

**From Deli Girl to Teacher of Artists:
A Visual Curriculum Beyond the Script**

BY

JoELLA EAGLIN SIUDA

M.S., University of Illinois @ Chicago, 1995

B.S., Elmhurst College, 1993

THESIS

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Defense Committee:

William H. Schubert, Chair and Advisor

William Ayers

Ward Weldon, Educational Policy Studies

Peter Hilton, St. Xavier University

Isabel Nuñez, Concordia University

This thesis is dedicated to my children, Roxanne and Maxwell. When each of you came into this world, my life found great meaning. And as I wrote this lengthy story of my life, you both reminded me again and again how important my life is. I am a lot of things to many people, but the most important person I am is Mom. Thank you for loving me and for giving me this gift of motherhood. Now I give you both this, my story.

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Let me start off our journey by saying this is a wonderful adventure of how I got my puppy! Have you ever wanted something that you would have to wait a long time for? Well I have.... I've really wanted a puppy since I was 8 years old. But my mom said I would have to wait till she finished her P.H.D. I thought, how am I supposed to wait for a puppy if I don't even know what a P.H.D. is and how long it takes to finish one? As usual my mom just said, "The more you ask me the longer it'll take to finish." This is where we begin our wonderful adventure of how I got my first and favorite puppy of all!

—Roxanne Siuda, "How I Got My Puppy!"

As I reflect on the path to this place in my life, I know that I have been blessed. This pursuit of a PhD was one of the greatest challenges of my life, but as you will read it is not *the* greatest. My greatest undertaking was pursuing college in the first place. Thank God for the energy of youth, which kept me up at all hours of the night to get things done, whatever the task. But energy without direction is a waste. I was lucky to have direction, as blessed souls kept emerging to accompany me for parts of my journey. For the sake of privacy, their names have been changed in my autobiographical narrative, but their deeds are present for all to recognize in this account. They are the ones who helped me to realize this story, my journey from community college to four-year institution and finally to graduate school for my Master's and now this PhD.

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And yes, Mom, you were right. You may not have a college education, but you *are* smart. In fact, you are brilliant, for your timing and love were impeccable as I pursued this degree. You always picked up the phone when I was ready to give up. You always knew when to share excerpts from your many books of positive wisdoms. You may have jumped the gun a little when you started planning my graduation party a few years back, but I still have the photo album reserved for the occasion here in my writing hideaway in the basement. One day at a time, you would tell me, one page at a time. Yes, Mom, this is how I would make a book—my book. Now, let’s have that party you’ve been talking about for so long.

It is my children that I lastly recognize, those little angels of mine. I started this adventure when my daughter, Roxanne, was one, thinking that it would be neat and fun to pursue a PhD. I

thought it would be the last beautiful thing I could do with my life. I was wrong, because, three years later, I had Maxwell. Between my two children I learned that if they could learn to roll over, crawl, and walk, anything was possible, even this. Thank you, my children, for your love, support, and kindness. Thank you for accepting dinners of hot dogs, my late nights at school, and the many hours I spent in the basement writing. Thank you both for being so strong, doing it on your own occasionally, each holding the other's hands when needed. To you both, I give you this work, my life.

JES

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SUMMARY

This work came out of a desire to showcase the learning of science via the use of multimodal formats and interventions. It was conceived as an attempt to highlight iconistic means of communication as a possible tool in the learning and teaching of science in the classroom. But as the pages were written, another theme emerged: the importance of telling the story of my life, especially as it pertains to my search for a life along the path of education as opposed to the well-worn path already laid out for me. These two themes, 1) the realization that education is an important and valuable pursuit no matter the obstructions, and 2) how one can possibly utilize the arts/aesthetics to understand science, were approached using a three-prong theoretical framework. I utilized the ideas that reflection can be a basis of research, that the Arts hold grounding in this research, and that engagement with life *is* curriculum.

My method of pursuing these themes involved a personal recount of my life. And as I moved between writing, reflecting, and experiencing all that had “composed” my life, as Bateson (1989) so eloquently puts it, I realized that this piece of writing was a gift. These words would be special, for they would tell the story of a young girl attempting to make a life of worth and value in a very dark place; this would be the story of the curriculum of a life, *my life*, and how it flourished against great odds. An even greater realization was that this story is universal, as all human beings are scampering to find worth and meaning for their existence sandwiched somewhere between the cradle and the grave. Thus, even as I wrote about my own past, present, and future hopes, I would also bring into this story the lives of my students through fictionalized structures; together we are each searching for our own unique path to learning.

This dissertation follows my life from the time I first found the courage to enroll in college, against all expectations, through the many years I spent attaining an associate degree,

my Bachelor's, and finally, my Master's. This journey would take me many places; sometimes I traveled alone, sometimes I was aided by important individuals who helped show me the way. My life in this way demonstrates Dewey's (1916) idea of transmission and reconstruction of knowledge for future generations. This was not merely transmission for the sake of the "social continuing of life" (p. 2); instead it was a call to realize who I could possibly be. This was reconstruction of the ways of becoming a college student, of what it *means* to be a college student, and what it could bring to the future.

As well, this dissertation notes the great breadth of curriculum that informs a life. My life was intertwined with running, music, positive thinking, and other curricula not considered the norm or part of traditional education. But these would foster my growth in college and are surely no different than the types of curricula my own students engage with. Over my years of schooling, I was as much involved in these particular curricula as I was with the chemistry I learned in the classroom. Bits of these unique curricula are interwoven throughout this narrative, enforcing the many Schubertian (1981, 2009) ideas on curriculum.

Lastly, this dissertation brings into focus a unique engagement with the teaching and learning of chemistry—via the visual domain. The visual is paramount in how I learned. Pictures, images, graphs, tables, and so many other iconistic avenues offered me a means to build my understanding of science concepts. Many of the visuals that directed my path in the learning of chemistry concepts are included here, as are the images of actual work by myself and some of the students I have engaged with in my years as a teacher of artists. What I *see*, what my students *see*, are communication snapshots; they express what our knowledge of science is at a particular moment in time. Just as Kress and van Leeuwen (1996, 1998, 2001) suggest, the visual is a language, complete with its own grammar and syntax.

The goal of this dissertation is to advocate for *allowance*. I try to illustrate the need to allow students to find their own paths (curricula) to learn and grow. This is a respectful cry for the integration of means to showcase knowledge of science constructs in the many divergent forms that exist. This is evidenced in my story and highlights Eisner's (1998) idea of the best possible truth that I can uncover with the enlightened eye. I offer hope for the removal of limitations on thinking, learning, and knowing by proposing an allowance for the visual icon to be a part of our teaching and learning experiences, intertwined with the mode of text.

I. INTRODUCTION:

WORTHWHILE STORIES: “RE-PRESENTING” THEN AND NOW

May 1980, eighth-grade graduation

“Jo, you really did an excellent job on that paper. Second place is wonderful. The Archdiocese felt that your writing was profound. Enlisting Our Spiritual Father, Pope John Paul II, as a comparison to describe the love and kindness of your grandfather was just superb.”

“Thank you, Sister Mary.” Buoyed by her words, I turn to walk away with the assurance that I am somebody.

“Congratulations, Mrs. Auer, you must be so proud of your daughter. She did a marvelous job, and I’m sure that if more time and financial backing had been put toward aiding the school, she would have earned first place.”

Head bowed, I pretend not to hear. I guess Debbie was first because she comes from a good family. And I was second because I don’t. My family isn’t good enough. I’m not good enough. And I’ll never be worth first place...

All voices need to be heard; none should be discounted. I can make this statement now but only after relentless periods of self-doubt. When I began this educational journey, my greatest obstacle was myself. I couldn’t believe that any words I put to paper might be of value, have meaning, or generate discussion worthy of a PhD. Now I believe these words *must* make up my dissertation, should be bound and placed on a library shelf. This work came about with the patient understanding and support of those who have been with me since I first hoped to realize a PhD eleven years ago. Now, as I move between writing, reflecting, and experiencing all that “composes” my life, as Bateson (1989) so eloquently puts it, I realize that this work is a gift to

myself that finally brings to light many of the intricate nuances that make me “Jo” and lends those qualities credence and value. Like all individuals, Jo is the manifestation of constant change and reevaluation; her life is an “improvisatory art... combin[ing] familiar and unfamiliar components in response to new situations following an underlying grammar and an evolving aesthetic” (p. 3).

I hope this work also serves as a gift to others—a *scholarly* endeavor highlighting the *human* endeavor to find one’s unique voice in this world. And the words here are indeed special. They speak of a young girl in a very dark place attempting to create a life of worth and value; the story is the curriculum of her life, and how she flourished against many odds. But the greater message is that this story is universal, that we all struggle to find worth and meaning for existence while sandwiched somewhere between the cradle and the grave—an idea I feel privileged to have developed under the tutelage of Dr. William Schubert and many others in the field of education. Here, following the example of DeSalvo (1999), I “re-present” my life, presenting not simply what transpired, a factual account of experiences, but engaging the writing process as a method of personal healing and perhaps as a means to help heal others facing similar dilemmas.

To state to the academic community the value of this phenomenon of inquiry seems almost moot—how can its worth be questioned if the worth of every member of humankind is assumed? But as a doctoral student in training, I must attempt to present a case for the value of the myriad nuances and characteristics embodied by life’s participants. All individuals, and the range of curricula that fostered them, are of worth. I have always felt that even the most inconsequential-seeming detail may be important—if not at this moment, then surely at another. My training in the sciences has contributed to this belief. Consider chaos theory and the butterfly

effect, which holds that the movement of a butterfly on one side of the world can lead to a storm on the other, or how a genetic mutation on the hemoglobin molecule is the same sickle cell that protects from malaria.

Dewey (1938a, 1998) describes experiences as being educative in nature, that each gives rise to the development of the individual. What mysteries, then, are there to be uncovered? How can one's life be a contribution to academia? I suggest that it is life as it is lived, the *lived* life—its unfolding, fine gradations, and interconnectedness of paths taken and not—that showcases life's great curriculum. Life is the great Teacher, the Student its soul. And as life is so grand, so encompassing, its curriculum is as vast as the imagination can travel. And each individual engages with this beautifully extravagant curriculum of life in constant evolution as a novel human being, completely unique from what has been or ever will be. Some of us are blessed with few hardships, while others are here by the grace of God, our mettle tested under constant duress. Some of us fall in between, bearing the distinct marks of suffering and joy. Life is a composition of such intricacy that it would be folly to think it measurable or an object of sure discernment. To avoid this trap, I continually address and readdress my theory, my beliefs, to see which have become too all-or-nothing, excluding other possibilities that could arise with a more open mind. With my proposal I learned to be wary of this pitfall, and I will continue to be diligent in this regard. In this way I remain true to my narrative (the dominant narrative, for it is *my* story), while noting that “reality is always messier, always more complicated, always more idiosyncratic than any particular story can honestly contain” (Ayers, 2008, p. 50).

With these thoughts in mind, I would like to look at my life. To see the young girl that decided to become something, anything other than a deli girl. To follow her journey, watch her work, think, believe, struggle, and move slowly forward. I want to know her. She is like the

phoenix emerging from the ashes, flying high enough to negate the suffering of the world that once confined her, the world that offered no future but the “scripted life,” the expected one, the life handed down from generation to generation (MacAdams, 1993). I want to understand two things: 1) how that young girl found the courage to leave the deli and enter college, i.e., the unknown, and 2) how she discovered her own mode of learning to not just survive school but to thrive in the sciences.

I so desperately need to interact with that girl, the Jo of my past, because I feel she aids me as a teacher. She tells me to work *with* my students, not *against* them—to help them find their own way of learning and sharing knowledge, and to allow them to engage in the classroom in this way—so that they can thrive. She reminds me to use all of my senses, because there is more than one way to communicate knowing. She insists that I integrate material, reminding me how she learned best by linking together information often presented as distinct. She would read, look at the visuals, hear the words, and look for points of similarity and difference. She would compare and contrast, combining ideas to create a visual image that clarified the story, gave it sense and meaning to her own life.

As an adult scholar on the road to a PhD, I can now see that the young Jo’s ideas of integration were neither far-flung nor whimsical but in fact supported by the literature. Echoing the Plowden Report (1967), which followed the Progressive Education Association’s Eight Year Study (1933-41), Kerry (2007) talks of integrated studies as key to a holistic view of curriculum, asking why, if children do not learn compartmentally, the school curriculum should be designed that way. Kerry argues in favor of integration, citing the false truth of a curriculum premised on the idea that knowledge falls into subjects that must be taught independently. He believes that all subjects follow the same epistemology and involve solving problems, collecting evidence,

drawing conclusions, and speaking in symbols (p. 79). He dismisses the notion of “subject specialists,” instead describing all those engaged in teaching as philosophers offering a “‘content-led’ distinctive contribution to human insight” (p. 79). In his 1902 groundbreaking work *The Child and the Curriculum*, Dewey suggests that the curriculum is fostered and driven by the curriculum of the child, the learner engaged with life’s experiences. Scholars including Schubert and the Dewey Ideas Group¹ read his phrasing of “the child and the curriculum” as an allusion to an integrated whole, whereby the child is not distinct from the curriculum but rather is the curriculum. Kerry (2007) echoes this notion and calls for freeing individuals to pursue their own way of learning, unrestrained by preset curricular disciplines, which he deems counterproductive.

[W]hile the physicist, the chemist, and the theologian may each have a content-led distinctive contribution to make to human insight, each insight alone is partial, potentially blinkered, and ultimately unsatisfying. Only by drawing all the insights—and others—together can the jigsaw of human life and the universe be more than a relatively random and incomplete corner of the real puzzle. (p. 79)

Thus I move forward with the realization that the way Jo learned in the past—and still learns today—follows an integrated approach to learning, one that I foster with my own students. I know that to discount those tender souls would be unkind. They are engaged with learning about life and themselves in the Deweyan sense. This allows them to find for themselves what is worth knowing—a very private imperative of the soul—and respects their right as human beings to showcase their knowledge in ways divergent from the educational norms. This is what the young Jo did instinctively, and it is what I believe is right today.

¹ Comprised of D. Wong, K. Pugh, R. Prawat, P. Jackson, P. Mushra, V. Worthington, M. Girod, B. Packard, and C. Thomas; their work involves interpretation of Deweyan writings.

Many in the world of education believe there is a need to open the classroom—and anywhere that learning takes place—to the myriad paths of coming to know. The goal of this work and that of other like-minded scholars is to promote inclusion, to bring into the fold the multitudes on the journey to learn and to allow them each their unique path. As Greene and Eisner (1981) suggest, the many modalities of learning need to be included in the educational process. This would allow the visual learner, the text-based learner, and the kinesthetic learner to all learn—and communicate what they’ve learned—in the mode appropriate to their cognitive design.

Our students are human beings who are so much more than labels (“inner-city youth,” “marginalized suburban youth”). They are unique souls who need to showcase their knowledge. It would behoove us in the field of education to reconsider how we reach our students and how they communicate their learning. Thus, this dissertation is an inquiry into the how-to of teaching and learning for those not exposed to the pursuit of education, those who, like myself, were not encouraged to even entertain higher education as an option. I would like those in the field to allow for greater inclusion of such students and to engage a more spiritual and psychological approach in our communal learning. I wish to avoid the ease of generalization, but I feel these goals are especially important with regards to the population I work with: mostly first-generation college students with little or no prior exposure to the world of education beyond high school. All are unique learners. We, as educators and as precious souls ourselves, must avoid the limitations of labeling and generalization.

In the 1930s, mathematicians of the Bourbaki school maintained that visuals must be avoided in teaching so as to stay “true” to the math and avoid “fooling” the mind’s eye. Many in the field scoffed at the idea, countering that visuals stimulated mental imagery and that there was

more than one path toward understanding math. I see the current state of education to be analogous: Who are we to impose such limitations on thinking, learning, and knowing by devaluing visual icons in our teaching and learning experiences? It is one thing to *not know* something—ignorance may stem from myriad reasons—but it is quite another to know something but be limited from disclosing it because of imposed rules on methods for what Dewey (1938a/1998, p. 23) called the “transference of knowledge.” How can we suggest that the only way to come to know is through the primary mode of text (i.e., traditional educational materials) and the only means of demonstrating knowledge is through standardized assessments? Rhetoric aside, how do we go about assuring equal standing for visual-based learning and communicating?

Again, I ask for an inclusive teaching and learning dynamic. Consider, for example, a test on the duality of light as both a particle and wave. What if instead of writing a verbatim definition of light’s characteristics according to some lecture, the student drew two illustrations: one of a wave and one of tiny pixilated markings that suggest photons? Would one answer be any more or less correct? I realize that text entails the rules of grammar, syntax, and punctuation, and that the rules guiding the visual domain are less clear-cut—thereby making assessment more complex than simply following an answer key—but does that mean one mode of answer is any more correct? While it would likely be easier to grade the written answer (policy does foster efficient assessment), does limiting the mode of response support the goal of inclusive teaching and learning methods?

These are questions that I wish to mull over and shine light upon in this dissertation. They are of value to me, because I am a visual learner. And I was one of those marginalized students. I propose that this research *is* of worth and value—again, not just for me, but for all

those like me, who were treated as inferior and whose voices were ignored. I plead for this opportunity for us to exist in the academic sphere. And perhaps once we are noted in this world, our presence will be embraced outside it.

II. THEORETICAL FRAMEWORK AND RELATED LITERATURE

A. Theoretical Framework

An ounce of experience is better than a ton of theory.
—John Dewey, *Democracy & Education*

To guide this inquiry and support what follows, a solid theoretical framework is advised. This seems logical and pragmatic, and I work diligently toward this end. However, I resist the urge to pigeonhole an experience—whether my own or that of a student’s—with the lens of any one particular theory. From what I have learned in my work with the sciences, phenomena must often be illuminated by more than one theoretical background; light, for example, has many unique characteristics, some illuminated by wave theory, others by particle theory. What a loss for science if only one theory were applied! Thus, with this in mind, I apply multiple theoretical perspectives to assure a more thorough, inclusive dissertation as I pursue two primary themes: 1) the realization that education is an important, valuable pursuit no matter the obstructions; and 2) the possible applications of the arts/aesthetics in the understanding of science.

As I introduce the components of my theoretical framework, I wish to make clear that no approach is superior to any other. I look at each as offering a different perspective and believe that together these perspectives form the most complete understanding of the experiences discussed herein at this particular time. I do not pretend to arrive at the Truth, only at my own best estimation of the Truth. (I don’t believe one can engage in life, gather information from the experience, and smugly surmise the one true meaning of existence.) As influenced by my background in the sciences, I believe that what we present as the best explanation—as Truth—may not tell the whole story; rather, the reality of our experience is composed of many

underlying points, dimensions, and *truths*. For example, weather formations—evidence of nature at work—may appear chaotic but in fact encompass underlying certainties. Careful examination of a small section of the entire chaos function, as haphazard as it may seem, would reveal that each component demonstrates consistent reiterations, formal wave functions, and mathematical principles. Surely, if science accepts the notion that in chaos there is form, so too can one reach the analogous conclusion that the Truth of a lived life is really the composite of many truths.

Here I must acknowledge the work of Dewey as the initial lead for this dissertation. It is in Dewey's work that I found the most progressive outlook on teaching and learning, and it is in his ideas that my own are rooted. From Dewey, I discovered the work of others who seem to embrace his educational philosophies. Maxine Greene (1981, 1988) and Elliot Eisner (1982, 1997), for instance, discuss the dynamics of teaching and learning, and how the process takes many divergences and requires consummate attention and reflection. Pinar (2004b), meanwhile, calls for inclusion of the arts in teaching to improve knowledge of a subject and knowledge of the self. My studies eventually led to the realization that teaching and learning are not confined to any one environment, the classroom, for instance, and that life provides the curriculum—that *life is the curriculum*—and is not limited by space or time (Schubert, 1981, 2008, 2009, 2010).

Bearing all this in mind, I invoke three dimensions for finding the greatest clarity in my subject matter, namely my own experiences and the experiences of my students as we engage in the communal process of learning and teaching science. These dimensions are: 1) reflection as research, 2) arts-based research, and 3) the idea of one's life as the curriculum, and vice versa.

1. Reflection as research

I would like to note those educational theorists and others who support reflection and reflective practices, specifically autobiographical narrative encompassing reflection on teaching and learning toward empowerment of both teacher and learner. Teacher reflective works abound; for example, Nash (2004) writes of the “echoing” of commonalities in the teaching and learning dynamic; Greene (1981, 1988) and Eisner (1982, 1997) write of affordances for empathy, understanding, and divergent ways of knowing; and Dewey (1916, 1934) writes of full submergence in worthwhile experiences relating to the learner, for the learner.

It is impossible to learn about my students without learning about myself. And here I cannot write only of how I see myself now, as a successful science teacher at an inner-city commercial arts college. Because as I look into my students’ eyes, I see a reflection of my past self. I see fear, worry, hope, a mixture of infinite emotions related to my students’ conception of science and, more importantly, their perception of themselves on their educational journey. I feel that by pursuing education, they, like I did, are working to “resist routine, seek expansion and emancipation,” as Greene writes in her foreword to Dewey’s *How We Think* (1988, p. xiv). Only by trying to “to see things as otherwise” (1981, p. 16) is there hope freedom will ring for them.

