

Orchestrations of Science Education Adventurism

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Prologue

One of my latest personal ventures has been to try my hand at being a coach. Of soccer. Of 5-year-old girls. It's an interesting social arena and a huge learning experience for me. Never having played the sport outside of the occasional P.E. unit in elementary school, I was first simply intimidated by having to distinguish between when a corner kick and when a throw in is necessary. Added to this is how to motivate and organize 5-year-old girls. "Coaching" is probably not a good description for what this looks like. Mostly I run around, clap and cheer, tie shoelaces, and hand out snacks.

What's most interesting to me is how these soccer "games" take place. The girls run around in shirts that are too big for them, hair tied in pig tails and smiles on their faces. Three girls from each team are on the field, all chasing the ball to various degrees and with a wide variety of technique. To use the typical clichés such as, "They're like sheep," or, "It's like herding cats" would be generous. It's a bunch of exuberant little girls, joyful just to be on the field, intrigued just as much with a blade of grass or a cheering parent as they are with chasing the soccer ball.

What struck me at our latest 10 AM Saturday match-up (The Rainbows vs. The Butterflies) was the fact that this level of coordination is not only spectacularly juvenile – they are 5-year-olds after all – but also strikingly familiar. The night before I had finished reviewing proposals for the American Educational Research Association's 2008 meeting. In the ten of them that I'd read, there was probably not a single reference that was common to the lot of them. Each had a valid pursuit and something worthwhile to say, but none of them had anything unifying them together. You could argue that this is just the nature of the way we work, and I'd likely agree with you . . . until reflecting upon how strikingly similar this was to a group of five-year-olds all running around on a soccer field. The combination of me as coach, their inexperience with soccer, and the general philosophy that we were all out there just to run around all contributed to the non-orchestrated nature of our game playing. As a result, kicking the ball the wrong direction, staring off into space, or even stealing the ball away from one's own teammate are all common practice.

The difference should be that most of us in science education research and practice are more mature and guided than a beginning soccer team. Yet, somehow we still exist as a wide array of individual research problems, individual reform efforts, and individual ideals for what science education should be doing.

My soccer team scored three goals last week. I wonder if science education will be so lucky.

“I went down to the Crossroads, tried to flag a ride”

This conference, *Science Education at the Crossroads*, has become more than a simple activity for me. Outside of teaching physics and science education courses, Crossroads has become my most important and rewarding professional endeavor. What at first was a simple venture responding to a frustration has since come this far.¹ Three conferences and one National Science Foundation grant later, I feel like I’m doing something that is particularly meaningful, at least to a small group of engaged individuals. Perhaps this even becomes meaningful to a wider group as you all go out and execute proposed ventures and new ideas that result from your collaborations with others at Crossroads.

For me, perhaps the greatest benefit of the entire conference is that you all -- the participants -- send to us your interesting ideas and cutting-edge ventures in a two-page narrative and then ask us for feedback. I get to read stuff that I have no business reading in the first place. That is, I have little expertise in most of these things that you bring to the table; and yet you invite me to peer into your world. You even explain it in a way that I can understand and get excited about it. It’s a tremendous privilege to see the group’s work at its early and developing stages. I feel like I’m privy to new ideas that few others in science education (not to mention a physics department) get to experience.

Also of incredible benefit to me has been the themes that have emerged from our series of Crossroads conferences. John and I have worked hard to figure out what exactly is going on, getting evaluations back from many of you and following up with exit interviews. I don’t understand it, but a few salient goals have been created from the group. These happen to coincide, incidentally, with the ideas of my keynote address predecessors. (Don’t ask me where the cause and effect are placed. I really think that much of this has simply emerged on its own from the social context that the conference has created.)

