High. All the students in the class were African American and as a white teacher who had just taken over the class from its regular teacher, I looked dazed, bewildered, slow, and unsure of what to do next. My deliberate and consciously enacted practices were reactionary to a class that was unlike any I had ever taught. I had little relevant experience to call on and most of my efforts to teach were shut down, ineffective in a stream of culture that simply swept over me. I was conscious of parts of my ongoing action over which I had no control. I was angry, sad, confused and afraid. My emotions were a turbulent flux that merged simultaneously with my actions that oriented towards teaching chemistry. A great deal more occurred too as I

moved around the class monitoring what students were doing. However, much of my conduct was beyond my awareness and revealed itself to me in my analyses of the videotape.

I struggled with my teaching, trying this and trying that. I changed my approaches to curriculum, including labs and topics focused on students' interests. Also I obtained texts and manipulatives to support learning. However, what I lacked was a suitable habitus for teaching fluently to successfully interact and transact with these youth. I would not become an effective teacher in this urban setting until I developed new ways of teaching, mainly by coteaching with a youthful resident teacher and being-with urban youth in class for a longer period of time, in peer teaching activities, and as they undertook activities associated with curriculum development, research, and teacher education (Elmesky & Tobin, 2005).

Agency, Passivity and Action

What is it that characterises good teaching? I am sure there are as many answers to the question as there are learners. I know what I think good teaching is and I will address that soon enough. What seems imperative is to look at this first from the perspective of a learner. What do I consider to be most salient about a good learning environment? For me, that is easy, I want to have a turn at orienting my action. What I mean by that is I need time to relate what is happening in class to my goals and those of the collective. Time is needed to make sense of what is happening and to act in ways that produce appropriate learning. The action may be internal or it may be external, but what is important is that it is intentional and goal oriented and I am in control of it. However, it cannot be like that entirely because of a paradox that I cannot orientate towards what I do not know. The role of the teacher is to orient me in a fruitful direction so that my actions align with the motives of the activity. In an important sense I do not know what it is I am to learn, even if

I almost know what it is I am to learn, and nor do I know exactly what others in the class will do, even if I can anticipate what is to come and I am not taken by surprise when it happens.

Others are transcendent to me (i.e., unknowable) and their actions constitute an unfolding tide of structures that I experience passively and react to without having full control (Lévinas, 1999). What this means is that I act in ways of which I am aware and over which I do not have direct control. Suppose a teacher explains why the full moon on the horizon is huge and deep red in color as it rises. Since I do not know what the teacher will say by way of explanation and do not know either of these facts about the moon, what is going to happen is unknowable until it happens (to me and to my teacher). Hence, during this class, which I refer to here as an ideal learning environment, my actions are both intended and unintended. I am partly in control and partly not in control over my actions. Given the ever-presence and transcendence of others, I will never have full control over my actions. Accepting this social fact I insist that I need time to inspect the culture I have reproduced and transformed as the lesson unfolds. Time outs are needed for the creation of thought objects and critical inspection of them should occur to ensure that I test the viability of the produced culture.

Having a share of the control over my personal conduct is an important criterion as far as having a productive learning environment is concerned. At the same time it is necessary to relinquish control so that others can afford the learning of something new. Having control and not having control presuppose one another and is a consequence of the agency | passivity relationship. Hence an effective teacher might ensure that a learner has control over those actions she can control and use her agency to produce the intended culture (i.e., teaching), continuously unfolding like a tidal wave, affording reactions over which the learner has no control while providing resources for agentic actions.

Capital, Teaching and Learning

Theorising learning as cultural production enables me to think about teaching through sociological lenses. With some caveats delineated below, I adhere to a theory in which a production spiral allows for the reproduction and transformation of teaching, which I regard as cultural capital (Bourdieu, 1986). I assume any teacher would have knowledge of how to teach, since all have experienced teaching in the home, at school, and myriad contexts. Furthermore, in those same contexts people are constantly involved in teaching others as they go about their social lives. Involved in the production of teaching are other forms of cultural capital and capital involved in creating status and social bonds with others. Production involves encounters, which consist of one or more interaction chains during which transactions produce capital in its various forms. The relationship between interaction and transaction is dialectical, each construct presupposing the presence of the other. Analytically, an interaction can be regarded as the appropriation of resources as social bonds connect to social artifacts. A transaction involves production of capital during chains of interaction (Appendix B contains a classification system for researching encounters). The capital produced also is holistic and it is an analytical convenience to separate capital into forms referred to as cultural, social and symbolic. As capital is produced during encounters it is simultaneously reproduced and transformed (i.e., reproduction | transformation).

Cultural capital includes all that a person knows, can do, values and is disposed to do. It extends way beyond preferences for food and high culture such as going to the ballet, music, museums, and art galleries. Everybody has culture and, as social life is lived, a participant (i.e., a person) acts in the world by producing culture during a series of singularities, which I call praxis. In Jean-Luc Nancy's terms, praxis is singular plural (Nancy, 2000). Hence, cultural capital is more than what a person believes and imagines and includes how a person feels (i.e., including attitudes, interests

and emotions), and what she does throughout her lifeworld. What is learned through life at home is cultural capital, as is what is learned in the streets, sports' clubs, church, shopping mall, museum, and school. Cultural capital includes what is learned intentionally and unintentionally and also what is learned that is beyond an individual's conscious awareness. Of central importance to my scholarship is that teaching and learning are cultural capital.