Thus this dissertation must involve reflection, that of an educator engaging with her past and acknowledging how it affects her teaching. How I teach—how I allow for student learning—falls squarely on my past; it is the direct result of my life’s composition (Bateson, 1989).

2. Arts-based research

Engaging with artists in the teaching and learning dynamic requires being “present” and using one’s ideas as a “communication venue” to gauge the specific characteristics and nuances of a work. One must strive to understand the person, the student artist, involved in the making of

art; as a teacher, it is crucial to gain insight into students' thoughts and ideas as they compose their work. Pinar (2004) offers great guidance for using the research methodology of A/r/tography to render one's knowledge of self in the creation and appreciation of an artwork.

While this is not my sole focus, I draw upon this line of research to grant my students—each their own artist—and myself alternative means of showcasing knowledge of science constructs. Each student freely makes use of his or her creative capacities, and evolving knowledge of artistic media, to present the concepts covered in class. Students' individual choice of media reflects how they have conceptualized an idea as well as their particular skills and the demands of the assignment. For example, a student artist wishing to model the spinning orbitals of an atom may choose Adobe Photoshop as their media over the standard sticks and putty of earlier times; representation of the movement of the various ellipses is made significantly easier this way. As a teacher, I appreciate this insight into a student's thinking. It not only helps to glean their understanding of a concept, it offers some idea of the value they place on it.

This type of inquiry is grounded in what I call *allowances*, a term nearly synonymous to *affordances* as used by Eisner and Greene (Greene & Eisner 1981) but that speaks more to my concerns about voices being discounted because of rigid expectations and privileged standards. “Affordances” means offering students opportunities for showcasing knowledge in other ways. I like to emphasize not only the affordance of options, which is rather abstract, but also the importance of ensuring that teachers allow divergent voices and perspectives in the classroom. I want to stay true to the tenets of Dewey and make learning an individual experience in which the child *is* the curriculum. The student needs to be heard. Specific to science, students may use art to engage with concepts and utilize knowledge particular to their discipline(s) to enhance their understanding (Radkin & Robbins, 2004; Heath & Robinson, 2004). Allowing students the

advantage of working in a familiar medium, using the tools of their trade, enables greater accuracy in assessing what they understand; it provides a snatch of what *is*, that is, insight into the cognitive understanding of the student with regards to the concept in question. This approach is related to ethnographic studies, as concepts are contextualized in the world of the participants (Glaser, 1978; Emerson, Fretz & Shaw, 1995). By accepting creative work as a valid form of communicating knowledge in the classroom, teachers allow students to learn on their own terms and “subjugated perspectives are given voice” (Leavy, 2008, p. 13).

These perspectives I would like to hear, and as a teacher I must work/inquire in the realm of my students. Perhaps I feel a need for engagement with the arts in the classroom because the medium has provided a venue for my own voice to be heard. Among my own mix of inner voices, there is one dominant voice that feels a need engage in the dialogue. And through the arts, this voice can be recognized and engage in communication with the voices of other artists. As I myself utilize the mode of the visual to teach and learn, I offer my students this same opportunity to speak and be heard through the arts.

3. Life as curriculum and beyond

Here I engage with Schubert’s (1981, 2008, 2009, 2010) ideas regarding the many curricula found in a life, as well as the layers of ideas that I feel I inherently follow. For instance, I think of these curricula coming together over the course of one’s life, becoming interwoven via Deweyan experiences (1934) to create a beautiful three-dimensional tapestry—a *life*, complete with a beginning, middle, and end. I find this tapestry evidenced in every human I casually encounter on the street, each exquisitely and uniquely formed. As a college teacher I want to encourage students to consider education as a worthwhile pursuit. I think of students like myself

whose first encounter with higher education may have come in the form of a college advertisement on TV. Such students begin far behind those instilled with the promise of college at family dinner tables where conversation centered on topics like grades, plans, and hopes for the future.

To engage learners who lack educational support at home, I must support multimodality in the classroom, for it is these students that Greene and Eisner (1981) argue learn in manners different from traditional modes. In my teaching I have facilitated multimodal learning of science concepts through the arts. My experience suggests literacy beyond the text in visual icons. Kress and van Leeuwen (1996, 1998, 2001, 2003) suggest there is significant merit to the exploration of the visual, drawing attention to the elements and structures of design, and the ways these communicate specific meaning(s). This dissertation is an effort to show how I have enabled students to find worth (Schubert, 1981, 2008, 2009, 2010) in the study of science through their own genuine interest in art. As they strive to make art tell the story of their understanding of the science, I too attempt to let this dissertation tell the story of their coming to know the science in a way that parallels my own.

III. Methodology

*You got a fast car
I want a ticket to anywhere
Maybe we make a deal
Maybe together we can get somewhere*

*Any place is better
Starting from zero got nothing to lose
Maybe we'll make something
But me myself I got nothing to prove
—Tracy Chapman, “Fast Car”*

But, of course, I do have something to prove. I come from a family in which most did not attend high school or finish if they started, so I always felt up against negative expectations as well as alone on my educational journey—first in high school, then in college and beyond. Growing up, my family’s perspective on higher learning seemed clear: College was just a pipe dream. Instead I should choose a more “realistic” goal, like getting married and a job at the grocery store. Still, I determined to charter my ship into the unknown. I had an idea only of my starting point: I came from zero, if not from somewhere in the negative digits.

I set sail in 1988, when I first stepped out of my secondhand Chevy Cavalier and into the local community college. When I embarked upon my voyage, I never guessed it would lead toward a PhD in Education. I had no idea where my ship would take me. Many times, I became convinced I would never find land. I was sure I’d wind up lost at sea, bailing out water from a sinking vessel while sharks circled, smelling fresh meat. Nothing seemed more treacherous than the journey to a PhD—that is, until I found the opportunity to bring “me,” Jo, into the work.

I eventually made it to this Midwestern university, where I took the classes and did the research but struggled with how to engage the tenets of the curriculum. I did not know how to get myself to the point where I could create a serious piece of scholarly writing. That changed as

I came to recognize my battle—the battle for others to understand me, to understand Jo and *her* ways of learning, teaching, knowing, surviving, and excelling. This, as my research advisor would suggest, was worthwhile. I needed to write about me—and about those that I engaged with in my vocation: my students. Deep in my heart I have always felt that my life was a gift from the Divine, even when others signaled the contrary. That is why I first set sail some twenty-two years ago, my sights set on college. And that is why I continued on to pursue my doctoral studies at this university, where I have docked my ship for the last eleven years. So here I am, nearing my PhD's completion, gripped by the need to document the journey, to reverence the life of Jo in an effort to understand her so that her own students may flourish. I hope that this work helps to help them realize more of their potential.

In telling the story of Jo's journey, in this “re-presentation” of the curriculum of my life, I uncover facets of myself—my beliefs, my concerns, my ponderings—that inform the way I teach science to art students. For instance, the novel way I came to understand the concepts of chemistry and the lack of support I received at home formed the basis for the ways that I teach in the classroom. I share my story in a semi-fictionalized autobiographical account. All names have been changed, staying true to the tenets of a sound qualitative ethnographic autobiographical piece (Ellis, 2004; Glaser, 1978). I recount my past, relying heavily on storied depiction of experience, emotion, and reflection to carry this work forward, showing it to be of value and merit, not just to myself but to others as well. I follow with reflection on these experiences based on my readings, my coursework, and the opportunities I have been given as a teacher of artists. Work of this kind speaks to the value of being true to the narrative and allowing for it to pull and push us forward in growing and learning as humans—teachers and students alike—in a progressive spirit (Ayers, 1993, 2008). In this way, this work is a gift to myself, to my spirit,

because by writing of the pain of the past I can “re-present it” to allow for healing (DeSalvo, 1999). This process, too, is part of my own battle to nullify the curriculum of a past that fostered feelings that I was not good enough to even attempt a work of this kind.

The ideas I explore come from three different camps, namely the artistic community, the educational research community, and the community of those engaged in cognitive studies. I believe the theories of all three must be weighed in contemplations of the learning and teaching of science through the arts, given the importance of the visual icon in artist attempts to make meaning of the world, the visual’s ability to convey student understanding of concepts, and its role in bridging and networking information, i.e., in the scaffolding of the brain. I discuss topics of multimodal teaching and learning from Eisner (1982, 1997) and Greene (1981, 1988), who suggest that multiple modes of communicating should be allowed so that one can “conceive a better order of things” (Greene, 1988, p. 16). I also delve into the ideas of multimodal literacy of Kress and van Leeuwen (1996, 1998, 2001), who note the importance of the visual icon in storytelling and its role in communication, including its inherent syntax and grammar. Discussion of the use of metaphors (Lakoff & Johnson, 1980) and analogies (Matewson, 1999) in understanding follows, as it is in the mind’s eye that we in the sciences design our models, rendering and re-rendering them as new ideas arise that must be accounted for (Nunez-Oviedo & Clement, 2003; Frederiksen, White & Gutwill, 1999).

Above all, Dewey informs my study, because it was he who reminded me of my altruistic self. His strong belief in the value of art, education, and experience is interwoven throughout his brave 1933 work *Dewey outlines Utopian schools*, and this underlies my own thinking, as evidenced not only in my reflections on the past but in my lived present as a teacher of artists. My students engage with art; I engage with their work. As artists design and generate work, they

evidence their lives and experiences. Those exposed to the process become privy to the artists' thoughts; we learn a great deal about how they engage ideas in the choices they make from conception to execution. Pinar (2004), Rabkin and Redmond (2004), and most recently Leavy (2008) all make cases for the arts as a focal point of the learning and teaching dynamic.

The methodological posture I take follows a chronological timeline, highlighting those aha moments that answer personal questions of what is worthwhile to myself and to my students in the integration of art and science. I work hard toward discovering “what kind and quality of knowledge and experience enable[s] a person to live a good and fulfilling life” (Schubert, 1986, p. viii), focusing on exciting, fulfilling interactions with science that may encourage my budding student artists to generate work that provides them personal satisfaction and a sense of worthy engagement. I attempt to stay true to the tenets of a good narrative: coherence, turning points, and replotting (Harvey et al., 2006). And I attempt to remain aware of my work as “evidencing the soul of the characters” in the narrative (Leavy, 2008, p. 32), for we are intimately involved. My students and I both are teaching and learning; we are the story.

Because my aim of telling our story is to advocate for the integration of art and science, I realize the importance of being painstakingly honest—I know that I must “muster the confidence to do the work” to have the opportunity to “theorize, speculate, to wonder, and to advocate” (Ayers, 2008, pp. 53–54). As many qualitative practitioners suggest, there is always, to some extent, “the personal embedded within the research practice and knowledge” (Leavy, 2008, p. 32). I suggest that an autobiographical account is the only way to generate credibility (Ayers, 2008), promote empathic understanding (Peliar, 2008), and support resonance (Ellis, 2004) as readers identify and engender understanding (Kim, 2006) with the “characters”—me, them, and the us that arises in the process of the story's telling.

In the spirit of being true to the past, many of the figures included in this dissertation are scanned images of my scribbles from the margins of my old text- and notebooks. This also helps to illustrate my maturation as a student in general and as a student of science in particular. The dissertation is formatted chronologically, evidencing my learning of chemistry via the integration of visual imagery, and includes insight into the realities of my life and the fears of my mind. For clarity, my past recollections, a worthwhile narrative (Ayers, 2008), are set in italics, while in standard type are the ponderings of a more mature PhD student engaging with the curricula in- and outside the boundaries of this Midwestern school (Schubert, 1981, 2008, 2009, 2010).

IV. THE FIRST STEP: REALIZING MY POTENTIAL

*When all I had
Was a hat full of stars
You loved the look
But you never looked inside
You could've seen far
You should've seen the magic
In my hat full of stars*

—Cyndi Lauper, “Hat Full of Stars”

May 1988, Wanting more from life than the deli.....

I run. When the voices get too overpowering and I can't take it anymore, I run. Running is good; it's my friend. When I run, I'm free—I'm alive—I exist. I put on my headphones and with my every stride become one with the beat. Music takes me away—to places I have never been, places I want to be. Away from the deli and its stink of meat. Away from home, if you want to call it that—to me, just a room in a house. And away from the houses that I clean, the homes that astound me with their stockpiled fridges and the buzzing of families always on the move, with things to do and people to meet. In those homes, money is in surplus, and twenty one year-olds like me don't have to work to pay for their food, rent to their parents, or for any of their basic needs.

“You're just like your father. You really think you can do this? What are you thinking?” My mom's words are punctuated by the tolling of the grandfather clock. The clock was a gift to her from my stepfather several years back. I could read and write, plus I was pretty good at math, so I tagged along with him and my eight-year-old brother that day to fill out the credit application. Mom's doubts echo in my brain: “What am I thinking?” The brochures I picked up at the local community college were filled with smiling students—I could be one of them. Marge

did it; of course, she had books and a desk and a calculator, but I could get those things, too. And, anyway, my best work in high school I did in my room, atop my bed, listening to my tapes—why change that now? My grandmother, who's less damaging to my spirit than Mom, or at least tries to smile and offer comfort, intercedes: "Jo, honey, the grocery store is good work, with reliable pay and health insurance. You're going to need health insurance. You can't keep getting lucky. You haven't had insurance since you were eighteen, and you're almost twenty-two. I'll get you in at Heinemann's if you're sick of the deli." The grandfather clock has stopped tolling, but the pendulum continues to swing. I need to go. I need to get out of here. Maybe they're both right: I'm like my father; I can't keep getting lucky. I don't know. I need to run.

My family did not know me, did not recognize the potential I felt deep inside. I had flashes of that ability, that stamina, that courage. Sometimes when I heard my best friend, Marge, talk about college with her family, I would see myself, a different Jo, following the same path; Marge was the mirror of my soul. In her, I could see what I could be and what I could do. It was that image, that Jo, that I kept reaching toward. And this girl I envisioned was not the anorexic of the past, who at eight years old weighed a frail sixty-seven pounds; no, this girl was a star, full of worth and potential.

But my family, they did not look very far. They could not see beyond the fear at the perimeter of their comfort zone. Maybe they had no mirrors for their souls? Maybe their mirrors had been shattered? I may never know. But I know it would be too easy to judge the situation from a single perspective, to focus only on my family's inability to foster my growth as an individual. Instead, I must find the courage to take a different approach, one more open to life, and that is the path I have chosen. From this more mature stage of growth, I revisit my

formation. The scientist in me looks back with a well-trained eye, looking for patterns, the repetition of subtleties, in the becoming of who I am—the end product of a dance of experiences and genetics.

What would Dewey say about this endeavor? I think quite a lot. After all, he was a champion of experience, noting the broad interconnected nature of experiences and the sense of their reoccurrence in the individual's mind. In numerous works he highlighted the merit of the lived moment, and the importance of garnering the most from the experience—for the present and for the eventual future. His *Experience & Education* (1938a/1998) still transcends time in its ideology, as seen in its 1998 rerelease with a foreword by Maxine Greene

Dewey (1929) also supported use of the scientific method in studies of teaching and learning, touting the lived experience as a valuable source of knowledge. In *How We Think* (1910) and *Logic: The Theory of Inquiry* (1938b), he builds his case for the lived experience as the curriculum of life. Today I hold this idea in high regard, that one's life experiences offer the keys to possibilities and potentialities and that each of us is a student of life engaged in the pursuit of what is worthwhile. In *The Child & the Curriculum* (1902a) and *School & the Society* (1902b), Dewey emphasizes the importance of offering the child opportunities to grow and learn, as they are the one who comprises the curriculum; they are both the designer and doer of learning. This is why many engaged with the study of Dewey's works (the Dewey Ideas Group, for example) suggest that the ampersand stands for *is* in Dewey's personal vocabulary. Thus, the child *is* the curriculum. Given the opportunity, they will learn what is important and appropriate according to their own lives.

Throughout his *Experience & Education* (1938a/1998, 1998), Dewey places great emphasis on the need for a strong, solid theory engaging the important tenets of experience. He

argues that experience should be looked at thoroughly, noting how “some experiences are mis-educative” and only have the effect of “distorting the growth of future experience” (p. 13). He asks rhetorically, “How shall the young become acquainted with the past in such a way that the acquaintance is a potent agent in appreciation of the living present?” (p. 11). These thoughts of experience, reverberate much in Elliot Eisner’s 1998 work, *The Enlightened Eye*. He suggests that “being smart about qualitative matters requires the ability to experience or create qualities worth experiencing” (p. 21). He showcases these ideas via an example involving two individuals that are chess players. One is an expert, a grandmaster, while the other is just a chess player, in no way having the extensive background, nor experiences in playing chess. He suggests that it is the grandmaster that “possess[es] a wider array of schemata with which to sort out the configurations on the board,” and would be able to differentiate and neglect unneeded info (p. 34). The two individuals would perceive things differently, see *truth* through their own eyes; there would be a striking difference in the completeness of the perceptions that they each have of this *truth* (p. 47). He talks of experience, suggesting that “we are always in a constructive position. We make our experience, not simply have it” (p. 59).

Dewey’s ideas reverberate throughout much of the literature of education, in different words by varying theorists and practitioners in the field of curriculum and at different times. For instance, Schubert (2009) discusses the lived journey to discover what is of personal worth to the individual—what is “worthwhile.” Ayers (1993, 2008) discusses bringing to life the “truth of the narrative,” the journey to find one’s own value(s) and meaning(s) in the course of living. This is the same journey described in Pinar’s (1975) concept of *currere*, an undertaking of self-discovery in which the present is understood more fully by noting the experiences of the past, their multidimensional nature, both conceptual and preconceptual. In his foreword to the original

1938 edition of Dewey's *Experience & Education*, Alfred L. Hall-Quest ties in Dewey's ideas of worth and truth with the great importance of confirming that these lived experiences are educative and build the foundation for more successful experiences to knowing. Hall-Quest notes how "frowning upon labels that express and prolong schism, Dr. Dewey interprets education as the scientific method by means of which man studies the world, acquires cumulatively knowledge of meanings and values, these outcomes, however being data for critical study and intelligent living" (1938a/1998, pp. xi–xii). He goes on to discuss how Dewey would envision utilization of the scientific method by those in the field, the actual scientists. These scientists do not confine their investigations to problems discovered but, he says, they proceed

to study the nature of problems, their age, conditions and significance. To this end, [they] may need to review related stories of knowledge. Consequently, education must employ progressive organization of subject-matter in order that the understanding of this subject-matter may illuminate the meaning and significance of the problem. Scientific study leads to, and enlarges, experience, but this experience is educative only to the degree that it rests upon a continuity of significant knowledge and to the degree that this knowledge modifies or "modulates" the learner's outlook, attitude and skill. The true learning situation, then, has longitudinal and lateral dimensions. It is both historical and social. It is orderly and dynamic. (pp. xi–xii)

To me, Hall-Quest here speaks directly to the four steps of *currere*—the regressive, progressive, analytical, and synthetical—that serve to reconceptualize curriculum and place the foci squarely on the shoulders of experience. Here, it is the scientific method that can shine light on the characteristics of this world and the experiences that the individual engages with on the journey to learn of themselves and their environment. The journey to discover the world, and the journey to discover oneself in this world, is the curriculum of a life. Use of the scientific method calls for logical interpretations and truth in evidencing the individual's encounters with their

environment. It is a journey of the individual to find their place in this life, one of meaning and worth. It is a journey that transcends limiting thoughts that do not stand up to the rigorous testing of logical scientific inquiry.

In *Teaching to Transgress: Education as the Practice of Freedom*, bell hooks (1994) hearkens back to the ideas of Dewey in *Education & Experience* (1938a/1998) as well as Paulo Freire (1970) when she writes of her commitment to eradicating *isms* that are essentialized in racism and sexism but also include the need “to eradicate systems of class exploitation” (p. 23). hooks (1994) suggests that students “want knowledge... addressing the connection between what they are learning and their overall life experiences” (p. 19). She writes that “students and professors [need to]... regard one another as whole human beings, striving not just for knowledge in books, but knowledge about how to live in the world” (p. 15). My experience also tells me that experience is the key point to the curriculum of today, yesterday, and our future.

V. THE SECOND STEP: FOLLOWING MARGE

Children's talents to endure stem from their ignorance of alternatives.

—Maya Angelou, *I Know Why the Caged Bird Sings*

I feel such sadness thinking back on the young Jo living the life that had been scripted for her, blindly following in the footsteps of family, whose ties can both nurture and bind. As Daniel MacAdams writes in *The Stories We Live By: Personal Myths and the Making of the Self* (1993), most people live according to a *script*—a set way of doing, thinking, and living that is expected of them by family, friends, or others. The great tragedy of living according to script is that one may never learn that the world entertained as reality could be a total sham; and, of course, what is lost is the life that could have been. I have always feared what I may be losing. And this fear is what at age twenty-two made me step into my Chevy Cavalier—less than four years old but already 200,000 miles on it—and finally set off to college and an unknown future.