David Moss, at our inaugural conference, started to help us identify and name something that was important to the group: scholar activism (Moss, 2005). The idea here was that we, as scholars, have a view of our own work that could be narrow. Indeed, the very academy in which many of us find our existence is fairly limiting in terms of making sure that our ideas find a foothold and make a real difference. We work in the field of education, after all. Thus, our research is not simply out there to build upon a particular knowledge base and change ideas in the ivory towers. Rather, it is out there so that it may inform and influence this invention we recognize as our modern educational system. We should continually work to reform the way we do things so that change is not simply possible, but aggressively pursued, especially at local levels where we can be in the thick of things.

Following up on these ideas from David was John Settlage’s keynote last year (Settlage, 2006). John introduced the idea that the philosophical foundation of Pragmatism was an appropriate place to stand as we endeavor to be scholar activists. For me, the imagery that John described in this work was particularly poignant. Not only do these ideas come from some of our heroes like John Dewey, but they embrace the notion that we are more than just thinkers and knowers. We are also doers and feelers. There is a spirit and an action in our work that must coincide with the scholarly pieces.

These pieces and the support that they have received from previous Crossroads groups has been inspiring to me. For me, it gives purpose to what I do *and* direction -- I can look forward and understand why I’m heading that way. At the same time, I can look backward to David and John and the many of you who have also embraced these ideals. There is a support group that has been

¹ An important warning to others: Be careful what you suggest out loud to John Settlage. He’ll take you seriously and you’ll end up coordinating a conference (or some other venture) with him.

established. Coming back to Crossroads, then, is not simply a way to see what you're working on and doing, but to revisit a support structure that shares a passion for a common set of goals.

I have a problem, however. David and John have riled up the Crossroads contingent to be active, to do something, to create ventures that effect change and are personally meaningful. At the same time, we come together as a group. To me, the most natural "next step" is to consider how we can create and coordinate collective efforts. Surely there is something to be gained by connecting our individual experiences and initiatives to one another, if not unifying them in some way.

This idea isn't so much of a problem. "Would you like to work with a collective of enthusiastic and energetic individuals so that we can reform science education, make society more equitable, and establish opportunity for all individuals within this democracy?" A clear and resounding answer would be (and has been) "Yes." The problem really is a matter of wondering where to go next. I can imagine John and I dismissing the conference telling you to "go forth and venture." But how does this connect us together? How is this supportive of your individual ventures and of the collective missions of the group? I don't have a model, either from experience nor from other resources, for this level of *orchestration*.

I suppose that there's more to it than simply wanting it, but then there's also more to it than having the ability to stage it. Both, and something else, too, must exist. Debra Meyerson, author of *Tempered radicals: How people use difference to inspire change at work*, suggests that there may be one of several conditions for organizing collective action:

1. the presence of immediate political opportunities or threats
2. available structures for members to organize themselves into a collective
3. the framing of collective identity, opportunities, and threats (Meyerson, 2001, p. 124)

Further, this organization can take place in one of a few different ways. It could be that a group organizes explicitly to respond to a shared threat or opportunity (p. 125), an individual's action encourages the participation of others (p. 126), or that some preexistent organization of a group allows for a collective action initiative (p. 129).

I read these descriptions (and little else of the book, frankly), thinking about how Crossroads has tapped into these conditions, at first unknowingly, but later quite explicitly and actively. We originated as a response to other conference organizations and a lack of opportunity to work collaboratively, but have since responded to individuals within the group, and now seem to act as – dare I say it – an organization. Having the blessing of the National Science Foundation for two years seem to only further legitimize this.

Neither Meyerson nor any other organization I've been a part of gives me a strong sense of how to create the orchestration I'm imagining. To even begin to think if this is possible, I decided to look to a set of metaphors for how we could possibly work together. As the term "orchestration" itself has suggested to me, I've decided to pull out the metaphors from music, both its performance and its composition, to try to better understand what *might* be possible. I will make no grand claims that this will produce answers, but I think it will produce new ways to consider what we're currently doing in coordination with one another, as well as what more we could attempt to emulate.

Orchestrations

Collaboration is something that I do sometimes, but understand little about. I once asked a pair of co-scholars and co-spouses how they write together, collaboratively. The response I got was that they each, individually, worked in a separate corner, reemerging when some piece had been completed, to be added to the collective work. I think I was disappointed. I couldn't really imagine it much differently, but I was hoping for a model for something I hadn't begun to picture.