As teaching is enacted in a field, encounters occur among participants as each pursues her goals, which are dialectically interconnected with the class's motives. When encounters are successful positive emotional energy is produced, providing incentives to continue with further encounters. Successful encounters are associated with fluent enactment of culture in that each participant in an encounter anticipates the praxis of the other and enacts culture that is appropriate and anticipatory. In a reciprocal way, others involved in the successful encounter do likewise, in a timely manner that shows up as synchrony. As each encounter succeeds there is widespread synchrony among participants and anticipation of what is to come next. Such conditions are analogous to a physical system being in resonant conditions—referred to here as entrainment. Hence pervasive synchrony, or entrainment, is associated with widespread success and a build up of positive emotional energy. The conditions necessary for entrainment and rising positive emotional energy are for participants in a field to be proximate so that they can create the necessary synchronies of action, establish a mutual focus on salient structures (notably one another's practices), and experience the build up of positive emotional energy to the degree that collective effervescence is likely. When successful encounters occur continuously, participants can create identity markers of affiliation with the group and the subject matter being studied. Artifacts associated with the activity then can become imbued with positive emotions—hence thinking about group members can produce

positive emotions as can thinking about the subject matter dealt with by the group. One way to consider this is that success breeds success. If a teacher can be involved with the creation of chains of successful encounters then rituals can occur with which participants can associate positive emotions, just by thinking back on the activity (Collins, 2004).

Emotions are part of the cultural capital produced during encounters, which may not always align with individual and collective goals, in which case, negative emotions can arise—such as disappointment and frustration. Negative emotions might disincline participants from getting involved and instead of affiliation, a sense of alienation might accumulate. A search for patterns during sequences of encounter might reveal asynchrony, resistance, and shutdowns—where one or more participants intentionally seek to prevent others from attaining their goals.

To attain the entrainment needed for success it is clear that teacher and students need to have a division of labor and shared motives or else the necessary flow will not occur. That is, it is more than the teacher who must enact culture fluently if entrainment is to occur. The implication is that entrainment necessitates a degree of solidarity and that even more solidarity emanates from entrainment, success, and positive emotional energy. The production of solidarity involves social networks, symbolism of belonging, and emotions associated with membership. In order to produce solidarity, participants in a field enact culture together in ways that are synchronous and when asynchronies occur, repairs are enacted to allow for a resumption of flow. As participants produce success culture is embodied and it can “come to hand” at a later time when the structures afford dispositions to re-enact it (i.e., as it is reproduced | transformed).

Fluency implies learning from being-with-others in this field and the continuous production of social, symbolic, and cultural capital.

Hence, successful teaching is a collaborative activity and is not usefully thought of in terms of dichotomies such as teachers having sole responsibility for teaching when the relationship between a collective and the constituent individuals necessarily requires shared responsibility for fluent enactment of culture during encounters. Thus, a key part of learning to teach is to create social networks among participants, initiate and sustain successful encounters, establish entrainment, and produce significant amounts of positive emotional energy. Social bonds afford encounters within a field. Networks that connect all participants and artifacts in a field define access and circulation. When access is widespread and strong then circulation can be pervasive and encounters can be successful not only for the individuals, but also the collective. It is important to mention here that I regard all individuals as dialectically interconnected with the collective, and each presupposes the other (i.e., individual | collective). This implies that no individual can act independently of the collective and individual actions become material resources that structure collective agency.

Asynchrony can occur when individuals have goals that do not align with the collective's motives. In such cases there may be competition for the appropriation of resources and one or more person's actions may not afford fluent enactment of others. Such circumstances may be experienced as lack of mutual focus and may be characterised as dysfunctional for learning. If individuals do not have the cultural capital needed to appropriate others' unfolding practices there will be breaks in flow and special efforts will be needed to get everybody involved and in synch. In our research we categorise repair rituals as interaction | transaction chains that can be initiated by students or the teacher. In the heterogeneous groups we establish to participate in cogens, breakdowns followed by repairs are frequent occurrences. Avoiding breaches is more desirable than enacting repairs and a goal is for all participants to produce interstitial forms of culture that can allow for successful

encounters. The production of interstitial culture is at the heart of successful cogens—forms of culture that are new for those involved and allow for progress towards individual goals and collective motives.

Especially in urban settings, but probably in all facets of social life, respect is a central requisite for participants working together to meet their goals. My research on learning to teach in urban high schools shows clearly that teachers must show their respect for students and be respected by them. If there is lack of respect, encounters may be unsuccessful and generate negative emotional energy and asynchrony. Hence, an absence of respect may shut down opportunities for teachers to produce forms of teaching regarded by others as successful. On the other hand, if mutual respect is shown there is a greater likelihood of successful encounters occurring, synchrony being evident in the actions of participants, leading to entrainment and mutual focus (Collins, 2004). In such cases the generation of positive emotional energy may produce collective effervescence (e.g., spontaneous applause). Importantly, success and associated positive emotions can imbue a series of successful encounters with signs of enjoyment associated with the sequence of encounters and sense of affiliation among participants. The affiliation, or sense of belonging to, is a form of symbolic capital associated with identity. Participation and success in a class can produce changes in identity that are conducive to an individual's participation in the future and success-oriented goals. Finally, accepting a teacher as "my teacher" is an important step in opening up to learning from this teacher and by being-with this teacher in class.

Cosmopolitanism Based on Difference

Since Aristotle, scholars have thought about cosmopolitanism in relation to the creation of states and cities. A common approach is to build solidarity based on sameness and to exclude those who do

not fit. For the most part educators have adopted similar ways of dealing with difference in schools and classes. Mainstream forms of culture are expected and individuals are required to conform. Those who do not conform are pushed out—marginalized and failed.