And as I reflect on that first step toward a new life, I can at last allow myself to fully experience the storm of emotions that accompanied it, a luxury the young Jo could not afford. The desire to shake loose from the chains of expectation took root in high school, but when others talked of college, invoking bright futures, I thought of my blue Cavalier. Bought when I was eighteen with money set aside for me by the dad I never knew, that car was my ticket out. On countless nights I drove it aimlessly, telling myself it was enough to simply stay on the road and between the lines.

August 1988, first day at College of Novet

I can feel the terror low in my stomach. What am I doing here? I can't do this; I can't even find the right building. Boy, is it cold out! The fall chill is usually bad enough, but standing

here trying to muster the courage to move forward, it feels as though the cold's creeping into the crevices of my bones and spooking my very soul. I never knew a school could be so big; I'm so lost. But I have to focus on the positive. Others have done this—I can, too! But, God, am I scared! What if I'm wrong? What if this is too big to take on? Maybe I should just get married, have some babies. I mean, my grandmother's right: That is all we know. I shouldn't "make waves." I should stick with the grocery store—be content as a "deli girl" like my grandmother and my mother, too. But I want more; I think I can do more.

Making my way through the parking lot, I gasp at how large and ominous the buildings seem. There's so much going on here—with all these structures, there must be. I have directions to the registration office, but I'm not sure which way to go. I head for the biggest building; turns out it's the aquatic center. I grab the kid nearest the pool and ask for help. Grinning widely, he instructs me to walk down this corridor and that till I reach the main area where Student Services are. He can't be more than eighteen, four years younger and already way ahead of me. I should have graduated college by now, but instead I'm just lost in the pool. I decide to go home. If I go home, tomorrow may be better.

And it is. The next day, I head straight for the right building, the right floor, the right room, and to Student Services, where Rebecca Hamnotting not only registers me for classes but gives me tips for navigating campus—liberal arts are in Building B, sciences in Building C. I've made it to campus, signed up for two classes, know where and which days to go. I'm not quite as lost; I can hold my head up.... And then out of nowhere I tell myself that these first two classes will determine whether I stay in school or not. If I pass, I stay. If not, I'm done. All bets are on Typing 100 and New Directions for Women 101, one to teach me what every college student should know, the other to help me find a "new direction."

Looking back, I ask myself why about so many things: Why did I place such limitations on myself? Why the arbitrary rules? I did this to myself every step of the way, telling myself that if I could pass this class or get to that point, I could keep going. For me, school was not for enjoyment or learning; it was a process of self-affirmation, a testament of my worth and my ability to be more than a deli girl. And these benchmarks kept me in check. No wasting time on a sinking ship, I told myself; always know when to jump overboard and swim to shore. The deli job, the husband in construction—those were sure things; I knew what to expect from that kind of life. But this college journey was just a boat cast at sea, where waves could crash down on me at any second. Alas, the vessel was a beauty, full of hope and opportunity, and I was determined to keep her afloat. This and the wonderful angels that God placed on my path helped me maneuver the seas and stick it out.

Only now, in the act of writing this dissertation, do I recognize my worth, appreciate my resilience, and perceive what my experience can offer to others. Perhaps someone will hear my story and be pushed forward, just as I was pushed forward with the help of angels like my dear friend Marge Keli, whose path I followed. I went to Novet for my associate's degree because she did. I transferred to Morewood, a homey liberal arts school, for my four-year degree because she did. That Chevy Cavalier I bought at 18? She had one as well. Marge was my mentor; she showed me another world. Friends since kindergarten, we spent a lot of time with her family, who taught me what family could be: how every member stood by the other and helped them to achieve collective and individual fulfillment. They embraced me, made me sandwiches for lunch, let me work alongside them folding clothes at the family laundromat, where I continued to work after starting at Novet. Rubbing shoulders with Marge, I'd drink in her stories about which

classes to take, where they were located, and which teachers were best. I also worked Monday through Friday at the deli to pay for those classes, which I somehow squeezed into my schedule.

I believe that mentoring and showing by example (as Marge did for me) helps to free us of the lives scripted for us. Life is a gift, one to be lived according to our own making or design. For example, if someone is endowed with leadership traits, then by all means they should be a leader. I am saddened when an individual with some ability does not pursue it for fear of going against expectations or because they don't see the opportunity to do so. This is where the mentor's importance becomes clear. To quote Maxine Greene from *The Dialectic of Freedom* (1988), a mentor offers a window into the unknown, opening the doors of the imagination to allow one to "see things as they could be otherwise" (p. 16).

Looking back at Marge's influence in my life, I also think of Sarah Lawrence Lightfoot, Mary Catherine Bateson, and Louise DeSalvo, who all talk of mentoring in some way. In *Balm in Gilead* (1988), Lightfoot reflects on her anthropologist mother's work in the field and uncovers beautiful insights into not only her family but also the human condition. In *Composing a Life* (1989), Mary Catherine Bateson fashions a story of opportune learning and growing as a member of the tribe of women, weaving together her past and present as the daughter of Margaret Mead, one of the most influential women of our times. Lastly, DeSalvo, in *Writing as a Way of Healing* (1999), begs "writers in waiting" to read the works of others with similar styles to appreciate the nuances of their genre and engage in an understanding of what being a writer means. Mentoring infuses the lives of these three prolific writers, and their stories' engagement with mentoring provided useful models especially during the process of writing this dissertation.

Be not afraid of life. Believe that life is worth living and your belief will help create the fact.

—William James, *Is Life Worth Living?*

February 1989, the outdoor lot of Fritz's Foods

I'm only six months into school at Novet and I can already type 15 words a minute; 25 is considered an A. I'm almost there... but then again moving up from the electric typewriter to the computer seems a bit daunting. And then there's Mrs. Sonnel. She seemed so solid and strong but this will likely be her last class teaching at Novet. When I asked to interview her for my New Directions for Women project, she said no—because she's dying. She only has about six months left to live. It's so sad—for her and for me. Why is it that the ones I so much need to learn from come into my life and then disappear?

But I can't dwell. I have to keep moving forward, focus on my goals and my survival. I also need to get back to work and, as usual, I'm late. I hate the deli. I hate being a deli girl. Maybe a few words from Pastor Peale's Power of Positive Thinking can help me see things in a new light; maybe there's something to be said for faith and belief, if only as something to hold onto outside my reality of bloody meats, walk-in freezers, oily chicken rotisseries, and customers who treat me like I'm worthless. But maybe there's also some chance I can get beyond this. Maybe college will save me. But how am I going to pay for it? I can't expect any help from Mom and my stepfather. Hell, even though I'm a student, I still have to pay them \$400 a month in rent. Then there's gas and insurance for the Cavalier, plus all my classes and books.

I pull out my notebook and stare at the record of all my income and expenses over the last year. There's a lot of negative numbers. Not so many positives. How come Mr. Peale's never around when you could use some practical advice? Doesn't matter—I jot down some figures,

trying to estimate the cost of all the classes I'll need to finish Novet. I scribble some more digits, erase some, add up others. I'm pretty sure that if I keep at least twenty-four hours here at Fritz's and clean at least two houses a week, I can finish community college. But what about a four-year degree? My God, how would I afford that? No time to think now. I have to get off these salt bags and back to work. These fifteen-minute breaks aren't much; they're here and gone in an instant, and me, I'm always late.

But I can't stop thinking, even as I'm slicing some meat for a customer. Who'd want their ham so thin you could see through it? It makes no sense. Neither does this job. But what job would? And what would I learn in college to help me find out? What knowledge should I pursue? Thoughts like these feel so superfluous while you're shoving tissue-thin ham into a bag. They sure aren't going to get me out of this deli or help at 2 a.m. with my homework—but could they? What is knowledge, anyway? Is the strange mix of classes I need to take for my associate's degree really of any meaning to my life? Will so many credit hours of liberal arts, mathematics, and science really help me “be and become a well-rounded, literate individual,” like my Education 100 teacher says? Will these wide-ranging ideas come together to create a life worth living? Norman Vincent Peale says so; well, at least he suggests it—that living the purposeful life is a life worth living.

Every Tuesday and Thursday morning, I sit in that Education class hanging on Mrs. Sonjohn's every word in hopes she can shed light on my situation. She speaks so passionately. She talks of Dewey, who brought education for all to the forefront, and delves deep into the history of the field—the great players, the many sides, her personal beliefs. It is her talk of the Great Books, the books “one must read to be truly enlightened,” that most entices me; perhaps if I were more well-read I would know more and be more. Mrs. Sonjohn seems to worry that those

in education will never agree on the right mix of classes to foster and perpetuate a literate culture. She sounds so scared when she talks about it, claiming that if we don't move forward fast as a society, the United States will fall behind other industrialized nations. I fall back to wondering, How can the mix of courses I'm taking help me to become more than I am: a deli girl sandwiched between a shop and a home without hope? Maybe that's why I run. Maybe I too am trying to move forward fast so as not to fall behind. I have so many questions. And I hope Mrs. Sonjohn is right: that if I read and I study and I run hard, I will not get left behind.

Those questions regarding meaning, value, and worth in education still haunt me and other educators today. In fact, it seems that the main issues regarding what constitutes *thinking*, its cognitive nuances and gradations, remain at the forefront of educational discourse. But to *know*, and how one can demonstrate *knowing*, is no different now than it was back then. In myself I feel only differences as reflected in my increased level of maturity, extra layers of experience, and the voluminous reading I employ in my search for answers. I now read the works of Dewey, as well as others' reflections on his work, and feel like I am part of a group that might offer thoughts on what is of worth as it speaks to the individual; each individual engages with the experiences of life and takes into account the information and knowledge that resonates with them personally. But more importantly, bolstered by Deweyan ideas and my own gut instinct, I can now say that I firmly believe that *there are no answers*, that there's just the journey of living, complete with teachable moments—the *journey*, not the destination. Maybe I feel this way because I realize this dissertation is a ticket to further journeys—not just for myself but for all those wonderful sparks of light who are discovering their individual paths, paths that often happen to connect with my own; this is our dissertation. But back in 1989, age 23 and

approaching my second year of college, I was counting on my teachers to clue me in to the value of my classes, to tell me what needed to be known. I was not proposing anything; I was just trying to get out of the deli, and College of Novet was my ticket.

But Dewey got to me, even back then. I really felt, as I still do, that he offers a map perhaps not to the destination but at least to enjoying one's travels. And for more than twenty years my gut has told me that he too felt there were no answers, but instead prized journeys to be enjoyed and savored. His conceptualization of education as a means of discovering one's shining purpose on this planet of rocks seemed so obvious and right to a girl of 23 who had sat through all the requirements of high school to no obvious benefit. Who could question his wisdom? A high school diploma alone didn't offer me much of a future, and I could have used a little help at East High to discover who I was or could be. A class like New Directions for Women would have been appreciated, but there was none so I followed the script and graduated to the deli.

At Novet, I saw Dewey's ideas as a breath of fresh air; but I did not understand why they were not accepted as a solid basis for examining ways to teach and learn. I guess a child of 23 has a lot to learn. But I did grow to learn much more about John Dewey, professor of Philosophy at Columbia University. I have fed a voracious appetite for his work, and I am not only excited to read him again now, but to read him in the context of other work he inspired. In reviewing *Experience in Education* (1938a/1998), for instance, what a thrill it was to find the preface of its 2nd edition written by Maxine Greene, another Columbia professor who was greatly influenced by Dewey and is among the list of characters I admire in education. Greene drew a lot from Dewey, but she disagreed with his lack of tragic consequences (Greene et al, 1996). This goes back to the idea of mentoring. I am riveted by the protagonists and antagonists in my readings, and by many of the supporting characters in the story of life. I sense the patterns and networks of

ideas as they grow from one another. This likely explains my passion in the classroom when I share with my students about the physicist J.J. Thomson and his student Ernest Rutherford, who disproved his teacher's Plum Pudding Model of the atom, thus paving the way for his own student, Niels Bohr, to develop a theory of quantum mechanics that challenged Einstein. This foray on models illustrates my focus on artistic portrayals as a basis for meaning and brings me back to Dewey.

I find in Dewey ideas that can relate to my student artists. Perhaps the most crucial concept in this regard is his way of looking at meaning making. As I see my students make meaning in the visual domain, I am reminded of Dewey's call for "consecutive discourse" and "reflective thinking" in *How We Think* (1910) and the *Logic: Theory of Inquiry* (1938b). By seeing how their decisions play out in their work, I become privy to my students' thoughts, which interweave a free flow of ideas. But even as these thoughts become more focused, gaining clarity and meaning, they also reflect back upon earlier ruminations. All this thinking, all these interweaved inner ramblings, have a purpose: to generate the ultimate expression of the artist's reality. I encourage my students to create the clearest reflection of the reality they perceive, and they work toward this goal using every means acquired in their time of learning, engaging with curricula both inside and outside the classroom doors (Schubert, 1981). I watch them choose their media carefully, look for good methods in which to engage, and attempt to correlate both media and method. And it is in these thought processes that I see Dewey's idea of the mind as a verb, an active process of discovering reality (Dewey, 1910). And in these processes I recognize the need for an understanding of what it means *to know* versus *truth*. Many classrooms today teach facts by rote memorization with some attempt to explain their processes and their interconnectedness, but this is a slippery slope, for every individual's perception of reality is

unique and one's "facts" together form individual truth. When some hear the word "apple," they think of a fruit; others, the computer giant. Knowing is influenced so much by an individual's perception of what is important and what is not.

As my student artists build, develop, and finally render their cumulative works, they are entertaining the reality that they perceive with all of their senses. But they are also entertaining the concept of finding meaning as they engage in the making of that final piece of work. It is the avenue(s) that they take and those they leave untraveled, the hidden dimensions of the null curriculum (Schubert, 2008), that excite me so. Here I am blessed with a glimpse into my students' thoughts during the process of meaning making. By engaging them in the making of art, I can witness the rationale behind the realities depicted in their final work. After long hours of toil and reflection, the final representation comes to be. It is the intertwining of process and product that leads me again to the capstone of Dewey's work: art and the aesthetic experience. I believe that the fact I work at an arts college provides me with a special affordance, in line with Greene's thoughts (1988), in taking this approach. Hired some fifteen years ago by a colleague who noted my tendency to draw images on the whiteboard when describing "fuzzy" science concepts, I feel fortunate to have such access to the privy world of the artistic experience.

It is also why I look to art, toward aesthetic experience, to see things differently—thus bringing my attention back to Maxine Greene (1998). I find it fitting that she offers the foreword to the 1998 reprint of Dewey's original 1938 *Experience and Education* because freedom to experience life is a tenet of Greene's and here I suggest thinking as a means of opening the doors to the experience of life and allowing the blossoming of freedom. In her foreword, Greene notes that the times of the book's initial writing were not much different from today, with problems such as student apathy, pipe dreams of a fix-all curriculum, and political blame games

dominating discourse, and she voices support for Dewey's (1910) idea that all individuals entering into a democratic society must "resist routine, seek expansion and emancipation" (1938a/1998, p. xiv). Greene had earlier delved into similar ideas in her book *The Dialectic of Freedom* (1988), in which she notes the need to open up opportunities for individuals to discover themselves and alternate realities. "Yes, there are realities to be considered... race, class, etc.," she wrote, "...but it may be however that a general inability to conceive a better order of things can give rise to a resignation that paralyzes and prevents people from acting to bring about change" (1988, p. 16). Ten years later, in the foreword to the Dewey reissue, she again notes the importance of the ability "to see things as if they could be otherwise" (p. vi)

Greene (1988) offers amplification of Deweyan work on consecutive discourse—that is, the bridging of knowledge to other bits of prior understanding—and the idea of making meaning of the reality around us. She notes that "little time is given to the multiple ways of knowing, coming to know, and in time to understand" (p. viii) and that utilizing such avenues opens "a new mode of living, for those who wonder, those who care" (p. xviii). Her focus on engagement in the pursuit of making meaning using all the senses, and the goal of finding relevancy to the lived world of the individual that inhabits it, echoes Dewey's (1910) ideas on reflection and consecutive discourse presented in *How We Think*.

It is concepts such as these I live out with my students—how I teach, how they learn, what they and I determine to be important. As a teacher of visual artists and as a visual learner myself, I cannot help but be excited by this opportunity to search for meaning(s) in uniquely individual ways. I reflect on the work of Greene and Dewey and feel aided by a map guiding one toward learning and doing what is needed to foster the complete individual in society. Greene says it beautifully in her foreword when she suggests that "long silenced voices need to become

audible” (1938a/1998, p. xiv). I agree, and among the tools and methods for opening the discourse should be the inclusion of the visual arts as a pertinent aspect of these communications. It is here, in the visual domain, where my individual story of learning begins. But before I get to those prized moments where it came together for me, I must again reflect on the journey...

Sticks and stones may break my bones, but words will never hurt me.
—nursery rhyme

April 1989, in the parking lot, on the salt blocks, yet again

Whoever came up with that idiotic rhyme should be shot plain and simple. They don't have the slightest clue about the hell I'm in. Did they really believe only physical wounds could cause hurt, that only blood and guts were cause for alarm? How about the little comments, the asides that can scar a soul? Just because you can't see them, doesn't mean the damage hasn't been done. And these wounds, they grow and debilitate. I can still hear my mother's nasty words: "You're just like your dad; you think you're so smart." Was it so bad to be like him? I have no memory of my father, but in the one picture I have he looks so happy. And he must have been smart because he worked for the railroad—you have to be smart to work for the railroad. And when he died that Christmas Eve, right after my first birthday, he left me stock in an electric company and enough money to buy the Cavalier when I turned eighteen. It's that Cavalier that takes me to Novet, the one place I pray will be my ticket out of the deli.

But as quarter after quarter of school goes by, I'm still lost. I've changed my focus so many times. I don't know what I'm "going to be" or even what really matters—I'm just buying

one class at a time. That's what it feels like, "buying a class," something I can put on my transcript. But what will I actually master? I'm afraid of math and science. Maybe I should pursue education. I love people. I love to talk. And, hey, I passed typing with a speed of 25 words per minute so I must be "college material," right? But what if I can't do it? Maybe Mom is right; maybe I am just some "know-it-all" who's convinced she can be someone. Every quarter has been a struggle. I get home late from the deli, greeted only by Shadow, my mother's Lab, who licks the meat drippings from my shoes and jeans. I sit alone at the kitchen table doing homework till one or two in the morning, then sleep, wake up, run, and set off early to clean houses before class. After that, it's back to the deli, where I'll have to close again. At least Shadow and I get some free meals out of it.

But despite making it through my math classes, I'm still behind for my age. I wonder how many college students have to take transitional courses before they get to the "real" math classes, the ones that count for credit. And how many of them have to review grade-school texts, labor late at night over fractions, decimals, and percentages while peddling a stationary bike to stay awake. Let's face it, I'm stupid, and I'm always going to be two steps behind. Just look at me: I'm 23 and still in community college, while many of my friends have graduated four-year schools, are in the right job for their major, and are getting married and starting families. I do deserve a little credit, though: geometry was a prerequisite for the two college math courses needed for teaching and I was able to test out of it. Not bad—choosing a used geometry workbook as "fun" summer reading turned out to be a smart move after all.

I just need to focus. I have to do what I do best—work hard, run, and keep at it. I read a lot, too. The Power of Positive Thinking really helps. I have to think good thoughts; good thoughts are the key to everything. Maybe I can kill the bad with the good; maybe if I think it, it

will be. Maybe I can rid my thoughts of fear, failure, and unworthiness. I found Pastor Peale's book at my hometown library sometime in the summer of '87, just before I decided to try college. It was an old copy, from 1953, and I loved its cover art: a picture of a nice-looking older gentleman wearing a smile. I thought, I'm so alone, maybe there's something in this for me, some words to bolster me. Why did I choose school again? Do I even belong here? And if not, where should I be? Positive thinking, huh? I do a lot of cheering myself in my head: "You can do it, Jo. You're good enough and strong enough. All you have to do is get up, one day at a time, one minute at a time, one class at a time." No one understands me. I know this. And without these pep talks, I couldn't muster the strength to try anything at all. I need to convince myself that I'm good enough or I might as well not waste my time. To get through college, I just don't have a choice.

But I'm tired, and so, so lost. I have no idea if I chose the right major; I don't want to be a preschool teacher and the classes I'm taking toward an associate's degree in early education seem worthless. Plus, I really don't like kids; they drool a lot and seem to know so little. But I like the prospect of teaching and there's no other relevant two-year degree at Novet. I just can't see myself coming out of a school without some kind of degree. Besides, the assessments we did in New Directions for Women said I was cut out to be either a cab driver, a teacher, or a police officer and teaching seems by far the most pleasant. I need just three more classes to finish my AA. Of course, they're all science. It was hard enough getting through the math. What would the sciences bring? Labs and goggles and calculators? Maybe I can talk to Marge. She took chemistry at Novet; maybe she could lend me her goggles and calculator. Then maybe I'd be ready.