Musicians perhaps work much more cohesively than most scholar-teams or many spousal partnerships, at least in the studio or on stage. This isn't to say that music is always a collaboration, though. It's also helpful to consider what musical arrangements (no pun intended) fail to collaborate and how these examples map to our own experiences in our own discipline.

Take for example the model of the air guitarist. Even if you don't know exactly what this is, I can assure you that you have been one. The guitar solo of your favorite 80's rock band begins to play and you find yourself fingering an imaginary guitar that is now playing so masterfully through the speakers in your living room, your earphones, or (praying you're at a stoplight) your car. In spite of having zero skill aside from the brief stint you had with the ukulele in third grade music class, you are going through the motions and playing the role of the virtuoso. If you've taken any graduate coursework at any institution in the U.S., you have shared a class with an air guitarist -- someone who can go through the motions and talk at length about his expertise, but demonstrate very little of it. Unfortunately, those of us in faculty positions work with plenty of air guitarists in our own institutions. I'm fortunate that none of them work in *my* department, but of course I've met them in committee meetings.

Karaoke, the pastime of singing the lyrics to well known songs in public as a recorded accompaniment plays in the background, is another model we could look to as one we probably don't have use for. Certainly, it's entertaining for all (either in appreciation of your singing talent or at your expense and public mockery), but it doesn't build on anything. It uses something that's already been created (the song itself and its recording) to provide us with something to do. I wonder what the original artists think of their songs being "used" in this manner. It seems analogous to an administrator using your research to support one of his initiatives at your campus. Or, perhaps it's a line of research that is unoriginal, simply repeating old work and creating no new initiative.

Air guitar and karaoke are obviously models that we don't want to base our professional and personal identities on, at least not for long. And, I'm proud to say, I don't have to really endure these from others too often. There is a list of very real metaphors that I think we see all the time, either for better or for worse. All of these reach out to build collaborations and create orchestrations.

Anthem

The typical conference keynote, generally given by an association's president or other officer, is generally a call to action. To me, it is reminiscent of the tune played behind a march, or some kind of an anthem -- a "rock anthem" by *Queen* comes to mind for me. As I listen to these keynotes, I suspect that there's a secret desire on the part of the speechmaker that we should all start cheering out in support ("*We will, we will rock you!*") and begin enacting new initiatives right there in the ballroom, tossing our unfinished plates of baked chicken fillets or vegetarian pasta and making reform a reality in science education.

Yet this never happens. I don't think it's because it isn't possible. After all, I have seen (at these same meetings, no less) individuals lead hundreds of conference goers in a ballroom in a country-Western line dance lesson; I've seen groups get out of their seats to follow intently the instructions for balancing a peacock feather on their chins; and, I've been told of an event in which a hall of stuffy researchers joined together to sing the *Brady Bunch Theme* in round. This is all to point out that we can get groups of individuals to do extraordinary things. Yet, the difference between these isolated events and the general call to action and reform is that we know how to give instructions on peacock feather balancing; but, I have yet to hear someone follow a call for educational reform with a set of instructions. I suspect very strongly that we don't have any idea what we're doing, and no set of instructions yet to follow.

Solo Guitar

I think we best understand how to work as solo acts. Furthermore, I'm confident that this is currently where most of the real work, both in research and in social action, gets done. I'm surrounded by solo efforts that are effective and inspiring. It's as if the actual musician that the air guitarist was impersonating steps out of the stereo or iPod and begins playing for us live.