Derrida (2006) considered the plight of refugees and their acceptance and rejection by the cities of France. Derrida expanded on Kant's principles of respecting human rights not only for citizens, but also for foreigners and recognising that all individuals have rights as citizens of the earth (Kant, 1991). Derrida advocated cosmopolitanism within cities of refuge, in which refugees had the right to live, not just to visit. These ideas are compelling when they are applied to the diverse classes that turn up to learn science in New York City. These students, irrespective of their differences from the teacher and one another, have a right, not just to turn up, but also to reap the benefits of science education. It is a civic duty of all participants belonging to the cosmopolitan class to act in ways to promote the learning of others, and to retain their individuality as they learn, albeit in ways that promote the motives of the class. Appiah (2006) describes the emergence of a moral solidarity built around difference. If solidarity is to occur, that is if affiliation with a group is to be produced, then it is essential that individuals acknowledge others' rights to be different. Also, there must be willingness to pursue collective motives and work out a division of labor that allows this to happen. This implies that cosmopolitanism assumes that individuals are: willing to produce interstitial culture and are receptive to breaches arising from others' practices they are unable to appropriate. Accepting such contradictions as normal and potentially fruitful might be salient to the production of science fluency. More than understanding others' culture is needed to produce cosmopolitanism. The challenge is to use difference as a resource for building solidarity through interstitial culture that supports science learning for an entire class. Successfully building

the interstitial culture needed to produce successful encounters is the central mission. The end game is not to produce sameness from difference, but togetherness and collective will to succeed in attaining agreed to motives.

Expanding the Roles of Learners

Teachers as Learners

As a science teacher educator I had a strong interest in learning to teach, and regarded teachers doing research in their own classes as an essential part of being a professional teacher. My perspectives had been informed by and were aligned with Stenhouse (1975) who advocated that teachers study their own classes:

The ideal is that the curricular specification should feed a teacher's personal research and development programme through which he is progressively increasing his understanding of his own work and hence bettering his teaching. ... It is not enough that teacher's work should be studied: they need to study it themselves. (p. 143)

When I first learned about doing interpretive research (Erickson, 1986) I embraced its hermeneutic-phenomenological foundations and endeavored to learn how participants made sense of their social lives in the research fields. Applying this principle to teacher researchers, an important feature of designing ongoing research would be to learn about what is happening and why it is happening from the perspectives of students. Hence, without reservation I accepted Frederick Erickson's suggestion to have each new teacher³ select two students from each of her classes to assist in answering the question: "How can I better teach kids like you?" Quite likely the goal of this activity, when we set out in 1997, was to obtain and

³ I use new teacher instead of student teacher, intern and teacher in training. New teacher captures the roles usually enacted during teaching experiences where learning to teach is a goal that sits alongside producing student learning.

learn from students' perspectives of life in classes taught by the teacher asking the question. Since we initiated this activity with the goal of learning from students we have developed cogens. Though we started with students advising teachers on how to improve the quality of class learning, we advocated that all voices be heard and inform consensus cogenerated by the group. We focused on class life, identified what was happening in terms of patterns and associated contradictions, discussed each from a personal perspective, and produced suggestions for change. Key goals were producing thought objects for enactment in subsequent meetings of the class and commitments to shared responsibility for the success of enacting agreed-to changes.

Structuring Cogens

I have now been involved in the use of cogens to improve teaching and learning for more than a decade. In its most basic form cogens involve a teacher and three to four students discussing what works well and what needs to be changed in a class. However, the focus of the dialogue need not be a class. Although any field can be associated with cogens, since most research with cogens has involved classes, the conversation in this paper is mainly focused on classes.

Cogens are fields in which new culture is produced, especially oriented towards the production of solidarity, by successfully negotiating differences as they manifest in action and a continuous and dynamic flux of structures, which become resources for production. If the participants in cogens are selected because of their differences, then successful interactions and transactions necessitate the production of hybrid or interstitial forms of culture. Within cogens, what happens is that individuals act across an agency | passivity dialectic, producing culture that structures the field and mediates others' productions. Other outcomes include co-respect and identity changes to reflect success in attaining new goals. That is, learning to show respect to, and receive respect from others

who differ in categories such as gender, ethnicity, primary language and academic achievement is symbolic and affords the creation of social bonds and networks with them and others like them. Successful participation in activity involves enacting roles and chains of encounters that include interactions and transactions.

Students are selected initially to include representatives from diverse categories that characterise a class, such as achievement level, ethnicity, gender, and religious affiliation. Inclusion in cogens also is an equity criterion and we adopt a procedure that allows students to rotate in and out while maintaining diversity among participants and a relatively small group that allows for a variety of forms of participation. It is important for all students in a class to be offered chances to participate in cogens because the evidence suggests they support the learning of culture that can greatly expand participants' roles in social life and increase their levels of success. Accordingly, after two or three cogen sessions a student would rotate off the group—usually becoming the cameraperson for the next session and then presenting a report on what happened in that session to the whole class. Once a rotation is established one of the students can assume responsibility for maintaining a roster that affords participation of all those with an interest in being involved. Also, depending on the issues under consideration, certain students might be invited to participate because their input is considered desirable. In a symmetrical way, we provide forms that students can fill out to request participation in cogen and to specify the focus. Participants in any cogen are delegates for the class and opportunities should be provided for them to educate class members about what was agreed to and accomplished.