As I reflect on my past, I realize what terrible feelings must plague the students at my school. I cannot say that every student at the small commercial arts college where I now teach feels as downtrodden as I did at College of Novet, but I have a feeling a good portion of them do. I see it in their applications, in the letters they write seeking acceptance. A significant percentage are economically challenged, receive little educational support at home, and are the first in their families to pursue college. I have sat on the committees that decide which students will be accepted and which not, and it's always the ones we turn away that I worry about most. What will happen to them? Where will they go? What could we, as a college, have done for them? They had found the guts to write that application letter and make sure it reached us. Shouldn't that count for something? I think so.

What's even harder is knowing that some of their parents might like to be supportive but just don't know how to be. I can still see the fear in the eyes of my mother and grandmother when I announced I was applying to community college; they urged me to get married instead. I know now with age and experience that they simply did not know how to help. Not only did they not have the opportunity to attend college themselves, they did not know it was a option. I believe that the idea of education, the idea of being a college student or of being college-bound, must be "transmitted," as Dewey (1916) suggests in *Democracy and Education*. I know that in this text, in the broadest sense, he is talking of the philosophy of education and suggesting "transmission and reconstruction" of knowledge for the sake of the "social continuity of life" (p. 2). By suggesting that "education, and education alone, spans the gap" between those who are aware of their link to the human condition and those who are "born not only unaware of, but quite indifferent to the airs and habits of the social group" (p. 3), he was illustrating the purpose of education in a democratic society.

But I am taking a slightly different view of “transmission,” adding to its purpose transmission of the idea that schooling first and foremost exists as an option. Only then can I get to the idea that schooling can bridge gaps and afford awareness of the plight of others bonded by the human condition. My mother and grandmother thought that my survival and the survival of our family was dependent on my taking the path of marriage to someone in construction; that was all they could “transmit” because of the limits of their knowledge of what is or could be. This was the curriculum of my home, as Schubert writes about in *Knowledge about out-of-school curriculum* (1981) and *What’s worthwhile? Playing with ideas in loving company* (2009). My family wanted me to avoid taking risks, to stick to what they knew, and most definitely not to take the road less traveled, the road poet Robert Frost described as having “made all the difference” (1920). Dewey’s concept of transmission and reconstruction with regards to education was not even a flickering thought among my family; they considered the road less traveled a path to danger.

And maybe it is my blending of this concept, transmission and reconstruction, along with taking the road less traveled that I prize so dearly in my past, and view so passionately with my current students; they, like I did, are going against the norm, whether societal, familial, or just traditional views of education: i.e., they’re pursuing careers in the arts as opposed to medicine or law. Their passion and hunger for something more reminds me of my days in the deli and the drive to push past the limitations of the script to become the teacher I am today. Without this past and present coming together into knowledge of possibilities gained and lost, I would not see possibilities of moving my students forward into their own unscripted lives. And while many of my students’ parents, who have had little or no educational background, are at a loss as to how to

help, I believe they desperately want their kids to make it, to become something more. It is a deep, profound desire and a contradictory one, too.

Why do I feel this way? Because I look and see, and am aware; my past is present, and I register the nuances of the present that are familiar from my past. I am not suggesting that what I sense is reality, but as someone who reads the visual, I feel that I can make a good estimation of *what is* based on the nuances and characteristics of a situation, and on the individuals at play in these contextual situations. This reminds me of Herbert's (1987) description of the Copenhagen Interpretation doctrine, one of the debated quantum realities that arose in the wake of Niels Bohr. Simply stated, the doctrine suggests that if it is observed, it exists; in other words, the observation creates the reality. I think Dewey, who demonstrated in *How We Think* (1910) his appreciation of the scientific method and specifically the importance of observation, would find credence in this belief. I can see Dewey supporting the idea that there are many avenues toward understanding an individual's present reality and that these avenues may entail observation to the fullest extent—i.e., through use of all five senses. Further, I suggest that Dewey would embrace the idea of looking at situations and individuals as cofactors, of seeing them in a synergistic manner. With this idea, one could read the reality present for the individual in question and engage in transmission and reconstruction of knowledge. For me, gathering this information allows me to “see” the reality that is present.

What do I see? I see individuals interacting, living, trying—in the spirit of Maxine Greene—to “see things as they could otherwise be” (1988, p. 16). I see parents walking the halls of my school with their sons and daughters, looking at the artwork, learning about the curriculum, carefully noting the employment rates of our graduates; I cannot help but register the tension in their bodies, how they avert their eyes when asking their guide a question, how they

shield their dreams for their children's futures from the obstacles determined by their socioeconomic status. And later I see the joy on their faces, how their eyes beam as they line up in the hall to offer flowers to their children as they exit the stage upon graduation, cameras flashing everywhere. I can see they now know that their children's children will know what college is and what "college-bound" means. Dewey's idea of transmission and reconstruction is illustrated by every passing graduate—not only in the construct of "school," and what can be offered there, but perhaps more importantly in the family lineage. As Dewey was careful to note, "schools are, indeed, one important method of transmission and reconstruction ... but [they are] only one means" (1916, p. 4).

Transmission and reconstruction of knowledge according to the directives of today's school system, with its focus on rote memorization and exemplary work defined by adherence to assumed ways of knowing, leave very little means of finding one's way, of coming to know in a way that is both personal and of sincere relevance to the engaged learner. Again I am thinking of Deweyan ideas of learning that promote the development of the self by way of a kinder and gentler curriculum that runs counter to the general malaise of the in-power educational system. In *Dewey outlines Utopian schools* (1933), Dewey imagines how visitors from another planet might react to our education system, saying, "the most Utopian thing in Utopia is that there are no schools at all... or, if this idea is so extreme that we cannot conceive of it as educational at all, then we may say nothing of the sort at present we know as schools" (p. 7). This, I feel, is the crux of the matter: learning involves more than the curriculum that has been defined as important and laid down as law in our schools with the tools that the educational system provides.

Dewey was not the only one to suggest this: Schubert (1981, 1986, 2008, 2009, 2010) calls for the recognition of "outside curricula," while Efland (2002), Eisner (1982, 1997), and

Kress and van Leeuwen (1996, 1998, 2001, 2003) pushed the boundaries of thinking, learning, and knowing by suggesting that cognition, the process of coming to know, was thick with networking, completely entangled in alternate forms of representation. Schubert (2009) defines his goal as a teacher as “encourag[ing] students to reflect on their experiences and hopes,” for the larger Deweyan occupation is composing oneself as a contribution in the world (p. 169). Tell me, how can anyone accomplish such a feat while at the mercy of an educational system that makes no allowances for individuals to discover what is of value to themselves or to use their own inherent tools of learning and meaning making? This is a travesty—most definitely not Deweyan or progressive—and a sad loss for society and the individuals in it.

Coming to know my learning style was a journey, an adventure that led me to some very dark places as I floundered. I wanted to be like the other students; they studied the notes, memorized, and moved forward. I felt so alone (and sometimes still do) because I understand things by seeing them—I need lots of visuals, few words—and in the dark recesses of my mind I felt I was not normal. Not just because I had an atypical learning style, but because I clearly did not fit in. I knew how college students looked, and how I did not. I could compare and contrast, and with the maturity of a ‘twenty something’ I decided I was in the negative: I was weird. I studied pictures, acquiring great depth of knowledge from their subtle points, from the variances that added or subtracted from one visual icon to the next. In the visual domain I discovered how to utilize images to understand concepts, see processes, and draw on analogies based on what I already knew to learn new things. I noticed colors, considered why some were used while others not. In two-dimensional renderings, I sensed perspective and depth, and attempted to perceive three-dimensional aspects. Shapes and sizes, choice of geometrical figures—all hinted at knowledge that I needed to grasp and reproduce in a test. I learned through the pictures and then

would link what I learned to the captions (nice, clear, concise bits of text), other drawings made on the board or shown on the slide machine, and other iconic images in the classroom.

I can still envision in my mind the first image that sparked my love of science. It looked like a tree on the horizon, its roots below and sheer awesomeness above. But it was no ordinary tree. It was an image from my psychology text (see Figure 1 for a close approximation) showing the extensive network of dendrites and axons cradled in the safety of the skull, all part of the synaptic network of electrical impulses and neurotransmission. These wondrous structures looked to me like branches, twigs, and leaf offshoots gingerly springing from the trunk of an old oak. A separate image (Figure 2) showed the network coming together at the base of the neck and spine and moving down through the confines of the neural tube to control the movement of the body and its extremities. And this too suited the tree analogy: the branching dendrites and axons that sat above the horizon were beautiful and strong, but the root system below was their equal counterpart, its branches, twigs, and leaf offshoots simply upside down to lead the way to the rest of the central nerve system.

Science, I was happy to discover, had a wealth of visuals for me to read. In the sciences, I understood the idea of processes. The arrows suggested the beginnings and endings of a story—a chemical reaction—complete with transmuted “characters” in the form of starting reactants and finished products. These chemical reactions, and the symbols that told their story, were illuminating the natural world in which I lived. As I read their stories, I came to learn the language of science, including its inherent grammar and syntax. I find it interesting that the first chemical reaction to thoroughly intrigue me was that of photosynthesis and respiration—oxidation and reduction reactions at the purest level, the means for the continuation of life. With the help of the sun, plants take in the carbon dioxide produced by humans to generate the life-

giving oxygen we so desperately need. In the illustration I remember from school (see Figure 3 for a close approximation), the arrows directed the story, showing how equilibrium and balance must be maintained for all to survive.

Thus, it was my last three classes at Novet—the science courses—that completed the puzzle for me: I was not stupid—I was a visual learner. Science helped me discover the means to engage with learning about life and its processes—about how its nuances and subtle intricacies were interwoven and linked. My journey through the College of Novet had great meaning and purpose. There, I finally learned how to learn, and it was deeply embedded in the moorings of the subject I feared most. God has an interesting sense of humor.

*There are only two ways to live your life. One is as though nothing is a miracle.
The other is as though everything is.*
—Albert Einstein

April 1990, Marge's Family's Cleaners

Here I go again, doubting myself; one day, I see myself filled with hope and promise, and then just a few weeks later I am pummeled by uncertainty. Just a month ago, after I aced that accelerated midterm in Earth Science, I envisioned my future success in Chemistry and Astronomy. And now, reality strikes. What in the world was I thinking? Earth Science was all about weather—storms and other basic stuff you could learn about while watching the news. But planets and stars, places so far away they appeared to be but points of light—how would I ever learn about those things? And what good would learning about them do me? Then there were the

atoms I couldn't see and even smaller particles whose existence I had to accept on faith... Why did I let myself believe I could do this?

Marge is a natural at science, but she and I are different. Her parents went to college. And her dad, a tool and die man, could repair almost anything. Shrewd with everything from electricity to machinery components, he was always tinkering with things at the laundromat. If Marge needed help with her schoolwork, all she had to do was ask him or her older brother, who just finished college. But maybe I could go to her if I needed a little help; she had all the books plus a neat calc. I've got to keep moving forward—one step at a time and no more putting off. The only thing standing between you and that AS is these classes, Jo. That's why it's called an Associate's in Science. That A in Earth Science shows you can do it. You're above settling for the easy way out. Take a chance, Jo, finish two more science classes and turn that AA into an AS. Go for it! ...But can I, can I do it?

And, you know, Astronomy and Chemistry really aren't that bad or that different. Both involve things I can't easily detect and both require a kind of trust. I will never touch an atom, see the electrons spinning around its core, nor will I ever feel the gravitational pull of the moon on Earth's waters. My human senses can only get me so far. So I must trust the instruments, those atomic absorption spectrophotometers, those infrared mass specs, and all those other high-tech gadgets that tell me atoms exist just as I must rely on the telescope to bring those dots in the night sky into closer view. Thank goodness there are so many illustrations—they're what bring it all together for me. In my Astronomy and Chemistry classes, illustrations are everywhere—in my textbooks, on the board, in my notebooks—and not only do they fit the images I formulate in my mind, they reflect the order of one another, with the celestial bodies in orbit recalling the

movement of the atoms. Everywhere I see things circulating about and I see order in their movements. In my own drawings (Figure 4), I capture their logic and organization.

Thinking back on those times, I can see how science seduced me. Its rules seemed so sure and right, without question. Logical argument and the scientific method promised a way to “truth.” Science, to my mind, was Truth, with a capital T—what is, what was, and what will be. The assuredness of order appealed to me most likely because of my past, which pulled me toward *not knowing*. I wanted *to know*. I wanted set answers, certain truths—about *something*, at least. And this is surely why I was drawn to educational pedagogies with a scientific bent. I moved toward them, excited at the prospect of having finally found a place where I could thrive. I instinctively sought a way to nullify the curriculum of negative thought, poor opportunity, and lack of support I was taught at home, where Jo—what could be—was never given the chance to breathe.

Much later, 2007 I think, in a graduate-level Educational Philosophy class at Midwestern University, I would pass a note reading “Go Positivism!” to a fellow student. As our class discussed Bacon, Descartes, and Kant and their attempts to construct a Positivist theory of science, I marveled at the idea of order that was perhaps possible in educational pedagogy. Their constructions of science and science concepts would be based on rules and regulations and a distinct axiomatic model. This felt right to me; it excited me. Surely, I thought, life should be like this. I wanted my own life to follow some reliable order. I hoped that Positivism, with all its rigidity and exactness (what I swore were its buttresses), could help me keep the chaos of my past in check.

Weren't there rules about how families worked? About how parents supported their children in their efforts to better themselves? About how they sent them to college? I imagined there must be some sort of instruction manual handed down from generation to generation, and the day they were issued my ancestors somehow got passed over. Maybe they weren't home that day. Perhaps they were just busy, tied up by daily struggles, "the realities to be considered" (Greene, 1988, p. 16), that they missed out on what I've come to think of as an "instruction book on life." In navigating the demands of daily life, their compass was set on survival, not on possibility. Sitting in class that day, my past ideas of the frailty of the human soul and the potential that could be realized in individuals with nurturing came back to me with full force. It was as if I were back in the lot outside Fritz's thinking of Marge's parents and how they were in my court.

But, of course, I did not want my own family to be. I had had enough of the status quo and it was slowly killing me. Keeping to "my place," I could feel the doors of opportunity closing—surely this was a form of death. Positivism offered a rule book, a procedural handbook, and it relied on scientific inquiry, whose practice I knew from my days of being reared in the sciences at College of Novet, the liberal arts school Morewood, and finally here at Midwestern. The chemistry, the astronomy, and all those biology courses were supported by extreme scientific rigor, just as Positivism was in my eyes. When I first encountered Positivism, I felt that I had discovered the birthmother of all inquiry into Truth, or at least those truths that comprised our natural world as discussed in the fields of science. When I wrote "Go Positivism!" that day in class, I thought I could apply its concepts toward building myself a better future, where my past would not follow.

I was hoping that Kuhn (1962) and his series of scientific revolutions could propel me away from this endless routine, this unending, tiring hamster wheel of despair. I was hoping for a paradigm shift, to replace the deli girl mentality with that of a scholar—someone who belonged and was worthy of her privileged academic settings. Kuhn wrote that, “competition between segments of the scientific community is the only historical process that ever actually resulted in the rejection of one previously accepted theory or in the adoption of another” (p. 8). I prayed that I could overthrow my old life in an analogous way. With every class I took, every discovery I made, I was enacting small revolutions that would move me closer to a new paradigm of self-worth and value. I wasn’t in competition with the scientific community; I was battling the beliefs, attributes, and experiences that rendered me in this forsaken form. I think the fight would have been easier if I’d been up against the community—I harbored such callous thoughts about myself.

In the end, of course, I came to realize that Positivism did not have all the answers; it only helped me for a year until Greene’s *Dialectic of Freedom* (1988) clued me in. What damages the human spirit and leads it astray from its intended path, Greene wrote, may not be the realities that surround it, but instead “a general inability to conceive a better order of things,” which “can give rise to a resignation that paralyzes and prevents people from acting to bring about change” (p. 16). So contrary to Positivism and its embrace of the axiomatic view, the inability to see things other than the way they are arrests human development. This is why I worked so diligently to expunge the fatalistic views of my past—because if I let them they would take my future hostage.

But however far I’ve come, the deli girl, who pursued scholarship as a means to negate her background, emerges now and then seeking security in axiomatic truths. But wrapped in her

is still a hopeful, believing child, like a little bird believing that despite the storm *she can fly* and evidence a new truth, not one of assured axioms or scripted lives. She searches for this life, one that is true to herself. She can learn and be more than a deli girl, and she can do it without the false security of the axiomatic-based sciences. As Maxine Greene (1998) suggests, many “may think of breaking free, but they will be unlikely to think of breaking through the structures of their world and creating something new” (p. 17). I need to pursue my own way of growing in line with my own experience and innate capabilities.

A major part of this has been recognizing what type of learner I am and aligning myself as a visual learner with my need for the assuredness and security of science. To me, the sciences showcase the inherent beauty of life, its textbooks crammed with intriguing pictures, elegant models, and “touchable” data “housed” in graphs. Science tells the story of life in the domain of the icon, a world I can access. I think that the designers of science texts know intuitively how difficult it would be to master such abstract concepts without some interweaving of the visual and textual domains. (In my mind, abstract concepts involve data that are imperceptible to the senses, or at least linkages to the modes of the senses.) And I think they recognize the need to incorporate metaphors and analogies that link the visual images in one’s mind with the science concepts on the page. Our minds count on visual input. Pictures constantly stream through our heads. And these pictures are all about us, how we outwardly perceive the world and evidence it in our minds.

As a teacher of visual artists working toward a career in the commercial arts, I aim for classes that foster a generation of premier leaders in creativity and in imagination. Although my science colleagues and I do not talk pedagogy, let alone methodology, in our own way we talk the world of the visual and thus embrace multimodal literacy. Kress and van Leeuwen (1996,

1998, 2001), leaders in this dialogue, talk about the visual as a form of language complete with its own grammar and syntax, noting its prevalence in advertisements, billboards, newspapers, and other media as a means to focus a story. Some have followed this idea of multimodal literacy as a way to inform their own work, but others have gone further, analyzing not just how visuals are read but how they grant greater understanding of how one thinks and brings in new information in the cognitive schema (Lakoff & Johnson, 1980; Hummel & Holyoak, 2002; Efland, 2002; Thornton, 2002). Others still look specifically at how the visual is used to inform and convey information that is scientific in nature (Gilbert, 1991; Frederiksen, White & Gutwill, 1999; Mathewson, 1999; Clement & Oviedo, 2003).

The ability of the visual image to communicate is quite exemplary by many standards, and I believe the best way to support this idea is by showing the work of my students. I require all of my students in Introduction to College Chemistry to design a project that illustrates *periodicity*, or the repeating patterns of the periodic table. To do this, they must take one or more concepts (electron affinity, ionization potential, radii, etc.) and apply the knowledge they have acquired in their individual majors (for example, graphic, fashion, or interior design; or animation and visual communication) to demonstrate their understanding. The point of the exercise is to illustrate a fundamental lesson of chemistry: rather than memorize the properties of individual elements, it is easier to understand them together in the context of the periodic table, which by design illuminates the *periodicity*—or repeating patterns—of the atomic world. And because my students work in the visual medium in which they specialize, they are able to generate a model for the lesson that makes most sense to them. I am certain this exercise follows in the spirit of Dewey and progressivism, particularly in light of Dewey's emphasis on experiences that make learning worthwhile to the individual.

In work after work, Dewey strove to outline a philosophy of the social factors that operate in the constitution of individual experience. He believed more guidance was needed toward learning, not less, and established contacts that the students could engage with, always cognizant of their need to learn through personal experience (1938a/1998). For example, students knowledgeable about a particular area would serve as mentors and engage their counterparts in dialogues and learning experiences geared around the topic at hand. Their ideas and thoughts were celebrated, and experiences that may seem of individual importance were fostered by those involved in the learning community.

Figure 5 provides an example of how this can play out in the classroom. It shows a few stills from an animation by one of my Intro to College Chemistry students, Christopher Boiske. The full animation runs only about two minutes long, but in that brief time Christopher succeeds in illustrating some quite intricate concepts. (The full animation can be seen on YouTube at <http://www.youtube.com/watch?v=s-QCA4yyYMI>). The three stills were chosen because of their importance in illustrating the elemental properties of ionization energy and electron affinity, the former involving the energy required to take electrons, the latter involving the energy gained in electron acquisition. (It should be noted that the animation required some 20 hours of design time with Maya 6.0.1 and After Effects software, plus 35 hours of computer rendering time to produce.) Here is how he describes his work:

Using the concepts I learned in my Chemistry class, I took my knowledge of Maya to create an animation that makes a somewhat difficult concept to understand verbally a little easier through presentation. The concept of the animation was to show how electrons are held in the atom's core, but that the force is not quite strong enough to hold the electrons in sometimes. Ionization Energy, the energy required to remove an electron from an atom (or defined as how strongly an atom holds its electrons), is primarily focused in this animation.

Concomitantly, Electron Affinity is also suggested, as it involves the idea of electron acceptance by another atom.