My model for this is Eric Clapton, both because his guitar playing earned him the title of "God" and because he is the guitarist and vocalist behind our conference's namesake, Crossroads (made famous by the band *Cream*, but originally written by Robert Johnson). It's interesting that behind Clapton there is always the bass guitar and the percussion, as well as the multiple and diverse preparations backing up the entire effort. Solos are dependent not only on individual skill and creativity, but on an entire support structure as well. It is this way with much of what we do as soloists in our own work. It could be that this is exactly what Crossroads (the conference, not the song) is supposed to be all about. That's really up to all of us. Individuals can go down to the crossroads and try to hitch a ride (as the song goes) or at least revisit the support structure for their solo efforts. This may be exactly the model we should try to continue to build.

Apprenticeship

Still, a great number of solo efforts, no matter how effective individually, seem to miss some other potential. We don't simply do our own thing. We are always working with others in ways that aren't simply the expectations that they'll be our drummer or bass player. Often we find ourselves comfortably sitting in mentoring roles to preservice teachers, graduate students, and even one another. Unlike many collaborations, this is something that many of us are at least implicitly trained in. We've had some kind of mentoring from some other individual, and we often have this role passed down to us. For me, my first real taste of research was in working with my undergraduate mentor, Michael Broide, in the physics department at Lewis & Clark College. Later, Julie Gess-Newsome and Sherry Southerland introduced me to a project when we were all at the University of Utah. Here's some data, they said. Here's how we're thinking about it, they said. Do something with it, they told me. This is how I became a researcher. I'm still working on my identity as a scholar, of course, but the process of initially becoming a part of the field and getting a sense of what it was all about was the result of others taking me under their wings -- at least initially -- and then finally letting me go. I specifically remember Sherry giving me an article to review and justifying this by telling me at the time that "you know as much about this as anyone else in the field." There was an apprenticeship experience that led me to

that level, and while Sherry was at the time trying to compliment me, it was really a credit to what she had done to allow me to work to that level.

Musicians undoubtedly do this all the time. One of my favorite musicians, Bruce Hornsby, spent many years playing along with the Grateful Dead. Now, even though that touring combination is no longer active, his live shows still incorporate the songs and styling of Jerry Garcia and the Dead, and “deadheads” are common followers of his shows. At a completely different level, my children each enrolled in music classes from when they were toddlers up through preschool in which they would sit in circles and imitate the sounds, movements, and instrument playing of one another, parents, and a teacher. There was no real instruction -- it was all mentoring. My experience as a graduate student and my daughters’ experiences in “Music Together” were not all that much different. (I’d argue that my dissertation was better, but I’m sure this is debatable.)

So, mentoring is something that we may already be good at. In fact, it seems to be something that we do naturally not only with our students but with one another. So, perhaps Crossroads could simply be a meeting place for the mentoring to take place. On the other hand, John and I are continually impressed and delighted with the graduate students and practicing teachers who are here holding their own from the very start -- no one needs to take them under their wings. Given the right atmosphere and the opportunity to share a voice, the grad student is giving advice to the seasoned researcher and the practicing teacher is advocating specific needs from the teacher-trainer. Perhaps mentoring takes place then, but not in any particular direction. The collective arena takes care of each individual. Yet, this would still reduce what we’re all about to a collection of individuals who will then go out to enact solo efforts in one way or another.

The fugue

It occurred to me recently that I don’t have any fugues getting stuck in my head, ever. This could be for several reasons, including the fact that I need to listen to more fugues and perhaps more classical music in general. However, from time to time I will get a piano sonata or a prelude to ring in my psyche, but no fugues. The reason, I think, is that a fugue is supposed to be a composition in which multiple “voices” emanate from a common instrument, calling upon and responding to one another. In effect, there is no real singular melody, so there’s nothing to key in on and hum along with. What’s interesting, though, is that the combination of voices, even as they call upon one another and even overlap, is completely coherent. One fugue in which this is particularly apparent for me is in Chopin’s *Fugue in A-minor*. (Apparently this is a relatively rare piece, and the only fugue that I know of that Chopin created.) It is played on the piano with two voices, one coming from each hand of the pianist. In a matter of just a few minutes, you can hear and imagine a conversation in which the dialogue goes back and forth, overlaps, contemplates something, rises to a conflict, and then resolves to some conclusion in which both voices arrive at a common note, but from different independent melodies.

