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On The Edge of Chaos: Co-evolving World(s) of Drama and Science

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Drama and science remain disparate subjects in curricula and teaching. At first glance, as with a water and oil concoction, we assume they don't mix. But like liquids with different sorts of tensions, many qualities of each are more similar than different. Yet another look reveals themes in doing science that overlap with ones in drama. Far from a common view of science as an accumulation of formal laws, the dynamic exploration of natural phenomena, for example, is enacting conditions of possibilities, interruptions, interpretations, and play(ing) with variable relations. It is the fascination with phenomena (like the presence and absence of light, sound and motion) that motivates both metaphoric and explanatory response. The question "what if?" prods scientist and dramatist toward creative exploration and interpretation of experiential sensual world(s), real and imagined.¹

In the physical science elective course we teach for elementary teachers in our two year teacher education program, bringing together science with drama and storytelling has opened a participatory space which primarily engages our bodies, voices, memories and imaginations. As such, physically interacting with an environment (e.g., swimming in a pool, skating on ice) and our recalling these shared events as stories and dramatic activities serve as mnemonic triggers that bring forth our experiential ways of knowing, which in turn can generate further inquiry of animate phenomena (such as motion, force, friction). This is not a minor point. The educational significance of such "performative inquiry" (Fels, in press)² means breaking with textbooks and lectures whereby teaching/learning ignores our perceptual world, and taking up alternative interpretations and improvisations while doing, telling, and creating. In the past two years our science students as interpreters have produced a variety of expositions including portfolios, scripts, videos, readers' theatre, improvisation, sound scapes, as well as a play (written and performed). Here we discuss performative inquiry as methodology for coupling science and drama, with memories of our students' science play intertwined with final thoughts about educational implications and possibilities.

The Coupling of Drama and Science through Performative Inquiry

Performative inquiry as a research methodology investigates the creative interactions be-

tween performance, inquiry, and experience thereby inviting students to an "interstanding" (Taylor & Saarinen, 1994) of a given environment, action, or phenomenon. Similarly, our science teaching emerged over the term as performative inquiry of physical phenomena. With the students, we explored light, sound, and motion within particular complex effects and events (e.g., coloured shadows, echoes, spinning on ice). It was significant that we participated in the inquiry as sensible receptors and bodies in motion: I see and observe; I hear and listen; I move and perform. Therefore, none of us was separated from the phenomenon under study but in many ways implicated in it. We *performed* scientific principles of motion by swimming, ice skating, and doing simple gymnastics as a group. Familiar common events became experimental events that we staged in creative ways to enact and interpret scientific ideas such as buoyant force, moment of inertia, center of gravity. For example, we explored the laws of motion by navigating through the medium of water with our bodies. The students' learning through such physical interaction later found presence on stage in a play where characters maneuvered through imaginary wind, mud and water.

During the course, our qualitative inquiry lead us to asking questions — What matters? What if? So what? — and doing further actions that situated a phenomenon in all its complexity and contingency. In a sense we were playing with possibilities and often qualifying the weary ineffable with, "It depends..." And once the phenomenon is understood as complex, a textbook definition appears incomplete and limited. For the students and ourselves the agenda became a re-interpretation of science learning/teaching that recognizes performance as a critical and creative means of engaging mindful participation with phenomena.

The Phenomenology of Sense Making. Performative inquiry carries the assumption that knowledge is embodied in creative action and interaction. As such, knowledge is not a representation of what is out there, but a "bringing forth of a world" as part of living it (Maturana & Varela, 1987). Knowing is rooted, after all, in the world of lived sensorial experience. From this phenomenological perspective, performative inquiry is a methodology that recognizes the spaces of action and interaction as possible sites for sense making. As a tool for exploration and interpretation, performance allows us to investigate our world(s) through creative and critical (re)imagining. Seen in this way, the arising "Aha!" is the moment of transcognition (Fels & Strothers, 1996), a space-moment³ of learning that comes into being through (re)writing the landscape of knowing.

Within this action-interaction space, it becomes difficult to say which comes first—the phenomenon or the inquiry. Both appear to co-emerge as iterative context, a weaving together, much like Davis, Sumara and Kieren (1996) describe it: "Context is not merely a place which *contains* the student; the student literally is part of the context" (p. 157). In action, the two "specify one another." But closer to the context of our interpretation of science teaching, phenomenologist David Abram (1996) describes all phenomena as "po-

tentially expressive" which actively solicit the participation of our senses (p. 81). The point is that the *inquirer and phenomenon co-participate*.

For us, our role as teachers of the science course was to create gesturing environments that speak to students and engage qualitative understanding, as space-moments of relevance (Aha!) that experience brings forth; and interpretation, as enactments of meaning from a "background of understanding" (Varela, Thompson & Rosch, 1993, p. 149). As a class within these enactive environments, we (de)constructed phenomena (what matters?) and opened the space of possibilities (what if?) as physics, but (re)contextualized phenomena within storytelling and the fantasy of a play (so what?).