In this animation, the crane is the core of the atom, and the balls, marked as e-, are the electrons. The crane rotates around the orbitals, watching the electrons and grabbing them if they try to jump out of their defined orbits. However, sometimes the crane is unable to grab the electrons due to insufficient ability/power, and thus the electron escapes the orbit. The three atoms represented in the animation are Magnesium, Chlorine and Fluorine. Here, Magnesium loses an electron, which Chlorine grabs. And in addition, Fluorine is depicted as being quite adept at holding its electrons.

Although I don't have a transcript of Christopher's presentation of his project, his summary gives an idea of the breadth of his understanding of the concepts. Standing at the front of the classroom, he discussed his work, explaining the rationale for every detail of the animation. He noted the significance of the spacing between the electrons, how he depicted the core's affinity for one atom over another, always referring back to the visual to explain just what electron affinity and ionization energy were. It was clearly important to him that his art was a correct and accurate depiction of his understanding of the two concepts, in line with the ideas of Kress and van Leeuwen (1996, 1998, 2001, 2001, 2003) regarding multimodal literacy.

By allowing Christopher and all of my students to use outside knowledge to gain understanding of and illustrate important concepts of science, I afford them a bridge to learning. And the use of bridging mechanisms to assist the connection between prior and new knowledge is nothing new in the field of cognition. Marshall (2005), in *Connecting Art, Learning, and Creativity: A Case for Curriculum Integration*, argued persuasively for the integration of arts in the curriculum, noting how they contribute to organizational thought, higher-order thinking, and the thorough development of ideas. An artist herself as well as a researcher, Marshall looks at these concepts from the arts perspective, but what I found wonderful was the broad carryover of her ideas to the field of cognition, where the arts were given consideration for integration in the

greater curriculum. Though they lean less on the traditional fine arts than Marshall, Hummel & Holyoak (2002) pursue similar ideas, discussing analogies as bridges for placing prior knowledge in correct juxtaposition with new knowledge to foster deeper understanding. Clement and Nunez-Oviedo (2003), who work in the field of neural networking and cognition, focus on abduction and analogy, or scaffolding new knowledge to knowledge already acquired but not settled into the cognitive scheme; in other words, they talk of bringing together information that is not so obviously linked via analogy and the nuances of metaphor. Although their work is broadly informed by Marshall's, they look at arts' involvement in learning quite broadly, focusing on cognitive nuances, such as how the mind will deal with similarities and differences in general concepts.

In my chemistry courses, my goal is not to make chemists. I am a teacher of visual artists who have chosen to pursue a career in the commercial arts. I must let them choose their own lives, but I can't help but want to aid them in their journeys with knowledge of chemistry. It may help them someday, perhaps, to produce a piece of art that is more engaging, more realistic, more "full," as Dewey characterized the greatest worth of an *experience* (*Art and Experience*, 1934). That is my goal, and based on works like Chris's over the years, I feel I am doing well according to my own standards. In my work with my students, I try to embody the mentor that guided and supported me, even when I thought I didn't have a chance. "Fast Car" was released in 1988, the same year I started at College of Novet, and when Tracy Chapman sang the line "starting at zero, you have nothing to lose" it always reminded me of myself. I have a feeling there are others out there that feel the same way and could use some support.

VI. THE THIRD STEP: NEGATING THE NULL CURRICULUM

Man can live about 40 days without food, about 3 days without water, about 8 minutes without air... but only about 1 second without HOPE.

—Hal Lindsey, *The Terminal Generation*

Spring 1990

Rod reaches for the answering machine and plays back the message for me. It's Mom: Mark, my stepfather, has been in an accident—he's been crushed by a Bobcat. "You need to handle this, Jo," Rob says. "You have to help your family." "I know I have to," I tell him, "but I can't. If I go back I won't make it—I'll never get out. I need to get my diploma. I'm supposed to graduate in June." Plus, I'd just moved out of Mom's and in with Rod, finally feeling like I could make it independent of them, juggling the deli job, cleaning houses, and school. If I go back now, everything I'd worked for at College of Novet would fall by the wayside. I was set to graduate with honors, now I have to figure out if I can delay my final classes till summer and still walk in June. Because I have to go home...

"You are not a paying customer." What does that mean? Mark had been crushed from the waist down. The bucket of the Bobcat had come down on him slowly as he lifted the seat and arms of the machine to do the grease and oil. The son of the Bobcat's owner had to turn off the machine to restart it and release the bucket. The initial crush left a clearance of 5 inches, not enough room for a man's torso by far, but the lift of the bucket "let the hydraulics out" and that's what made the crush so extreme. Daniel, just 18 years old, picked up Mark, placed him in the cab of a truck, and drove him to the hospital. In the few weeks since, Mark has been through 16 hours of surgery—a total of 23 reconstructive operations—before Dr. Unfrank would tell him that his time was up. He had to leave. We had no insurance. Mom just assumed that since Mark

was a vet he'd be taken care of. Except this wasn't a VA hospital; because of the severity of the accident, Mark had been brought to the nearest hospital to be treated.

Mercury benefits, lawyers, corporations, bill collectors, food stamps—these have become a part of my everyday vocabulary. I sit in Family Services. The woman is nice enough, although she only talks to me, ignoring Mom. Of course, I can't blame her—Mom's gone. I caught her once trying to "change a light bulb." She thought it was out but there was nothing there. I swear she would have shocked herself if I hadn't stopped her. I'd been advised by Mom's lawyer, a teacher at Novet, to drive my own car to the Family Services offices. "Your car's old," he reasoned. "Don't take the van, it looks newer." I'd met him through his wife, one of my education teachers. I sat every Tuesday and Thursday on his office couch eating yogurt and telling him what was going on in my life. He took an interest. And then he took on Mom's case.

Gangrene moves. I've seen it pulsate and vibrate. Mark's been transferred to the vet hospital in the city. I went to see him the other day and I saw how gangrene had taken over his left leg. It was green, smelly, seemed to have a life of its own. Surgery was scheduled; the leg could not be saved. Mark didn't cry. I talked to him; he didn't hear me. Or at least he didn't reply. His face was hidden behind an oxygen mask. Maybe that's why he didn't say anything, or maybe it was that didn't have anything to say. I listened close, but no words came. Mark used to always talk and laugh. Now he only grunts.

It's a few days after the surgery and I'm back to see him. His leg is gone. He still doesn't talk. What's there to say? I've got nothing, so I show him Buster, Rod's and my Australian sheepdog. I thought Mark might like to meet him. Mark looks at me, then back at Buster, and then closes his eyes. Guess it's time to leave. I walk out to the hallway, where I bump into a patient lying on a makeshift bed. He seems like a happy man, happy at least to see an animal at

the hospital. He asks if he can hold my Buster. "Sure," I say and move to place the dog in his arms. With a smile, the man reaches out from beneath his covers. He only has one arm. What do I do? I can't think. It smells in here. The halls, the rooms—all disinfected and chemically clean. The janitors have killed everything in this place. I bet that's why Mark won't talk. They've killed his spirit along with all the microbes.

"Can I hold your dog, please?" the man says. "I used to have a little one just like yours when I was young." How long had it been since he was young? And what had happened between when he had a dog and two arms and today? "Please," he says again, lifting himself like a corpse from the grave. He turns his torso toward me, grabbing Buster between his arm and his stub, his eyes begging, pleading. His eyes look like Mark's. I think to myself, His spirit must be hiding in there deep inside so the disinfectants don't kill it off. I think of Peale and the importance of staying positive, and then firmly press Buster onto the man, telling him to be a "good boy." I'm wet. Why am I wet? Oh, no, Buster must have peed. But then I feel tears pouring from my eyes and see the man crying into Buster's fur. I gotta go. I need to run. Where's the door? We're crying—this one-armed man and me—but I grab Buster and I bolt. I don't want to die here. I don't want my spirit to hide away the way Mark's and this man's have.

It's so easy to stay in a comfortable cocoon and not really see others, but we are all human beings and of equal importance. To this day I don't understand how we can call people veterans and not give them due respect. The patients at the VA hospital where my stepfather was taken weren't even guaranteed privacy; they were left in the halls because there weren't enough rooms. But why weren't there? I needed answers to these types of questions twenty years ago and they still aren't evident today. Back then I turned to chemistry, a world I understood and

whose logic and formulas comforted me. Chemistry, I thought, could answer my questions. With it, I could even find a formula to determine the human tipping point, where the spirit dies, moves on, gives up. Chemistry, my first love, my guardian, keeper of logic and order—what is the point where this metal breaks, suffers a fracture, where that soul breaks, suffers a fracture?

In my mind, these fracture points are analogous. How does the soul break? Is it the result of cumulative experience or does it trace back to just one? What one thing can disrupt the equilibrium, force a break in sanity, spur the loss of all hope? What is that *particular experience*—that minute fracture that grows and spreads, and leaves the “mettle of man” shattered? It is against such thoughts that chemistry feels so safe. Chemistry is logical, completely unlike the chaos of the lived life. Equilibrium is determined for a chemical reaction by set formulae (Figure 6). Pressure, volume, temperature, number of atoms—these are the determining factors. Only the variables can be manipulated, all cold, hard facts and data points. Equilibrium in a chemical reaction is void of particularity and does not look for rationale. One atom too many throws off the equilibrium and the metal breaks, or perhaps a fluctuation in pressure or temperature has upset the balance. But there is none of the nuance of the lived life, the types of experiences that engage (Figure 7) or disengage the soul (Figure 8). Chemical equilibrium is void of feeling, thinking, and sensing. Only the lived life, the great and minor experiences that comprise it (the curricula engage from all angles), leads to the testing of one’s mettle. Unlike the fracture of a metal, which can usually be deduced, human mettle can fail for unknown reasons and before you know it the soul is lost.

Summer 1990

“The operation went well, Jo. I think we got it all. It’s, OK, Jo. You can stop crying. It’s OK.” I’ve just had laser surgery, an outpatient procedure to remove precancerous cervical tissue. All I can think is, I need to get out of here; this hospital’s going to eat me up. I can’t breathe. Everyone I know dies here—Grandpa, neighbors, friends. If I don’t get out, I’m going to die here, too. I need to go. I need to run. Months have passed since that fateful call pulling me back home. But even though I was able to walk in June—no diploma in my cover, just cardboard and hope—and finish my remaining credits this summer, life just seems to be getting harder.

“You’re tired, Jo; the anesthesia will wear off and you can go home.” She’s right. I am tired. I couldn’t sleep last night, and at 4 a.m. I just gave up and went for a run. It was still pretty dark out, peaceful, though—just me and all that quiet. Then I went to work. I scheduled the procedure so that I could get a cleaning job in before checking in at the hospital. It seems to have worked out: Dave and MaryAnn have a clean house, and I have a clean cervix, hopefully cancer-free.

“Just lay here for a while, Jo, and I’ll get you some crackers and juice.” Who is talking to me? I can’t tell. Everything’s just a blur. God, I hate hospitals. The crying, the moaning, the smell of disinfectant. This place is the killer of souls, its bitter sulfur smell like the smell of the river Styx. Hospitals take the color out of life, all the joy. Why all the white? I want color. And I want a variety of shapes, not just the hard angles of squares—boxy rooms, narrow beds, little, square tables on wheels. There are so many other shapes, and a variety of colors, too! Didn’t anyone ever think of that? I gotta go. I gotta run. I need out. I’ll reek of this disinfectant soon if I don’t run—now!

And I’m home, not home at my mom’s but at Rod’s. I probably shouldn’t have gone for that run so soon after the procedure but I feel better. Running is my food; it sates my soul. Now I

just need to shower, dress, and head off for orientation and a few entrance exams at Morewood so I can start work toward that beautiful bachelor's Degree. Oh, what a gorgeous campus it is, and at thirty miles away just far enough from here.

I know how crucial it is to seize the moment, but throughout most of college I lived in the hope of another, better one. I ran to both escape the past and move toward the future, going against one of the fundamental ideas of Dewey (1938a, 1998) outlined in *Experience and Education*:

The idea of using the present simply to get ready for the future contradicts itself. It omits, and even shuts out, the very conditions by which a person can be prepared for the future. We always live at the time we live and not at some other time, and only by extracting at each present time the full meaning of each present experience are we prepared for doing the same thing in the future. This is the only preparation which in the long run amounts to anything. (p. 49)

But I had to run because my present, for the most part, felt bad. I disengaged from rather than embraced “the only preparation which in the long run amounts to anything.” I was always looking forward over that mountain. My life path was not a spring's journey through the fields but a marathon run at breakneck speed. I was goal-driven, in search of better moments, anywhere but “here.” Running gave me glimpses of some untold future, as did attending classes at school. Those moments were full of hope, and that's what I wanted to immerse my soul in.

Going back to my mom's house made me feel out of place. I didn't really live there anymore, although that's where everything I owned was and that's where I would visit when someone in the family needed me. I felt trapped between the home that I wanted, with Rod, and the home I was raised in, with Mom. I would do everything I could to get to Rod's house, only fifteen minutes from my mom's and the deli but light years' away. Unlike at the isolated

farmhouse my mom rented, we had neighbors there, and a fridge stocked with Diet Pepsi. There was a table where I could do my homework. And Rod's stereo, which I used to soothe my soul. I could listen to almost anything—from Fleetwood Mac to Seal—and be at peace. And I would watch movies, happy movies where everyone is smiling and there are life lessons to be learned in everything.

I still remember watching *Miracle on 34th Street* (Seaton, 1947) during my first year at Morewood. I was so moved by Kris Kringle's words to the skeptic Misses Walker that I paused the DVD over and over to write them down. A single mother to a young girl, Misses Walker had long ago stopped believing in Santa Claus and lived a life based on logic and safety. She had closed her heart to hope and taken her daughter with her into that darkness. But with a few words, Kris Kringle unlocked that barrier to hope. I scribbled them down and read them again and again along my journey through college:

“I am not just a whimsical character that wears a red coat and has a jolly demeanor. I am a symbol of the human ability to suppress those selfish, hateful tendencies that rule a major part of our lives. If you cannot accept anything on faith, then you are doomed to a life dominated by doubt.”

My soul needed to hear those words. They offered a rationale for a belief in God's presence. I did not want to be “doomed.” I had to believe there was a reason for everything, that everything had a purpose—even the unraveling of my world and the struggle to keep my ship afloat while minding the buoys marking my educational journey. I was entering a new college, Morewood, but College of Novet was not so far away in my mind. The ship that got me through it now faced another storm, a treacherous one that threatened to capsize my vessel and scatter the hopes and dreams I sheltered aboard it. I was not sure if I could ride it out. There was just too

much *bad* swirling, mingling, and invading my life and my thoughts. Hope was fleeting, and things were very dark indeed as the storm clouds rolled in and the seas churned.

And this was just the normal state of affairs for me; the status quo was turmoil, it's all I knew. Which is why I wanted to put my present behind me. Still working at the deli, and cleaning houses on the side, I tried to be positive and make my world a positive one. Anything was better than the reality of it. Mark was getting progressively worse, undergoing more operations to rebuild his body, and Mom was struggling. And while I made it to Morewood and could stay with Rod when I wanted—he gave me a key so I wouldn't have to come in through the garage door—I was always scared that I might “fall back” into my past, the one thing I truly wanted to leave behind.

I needed to know there was more to life than that what I knew. I was no longer completely entrenched in the life that had been scripted for me—I had not become the deli girl/construction man's wife—but neither was I where I wanted to be: successful, self-assured, with a four-year degree. Instead I was lost in new territory, a vast ocean. I did not feel like I belonged anywhere. Practically homeless, I stayed wherever I could to study and survive. I was in limbo. But I wanted to change my circumstances. And I felt that positive thinking and bringing in new thoughts could counter the threat that the old life might regain its hold on me.

I looked toward the “curriculum of life,” a phrase used often by Mrs. Sonjohn at College of Novet, to take me to a new place. I thought it was completely applicable to my longing for a new and better home. And I felt that it was my job to develop “positive powers” to assure my progress. I clung to books such as Peale's (1952) *Power of Positive Thinking* and movies such as *Miracle on 34th Street* to help me find the blueprint for a new “Jo,” one that could succeed and be

fulfilled, happy. I did not want to be the Jo that I had been, a faithless Misses Walker. Seeing all those nameless New Yorkers in the movie looking so lost and forlorn really hit me.

Ideas like these would be reflected back to me some years later in graduate-level discussions of Dewey's (1933) *Utopia* or Schubert's (2009) elaboration on Eisner's (1979) idea of null curriculum. This elaboration, as illustrated in *Dewey Outlines Utopian Schools* (1933), focuses on what society needs to do to "reconstruct" itself, not unlike the young Jo who sought to reconstruct herself with a college education. Such reconstruction is too often a null curriculum. At that time in my life, all those years back, I saw the deli girl and the construction worker's wife in the null curriculum (Schubert, 2009): not reflected in education and in this way devalued. This was my reality, what I perceived, as I tried to take a different path, for what I saw in my family as a child was emptiness, and roads not taken. But in no way, should this detract from the importance, the inherent value, of those of the working class, who work with zeal and enjoyment, celebrating their contribution to this world. Thus, I look back at my life now with the great breadth of knowledge gained from my graduate studies and see things differently. I think I wished that this curriculum of life, so very far from school and the logical sciences, would teach me to find a more habitable space for my soul to live and grow. I wanted to learn what the "Utopians" believed to be important, as Dewey tried to ascertain in his discussions about personal experience and worth. I wanted the fundamental purpose of my personal education to be, as Dewey (1938a) wrote,

the discovery of the aptitudes, the tastes, the abilities, and the weaknesses of [myself], and then to develop these positive capacities into attitudes and then arrange and reinforce the positive powers so as not to cover up the weak points, but to offset them. (p. 138)

I knew that to be a success in college, I needed to learn about myself, my loves, and my desires--all known curricula in most formal education institutions I have encountered. And I learned this through careful study of how Marge lived, all those long nights reading Pearson, and even the words of Kris Kringle. But I also knew that I was fixing something broken, challenging the *scripts* of MacAdams (1993) I would later learn about. Thus, I engaged fully in the null curriculum to build Jo's soul, consciously working with great effort to nullify the bad. This was a positive engagement, because it was taking me closer to the person I could be. And I took the endeavor very seriously. My music, my readings, my movies—all were chosen to help me grow in positive ways and to develop positive ways of thinking, believing, and acting. I needed to find out what was important to me, just as Dewey's Utopians did. Back at Morewood, I was on a mission to reconstruct myself. I needed to forget the "whole concept of acquiring and storing away things" and instead focus on the "concept of creating attitudes by shaping desires and developing the needs that are significant in the process of living" (p. 139).

The null curriculum is a point of departure from the status quo of educational policy and standardization, representing the movement toward a paradigm shift and the beginning of a new era, in which "new ways of conceptualizing educational problems, formulating educational questions, and pursuing educational aims" (Eisner, 1982, p. 142) would arise. The null curriculum that Eisner envisioned "revolve[d] around ideas of classroom experience, aesthetic cognition, expressive objectives, enactment and multiple forms of knowing" (p. 138), but his vision has yet to be manifested in the classroom. What we have today is a controlled system of education, with a set program of study with standardized objectives, outcomes, and assessments. Eisner himself offered an explanation as to why the paradigm shift has yet to take hold: allowing

students to be engaged with their educational opportunities, he wrote, would make this “system difficult to control, hard for educators to manage, and complex to evaluate” (p. 141).

Just as I take Dewey’s (1916) ideas on transmission and reconstruction of knowledge in *Democracy & Education* and connect them to the idea of transmitting *the needed knowledge to pursue college*, I take the concept of null curriculum and frame it within my own personal experience and philosophy. My thoughts work with the ideas of Eisner (1982) and Schubert (1986), who suggest there is more to the curriculum evidenced by the student than what is laid out in the prescribed educational system. Beyond the set objectives, competencies to be met, and assessment tools to be *wielded* are the hidden nuances of the learning environment, the voices of women, children, and other marginalized peoples that “are only beginning to be excavated, studied, and integrated fully in [the] discourse about curriculum” (p. 13). I combine the concept of the null curriculum with the idea of allowances and opportunities for individuals to become more than who they are. Specifically, the null curriculum for me is all about how recognizing my particular learning style (one of the multiple ways of knowing) opened the world of education—and more—to me, yet I continued to feel a need to nullify the life I came from. My family’s socioeconomic status made mine a marginalized voice and I needed to be heard. So I went to college and made decisions toward my continued success in this pursuit. Thus, I think of the null curriculum as the changes I effected in my life to nullify the script of the deli girl married to a construction laborer. I know that I diverge from the field and take great liberty in my reframing of this concept, but in light of a past that I am trying to expunge I feel confident in my assertions. In everyday usage, *null* means a lack of acceptability and validity, and that is precisely what I was, and still am, working to avoid. In the field of mathematics and science, *null* has a slightly different meaning and is used to represent the concept of approaching zero. This is how I felt

about my former life: I was approaching zero, feeling like I literally had nowhere to go. And again, these are thoughts based on how I looked at my past as not fostering my personal growth as an individual. But surely, this is in no way represents how others may look at their lives, those hard working, diligent workers in all aspects of the working class. They too have their narrative, and, hopefully, are as true to it as I try to be to mine here.