I think it’s significant that a fugue is difficult to hum or even remember. The combination of voices is a bit foreign to us and our bias for solos rising above the rest of the musical structure. Similarly, we are unfamiliar with other collaborations in which the voices are both equally heard, simultaneous, coherent, and still responsive to one another. I wish I had more examples of this in my professional life.

Yet, when I think of the process through which Crossroads participants work through in their writing and efforts culminating into the incubator sessions here, I think there is something very fugue-like about the entire process. A single voice tries itself out in a written proposal, to which a reviewer

(usually John) responds and then subsequently an additional reviewer (usually me) responds again. And then the writer gets to respond again, often incorporating suggestions we've made as reviewers, but almost as often voicing a different idea or tactic than what we suggested. Then, this voice is heard in the incubator session at this very conference, and other voices begin to play along.

Throughout these fugue processes, each voice is heard and responded to. While there is no melody, there is resolution and collaboration. I wonder if the model of the fugue could model other ways in which we interact. I wonder if we are too often afraid to lose our own melody -- perhaps our own voice -- when others chime in. Or, perhaps there are not safe structures in place to support this back-and-forth, give-and-take interaction in most settings. Crossroads, of course, makes efforts to build in safety and interaction in the conversational fugues; but, this structure built into Crossroads doesn't naturally extend beyond the conference's review process and dialogue of an incubator session.

Jazz improvisation

In large group discussions at last year's (2006, in Ogden) Crossroads there was some resonance with the idea that members of the group each brought their own piece of creativity and an amount of freedom which allowed for them to play with this. Bringing all of these creative expressions together was likened to a jazz ensemble, and I distinctly remember Barb Austin (Northern Arizona University) describing Miles Davis' sessions. This is one example of how Davis' sessions for the album *Kind of Blue* were described by fellow musician Bill Evans:

Miles conceived these settings only hours before the recording dates and arrived with sketches which indicated to the group what was to be played. Therefore, you will hear something close to pure spontaneity in these performances. The group had never played these pieces prior to these recordings . . . (Evans, 1959)

It's true that this kind of setup is similar to what we do for Crossroads. We don't ask participants to rehearse a specific presentation. Rather, we set up our own studio and listen to the creative contributions of one another, and then we get to play along. This isn't easy, though. It requires more than just imagining it all. Evans says it this way:

Group improvisation is a further challenge. Aside from the weighty technical problem of collective coherent thinking, there is the very human, even social need for sympathy from all members to bend for the common result (Evans, 1959).

The dilemma is in the contrast between the individual and her creativity and the group and its collective rigidity. Somehow, creations like *Kind of Blue* and our own conference call upon the "social need for sympathy from all members to bend" towards something that is common to all of them. How does this happen? Certainly, Davis' ensemble was small in number but large in talent -- perhaps genius, considering that John Coltrane was playing along in addition to Davis and Evans. While I haven't yet heard anyone from the Crossroads contingent wailing on a sax, there surely exists some real genius, talent, and pure creativity in the mix. And, like Davis' group, we have a small collection of these individuals. This must be part of what contributes to our successes.

But, I think there's something else as well. There must be some inspiration that each of us gets from the group and gives back in turn. Take, for example, the interaction of Thelonious Monk and John Coltrane. A couple of years before Coltrane played on *Kind of Blue* he was coming to understand and play along with Monk at a small club. Eventually Monk's quartet, along with Coltrane, played at a

benefit at Carnegie Hall. (The recordings of this performance was serendipitously found in the holdings of the Library of Congress in 2004.) This collaboration was described as follows:

Everything they play is exciting, dynamic, sometimes adventurous, and very much in sync. Monk is having such a good time at the piano that he hardly gets up from the bench. The stories . . . always portray Monk as dancing around or heading toward the bar while Coltrane blows with the rhythm section. But what Monk is playing underneath Coltrane is pure brilliance; to call it “comping” [typical blocking of chords in jazz piano accompaniment] simply does not do justice to the creative dialogue Thelonius is having with the entire band (Kelley, 2005).