In setting up cogens we developed a rule structure that begins with a commitment to accepting and learning from difference. We make it clear that each person should have approximately equal time to talk and equal turns at talk. Also, all participants should

listen actively and new topics should not be introduced until there is agreement on changing focus. A common (important) purpose of cogens is to improve the quality of teaching and learning by discussions about shared experiences in the class. These might involve what is happening and/or why it is happening. Hence, conversations will address patterns that are identified and contradictions to those patterns. We encourage participants to present their personal narratives on lived experiences and assure them that we expect different renderings of what is salient in a class. Our view of social life is polysemic and we are anxious to bring these multiple meanings to the fore through cogen. Participants are encouraged to take turns at bringing artifacts to focus discussion and the production of changes to be enacted in the curriculum. Videotape excerpts, digital images, and student work samples are examples of artifacts that commonly focus cogens.

We have found it useful to schedule cogens once or twice a week, usually at lunchtime, after school, or before school. When a whole class participates in cogens, a class period or part of a class period can be used, although Bayne undertook cogens involving nearly all of her class during lunchtime (Bayne, 2007). Typically the length of cogens is between 40 minutes and an hour, though the time obviously can vary. Elsewhere we described very brief cogens that occur during class as teachers and students form a huddle to review what has happened and what needs to happen next (Tobin & Roth, 2006).

Different ontologies are expected to manifest in participants' practices during cogens. Also variations are expected in what is considered most salient by different participants. A goal is to create solidarity grounded in deep respect for difference and willingness to learn from others, as long as an individual's actions also contribute to attaining the collective's motives. Participants should not act in ways that prevent others from pursuing their goals. If goals and

associated practices of a subset of others inhibit the attainment of individual and collective goals then participants within the cogeneratedive squad⁴ should discuss the deleterious goals and practices.

It is not surprising that initially a teacher would assume much of the responsibility for scheduling and setting up a rule structure and additional structures to allow for more ideal structures to emerge in which leadership is distributed across participants and is rotated to be appropriate and inclusive. Of importance is that all participants have the power to convene cogens and, as necessary, invite relevant stakeholders to participate. This is important because of the nesting of fields like a science class in larger fields such as a school, which is itself nested within a neighborhood. In this case it is often useful to invite administrators, policy makers, and parents, for example, to participate in cogens and, if students feel the present participants cannot enact necessary changes, it is a good idea to allow them to propose others with the appropriate expertise, authority, and power. For example, a cogen comprising students and a teacher might invite school and/or district level administrators to participate.

An important outcome of cogens includes agreements on what to do in subsequent lessons to improve the quality of teaching and learning. Also the cogen squad should decide how to improve the quality of what happens in cogens and what is to happen at the next meeting. First, cogenerated outcomes should be produced by the encounters that arise during cogen. Clarifying the meaning of “cogenerated” provides insights into what needs to occur. The “co”

⁴ Why use the term squad? Initially the urban youth involved as co-researchers in our ongoing studies suggested we use the term to describe relationships between participants, all of whom would demonstrate loyalty to one another and the collective. The urban metaphor for this relationship is to “have one another’s backs.” In that regard a squad is an appropriate label, since solidarity, loyalty, mutual respect, and affiliation are critical markers of a cogen squad.

syllable suggests that all participants should be involved substantively in what is generated. Hence in cogens all participants produce culture collaboratively. Accordingly, at the end of a cogen we should be able to look back and observe that all participants have been actively involved, collaborating to produce through dialogue a set of resolutions, which are accepted by the squad. These resolutions might involve changes in rules, roles of participants, materials accessibility, and human resources to support the curriculum. Being respectful of others also is a central feature of cogens. As encounters unfold, participants should show and receive respect and, when examples of disrespect are observed, repair rituals should occur, the result being a net gain in showing and receiving respect.

Because dialogue is a key feature, the flow of talk is a criterion for attaining success. When flow is optimal one person's actions are anticipated by others and become resources for their participation. That is, one person's actions expand others' opportunities to act. When actions are anticipated, appropriate, and timely there is a continuous flow of culture that involves participants. In a productive cogen everybody cannot speak at the same time, however, all participants can act in synchrony by listening attentively, gesturing, moving the body, and engaging in self-talk as the spoken (and heard) dialogue proceeds. Evidence of synchrony involves participants appropriating one another's practices and participating fluently in encounters—often providing one another with cues to signify synchrony (e.g., facial expressions, head nods, body sways, and verbal fillers). When fluency extends across participants, time, and space, the unfolding structures are just in time, anticipated, and appropriate. Hence, there is widespread fluency and the unfolding structures signify entrainment—resonant conditions to support success, fluency and streams of participation. Chains of successful encounters can produce continuous positive emotions that are evident as a build up of positively valenced

emotional energy—a collective sense of feeling good and being energised through participation. According to Collins (2004), continuous success and the presence of positive emotional energy can lead to affiliation with the squad—or solidarity.

Addressing macrostructures that might produce disadvantage also is an important goal of cogens. If the human resources needed to solve specific problems do not exist among the students and teachers, then others can and should be invited to participate in cogen. For example, if school policy changes need to occur, then school administrators, such as principals and department heads, might be invited to participate in arriving at solutions to problems. Participants in cogens in which I have been involved include university researchers, teacher educators from a university, school and district administrators, and parents. Obviously members from the business community and former students also can participate in cogens.

Representatives from key stakeholder groups participating in cogens can avoid a common problem of outside-in—where administrators and policy makers judge and decide about schools and classes without having direct experiences with the fields to be transformed. Creating schemas as mandates (e.g., policies) to be enacted by others, with accountability consequences for failing to meet established benchmarks, ignores individual | collective relationships and the dynamic complexity of social life. While participation in cogens does not completely overcome the potential coercion of outsiders ruling over participants in socially distant fields, regular participation in cogens raises the hope that cultural production will directly advantage participants of the class and school concerned, with the possibility of repetition occurring through ripple effects and dissemination of outcomes.