That's why things like *Miracle on 34th Street* had such a strong impact on me. If I close my eyes, I can still picture those lost souls on the streets of New York, their downcast looks, their bodies enshrouded by a black haze. Their souls have been caged; they're not where they should be. I know that feeling. I mentioned it once in a graduate class on my way to earning this PhD. "I see all these people huddled in the trains," I told the class. "I see how our city's public transit shuffles all these bodies around, takes these empty shells to work. I envision their jobs as hopeless, meaningless—just work, not something that entices or seizes them. I think this must be the case for many—maybe most—people, but I wish this was not so." I told my professor I was reminded of Dewey (1938a) and his belief that schools must realize that "there is no production without enjoyment [and that] the only education that really could discover and elicit power, was one which brought these powers for immediate use and enjoyment" (pp. 139–140). Dewey, I noted, spoke of the need for the curriculum of our schools to bring "creation of attitudes," to provide the environment and activities to allow our students to "operate more effectually," with "production based in enjoyment and satisfaction," not "myths" (pp. 139–140). The class understood my anguish. Later that semester, our professor issued a handout reflecting much of what came up that day in class. It read, in part:

This revelation alone explains the frustration, despair, rebellion, disappointment, apathy, and hopelessness so widespread not only among the inhabitants of schools today, but in the general citizenry, as well. (2004, class handout)

And this idea of a general citizenry full of apathy and hopelessness makes me wonder, Why is this the case? Does the time spent doing things that are not of worth and purpose to the individual have any bearing on this? Is that why public transit emanates sadness? Are those forlorn commuters victims of the tragedy of what could have been? Or again, am I not privy to their particular reality, in which they are off to toil at something they love and cherish? I need to always question. It is imperative that I always am humble and gracious, for I may know some things, but again, what I am *more* certain of, is how very little I *truly* know. I am always learning, and I need to work with my limitations, question myself, and be courageous. I need to act forward, and be reassured that there are no absolutes on Truth, just many diverging truths.

In *Art as Experience* (1934), Dewey notes the importance of human engagement in meaningful experience. In his estimation, to enrich the human life was a paramount goal of the experience; this is evidenced in the great pains he took to explain in critical detail the intrinsic and extrinsic layers of full immersion in it. Dewey paid consideration to both the primary emotions unified with experience and the secondary ones that would evolve in memory. He wished for individuals to see that “the things that we realize as useful objects—that is, tools for the attainment of desired ends—are also events to be enjoyed and/or suffered through in their own right” (p. 18). I understand him to mean that all of life is an experience to learn from and that all that comprises life—every experience—is crucial to the development of a fully lived life. The extrinsic path to meaning, he suggests, would become intrinsic and stay with the individual for the course of his or her life. I connect this with Schubert’s (1981, 2009) idea that the

meaning-making of experience involves a painstaking rooting out process to find what is of worth, value, and importance to the individual. I believe that in this experiential dynamic process, value judgments must be happening concurrently. And this, too, is part of the full range of experiences that Schubert talks about. Again I must note that the concept that no moment or experience is inconsequential meant little, if anything to me in the past. Back then, my distaste for seemingly infinite useless moments made me search out experiences that would bring me something more. I would, did, and still am attempting to grasp moments of worth and value and stockpile them toward the full life I want to compose.

To connect to the role of arts in education and multimodal literacy, I return to the work of Kress and van Leeuwen (1996), whose groundbreaking *Reading Images: The Grammar of Visual Design* (1996) explained how image(s)—in books, newspapers, advertisements, etc.—could be manipulated in such a way to tell a more complete story and give meanings greater clarity. With color manipulation, degrees of saturation and intensity, foreshadowing or lack thereof, the visual icon becomes “textual” in its ability to communicate and follows its own rules of grammar. Text, too, they consider to be a visual icon whose meaning is manipulated via font style, point size, placement, etc. Kress and van Leeuwen ushered in the era of typography, a crucial class for my student artists. I am particularly drawn to their idea of directionality and ways of communicating movement with well-placed vectors. Take your standard skin cream advertisement, for instance. A luscious model with perfect skin directs her outstretched arm toward the prime product and we the audience subconsciously reach for that product too. We wish to be similarly perfect and our mind connects that perfection to the product. Her eyes directed toward us viewers, the model engages further, speaking to the value of the product in our lives. This is how the visual icon works its magic.

In *Literacy in the New Media Age* (2003), Kress and van Leeuwen take their earlier ideas about two-dimensional imagery and apply them to the realm of film. What are movies after all but moving pictures? In film, the vectors indicating directionality in two-dimensional works reach a new apex. Our eyes register the pictures streaming in the movies and see them as streamlined and coherent. The images move as they tell a story, and each frame is a piece of that story. Each clip, meanwhile, is a mini story that can be read according to the rules of grammar for the visual icon. For example, in *Miracle on 34th Street*, the image of rosy-cheeked Kris Kringle strikes the right note for his speech to Misses Walker. He is the symbol of Christmas, replete with all the regalia required for the position. But then, quite quickly, the image cuts to those desperate individuals on the streets of New York. And, our auditory senses engaged, we hear Kris Kringle's message that he is symbolic of hope for mankind to "suppress those selfish, hateful tendencies that rule a major part of our lives." We are reminded that "if you cannot accept anything on faith, then you are doomed to a life dominated by doubt." As our minds ponder these words, our eyes linger on those hopeless souls on the dirty, asphyxiating streets of New York. And then this image fades to show the forlorn Santa Claus in the sanitarium. He is sanitized, void of color, and caged in a place like a hospital, where souls go to die. It is the visual, I believe, that really drives the story home. A series of moving images, engaging both visual and auditory senses, is as efficient, if not more effective than text in telling the story.

VII. The Fourth Step: Following Marge... Again

*Heard a story the other day,
Took place at the local VA.
A father talking to his dying son,
This was his conversation.*

*"It's not supposed to be like this.
You can't go first, I can't handle it."
The boy said, "Dad now don't you cry.
Remember when I was a child what you used to tell me when I'd ask why?"*

*"(You'd say) Gravity is gravity,
It doesn't try to pull you down.
Stone is stone,
It can't help but hold its ground.*

*"The wind just blows, though you can't see,
It's everywhere like I'll always be.
You already are what you are,
And what you are is strong enough."
—Jewel, "What You Are"*

August 28, 1990

"Get up, Jo." I couldn't get myself out of bed so I'd called Marge's mother. I needed to tell someone how sad I felt, how bad. "Get up, Jo. Just get out of that bed and drive to that school. You worked hard to get there, now go there! Just put on anything and drive. You'll know what to do when you get there. But first you have to get out of that bed, Jo. I'll have Marge call you when you're done with classes; you two can chat about Morewood. You'll love the campus. Marge loved those trees. She would hang out in the arboretum when she was done with her classes. Are you out of bed yet, Jo? Go!"

I'm crying. I beg her not to make me go. "I don't think I can make this one, Edan. I'm too tired. Maybe it's time to call it a day and accept my limits. I can't fight anymore."

“Right now is the hardest you will ever have to fight in your life and all you have to do is get out of bed. It’s time to go, Jo. You’ll make it. I promise you that your only battle right now is tuning out those useless thoughts and getting into that car. And then you’ve got it from there. It’s time to go to college, Jo. You’re good enough, you’re strong enough, and you’re ready. You were made to fly—now fly. Let everything else go and get into that car.”

I pull myself out of bed, throw on some sweats, and drive. I have a nine o’clock in Cell Biology, followed by a non-credit math class. Nothing new there—as always, I’m already behind. But for God’s sake, at 24—no doubt the oldest among my classmates—I’m still not college material but need non-credit classes to catch up.... Focus, Jo, get out of the car. You’re here, and you need to get out of the car.... But they’re all so young, and I’m not. Plus my hair’s a mess and I’m not wearing any makeup—and just look at these sweats! “Get out of the car, Jo.” I can hear Edan’s voice; she’s in my head.

Edan’s tough. At age eight, she played on the streets of Hungary after the war, led games of hide-and-seek amid the rubble. She kept living. She didn’t give up. Here in the United States, she and her husband thrived, had a boy and a girl, my Marge, and ran the family business that would get everybody through college. “Get out of the car, Jo. You’re going to be late for class. They take attendance. Go.” She’s still in my head, thank God.

Cell Biology, what a fantastic class—full of pictures! I love the cartoon (Figure 9) Dr. Arnold puts on the projector: Two scientists reviewing a complex equation whose solution is zero. “No doubt about it, Ellington—we’ve mathematically expressed the purpose of the universe. Gad, I love the thrill of scientific discovery.” It’s a simple drawing with very little text but it communicates so much: there’s God, or escape from God with a new word, “Gad,” and enough math to think it really means something even if it really doesn’t. And the scientists—

they're men, not surprisingly, but they're also fat and balding. So I guess scientific inquiry amounts to nothing, plus it makes you frumpy? Excellent. Why am I here again? Plus, this class is full of guys. I figured I'd be the oldest, but I'm also one of—what?—three girls, all of whom dressed up for class. Great. Love these sweatpants. At least no one will notice me. I can just hide in the back here with my book. It's nice, full of pictures... actually really heavy. Hasn't anyone ever heard of soft cover? It's cheaper, lighter...

“Jo, what do you think of that slide [Figure 10]? What is it evidencing about cell composition? What stands out?”

“Circles, Sir, lots of circles, each found within the ultimate circle, that animal cell. Each circle is an area all its own. One powers the cell, that is the mitochondrion, and then there is the nucleus, the center circle that holds the ‘book of life,’ all the genetic material in perfect loops that can unwind. And that oblong circle is the endoplasmic reticulum, the protein packaging place with lots of folds, like waves in the ocean.”

“Interesting... Why the ‘book of life’?”

Didn't I answer the question well? Everyone is looking at me. Do I know the answer? Maybe my answer was wrong.... Stop thinking useless thoughts, Jo. They'll get you nowhere. Just go for it; open your mouth.

“Because you need to get the information about the organism from a cell's nucleus. This is where the DNA, the genetic material is, so this is where the instructions for making life are. And it's a ‘book’ because it has so much information in it. And it's a ‘library book,’ filled with very important information, so it's ‘on reserve’ and you can't check it out. The nucleus is the ‘library,’ and the pores are too small to let the DNA out, so if you want access to any of the info you need to take the ‘book’ from the ‘reserve shelf’ and make ‘photocopies.’ Making ‘copies’ is

called the process of transcription, like the old scribes did with the precious texts that couldn't leave the monasteries. Once you've transcribed your copies, you can take them out and use those. These copies are 'blueprints' for making precious things—things that are part of life—and the 'machinery' to do this is found in the cytoplasm, like how 'blueprints' are used by engineers to make buildings and the construction equipment is out at the job site. Here, the 'blueprints' make living chemicals, the proteins, by the process of translation."

"What do your parents do, Jo? It seems you know a lot about construction."

I need to run. All I can think about is running. What do my parents do? Do I have to answer that? I bet no one else here has parents who do what my stepfather does—or used to do, before the Bobcat crushed him. I need some Diet Pepsi. Where's my lunchbox?

"Jo, I'm sorry, didn't you hear me?"

"My stepfather is in construction. He's a heavy equipment operator, lays down the pipe for sewer and water for just about anything, from subdivisions to industrial parks."

I hope that sounded intelligent.

I think back to the day I first noted all those circles encasing cell materials and how those circles were ultimately encased by the cell wall (in the case of plants) or cell membrane (in the case of animals). Back then, I just saw circles—geometric shapes that made the cells easier for me to understand. And I was able to give the parts of the cells meaning, taking their jobs in the cell and analogizing their particular work to that of machines designed to keep the organism alive. That cell had to function, and "properly oiled" components, along with teamwork and continuity, allowed for this to transpire.

The designed model—in the case just described, the model of a cell—offers another means to represent key concepts found in science, including those that are abstract, describe invisible processes, or are otherwise difficult to master. And the images they conjure often represent the processes and/or classification-oriented characteristics of the physical world that benefit the learner or learning community. Recently, emphasis has been placed on integration of the arts in the science curriculum, with an eye toward including more visuals alongside text to better engage iconistic, visual learners and improve learning overall. Matewson (1999), noting that visual-spatial thinking had been “an overlooked aspect of science educators,” talks of the role of creativity in the field, defining science creativity as “an amalgam of three closely allied formats—images, metaphors, and unifying ideas/themes” (p. 35). Along the same lines, Miller (1996) writes about “sparks in creativity in science and the arts having important fundamental characteristics in common” (p. 96), such as the development of higher order thinking skills that allow for novel thinking, or thinking “outside of the box.” Miller considers fostering the ability to analogize and see structures inherent in everyday nature to be crucial to the sciences and the arts, and believes that linkages between the two are inherent to the process of understanding and to the creative expansion of the individual.

According to Girod (2003), aesthetic understanding plays a crucial role in teaching key science ideas; he concludes that “if we truly wish to educate our students, we must develop both the scientist and the artist within them” (p. 577). Marshall (2005) takes this premise and brings in scholarship from divergent fields, including the work of Lakoff and Johnson (1980, 1999), to make the case for “substantive integration,” the thorough, intrinsic fostering of ideas and concepts within the existing schema of the individual. She argues that many higher order thinking skills—analogous thinking, metaphor bridging, increased creativity, schema building,

etc.—are sure components of scientific thought processing, and notes that the use of visual images can give way to “seeing” these higher order mental processes. For example, the use of a spiral staircase to depict a double DNA helix represents not only great knowledge of science constructs such as nucleotide bonding pairs and the sugar phosphate backbone but makes a great correlation between those pairs and the staircase steps, and the backbone’s and the steps’ connection to each other.

Marshall (2005) further raises the issue of collage and its link to brain functioning and pathways to suggest that postmodern thought can be useful in the teaching and learning of art, as well as in the inclusion of the arts in other subject areas, noting how it was the postmodern era that called for allowances, diversity, and inclusion in education:

Postmodern theorists endorse an art education where art is contextualized, boundaries between domains are blurred and emphasis is placed on content in relation to form. Integration of art with other subjects is congruent with tenets of postmodernism because it relates ideas to form (shifting the focus of art education away from formal concerns to meaning-making), crosses disciplinary boundaries to reveal conceptual connections, and locates art in context with other disciplines. (p. 227)

Citing the work of many in the field of cognition, she aims to show how “substantive curriculum integration” can be a proponent of meaning making, connection making, and increased learning and creativity. Allowing for experiential learning to be a part of the curricula, for example, frees students to bring in prior knowledge and link it with newly acquired information, adding a new dimension to the lesson. This idea of substantive curriculum integration can be seen in the staircase model of the DNA double helix. Most students are familiar with staircases and based on past encounters with them have some notion of their usefulness, ingenuity, and beauty as a solution for getting from Point A to Point B. As Dewey (1934, 1938a/1998), Schubert (1981,

2009), and so many others in education note, the means of knowing some *thing* come from a great many curricula, engaging numerous interactions with others and the environment, and not just from the limited curricula set down by a school administration. As Marshall writes, postmodern “theories describe learning as essentially a situated, socially-constructed, and culturally mediated process of meaning making” (p. 227).

Cognitive linguists Lakoff and Johnson (1980, 1999) discuss the neural connections involved when engaging with physical reality, writing that “we form extraordinarily rich conceptual structures for our categories and reasoning about them in many ways that are crucial for our everyday functioning. All of these conceptual structures are, of course, neural structures in our brain” (p. 20). Koestler (1990) and Hummel and Holyoak (2002) suggest that creative thinking is linked to the ability to develop analogies, while Marshall (2005), citing Lakoff and Johnson, links it more specifically to metaphor and cognitive discord: “To Lakoff and Johnson, metaphor is where creativity and learning intersect; it is also the primary principle of consciousness and cognition.... [A]nalogy then serves as a basis for projection, where something is seen in terms of another” (p. 230). In the world of metaphor, she explains, “there is not complete accord between the two conceptual entities. The discord between the two entities challenges the mind to re-conceptualize the original entity, and see it differently” (p. 230). In short, when the mind struggles, new analogies are fostered, as is creativity. Marshall proposes the fostering of creativity as a means to develop a greater understanding of how conceptualization occurs and thus develop better tools and methodologies in educational praxis. The core of learning, she writes, “lies here in the analogous thinking” (p. 229).

That model in my Cell Biology class helped me to understand the symbiosis between the parts of the cell and their collective work toward one goal, the continued life of the cell. And I

made continuous analogies to achieve mastery of the concept. What I saw in that visual representation of the animal cell were working processes between component parts of the cell, a specifically designed living entity. I saw that the cell was made to function and that each part was indicative of this goal to live. But what of the cell that does not fit this working image? What of the cell that is misshapen or suffers other mutations not designed for the altruistic survival of the life-form? Marshall (2005) notes how not only the “correct” model but also the visual icon that depicts something that is “not right” can be a tool to learning and understanding. She talks of how the “wrong” image can prompt a change in perception that could introduce a greater connection between the learner and their view of the existing world. This idea of dissonance and reconceptualization recalls Bruner’s (1996) ideas of incongruence leading the way to divergent thinking and intensive cognitive functioning to deal with anomalies, as well as Kuhn’s (1962) scientific “revolutions” in which existing practice must change to contend with anomalies in the reigning paradigm. I can’t help but think of Greene (1988) and her call to see things “as they might be otherwise” (1988, p. 6). Leaving one’s comfort zone—namely, the methodology and curricula of today’s schools—and trying divergent paths, as she and Eisner (1981) suggest, may offer hope in the formation of a new way of looking at the art of teaching and learning.

I work to reflect this research in my own teaching as I continually engage the visual in the learning of science. In my Introduction to College Biology class, I start with the model of the cell and describe the particular characteristics that allow it to survive. After noting the compartmentalization of the cell, and the processes of each key component (the nucleus, the endoplasmic reticulum, etc.), I go deeper into the cell’s workings. I show images of the transcription and translation process (Figures 11 and 12) and discuss the processes as mechanistic and following a set protocol. I also talk about what can occur if the cell suffers and

strays from the protocol. Starting with small discrepancies and moving on to much larger failures in the transcription and translation processes, I describe how the cell can become abnormal to the point of cancer or even cell death. As a student at Morewood College, I understood and discussed the various components of the cell in terms of their particular jobs and as contained units. I thought of this information as something to recognize and memorize, although I always had shorthand notes in my head of what each part was or did. For example, the nucleus housed genetic information so it was the “book of life” holder, and the cytoplasm was the location of the “machinery” for the production of proteins. At that point, my goal was to classify the parts and recognize them individually. And I still think it is important that my own students view this information in this way. But when I want to discuss the processes—when the DNA unwinds and a copy is made to engage the “machinery” found in the cytoplasm—I think differently, seeing a more holistic purpose to the work of each cell component. I think in “fluid movement,” engaging the visual with directionality, forward or backward, as the DNA helix unwinds and all the components of the cell system kick in to make the protein the cell needs to survive. To help my class see this too, I pull up an illustration of the dogma of genetics (Figure 13). Not only does the image illustrate the holistic process of protein production, it suggests a rationale for the means of the production. For example, when you see the size of DNA versus mRNA, it is easy to rationalize why the DNA cannot leave the nucleus. Only the single-stranded, slithery mRNA can get out to the needed machinery in the cytoplasm. In my mind, and I believe in the minds of my students, the words and images are compared and contrasted toward understanding the intricate process of protein production.

The dogma of genetics outlines the fundamental belief held by all of us in the biochemical field. Once my students grasp this relationship between the DNA, mRNA, and the

desired protein—the basic concept for understanding all of rudimentary genetics—their world opens up, to the point where they can conceptualize anomalies. I relate anomalies in the process of transcription and translation to an issue relevant to my students and the world: AIDS and the human immunodeficiency virus that causes it. The main point I want to suggest in these discussions is that the virus does not consist of the usual DNA, but rather RNA. This allows me to then suggest that the virus needs to undertake extra steps to get to a DNA form. From there, I can ask my class, ‘What are those extra steps?’ This requires going in reverse, against the directionality of the dogma of genetics. And this is the determining factor for AIDS’ continuation in the human body. Normally, one’s immune system will attack roaming viruses, annihilating them. But by using our body’s machinery, the virus makes DNA with reverse transcriptase, giving rise to the mRNA that will allow the virus to reproduce itself. It literally uses our system against us, eventually resulting in full-blown AIDS.

Once my students have grasped the central dogma of genetics, I move past the main points of transcription and go into the nuances of the process. Again, one important lesson is that size limitations only allow the mRNA, the “blueprint,” to pass through the nuclear pores but not the DNA, which must be unraveled to allow for production of the “photocopied” “blueprint.” The integrity of the source, in this case the DNA, must be maintained at all costs. Safety for this exquisite biomolecule lies within the nucleus, whose nuclear membrane provides a wonderful shell of protection. The gear for unwinding this biomolecule is also housed within the nucleus. The cell design is industrious, orchestrated, and compartmentalized to offset damage to the “book of life.” This is what I want my students to appreciate—the importance of the “book of life” to the continuation of life as we know it. With an understanding of this concept, one can appreciate the spectacular nature of DNA, this double helix that can unwind itself and wind up

once again after the process is accomplished. I still remember one of my biochemistry teachers at Morewood telling us that if you unraveled the entire DNA in all of your cells and placed them end to end they'd reach the moon and back 130,000 times. Today I impress my own students with these same types of mental images, while encouraging them to develop their own.