The Landscape of Language⁴ Embodied. Dramatist Barba (1995), in reaction against stereotype or artificial gesture, encourages performers to dance their presence into the choreography in order to realize the living world on stage. He writes:

Not walls
of cement, but...
the melodies
of your temperature

He goes on to say: "I don't want to see dance. I don't want to see theatre. I want to find myself face to face with that which 'is-in-life' and which reawakens, echoes, and silences" (p.162). In the same way, performative inquiry encourages educators to bring to their classrooms not cement walls of curricula but instead, "porous mirrors" of investigation through which students may enter in resonance and recognition of personal and shared experience and language. And, it was in the shared language embodied in our science explorations that our students voiced their presence, or as Barba might phrase it, they sang "the melodies of their temperature."

Thus, storytelling and dramatic activities became powerful methods for muting the "sounds of silence" throughout the course and a means of participation within the context where situated meanings exist. The students quickly replaced the scientific language of the textbook with metaphoric and "everyday" language which spoke of their experiences and imaginations. In most cases, students no longer relied on faulty memories of scientific definitions to explain phenomena, but spoke to their experience and *understanding* of particular phenomena through metaphors, comparisons, and body language. In the end, storytelling eventually allowed us trespass within science discourse. As Abram (1996) points out, stories are judged on whether or not they make sense, and making sense is "to enliven the senses" (p. 265) in stirs and awakenings. And so, for instance, from our experiences within the swimming pool and remembered stories of learning how to swim, we "language" our understanding of buoyancy into our play.

A Place of Play(ing) Experience

Before the course began we chose carefully the physical phenomena and effects to investigate over the term. For example, the possibilities for studying shadows in the classroom boggles the imaginative mind. In the lab, students created a shadow that was not the shape of the object blocking the light (Meyer & Woodruff, 1977). There a drama easily unfolded, *stopping* deeply held models that have origins in experience (a shadow is invariably the same shape as the object); *interrupting* language (a "shadow" belongs to an object that "casts" it; "its" shadow, "my" shadow); and *interpreting* culture (contextual or symbolic meaning, shadows are dark and mysterious).

And there the idea for the play emerged. The blockage of light from a chair with clothes thrown on top became the shadow monster in a little girl's room. The journey from idea to stage involved the creative and practical application of the students' knowledge of shadows and light, sound and silence, motion and stillness. One of the students reported in her portfolio:

...the science was pervasive in this course. In problem solving the lighting, there was not one area of light that we did not actively discuss during our preparation for the play. I now know intimately how to make large and small shadows and create any colour shadow on demand. And don't even get me started on spot lighting...there is nothing we can't do now.

"Light Sound Moving Around: What are Monsters Made of?" And now, let us slip into our seats in the auditorium. The house lights dim and the curtain rises:

Wendy: You know, Einstein, I really hate this science homework. All we do is read from fat textbooks... and memorize formulas that just don't make sense! It's all scientific baffle-gab to me. Why don't they just use normal language?⁵

Wendy is our play's heroine. The stage is a bedroom at nightfall cluttered with scientific textbooks, a (six-foot) "stuffed" bunny named Einstein, and an unexplained monster in her room. Intrigued, she abandons her textbooks and seeks out the Monster through her closet door, a journey that unfolds in the surreal lands of light, sound and motion. With a reluctant Einstein in tow, she unravels the mysteries of coloured shadows, survives exploding carrots, jive-dances on musical stairs, and rescues her long-eared companion from shark-infested waters (all choreographed according to physics).

What happens when ten student teachers are invited to create a performance piece incorporating the principles of light, sound, and motion? They imagine into being a tall pink bunny who rolls scientific definitions off his tongue, an animated metaphor of their experience in traditional science classrooms where the science textbook dominated. In fact, the entire play becomes a metaphor and critical interpretation of science teaching/learning and education in general.

Einstein: HELP! There's a giant bunny after me! Don't panic! Stay calm! There must be a scientific explanation for this? .. Ah, yes! When an object intercepts the light falling on a

surface, then the size of the shadow will be dependent upon the distance that the object is away from the light source! Whew! *Einstein turns around and sees his own giant shadow and again screams loudly.* It's still there! Wendy! Come over here! Quick!

In the script Einstein mouths incomprehensible scientific definitions while being chased by a giant bunny shadow (which is really his own) but is unable to rescue himself from the scientific phenomenon *hot on his heels*. It is only through the interactive investigation by his friend Wendy (and the lighting crew) that the nature and behavior of shadows is finally understood by Einstein and the giggling audience.

Einstein reads. The science of his world is words, and he deciphers Wendy's text over and over. He studies. But this madcap scientist is afraid of his own shadow. He leaves her room (until Wendy drags him through her closet door). His scientific edge is a science without a context. But there is nothing like the "real thing" success, recess, playground pendulums, inclined slides, and rotating carousels to move rote learning into application. These are technology for discovering motion. And experience has the momentum of a thousand words.