A change frequently seen in class is that participants from cogens begin to coteach in a variety of ways, assisting peers to learn when

help is needed. Coteaching takes many forms and often begins with one-on-one tutoring as students assist their nearest neighbor. Other examples have included teaching small groups, explaining to the whole class, and working solutions to problems on the chalkboard. When the class becomes too noisy it is often a student from cogens who will call peers to order.

Because production involves reproduction | transformation, learning always reflects the resources available for appropriation and then, as culture is enacted, the enactment becomes part of a dynamic flux of resources that support collective and individual agency and is also a resource for passive action. Our research suggests that participants in cogens learn through their participation and then what is learned is enacted in the cogen and the class fields. In making this claim I do not argue that what is enacted in the class is identical to what was learned in the cogen—instead, I argue that there is a family resemblance in the culture enacted in each field.

Solidarity Across Difference

Chris Emdin, a teacher researcher, taught physics to the inaugural freshman class at New York High in 2004. The racial distribution of New York High was 3 percent white, 46 percent black, 51 percent Hispanic, and 1 percent Asian American (Emdin, in press). At that time Emdin implemented cogens with his physics class and students began to assume responsibility for their learning. Students who were disruptive and disengaged in schooling found cogens were catalysts for improving the quality of their own participation. The students' practice of selecting video vignettes for use in cogens let them compare their own participation in relation to others in the class. Their suggestions in cogens make it clear that they were willing to accept responsibilities for others' learning. This responsibility was evident not only in planning and evaluation in cogens but also in science classes. The students initiated requests to coteach difficult topics and frequently came to the board to teach the whole class.

On other occasions they addressed the class from their seats. Another practice to help peers was a buddy system (i.e., peer tutoring) and ensuring that learning extended beyond the class. Accordingly, student buddy teams studied together, sat together in class, helped one another with homework, and provided emotional support to one another.

In the second year of research Emdin cotaught chemistry with a colleague and the same class enacted cogens and coteaching. On this occasion teachers and students participated as coteachers and the class overcame difficulties associated with cultural misalignments between most students and the chemistry teacher, who was Filipino. Through the use of video clips the teacher and students identified instances of contradictions to be resolved and, over the course of a year, there was evidence of a higher incidence of successful encounters and an increase in positive emotional energy. Emdin's presence in cogens supported participation of the chemistry teacher, creation of social bonds, and production of respect for and of students.

Students accepted roles as researchers and identified out-of-school rituals that were beneficial and others that were detrimental to learning of science. With student researchers, Emdin examined the lyrics of rap music and noted ways in which education was represented in relation to getting a good job that pays well. Emdin's research reinforces James McBride's admonition to take seriously the social commentaries embedded in rap (McBride, 2007). If students see the validity of exhortations that education does not produce the transformative lives it promises, then students may not put in the effort needed for success. At the same time, within the lyrics of rap artists are segues into learning more about science of such topics as nutrition, asthma and energy conservation, just to mention some of the issues addressed by Beanie Sigel in his raps (e.g., Sigel, 2005).

In the third year of the research, in addition to students coteaching in the living environment class⁵, they also assumed responsibility for coteaching chemistry during their unscheduled time. Students got involved in curriculum reform, suggesting projects to infuse rap into the science curriculum and creating podcasts to teach difficult concepts such as cellular evolution.

Enacting Culture in Different Fields

Gillian Bayne successfully used and uses large group cogens in an ongoing three-year longitudinal study in a public school in New York City (Bayne, 2007). A move towards larger sized cogens occurred because the class as a whole had to agree with changes recommended by smaller cogen groups and, as the advantages of being involved in cogens became evident, an ethical imperative was to allow all students to gain the advantages that accrue from participation. Students involved in cogens showed evidence of changes in identity and expansion of their agency. Also, through their efforts in the school and larger community, students showed an acute awareness of their concerns for collectives and willingness to act in the interests of the collective. Theoretical ideas discussed in cogens, such as communalism as a disposition of African American youth, were debated, adapted, and applied in school wide projects, after consultations between students and school administrators.

Bayne's research shows how students enacted knowledge produced in cogens in numerous different fields over several years. The students expanded their roles and enacted coteaching roles spontaneously—showing evidence of accepting responsibility for collective motives. In one striking example, students appropriated the concept of the buddy system, tried it out in several high school

⁵ Living environment is the third science course in a sequence that began with physics and included chemistry. An integrated capstone course is being studied at the time of writing, in the students' final year of high school. Our research is ongoing.

classes, and then created a plan for applying the buddy system in all classes in the middle and high school to produce a higher degree of communality and address hot button issues identified by students and school administrators. There was evidence to suggest that students arrived at consensus in ways that acknowledged and accepted difference. The solutions they agreed to usually did not require students to be something they were not—that is, there was willingness to make use of each person’s capital to improve the learning of others. At the same time, there was an expectation that all students would continuously change their identities and benefit from school life.

Producing Success in Heterogeneous Fields

In this section I describe research in which cogens were used to address contradictions associated with ethnic diversity among students and teachers. Here the focus is on cogens as fields for producing culture that identifies, understands, and redresses dysfunctional learning environments.