“Exciting,” “dynamic,” “adventurous,” and “in sync” are perhaps those additional elements that create this kind of creative output. For me, these elements exist at Crossroads as well, and they may be what produce the “creative dialogue” that we experience here. The small group of creative individuals may be necessary, but not sufficient. Monk was having fun, and that may have made all the difference. In this case it kept him at his piano bench rather than at the bar. I’ve noticed that Crossroads sessions do the same for many participants who, when watched carefully at other conferences, are often skipping out of sessions and finding themselves at other establishments.

This metaphor may be exactly what describes Crossroads and perhaps it even gives us a model that we can continue to use in order to sustain what Crossroads currently is. But let me push things just a little more. If we simply sustain what Crossroads currently is, we may be selling ourselves short. In addition, the pieces of Crossroads that are exciting, dynamic, adventurous, in sync, and fun are all in effect while the conference is in session. There may not be a way, with this model alone, to ensure that orchestrated efforts occur beyond the time and space of the meeting itself.

A night at the ballet

I love ballet and I’m not ashamed to admit this. I couldn’t have told you this a few years ago – I’d never been before. But I’m fortunate enough to have a partner who insisted that going to Tchaikovsky’s *Nutcracker* is an annual tradition that we needed to start. She was right. (She always is.) Let me try to explain, but keep in mind that describing the experiencing of *The Nutcracker* is nearly impossible -- even more so than trying to describe a jazz performance.

The Nutcracker, as it is a ballet, has elements of dance at its core. The dancers, of course, all play roles that fit together into the telling of a story. Layered behind this is a stage with giant elements of artisanship that also tell part of the story. And layered in front and ethereally around everything is the music of the orchestra. So, hold onto all of this and then imagine that one of the dancers is a giant mouse, and one of them is a reincarnate nutcracker, and that these two are having a sword fight. While dancing. To the music. In front of the scenery in which a mediocre Christmas tree has grown into a gigantic auditorium appropriate tree and the rest of the stage is alive with mice, soldiers, and a little girl. And the music continues to envelope the entire thing and the dancing continues and the story is, believe it or not, coherent and beautiful.

This doesn’t simply happen on its own. For as talented as the geniuses of Monk and Coltrane and Davis were, they could not (or at least *did* not) get together to create something as multidimensional as this. It simply can’t be done if you only rely on the flow of creative juices and a bottle to catch them. Something else has to be planned. Frankly, I don’t understand at all how this works, but surely it does.

So I'd like to try to imagine how the kind of orchestration that is had in a ballet between the choreography and the visual appeal and the music can be used in our field. How do we create something that is so well implemented and coordinates so many levels? This, to me, is something that can endure *and* something that can reach out at a grander scale.

While I don't understand how to do this, I do know that we have before us the dancers, the artists, and the orchestra. Take a look at our Proceedings and our authors and titles (see Appendix A). Here we have teachers, policy makers, and researchers, all together. And here they produce questions about personal pursuits, teaching improvements and reform, research methodologies, and new actions that they are venturing to do.

So, while I don't know how to choreograph a ballet, I do recognize that we have before us all of the right players. They are here at the Crossroads. My challenge to you, the Crossroads collective, is to find a way to orchestrate our efforts -- the solos, the fugues, the improvs -- into something that is greater than even the sum of our individual efforts.

Epilogue: "This is even more important than Crossroads"

I would really like to end with the image of us creating a ballet together, but I'm not sure that this would be completely honest. I have to admit -- and I'm nervous that if you've read this far that you're going to be mad at me -- that I'm not sure if the ballet is really necessary. Let me give one more example of what is done all the time, and let me admit that maybe this is exactly the mode we all need to work in.