The play came to be the integration and interpretation of what the students had learned, imagined, and created during the course. Through the writing and producing of the play, students applied phenomena and "special effects" explored earlier in class investigations. They romped science out of the closet through a surrealist door and, in the end, confronted and challenged our experience of science as students and educators. As we moved toward the performance date, it became impossible to know what shaped our experience and the co-emerging script with its many authors. Drama or science? Science or drama? Only a curtain separated the two within the co-evolving world(s) of science and drama education. When the curtain opens, the (inter)play begins.

The Critical Interpretive Space. How did performative inquiry in the science classroom shape the experience and expectations of each participant in their understanding of science and its possibilities in the classroom? For the drama educator, the Pandora's box that was science explored in the course opened into the possibilities and wonders of science unimagined during long hours of grade twelve physics classes. *Physical phenomena became the raw material for dramatic exploration. The possibilities of drama and storytelling within the science classroom evolved into an unexpected site (sight) of journey and opportunity.*

For the science educator, drama enacted science as inquiry of our living world, where lighting, sound scapes, and action situated and contextualized phenomena. Further, performative inquiry of phenomena meant imagining and enacting possible variations, interrupting our own sense making, and interpreting what we experienced (what does it mean?). Storytelling through imagination and experience returned the language and ex-

ploration of science to the learner and educator. Such events were foreplay for qualitative understanding, a necessary precursor to quantitative analysis (of most physics). Thinking deeply about the phenomenon required mindful resonance with it in all its complexity. Though the real perplexity was wondering why we hadn't thought about it before. Suddenly, shadows became visible as we storied what they tell us about objects, space, time, and our relationship with them.

For our students, drama and storytelling in the science classroom offered an opportunity to explore alternative ways to teach and learn science that sanctioned doing, knowing, talking and creating. This (re)vision of science was a last-ditch effort for those students who had been afraid to trust in their own knowing and interactive exploration of phenomena within learning and teaching. In the end, our students brought forth their knowing as language embodied in performance to the stage, and in doing so, embraced the Monster that was once their science.

The question, "What are monsters made of?" is never answered in the play. Like all theories, however, possibilities are presented. Perhaps monsters in the classroom are disciplines kept separate: the scientist who fears to tread where the dramatist claims authority — the dramatist who shies from the language and practice of the scientist. Both fail to locate possible meeting places. But further, as our experience suggests, the monster is the cement wall between curriculum and learners that excludes and denies their presence. *We are here*. As educators and participants, we suggest that it was within the interdisciplinarity of our shared journey that we and our students voiced our presence. But it is a journey that is not without risk. Anne, the director of the play writes in her portfolio:

This class has certainly been the most personally risky of all my classes. Even my practicum was nothing compared to this science course. If you had told me a year ago that I would not only help write and create a play about science, but direct it as well, I would have told you that you were crazy.

To embrace performative inquiry is to acknowledge the risk, the unexpected, the interruption located in spaces that open us to possibility. This latter point, the debut of possibilities, eloquently articulates the complexity of embodied knowledge. To that end, complexity theorist Waldrop (1992) proposes that the "edge of chaos" is the balancing point between order and chaos, neither locked or turbulent but "spontaneous, adaptive and alive" (p.12). It is within this space where patterns of interrelations are continually created and recreated through an "endless dance of co-emergence" where possibilities seduce, and life dances into being. On the edge of chaos, where our worlds (drama and science) co-emerged, we located ourselves within an interdisciplinary space of action and interaction, where an unexpected critical reading of education and its possibilities danced into play.

Our work challenges education to reconsider the interplay and interrelationships between student and teacher, mind and body, learner and environment, knowledge and action.

Each is implicated in the other, and the boundaries are caesurae and between-ness. In teaching, the teacher and students bring forth a world together (Davis, Sumara, & Kieren, 1996) which is the linking of the critical (what matters?) with the creative (what if?). Education (so what?) then becomes enacting and interpreting our presence in the living world.

Endnotes

- ¹ We identify the intersection between the "real world" (i.e., within which is both the known and unknown) and the "imaginary world" of performance as the site of learning through which the "not-yet-known" is realized through creative action and interaction. This critical intersection is what drama educators call the "aha!" moment (Fells, in press).
- ² Performative inquiry uses drama processes such as improvisation, tableau, creative movement, sound scape, script writing, as tools of investigation. The conceptualization and articulation of performative inquiry by Fels has been informed by her work with Stothers, 1996, and with readings by Applebaum (1995); Barb (1995); and Phelan (1993).
- ³ See also Abram's (1996) discussion of the "invisible or absence within presence." Acknowledging Heidegger's suggestion that time and space are not separate entities but embodied within a single entity which he named "time-space," Abram claims that when we acknowledge an awareness of time embodied within space, then "Space is no longer experienced as a homogeneous void, but reveals itself as this vast and richly textured field in which we are corporeally immersed... (p. 216). However, we use the word "moment" rather than "time" to suggest a happening, as a moment located within space through which creative action and interaction realizes an absence made present.
- ⁴ A phrase borrowed from David Abram (1996), although he precedes it with "in."
- ⁵ Excerpt from *Light, Sound, Moving Around: What are Monsters Made of?*, written and produced by ScEd 310 students and performed on April, 1996.

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