Negotiating Teacher and Student Differences

“These kids come to schools with enormous problems. I realise they need my help.” The teacher, who has now taught in the United States for 17 years, was sincere in his remarks about his students, but as he spoke to our research group about the problems he faced in his class two main thoughts swept through my mind. “He is stereotyping urban youth and he is using deficit frames to define his roles—and theirs.” Of course the teacher researcher was not aware of this at the time, and he was determined to improve the quality of the learning environments in his science classes. Ashraf Shady, as an immigrant from Egypt to the United States, became a science teacher and was assigned to teach students in a middle school in New York City. The ethnic breakdown among the students at his school was white 8 percent, black 24 percent, Hispanic 48

percent, Asian and others 20 percent. Most of the students came from home conditions of poverty, with more than 80 percent being eligible for free lunch.

The demographics at Shady's school are coarse and obscure important cultural resources. This may be especially important as 65 percent of the persons in the region in which the school is situated, are documented in the census as speaking a language other than English in the home. The most common language other than English is Spanish, and this may reflect immigration from many different countries. How can teachers capitalise on the students' and their parents' possible fluency in Spanish or another language other than English to produce higher achievement in science? Are there resources available to support the learning of science in the many languages represented in Shady's classes? Or is it possible for students to produce science learning resources in their own languages for the benefit of others in their class? Perhaps this would be one way to expand the roles of students to include curriculum development and also to create a sense of belonging, of cosmopolitanism in a science class built around affiliation with individuals who are keen to bond around their individuality and difference.

Being racialised creates contradictions, not only among students, but also for teachers like Shady. As an immigrant from Egypt, Shady regarded himself as black and African American. Yet, in a political move associated with affirmative action laws, Shady is regarded legally as white. Furthermore, because he is light skinned in comparison to many of the students in his school, his students also regard him as white. As he describes it, passivity inscribes his identity to the effect that he is regarded by his students as white, stereotyped as having a big house and two cars—unlike African American and Caribbean teachers who are regarded as struggling financially and socially closer to the students' parents (Shady, 2007).

Shady's research involved a culturally diverse grade 8 class in which there were 14 students and, on any given day, attendance did not exceed 50-70 percent—far below the school average. The proportion of the black students in the class was high compared to the rest of the school. The students were part of a small learning community that emphasised world culture and diversity.

Shady experienced problems with this class that he attributed to an inability of he and his students to connect with one another's culture. Often they were out of synchrony and Shady felt a need to address the misalignments by producing sameness. That is, he worked towards the development of a culture that would produce effective learning of science. This goal necessitated all participants changing what they do and working towards a common culture. An outcome was negative emotional energy, a sense of "teacher-and-other," and the reproduction of failure in the form of low test scores, resistance, and heightened negative emotions. Shady was well aware of the need to show respect for his students and, in so doing, earn their respect. In this class he felt that students often acted to make him look bad and, in cogens, they sometimes laughed at him, not with him—showing their disrespect for authority and him, for the benefit of impressing peers.

Shady selected two students to participate in cogens based on their differences from one another and the class. He described both as black, one male and one female. Unlike many others in the school, these students were born in the United States to parents who also were born in the United States. They both identified as African American and were from home conditions of poverty. Shady met with them prior to class to co-plan what was going to happen and from time to time, after class to debrief.

Shady describes how during a lab the female student appeared to initiate a water fight with peers. The lab was dysfunctional and fell far short of what had been planned in the cogen. Feeling

betrayed, Shady scheduled a follow-up cogen with the two students immediately after the failed lab. However, the students seemed just as unwilling to cooperate in the cogen as they had been in the class. They appeared to create an alliance and “played him⁶.”

The two students were teenagers in grade 8, identified as African American, and brought together because Shady regarded them as different. Even so, their identities as students and peers set up a context in which they seemed willing and knew how to play their teacher. They earned one another’s respect by setting up their teacher and acknowledging to each other that he was an object of ridicule. This was not necessarily a goal they were conscious of pursuing and may have been partly habitus, something minority youth do to authority figures so often that they know the genre and coparticipate at an unconscious level. In this case their teacher, Shady, was older, white, and an authority figure whom they were supposed to respect. All three criteria were reasons for disrespecting him by playing him and resisting his authority in cogens and in the class.

In the initial cogens misalignments occurred and associated asynchronies produced unsuccessful encounters in relation to the goals of cogen. Participants were not sharing turns at talk, not building off one another’s actions, and there was no sense of active listening with the purpose of moving towards successful outcomes. Only Shady was participating in the cogen field since he was focused on the goal of improving the quality of the teaching and learning. In contrast, the students seemed more intent on disrespecting their teacher and thereby ensuring that the intended goals of cogen were

⁶ To play someone is to create them as a thought object that can be disrespected because of their perceived gullibility. In this case students could exaggerate, then when the teacher expressed signs of belief, laugh at him to communicate to the other student they had “scored in the game.” Because of the ambiguity of laughter, the teacher also laughing was a sign of further gullibility, that he was caught and they had scored again. What is experienced as laughing together by the teacher may be intended as laughing at by the students.

not accomplished. What seems salient is that Shady did not have the culture to successfully interact | transact with the other two participants and the flow of dialogue was too fast for him to produce appropriate hybridized culture without the two students providing structures for him to do so.

During the cogen the female student took the opportunity to speak about her life out of school show how her participation in class reflects what happens out of school. This was a breakthrough moment from a research perspective since it revealed just how important it is for students to have a voice and sensitive listeners. No doubt there were benefits for the three participants coparticipating in cogens. Although Shady did not study the records systematically to identify benefits, by being together in cogen, interacting and transacting in numerous encounters, there were likely positives and negatives. In this case Shady decided the negatives carried such a weight that immediate changes were needed to address problems that were well documented. Changes were warranted to benefit the interests of participants in cogen and the class. Even though there were only three participants they did not create the interstitial forms of culture needed to create and sustain successful encounters. Accordingly, Shady decided to enact one-on-one cogens involving him and one of the students.