For example, one student, Deann Igor, in response to an assignment on human genetics, built on the visual imagery of the spiral staircase and incorporated multiple metaphors to help describe her conception of the infinite potentiality of DNA (Figure 14). She described the double helix as:

A staircase that keeps going on and on, all the way to the "Man in the Moon".... Perhaps this Man is the "One," the responsible party for all of life down here below on this blue marble we call "Earth." But, alas, this is stuff of speculation. Now to the recent scientific discoveries.... Unraveling right to left, and left to right, with the help of RNA polymerase, the enzyme [whose] name tells you its duty... to make RNA, to make the polymer, the messengerRNA (mRNA), that will leave to the "machines" of the cytoplasm via the small door pores. Working to separate the coding strand from the non-coding strand, it works to interrupt bonds, those bonds that "zip up" the DNA strands initially into this spiral staircase. Thus, where there once was A's [adenines] bonded to T's [thymines] and G's [guanines] to C's [cytosines] in this spiral staircase, now all that is seen is the gentle separation of the zipper sides. And as one comes unraveled, mRNA comes to be, with a single-stranded entity void of T's, and complete with U's [uracils], those "nasty" nucleotides that are responsible, and allow for mutations.

Deann's response is not only poetic it demonstrates a great deal of knowledge. One thing I find striking is the way she describes the openings in the nucleus that allow the mRNA through. By calling them "door pores," not only does she lend her presentation of facts lyricism, she engages knowledge of what the pores are—doors to the "machines of the cytoplasm." I am also impressed by her use of analogy in her description of the double helix as a "zipper" and the separation of the strands by mRNA as a "gentle separation of the zipper sides." Deann presented

her knowledge in an artful, poetic way, offering a working example of the bridging mechanisms (Kestler, 1990), analogies (Hummel and Holyoak, 2002), and metaphors (Lakoff & Johnson, 1980, 1999) described by those in the fields of cognition, the arts, and education (Marshall, 2005). Her poetic approach and inspiring artwork also recall Girod's (2003) belief that students need to embrace the inherent beauty found in the natural world and the sciences that try to depict this beauty. Her work is an engagement with science, and my teaching is an engagement with her world. Could this be what Girod envisioned when he wrote that "if we truly wish to educate our students, we must develop both the scientist and the artist within them" (p. 577)?

I end my class discussions on genetics by focusing on the "machines" that give rise to protein. Again I use the gene dogma diagram (Figure 13) to discuss this special process, highlighting specific points of the visual during my lecture to indicate how the information it communicates coincides with my lecture and the drawings on the board. I watch my students glancing at the projected image on the wall and back to their notebooks, writing at a frantic pace to get my words down. But what interests me more than the words they copy in their notebooks are the doodles and pictures they create to supplement them: anything from a circle or a bunch of squares organized in specific patterns to color renditions of heavy machinery. For instance, in student notes on the process of translation, in which the "machines" in the cytoplasm make protein, I've seen drawings of dump trucks, cranes, or other construction equipment hauling amino acids; other times, I've seen planes dropping parachuters with the amino acids down to the waiting mRNA and rRNA. In my students' art, I see their science. And again I see those bridging mechanisms and a rationale for Girod's (2003) push for full integration of the arts and science in the education of our students. In their work it becomes evident why Kerry (2007) pushed for a clearer definition of *integration* as the "golden key" in education, writing that:

while the physicist, the chemist, and the theologian may each have a content-led distinctive contribution to make to human insight, each insight only is partial, potentially blinkered, and ultimately unsatisfying. Only by drawing all the insights—and others—together can the jigsaw of human life and the universe ever be more than a relatively random and incomplete corner of the real puzzle. (p.79)

When I lecture, I work in the world of analogies, and I encourage my students to do the same. In their scribbles of parachuters with colorful loads, I can see the particular amino acids that equate with the colored codons on the mRNA. And in their work, I see that they get the science, each in their own way. In my classroom, I see integration occur as the arts and science meet and learning happens.

VIII. The Fifth Step: On My Own... Again

*It must've been a place so dark you couldn't feel the light
Reachin' for you through that stormy cloud*

*Oh, why? That's what I keep askin'
Was there anything I could have said or done?
Oh, I had no clue you were masking
A troubled soul, God only knows what went wrong*

*Oh, why? There's no comprehending
And who am I to try to judge or explain?
Oh, but I do have one burning question
Who told you life wasn't worth the fight?
They were wrong, they lied, and now you're gone, and we cried
—Rascal Flats, "Why?"*

January 15–16, 1992

I'm going back. I don't want to go back. It's dark. I'm cold, and I'm alone. No one cares. I'm twenty-five, living at Rod's, still cleaning houses to cover my gas to get to school. But what does it matter? If I can't get my life together, it won't matter when I finish Morewood next year. And this medicine isn't helping at all. I'm still sad, and no one cares. What was I thinking? I'm from the wrong side of the tracks. Maybe it's like Rod said, people like me should stay down. I'm behind in all my classes. Some days I can't even get myself out of bed. Rod goes off to work, and I go back to sleep. Sleep is good. I get to forget awhile, forget about how I'm going nowhere.

The path is wet with snow, and my feet just slosh along. I'm walking, not running. No matter how far I walk, I don't feel any better, I can't get away from my head, and my head hurts—my life hurts. And they don't care; I'm a mistake that no one wants around. Rod's friends are right: I'm an idealist who'll go nowhere. Mom, Rod, they both wish I'd just stop getting sad, think it's all in my head. They say I'm the problem. My eyes burn, the wet lashes sticking to my

skin. Maybe if I run, I won't hurt.... This medicine is definitely not working; I'm more sad than I've ever been.

"Jo, you know that Koleta is useless. She gave medicine to Uncle John, and now he's dead. Stay away from her. Those antidepressants are useless, and you're on the same kind that John took. Now look where he is... gone." Mom, get out of my head. I don't need any more people in my head. I'm running around, trying to make everyone happy, and no one is happy. Get out of my head, Mom.

I'm cold. Running isn't helping. Nothing is helping. Maybe if I go home, I can call Koleta—she is my doctor, after all—and ask if I can take another Prozac. I want out. God, where are you? And where were you the night John died a year ago? That day he left his face in a bag and a note for Mom to find in a trailer reeking of cat urine. He was all alone, save for those two cats. I wonder if they knew he was dying. Did they lick his face? Caress his cheeks with their sandpaper tongues to try to take his pain away?

It wouldn't have made any difference; he was alone, cooped up in the spare bedroom of Gram's trailer—a house full of nothing, where all would die in time. Gram had just died herself, Christmas Day, and that's probably why John gave up. Gram had raised us both in that trailer, and John was more of a brother to me than an uncle—how we both loved Def Leppard! But I eventually moved away, still visiting on occasion, while John got left behind. After Gram died, all he had for comfort were those cats.

I had a feeling something bad had happened. One night in a dream, I saw the darkest creatures slip into Gram's trailer. Wisps of black, they rose from the dirt and gravel of the trailer pad and slithered in through the underskirt. They oozed and flowed through the vents. They wanted John, and I knew it. I ran from the back of the trailer, where my own bedroom once

was, and screamed for John to get out. But no matter how fast I ran, I couldn't cover any distance. The trailer was a long shoebox—with corridors of dark plastic instead of wood. "John, go! John, get up!" Blood is red. There was so much red in the trailer; I was engulfed in red.

The next day, I called John the minute I woke up; he didn't answer. He was eight years older than me but still just 32 when he died. Died alone. Mom found him, and I came soon as I heard. There was no blood, just a terrible odor—the cat pee, I'm sure. Around his body lay a garbage bag, empty liquor bottles, a letter, and Jack Kervokian's Prescription Medicine: The Goodness of Planned Death. John had followed the book's instructions to the letter. Time of death, unknown; date of death, January 5, 1992, Grandma and Grandpa's wedding anniversary.

I'm alone. Rod isn't answering the phone—probably doesn't want to take my call. He wants to hide me, and I can't blame him. I would hide me, too. He's at work again. He's always at work, and I'm always alone at his place. Not mine, his—I'm just a visitor here. I want to stop feeling. I want to stop hurting. I go out to the prairie path and I bring a knife. I caress the blade, then run it across my arm, scratching back and forth. I see red, just like in my dream. Sticky and sweet, it slowly trickles out. Six cuts, but none that will end it all.

The ambulance comes and picks me up in the parking lot of a nearby grocery store. Rod never answered my calls. I'd left messages, tried calling again and again. Then the phone stopped working—no dial tone, nothing but silence. Maybe Rod got tired of me calling. Maybe he picked up and just put the phone down without disconnecting. Either way, I couldn't dial out from home anymore. I couldn't call anyone. So I went and found a payphone at the grocery store, where some nice lady got me help.

"Will I be put away? I have school tomorrow. I need to go to school." The EMTs don't answer. They just offer calming words, put me in the back of the van, and drive me away. Mom

and Rod show up at the hospital but I can tell they don't care. They can barely look me in the face. They discuss me and I go back to Rod's. All I can think is, Time to go to bed. I have class tomorrow.

Four a.m.—I can't sleep; might as well go for a run. It's beautiful outside, dark and misty, and the moon is full. In my head, I replay my conversation with Edan, who called when she heard the news. "Jo, what were you thinking?" "I don't know, Edan. I don't know." "Jo, just get back up, go to school. The rest will happen. Just do your part." "Edan, you have no idea how hard it is to do my part." But I'm glad she's here with me in the morning dew. I run home, shower, and go to school wearing a long-sleeved shirt.

Head down, late for class, and my homework undone, I walk into precollege math and take a seat. "Nice to have you join us, Jo," Mrs. Reynolds barks. I just smile, take out pencil and paper, and start taking notes. And then my head starts up again: I'm never going to get this. What do I know about sine and cosine? It's like a foreign language to me, I can't even figure out my calculator—

"Jo, can I have a word with you?"

"Now?"

"Yes, now."

Mrs. Reynolds pulls me aside. "You haven't turned in any work for my class lately. You need this class to go forward. I know you can handle the work, and I know you want to make it. What's going on?"

I stuff my hands in my pockets. "I'm falling apart. I can't handle all this stress; there's so much bad in my life."

"Jo, what happened to your arm?"

“...I cut myself.”

“Jo, there are worse things in this world. Not that I’m discounting your pain, but imagine Clarise, fighting cancer every two years, losing her hair from the chemo.” Clarise is the secretary that runs the physics and mathematics departments. “You feel bad now, but this too you will survive. Go within. Go forward. The best thing you can do now is appreciate what got you here—your drive—and go forward. Think of Clarise, and get all that late homework in. I’m giving you an extension, till next Monday. Get it done, Jo. Get it done.”

May 1992

I pulled off those precollege math classes—two Bs, done!—and Clarise made it through another round of battle with cancer. I work for her now; I clean her house. Between Clarise, Dr. Gestof, Kristen Whiteford, and Dr. Leavy, I pull in about \$400 a month cleaning houses for folks from Morewood. I listen to music as I scrub their homes, stopping every now and then for a Diet Pepsi and one of the snacks left out for me. From where I am now, the deli is so far away. How three years fly by. I never thought I’d escape it. Now these jobs are enough to cover the extra expenses of school. And Clarise, she’s a gift. Wearing the winter coat she gave me, I set off for Kristen’s; a little Annie Lenox on my headphones and I’m ready to clean toilets. (Gotta keep a sense of humor...)

August 1992

Another year at Morewood, and sitting in Organic Chemistry with some of these older students I feel less lost. Michael Whitehurst and Rhonda are here. They’re both married, but I sense they like each other. They’re always together. If they’re not in the organic lab, they’re in our ACS student lounge. They’re good people.

“Jo, what kind of yield did you get of the acetylsalicylic acid?”

“You know me, John, theoretically I should have had 3.2 grams, but I got a whopping

1.3. How about you?”

“Before or after I gave some to Rhonda? She lost her whole yield in the last condensation round. Nothing but water.... Maybe there was nothing there worth condensing.”

“Cute. Tell that to Lothey. I’m sure he’ll love why she has nothing to mark on her lab report. I see him giving her a nice, little F for yield.”

“There will be no F! The actual yield for me was 5.7 g—an 86% yield. But now it’s 49% and Rhonda has a little to show for herself.” He pauses. “So, Jo, how did your arm heal?”

“What are you talking about?”

“Jo, you can’t wear long sleeves forever. Sooner or later, the sun shines, and the heat rises, and your wrist will see the light of day.”

“I don’t want anyone to know.”

“The truth comes out, Jo. You can’t bury it. And, anyhow, your scars don’t show that much. I know scars. And I know you had no intention of killing yourself. If you really wanted to do it, you would’ve done it like this.” John flips his left wrist and, using a microscale spatula, traces a path along his arm, going up and then down, not horizontal like I did. “Nope. You did it all wrong. If you really wanted to die, you would have done it right like me.” Then he flips his right wrist to reveal deep gouges running up and down his arm along the veins. Scarred forever—the cuts healed, but, I wonder, what about his soul? I think about what he’s said. No, I didn’t want to die. I just wanted someone to know I hurt.

I believe that the aesthetic experience is personal and unique to the individual, and that art in the classroom provides students the opportunity to confer meaning and value to the various dimensions of their lives. It also affords students a level of freedom in an educational setting that dictates what they must learn, allows for personal input in the delivery of the curriculum—thus investing them in the process—and assures them that their contributions are of worth. In a most profound way, this aesthetic experience can define one’s identity and what one perceives to be worth knowing. To capture the imagination and speak to the soul, art can open doors to realms of knowledge that otherwise might remain closed or blocked. Bridging areas of study by inviting the student to tap into personally meaningful, creative resources may contribute to seamless synthesis in educational practice.

In *Experience & Education* (1938a/1998) Dewey proposes progressive education to transmit the knowledge needed for an individual’s future. To this end, he cites the need for a well thought-out philosophy of the social factors that operate in the constitution of individual experience, writing that

[t]he more definitely and sincerely it is held that education is a development within, by, and for experience, the more important it is that there shall be clear conceptions of what experience is. Unless experience is so conceived that the result is a plan for deciding upon subject-matter, upon methods of instruction and discipline, and upon material equipment and social organization of the school, it is wholly in the air (p. 17)

In my own classroom I try to manifest his belief that “a philosophy of education must be based on a philosophy of experience” (p. 18), and I see engagement of the arts as a great way to bring the many ways of knowing and experience to the forefront. Eisner (1998) speaks to this idea, writing that “it is important to attend to the array of forms of representation emphasized in a class because of the different kinds of meanings that each provides and the different kinds of

thinking skills each develops, and because educational equity is likely to increase as the diversity of the forms grows” (p. 179). This is a call for allowances in the classroom, for experiences and personal aptitudes to not only be noticed but fostered by teaching that includes more than the curriculum of delineated subject area courses. Dewey is careful to stress the importance of *positive* experience in learning, defining its opposite as mis-educative in that it disrupts or arrests the growth of further experience. In traditional schooling, he writes, the “trouble is not the absence of experiences, but their defective and wrong character—wrong and defective from the standpoint of connection with further experience” (p. 16). I propose, as Dewey and Eisner appear to suggest, the arts as the tool to nurture students’ development and their creative souls.

While at Morewood College, I attended seminars that offered students the opportunity to go deeper into areas that dovetailed with their major. Since I was chemistry major, a biochemist, I was interested in pharmaceuticals. I studied the design and structural analysis of drugs in classes for my major, but I was curious about the business side of the industry. What did I learn? That it was all about profits. Unlike John, Rhonda, and I generating yields for our grades but helping one another regardless, the industry’s focus seemed only to be gain for itself. That bothered me (and it bothers me still). How could drug companies not see the real, sometimes survival-level need for their products? Did they just ignore the ailing? Why didn’t they want to help? We pursued this line of thought in our seminar, asking: What would make someone help? What would cause them to not help or to prevent help from occurring? Our readings delved into the psychological theory of systematic desensitization, in which small incremental changes make us less sensitive to great atrocity (Gurman & Messer, 2003). We read works about the Holocaust—including Wiesel’s *Night* and Verlag’s *The Good Old Days: The Holocaust as Seen by its Perpetrators and Bystanders*—and drew comparisons. We discussed the Gauguin

dilemma, about the “artist ... having to choose between two of his identity components, the moral and the creative” (Kurtines & Gewtiz, p. 487). It was a true ethical dilemma: should Gauguin be true to himself and pursue the arts, or stay with his family and fulfill his role as husband and father? We played on this question, asking, ‘Would it be OK to steal medicine for a dying spouse?’

Among the classes I teach is Chemistry and Society, and in it I try to be equally free-ranging in our approach to the material, encouraging students to integrate their personal experiences and the arts in their demonstration of their learning. In the tenth week of class, the students must make a creative presentation in which they highlight some concept of chemistry in connection with their thoughts and feelings on a particular ethical issue, whether eco-friendly building materials or the runoff of textile dyes in India’s waterways. In my fourteen years assigning this project, I’ve seen the gamut: some good, some not so good, but all reflecting a bit about the student and knowledge of the science concepts raised in class. One particular presentation from 2008 sticks out for its effectiveness and because it took me back to Morewood and reminded me of me. It was by a shy girl, a fashion major, who barely said a peep in class. Her topic was depression, and she’d made a PowerPoint, including a table outlining the risks and benefits of the new antidepressants on the market (Table 1), as well as a dress she titled Twisted (Figure 15) to illustrate her ideas. Our class cried together—twenty-five students and me—as this sparrow of a girl described the disease, giving it a form and shape, and read us the letter her brother left upon his suicide. And then she showed us her dress: black and red, cut throughout with razor blades, its representation of pain was unmistakable. She said:

Have you ever been depressed? What do you think depression is? Well, in my mind depression is a thing that no one can describe, and in some ways it is twisted. Therefore, this dress is inspired by depression.

The dress has specific colors, consists of specific materials, and is full of reason. Nothing in my dress is an accident. I am speaking for all those in pain, that do not know what words to use. Thus, I hope this dress could be the vehicle for their communicating to all of us. May they find hope. May they find meaning, to a new life of promise!

COLOR

When I think of depression I think of darkness and death, so the main color of this dress is black. Gray is a color of dullness, lack of value and excitement. Many depressions lead to suicide, so I also threw in splashes of red to represent blood or fear.

MATERIALS USED

The material used to make this “Twisted” piece was mainly wire. Wire is a substance that, like our lives, can be easily molded. When people are depressed, they often think that their lives are more complicated than everyone else’s, and that no one understands. The cuts are to show their pain manifested, as their minds break the spirit of the soul.

REASON

As you can see, the gray wire is twisted somewhat representing barbed wire. I twisted the wire to suggest that it is a representation of pain and sorrow. The red wire represents the flow of life.... Sometimes we think it will never end, but through life’s up and downs, there is always an end. And it is the ladder that represents one’s ability to climb upward, if that choice is made. Lastly, the razors tell of the story how innocuous blades are in terms of their purpose. Though used to shave, to beautify, they can as well cut. They have the ability to be used by the mind to break the spirit of the soul.

NEW LIFE

The materials used to create this piece were chosen specifically to represent new life. The black dress you see here was actually bought at a secondhand store for \$11.29. The wire is what was left over from rewiring an old house. All this symbolizes a new beginning. Some people with depression seek help in some way or form, whether it’s via medication, or just loving a friend. This helps the person realize the importance of life, therefore taking that second chance... just like these used materials.

That she successfully integrated such an emotionally rich and artistic presentation with the cold facts of science (Table 1) supports my belief in integrating science in the real-life experiences of those I teach.

IX. The Sixth Step: Leading, Not Following

Whatever you do in life will be insignificant, but it is very important that you do it, 'cause no one else will.... Michael, Caroline asked me what I'd say if I knew you could hear me. I said, "I do know. I love you. I miss you. And I forgive you."

—Tyler Hawkins, *Remember Me* (2010)

January 1993

Yes, Uncle John, I forgive you. I miss you. And I so love you. Always have, always will. And I still see you. All the time, you are there. I see your spirit, I see all that potential. You're in my music. You're with me when I run. Sometimes when a song by Def Leppard or Black Sabbath comes through my headphones, I see you shoot right past me on your bike, your Cubs shirt billowing in the wind. I see you, John. I see everything that you could have been. And it saddens me, because I can only see what "could have been" and not what is.

But, John, I love you too much to keep thinking like this. I have to believe there's a reason that you had to die, a reason why you wouldn't let me—or anyone else—help you. Were things so dark? Were friends hard to come by? Couldn't you talk to God and ask for help? Me—I do it all the time. God, I miss you. Why couldn't you see that you had worth, that you could make a difference—make a difference to someone like me? I needed you. You recognized the value of school, what it could do, what opportunities it could afford. I can still see you pulling up to Gram's house in your Camaro Berlinetta, its windows open, your long hippie hair tousled by the wind. I see you running in to greet me at the kitchen table, where I'm troubling over some math. This crap will be the death of me, I say. And you smirk at my scowl, grab a glass of milk from the fridge, and work some magic for me: Voila—the answer!