This summer, almost by accident, I designed and ran a summer outreach program that was my own solo guitar performance, most certainly with the support of colleagues (Stacy Palen here in my department in particular) and students (staff of the Ott Planetarium at Weber State). It consisted of me taking a crew of undergraduate science majors in a van loaded with items ranging from aluminum foil and metal washers to corn starch and a small kiddie pool to five gallons of bubble solution and PVC pipe. These assortments and many like them went with us to local parks in which a federally funded free lunch program was made available to kids. We used our funding to partner with the lunch program and bring science to where the kids already are. (The pictures and brief description of this program are at <<http://dewey.weber.edu/ottreach/index.html>>.)

There was a huge amount of effort that went into this, but at its heart it was very simple. Get some tables and some tents, and then set up activities where the kids can play with science. They made trumpets out of pieces of pipe, giant bubbles from pieces of string, and telescopes from a couple of surplus glass lenses. They stayed with us in the park after eating their lunches rather than going home or playing on the playground. We had around 1000 kid-day interactions in a three week period. They were, like Thelonious Monk, having fun. So was I.

As this was being put together, Karyn (the same brilliant person who suggested we go to the ballet) told me what she thought of the whole project: "This is even more important than Crossroads." At first, I didn't have any coherent way to respond. After all, as I've said at the outset of this paper, Crossroads is the most important piece of professional work that I engage in, I think. But then I came back with a response that was both honest and effective: "I would not have done this if it hadn't been for Crossroads." Even though I had never before conceived of our program previously, when the opportunity arose I was brave enough and inspired enough to put it into action because of what I'd

seen others doing as a result of Crossroads and because of the passion of the group that had since infected me. The collective and its calls for scholar activism and pragmatism had become a part of my core.

So, maybe we do need huge orchestrations, but I'm learning that this isn't necessarily the silver bullet. Perhaps it isn't even part of the answer. I'm open to the possibility that the bravery inspired by Crossroads may be contagious, that (quite opposite to my plea for the orchestration of the ballet) there may be more to all of our individual ventures than I can yet imagine. If Crossroads is a continual source of these, then it will continue to be the most important professional endeavor that I can imagine engaging in.

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Appendix A: The choreographers, artisans, dancers, and orchestra members

Kip Ault

Lewis & Clark College

Macaques, Medical Research, and Middle School: Adding Social Context to the Culture of School Science

Lloyd Barrow

University of Missouri

Are Geological Science Concepts Endangered at the High School Level?

Francis Broadway

The University of Akron

To Be a Male, a Negro, and a Queer: Pedagogy in (Science) Education

Michelle Brown

O. Henry Middle School, Austin, TX

Trying to Fly When I Don't Have My Wings: Inquiry as a Beginning Science Teacher

Malcolm B. Butler

University of South Florida, St. Petersburg

The Invisible Science Educator

Mary Anne Butler

CT State Department of Education

Professional Development that Looks Beyond the Test

Cory Buxton

University of Miami

Moving from the Regressive to a New Intersection

Heidi Carlone

The University of North Carolina at Greensboro

Defining My Post-tenure Self Within and Against Historically Worn Grooves of Academia

Robert Ceglie

University of Connecticut

Why Science? Trying to Find and Define a Science Identity

Terri Clark

Connecticut Academy

Standards & Curriculum for Informal Science Education

Amy Cox-Peterson

Cal State Fullerton

I've Played the Game: Now What?

Kathy Crooks

University of Akron

Finding a Place to Support and Sustain Lasting Change

Dina Drits

University of Utah

At a Crossroads at Crossroads: Looking Ahead as I Prepare to Leave My Student Status Behind

Mark Enfield

The University of North Carolina at Chapel Hill

Re-envisioning Roles in the Improvement of Science Teaching and Learning

Steven S. Fletcher

St. Edwards University

Killing the teacher within?: Challenging pre-service teacher beliefs about teaching and learning and the theory/practice conundrum

Larry Flick

Oregon State University

Reexamining 'Hands-on Science' as a Tool for Learning

Magnia George

Emory University

Disentangling Goals, Agendas, and Outcomes – Science For All Is As Much a Moral Imperative As It Is an Issue of Global Competitiveness

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