In one-on-one cogens Shady sat face-to-face with the student so that each had direct access to the other's emotions. The cogens began to produce successful outcomes. Microanalyses showed evidence of mutual focus, synchrony, and fluent enactment of culture as each of the participants spoke, listened to the other, and collaborated to produce ideas for improving the quality of teaching and learning in the class. The success laid out a context for the emergence of positive emotional energy and, over time, a sense of solidarity. Of key importance is that the two students who engaged in the separate one-on-one cogens were then willing coparticipants when the class was enacted in accordance with the agreed to changes. That is, the

two students assumed co-responsibility for enacting agreed to changes in their science class. Through the coordination of talk and time, spaces were created for new forms of discourse, interstitial culture that afforded successful encounters and hence successful interactions in which transactions led to the reproduction and transformation of appropriate culture. Not only did participants produce plans for enacting subsequent classes differently, but they also learned to produce successful outcomes together. Hence, social capital was produced between participants and an affiliation emerged as a basis for solidarity grounded in respect of and for difference. There was no expectation of becoming like the other or of giving up what makes each person different. Instead there was an acceptance of others' positions in a context of mutual co-respect.

What Have We Learned?

If teachers are to successfully mediate the learning of science it is imperative that they allow students to participate in ways that afford them producing science culture that can be reproduced and transformed as appropriate in the students' lifeworlds. In this paper I have explicated promising sociocultural theories that can illuminate different problems and solutions related to teaching and learning science classes. The success of encounters stands out as a rate-determining step in whether teaching and learning are productive. If encounters succeed the conditions necessary for effective learning can be established and sustained. If just a few encounters fail, repairs can be enacted and breaches to flow can be restored. However, emotions are salient in producing and maintaining optimal learning environments and theory and research point to the desirability of building positive emotional energy through chains of interactions and transactions that produce success among most, if not all, participants. If high levels of emotional energy are produced and sustained then breaches can likely be repaired and cultural flow maintained.

Because the cultural resources students bring to class differ among students and from those of the teacher, there is a necessity for all participants to build interstitial culture continuously. This is a challenge because interstitial culture is new (and hence strange) for all participants and can lead to uncertainty, lack of flow, and possible breaches to continuity. More needs to be known about the ways in which participants successfully appropriate what is new and strange and produce success that ultimately leads to learning science. We need to know more about recognising and legitimating Creolised forms of science so that all participants can, on the basis of participation, acknowledge success and progress towards science fluency and literacy. An implication here is to generate new sets of standards that embrace the creation of interstitial culture en route to enacting Creolised versions of science. Learning to recognise and value difference in what constitutes science is a priority for policy makers and educational professionals of all genres.

Teachers and students need to create fields in which they can learn to successfully interact and transact with cultural others. From rookies to seasoned veterans, all need to create social and symbolic capital with those whose cultural differences make this difficult in the school and class fields. We utilise cogens for this purpose and by varying the composition and number of participants the structures needed for success in cogens can be provided and sustained. As seedbeds for capital production, cogens are places in which all participants can learn to cogenerate outcomes when cultural differences are manifest. The milestones representing what can be accomplished in cogens include producing success through the creation of interstitial culture, successfully interacting and transacting with cultural others, producing social networks that include participants from diverse constituencies, and earning and showing respect for others' culture and cultural others.

Initially the *raison d'être* for cogens was curricular improvement. Delegates were chosen to represent the diversity of a class and

subsequently regular meetings that included discussion of artifacts and analyses of what happens in classrooms produced rich descriptions of class culture in terms of patterns of coherence and associated contradictions. Participants in cogens reached agreements that reflected different perspectives in the squad and in so doing they built understandings about others' ontologies. As the number of cogens built up over time there were changes evident in the class, the school, and the roles undertaken by many of the participants. Notably, students showed willingness to be coteachers, curriculum designers, teacher educators and school reformers, by reaching out to other classes, grade levels, and schools. Cosmopolitanism embracing participation of youth and acceptance of difference is an assertion for which there is considerable compelling evidence based on 10 years of research on cogens in New York, Philadelphia, and elsewhere. Using cogens appears well justified as a practice to be adopted at most grade levels from pre-K through College, though exactly how they work and what the products will be need continuous and ongoing efficacy research.

In this paper I endeavoured to accept the challenge of developing theory on radical passivity within a framework of the teaching and learning of science. As receptivity, I began to see how participants in any field are constantly acting partially with and partially without control. The structures associated with social conduct over which a participant has no control warrant much more thought and attention. The transcendence of the other is a significant resource for passive conduct and it is here that I have directed most attention in this paper and it is here that I will direct ongoing research. As material practices of participants unfold as praxis, they are anticipated on the one hand and transcendent on the other. Similarly, in praxis, the self also is another and is transcendent. What is done, as it is done, is not within the full control of an actor and just how this relates to agency needs more intellectual work. There is more

to be done and within our research squad we are determined to push the theoretical and empirical frontiers to ascertain the salience for science education of the agency | passivity dialectic and learn other ways in which radical passivity plays out in the teaching and learning of science.

I conclude with a social fact that speaks to science teacher educators. For decades the focus in teacher preparation programmes has been on ensuring that science teachers knew science. I feel like a beneficiary of becoming a science teacher in an era when this was the concern. My preparation in science and my instincts about what constituted effective teaching were sufficient to propel me through for as long as I taught students within my own sociocultural sphere. When I first taught I was youthful and understood youth culture. As I aged and taught in other parts of the world, cultural diversity increased the challenges I faced in effectively teaching science. Salient categories of difference included age, ethnicity, social class, religion, and gender. In this paper I emphasised that teachers and students must be cultural brokers if they are to create and sustain productive learning environments. The sobering reality I faced at City High was that it made not a jot of difference what I knew about physics and science education. Unless I could figure out how to get those students to acknowledge that I existed and was not an object for their disdain and disrespect I might just as well have stayed at home. As we create programmes for new science teachers to assume their professional places in today's diverse schools we must pay attention to the extent to which they can create interstitial forms of culture, see value in the capital of others, and afford students developing Creolized versions of science that expand possibilities in learners' lifeworlds.

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Appendix A

Glossary

Action is human conduct devised by the actor in advance—that is enactment of culture (or social life) according to a conscious decision by an actor. An act is what is accomplished by an action. I refer to acting in progress as praxis. Action is experienced “after the event” when an actor “stops to think.” As Schutz notes: “it is, however, not my ongoing acting that I can grasp. What alone I can grasp is rather my performed act (my past acting) ...” (p. 214)

Agency is the power to conduct social life and is a principal framework for understanding identity. Dialectically related to structure, agency involves access to and appropriation of structures and pertains to the fields in which culture is conducted.

Capital consists of the stocks of knowledge available to conduct social life. I adapt Bourdieu’s forms of capital in the use of three forms of capital: cultural, social and symbolic. The forms of capital presuppose one another and capital is produced when symbolic, social, and cultural capital afford successful encounters and the production of positive emotional energy (a forms of cultural capital).

Conduct is used includes an actor’s subjectively meaningful experiences, may be overt or covert, and does not imply intent (Schutz, 1962, p. 211).

Dialectical is used in several ways in this chapter and elsewhere in my research project. If A and B are patterns applicable to social life, a dialectical relationship can be recursive; a continuous flow from A to B and back to A. In this instance A and B might be considered opposites. In our research we soon came to realize that for any assertions there are contradictions, not due to measurement error, but because in social life there always are enactments that do not conform to patterns of (thin) coherence. Often these contradictions are cultural resistance to norms or transformative

culture that reflects newcomers in a field. That is, when considering a dialectical relationship between A and B there would be patterns to support A, patterns to support B, and patterns that support neither A nor B. A dialectical relationship between reproduction and transformation, which we use to define production, can be thought of as parts constituting an inseparable whole, that is, a both/and relationship. In production, both reproduction and transformation occur.

Encounter occurs when an actor interacts with a social object. I regard interaction as dialectically related to transaction, an acknowledgement that during an encounter, production occurs. Just as I see action as a progression that occurs over time, so it is with encounter. Encounters are experienced “after the event” in the same way I describe for action. Hence, they can be thought of as they happened and can be projected or planned. In examining encounters they are temporally bounded, seen in relation to purpose, and involve conduct consistent with an individual | collective relationship.

Field is a site for the conduct of social life. Fields are structured and culture is enacted in them. Like an electric field, there is no boundary around a field, though the dynamic structures afford characteristic forms of production, but not in a deterministic way. Because there are no boundaries, culture produced in another field can be enacted, thereby changing the structures and the potential for conducting social life.

Hegemony arises when participants within a subculture are disadvantaged by structures, regarded by the oppressed as the way things should be. The disadvantaged accept their relative disadvantage as normal rather than rising up to identity and remove hegemony and disadvantage.

I analyse and give meaning to social life in terms of three levels: **macro**, **meso** and **micro**. Social life is not experienced in terms of

these categories. The categories are heuristic, useful in research, and dialectically interrelated with each presupposing the others. I use field to distinguish macro from meso, arguing that a macro focus involves multiple fields in an analysis whereas a meso-analysis occurs in a single field. Ethnography is ideal for in macro and meso level research. The micro level is distinguished from the meso level by manipulating time in the analysis, either by slowing down video and audio tape or speeding it up. The focus is on the appropriation of resources and in making sense of the anatomy of encounters. In contrast, even though meso level analyses might involve videotape, they are done without changing the timescale. Making sense of encounters usually involves coordinated analyses at all three levels.

Passivity involves encounters in social life in which an actor cannot exert any power. Passivity is similar to receptivity—it is not the opposite of activity and concerns acting without power, with no possibility of “taking situations in hand” (Juffé, 2003).

Structures are the resources of a field. Structure may be schematic and material, and include participation. I regard structures as a continuously dynamic flux that structures, but does not determine social life. As social life is conducted resources are appropriated in the production of culture (i.e., reproduced | transformed).

Appendix B

Encounters

Research on encounters in cogens is relatively new and we have just commenced to develop an analytic framework to underpin studies that coordinate the appropriation of resources at the micro level during a variety of encounters identified as particular types during mesoscopic analyses. Table 1 contains a list of ritual encounters that might be recognised as symbolic and incorporate particular roles for participants.

Table 1
Types of Ritualised Encounters

Initiation	Closure	Evaluation
Assessment	Structuring	Motivating
Questioning	Responding	Elaborating
Clarifying	Celebrating	Controlling
Interrupting	Shut down	Repair
Transfer control	Saving face	Disrespecting
Rewarding	Sanctioning	Apologising
Encouraging	Arguing	Emphasising
Reviewing/summing up	Emphasising	Justifying
Complaining	Story telling	Joking
Telling	Chanting	Mimicry
Resisting		