But you only had the solutions to math. You had no answer to the problem of how to survive the ups and downs of life, its pain and hardships. And I couldn't help you. And to this

day, now two years later, I still can't help you. All I can say is, Yes, John, you're right: Perhaps all is moot and nothing has purpose. BUT—I say, do it anyway because the time will come when all that you deemed insignificant reveals itself to have value, when by your presence you make a difference. In a moment, the worthless reveals itself to be worthwhile. And it is this message, John, that I take from your death.

I want you to know that I love you and that I will keep moving forward, see what happens. I'll keep my legs moving, while trying not to get so caught up in the past. I'm going to run from that darkness that consumed your soul, that took you away from me. I'm going to run into the light, armed with a lot of prayer, honesty to those around me, and the conviction to stop hiding. My arm will see light again. It is time—

“Is Jo Ella Eaglin present?” My classroom reverie interrupted, I put my head down and begin to fidget. “Excuse me, is Jo Ella Eaglin here?”

What do they want me for during biochemistry? I just want to disappear. I didn't even shower today. Just went for a run and got in the Cavalier. God, my hair must look atrocious; thank God it's curly—a little scrunching can hide a lot. But I smell. I wonder if there's time to grab the perfume from my purse and put a little on. Nope, not so lucky.

“Jo, could you please come here to the front of the class?” Dr. Lothey says. “This is Dr. Woods of Omicron Delta Kappa. He's here to speak to you.”

I look up to see a group at the front of the class dressed in flowing, exquisitely colored robes, and I notice the class has fallen silent. They must be as in awe as me of this pomp and circumstance. Except I had to present myself to this regal group, and I didn't even shower today. Mental note to self: run AND shower.

“Jo Ella, you have been awarded the opportunity to join our society. Professors that have worked with you these past years suggest that you are capable of leadership and excel in your studies. In addition to your strong G.P.A., it has been recognized that you engage in many services here at our college. Throughout the summer’s accelerated Organic Chemistry laboratory, you have served as a teaching assistant to Dr. Lothey, helping 25 students as they perform technical laboratories. You also manage the chemistry stockroom, ordering chemicals and setting up organic labs for the students. In addition, you are a secretary for the college chapter of the American Chemical Society and have presented work at college functions in this regard. Lastly, it is your awarding as Organic Chemist of the Year by the ACS that exemplifies who you are as an individual. We hope that you will accept our invitation. Thank you, Dr. Lothey, for letting us interrupt your class. Congratulations again, Jo. Good day to you.”

I knew I should have showered. What just happened?

“Jo, congratulations. You earned this, and so much more. Congratulations.”

“Thank you, Dr. Lothey. Thank you very much.” I return to my seat, look toward the window, and see the sun of autumn; for once, the light was not just in my mind. John, I did it. I love you, John.

Organic Chemistry and Biochemistry are my two loves. One provides the recipe for every reaction, allowing you to make or break any molecule that is known. And the other takes those reactions and attempts to perform them in a living system. Now that’s the hard part—working that living system. It’s not like measuring out chemicals on an electric balance to place in some impersonal beaker or flask. It’s dealing with a living, breathing system, a system that doesn’t always follow all the rules in the lab manual or interact with chemicals in the way one

would expect. Biochemistry is a world of cyclic cascades and multidirectional interactions. Reactants A plus B do not always give rise to the expected C; rather, one reaction begets another reaction, which initiates yet another, and the cascade continues from there. The living system is a symphony, highly orchestrated and in tune, that gives rise to the most beautiful music—life as we know it. From the perfect energy levels of carbon, so conducive to polymer bonding, life takes shape. These forms allow for functionality; and when processes begin, life begins.

In the classroom I bring my two loves together and try to integrate them with the loves of my students. My students are designers—fashion designers, interior designers, graphic designers, etc.—and I teach them about the ultimate design unit: carbon, the building block of all life. As designers, my students understand the meaning of design and are intimately connected to the media through which their work will manifest. I design molecules toward various ends, using the tools and equipment specific to my field. Is that any different than someone in multimedia designing an advertisement using Photoshop or InDesign? They have a goal, they know the software—they use this and their own creativity to generate a design, a work of art in their field.

I teach a laboratory in my Introduction to College Chemistry course called Form Fits Function (Figure 16) with these thoughts in mind. Using molecular modeling kits, my students must design and build molecules whose forms fit the precise use of the molecule by a living system. I start by explaining that a molecule's design must follow the particular forms that we engage with in nature, for example, tetrahedral, trigonal, and octahedral shapes (Figure 17). All geometries result from angles—consider the 90° angles that form a square. These specific angles arise as electrons pairs bond or repel between two nearby atoms. Atom size and electron shell makeup contribute to this repulsion or attraction, but so too does the individual electrons' desire

to achieve the right fit. Nature supports electrons “coming in” in specific shell order, filling the outermost shell to a precise threshold of twos (duets) or eights (octets), as bonds form.

The elegant and exquisite dance of electrons leads to all of the intricate molecular shapes and designs found in nature. And if you take a deeper look into these molecular designs, you can see that their formation is directly linked to chemical properties such as electronegativity, ionization energy, and electron affinity. Observable physical properties, such as density, and melting and boiling points, directly correlate to these more abstract electron-driven chemical properties. I explain to my students how they can see it all come together at the macro level in water coalescing on a windshield or in the flow of blood through our veins. It is all about design, and in this case, how the form fits the function.

Once I have wowed my students with this premise, I have them build models of molecules. Making, I believe, is a key to understanding, because it fosters engagement with the world. I encourage my students to put their various experiences to use in their work. Some students first draw their design, using colored pencils, charcoal, or paints, while others use computer programs such as Illustrator. It’s up to the individual whether they prefer working with their hands or modern technology; like the early Disney animations versus Pixar, it is simply a matter of aesthetic preference. After rendering their molecules, the students label the constituent atoms and their bond lengths and angles. It is interesting to see how some students choose to label their atoms with letters while others might use IUPAC (International Union for Pure & Applied Chemistry) color codes: blue for nitrogen, because our sky has a high concentration of this element, or black for carbon, the chief source of coal. Some students make legends to spell out this information; some engage the inherent meanings in the drawings themselves. All are unique.

For example, one student with some life drawing experience made a hand-rendered drawing of a methane molecule (Figure 19), its tetrahedral geometry resembling a piece from the playground game Jacks. Because of his background, this student liked color and enjoyed simple geometric figures. He considered the role of shapes to be *getting a point across*, while the job of color to be *adding definition*. Although not very tech-savvy, this student used his experience in drawing to add needed perspective to a limited two-dimensional medium. This method of manipulating shape and color to communicate meaning directly recalls the work of Kress and van Leeuwen (1996), who note that “what is expressed in language through the choice of different word classes and clause structures, may, in visual communication, be expressed through the choices between different uses of color, or different compositional structures” (p. 2). Text and visual images have an intricate relationship, and each mode of communication offers different affordances for meaning. My student understood this, and reflected this principle in his work.

Once my students have built their models, I ask them to find uses for them in society to lend the molecules meaning in light of the human condition. For example, how does the development of synthetic bloods, and the protein molecules that they harbor, play out in improving medical care? Or how can certain organic polymers be utilized in textile development to make more eco-friendly fabrics for an ever-increasing population? And, because personal relevance is crucial to learning, I ask them to consider if the shapes of their molecules can be found in their own art or in the tools they use. If they do not make the connection of knowledge to themselves personally, it will never add to their lives as individual participants in a global society:

To gain an integrated individuality, each of us needs to cultivate his own garden. But there is not a fence about this garden; it is no sharply marked-off enclosure. Our garden is the world, in the angle at which it touches our own manner of being. By accepting the corporate and the industrial world in which we live, and by thus fulfilling the pre-condition for interactions with it, we, who are also parts of the moving present, create ourselves as we create an unknown future. (Dewey, 1930, pp. 122-23)

I wish for my students to engage the material of my class as they see it played out in the world they know. I want them to fully engage chemistry as a means of bettering their individual and collective lives. Borrowing from Schubert (2009), my goal as a teacher is to “encourage students to reflect on their experiences and hopes” toward “the larger Deweyan occupation [of] composing oneself as a contribution in the world” (p. 169). I do not want them to seize only one side of study, the memorization of facts. This only leads to a decline in the value of knowledge obtained. As Dewey (1938a/1998) wrote, “mental poverty that comes from one-sided distortion of mind is ultimately more significant than poverty in material goods” (p. 63).

Toward full engagement with the material, I make art central to the class. Dewey, through his many great works, helped bring me to this summation that the arts epitomize a type of enriched experience that contribute to transformative powers of perception and value in all of life. They lead to a state of *awareness* that allows one to see the synonymous nature of life and learning. As Jackson (2000), a member of Dewey’s Idea Group, writes,

[A]rt throws off the covers that hide the expressiveness of experienced things; it quickens us from the slackness of routine, and enables us to forget ourselves by finding ourselves in the *delight* of experiencing the world about us in its varied qualities and forms. It intercepts every shade of expressiveness found in an object and orders them to a new experience of life. (p. 110, emphasis my own)

The key is *immersion* in the experience, without self-consciousness, and thus firmly rooted in emotion, meaning, and wholeness, according to the individual. I wonder how much more meaningful life might be “if only we would heed our individual and collective wills in that direction” (Jackson, 2000, p. 34)? And how would such a move impact education? As Jackson (2000) notes, “what holds true for experience in general may also apply to more specialized forms of experience, such as those occurring within schools and classrooms” (Jackson, 2000, p. 34).

The molecular modeling laboratory was designed to allow my students to use their own experience and engage various media to communicate their comprehension of the molecular structure. As they work toward rendering their work, in both text (Figure 16) and art form, they generate ideas and then show them in the various forms that support communication of meaning. I witness their creativity as they go between the forms of representation, that of text and that of their art. As they choose particular forms of media, or entertain text in certain manners, I see how they are building cognitive bridges that for them link both abstract and concrete scientific ideas with their own particular disciplines. They are learning via personal analogy. As Root-Bernstein and Root-Bernstein (1999) wrote, “it is not our senses that limit or liberate us, but our ability to illuminate the unknown by means of analogies to the known. Learning itself depends on analogizing” (p. 142).

For example, a fashion student responding to Part III of the Form Fits Function laboratory compares the enzyme form required for a substrate to bind to a woman’s figure and the fit of her “little black dress” (Figure 20): all women can have a little black dress, he analogized, but they have to be careful to work with their particular body type. Enzymes are the “locks” to the substrates’ “keys,” fitting so well that the resulting chemical reactions undergo

minimal change in variables such as heat and pressure. The enzymes' physical proximity to the substrate allow for reactions to happen, but the enzymes only "work" well if they are designed to fit the substrate they engage with. My student explained that this is analogous to the little black dress because, as there are multiple body types, there is no one design of 'LBD' (Little Black Dress) that works for everybody. Just as the enzyme bonds in certain conformations, according to energy considerations that are more allowable than others, so too does the "right" dress make a woman feel at her best.

Holyoak and Thagard argue that "making analogies may lie at the core of human thinking [and] certainly lies at the heart of what it means to think creatively" (cited in Root-Bernstein & Root-Bernstein, 1999, p. 144). In my work, I am attempting to foster successful artists who engage life. And I feel that this engagement with life can be deepened with knowledge of the nuances and intricacies of chemistry. I see chemistry as a means to foster higher order thinking, to help my students make mental leaps that will spark and nurture their creativity. I have a higher purpose for chemistry. My aim is not to make chemists, but to make artists who are the better for their knowledge of chemistry. I borrow the frequently used words of Maxine Greene, I aim to help them "to see things as otherwise."

X. THE SEVENTH STEP: SEARCHING FOR A NEW HOME



Karen Carpenter's Final Resting Place

May 1993

I need to run. I need to run somewhere new, somewhere sunny, full of color and life.

Arizona!—that's where I need to be.

"Midge, are you sure I can come and spend some time with you? I just want to run and sleep, maybe swim a bit. I made it—I have the degree—but it took a lot out of me. The eating wasn't as bad as usual, but that's probably because I just kept running and didn't give it time to consume me. But it was close."

"Book the train, Jo. Bring some of the textbooks you need to prepare for your entrance exams and study on the train. You did it. Now let's get you to your next home. Your new apartment, your new school—both are waiting for you. You put in the time. You filled out the paperwork, you applied to grad school, the lease is up. Take a break, breathe a bit."

My mind awhirl, still unsure of myself, I hang up the phone and book a Metra ticket to Arizona. Have I really "made it"? I truly don't know. Study, run, clean, eat, exist—it's all taken

its toll. Can I enjoy my success? Should I enjoy this success? What success? There is still more to do. I need to keep going. But I'm tired. I've lost weight. I can barely take a spoon from the cutlery drawer. I have a hard time getting off the scale; I should leave it in the closet.

"Focus, Jo. Focus. You're fine. Eat!—let the fear roll off you." There's Midge in my head again. One of my dearest friends, she knows the pain of obsessing, the comfort of obsessing—that double-edged blade that can help you, hurt you, leave your body masticated, emaciated. I met Midge at Overeaters Anonymous when I was 18, soon as I got my license to drive and could escape all the anger and screaming of home. Midge stood out; she was peaceful yet daring, everything I was not. Midge was a recovering bulimic; I was anorexic. She would eat and puke; I would starve myself and exercise to exhaustion. Both of us were in hiding, struggling with our pain, battling a need you can't just walk away from—food.

Unlike an alcoholic or a drug addict who can try to turn away from their desires, we had no choice but to face our demons head-on. You can't avoid food. You need food to live, like the air that you breathe. And it's everywhere and in so many forms! We were confounded by it all. How do I eat? When do I eat? You have to eat. But I couldn't. I still remember the day I first told Gram. I was thirteen, sixty-five pounds; with my knees to the ground and my head in her lap, I cried. But the truth was, I enjoyed the power, was constantly checking the mirror to see if my bones still showed. My battle with weight pulled me away from my home life and into a world that I alone controlled. The irony, of course, was that it controlled me. I was always obsessing over maintaining some perfect number on the scale. Despite all my imperfections, the right number would assure me that all was well. What lies numbers can tell. But this summer I'm putting that all behind me....

It's so beautiful here. I play, I swim, I run. And I don't run to escape but to enjoy. On the long, winding desert roads I see the flowers and the butterflies. I breathe in the dry heat, smell God's gifts all about. Tempe has to be one of the most beautiful places I've ever seen. Its exquisite colors are so full and vibrant, I feel embraced in their auras, can feel them breathing new life into my soul. I run and all becomes well in my world. Under the hot sun, the loose red clay beneath my feet, I run toward the Light—and Arizona is all light, nothing but light. Here I prepare to embrace my new life. I am ready. But is it ready for me? To be or not to be? That is the question. And, me, I chose to be! I made it this far and now it's time to embrace the Jo, the one I knew existed, the one who pulled out of the storm and moved into the light of God's love.

I think back now to that summer before I started graduate studies at Midwestern University. I had yet to be introduced to the notion of transmission and reconstruction in education, nor had I learned Dewey's conceptualization of experience. His ideas on the commonalities of true experience were foreign to me, ideas regarding the completeness of the experience, its need to be individually unique and self-sufficient, to carry through a unifying emotion, and to offer a venue whereby the extrinsic meaning becomes intrinsic to the individual. Yet I somehow intuited them. I knew that I needed to find a new path of my own personal making, that I needed to enlist help from those who found ways to live a more personally meaningful life. I knew every experience would be useful as I undertook this new path. And while I did not think in these words exactly, I felt in the pit of my stomach that this new life would be made up of "events to be enjoyed and/or suffered through in their own right" (Dewey, 1934, p. 18). It was a time of new awareness and a time of beauty, of engagement with things for their own sake.

Dewey (1902a) posits that the child learns from engaging fully with life, writing that for them “the universe is fluid and fluent; [and] its contents dissolve and re-form with amazing rapidity” so that “[t]he things that occupy [the child] are held together by the unity of the personal and social interests which his life carries along” (pp. 5–6). In this way every experience is complete in itself: “Whatever is uppermost in [the child’s] mind constitutes to him, for the time being, his whole universe” (p. 6). Thus, it is of great importance that an individual’s personal experience(s) be reflected in education; to me, this is why the child/student *is* the curriculum, for it is what they know, believe, and involve themselves with that are central to the lessons they take from life. The purpose of the teacher then is the “development of experience” and to see “its justification in the future growth which it ensures” (p. 22). Dewey (1902a) outlines how various sects in educational thought work toward this common goal. Does the educator let the student be “the starting point, the center, and the end,” (p. 9) and be involved with the curriculum of their particular life, or does the educator try to save the student from harm by assuming a need for their “narrow experience to be widened” (p. 8).

August 1993, first day of grad school

“Jo, we have the results of the entrance exams and they’re a bit disappointing, lower than I would expect from someone coming from Morewood with such good grades and high recommendations. Perhaps you didn’t study enough? Or maybe you aren’t much of a test taker?”

“Trust me, Dr. Kagat, I can read and write, and I know my chemistry. I’m just not so great at taking tests. I don’t feel very comfortable.”

“I’m sorry to tell you this, Jo, but tests are all you’ll be seeing here in grad school—tests, lots of writing, and numerous presentations on your research. Comfort is not an option here, only hard work.”

Trust me, I know hard work—it’s all I know. And comfort? Sleeping wherever, waking early, working delis, cleaning houses—my life has seen just about everything but comfort to this point. Other people got a life of comfort. I was just getting by. “Dr. Kagat, I will work very hard. I just need a chance to show what I can do. Please give me that chance.”

“We want you to know that we are very excited to have you here, and we will support you as much as we can, but this is an institution of higher learning and the expectations are very high. Your Morewood professors think quite highly of you, and we look forward to seeing what you are capable of. I’m hoping that the extra chemistry classes will fill in any holes you have in your knowledge base. The first cumulative exam will be next Friday at 8 a.m. Remember, you need to pass six to obtain your chemistry degree, as well as complete the coursework and research hours required for the degree.”

“I understand, Sir.”

“I hope so. There are very few females here. I don’t know why so few apply, but we would like you to be the example of what can be done if you set your mind to it.”

Friday, 8 a.m.

Every day I know I’m being watched—observed like a rat in a lab. Campus, void of green, is nothing more than a series of squares and abrupt lines, a concrete maze. Which way would I go? In these hallowed halls lay the path to a chemistry PhD. But the chemistry I love cannot thrive here. I learned right away not to feel or enjoy but to just do. All there is here is

cement, lots of it—cold, impersonal cement. I realized this cement college could kill a soul, and that's when my survival instincts kicked in. I've been here before, I know I can do this again.

“JoElla, what is your major?”

“Biochemistry, Sir.”

“Do you have an advisor yet?”

“No, Sir. I do not.” Aren't there already enough questions on the exam? If this inquisition doesn't stop, I won't be able to finish my exam. I only have two hours, and I'm going to need every second of them.

Thank God for Dr. Lathey's biochem class at Novet. Because, in fact, I do know five ways to translocate substances across a membrane. And not only can I list them, I understand them. I get it, and I can draw what I see. Lathey's class was a year ago but I can still picture those images in Voet and Voet, that husband and wife team of biochemistry. Judith is her name, I think, can't remember his—Focus, Jo! No one cares about that. Your job right now is to draw the pictures and write a description. Just draw.

Figure 21 shows a scan of my answer to the first cumulative question on the translocation of proteins through a lipid membrane. Needing to discuss a very complex occurrence in cells, I first started to write an explanation of the different means of translocation but almost immediately felt that it would require too many words. After fidgeting with my pencil and nervously checking the clock, I started to imagine various models to describe the process. First came the pictures in my mind, then they found their way into my answer book. Then I added bits of text to annotate my drawing. Looking back on it now, my approach recalls the research of Marshall (2005), who talks of the organization of items and the cognitive rationale

for their placement in particular pieces of fine art. Her work follows ideas presented by Lakoff and Johnson (1980), who also proposed a conceptualization of the world based on the placement of phenomena in categories, thus beginning the connections to higher order thinking. Marshall focuses on the placement of visual components in an art form such that the placement reflects not just understanding of the science concept(s) in question but how the artist “thinks as a scientist.” Placing great importance on organizational skills, logical thought processes, and “correctness” in representations of science concepts, Marshall fosters the idea that artists and scientists are not so disparate because they are each in their way trying to represent the reality in question most clearly and effectively.

This recalls Dewey’s recognition of the importance of the scientific method and logical inquiry toward seizing the greatest meaning from what is present. In *Logic: Theory of Inquiry* (1938b), he places inquiry and the logical framing of questions at the forefront of human endeavors to engage in the many experiences of life. I am also reminded of *Experience & Education* (1938a/1998), in which Dewey writes that “the best type of intellectual organization which can be found in any field, needs to be allowed for, called into play” (p. 22). I was trained as a scientist, to be logical and ordered in my thinking; on the day of that cumulative exam, this training helped me to answer the question succinctly. I could understand the concepts of fats or oils, and their interaction with water, and the importance of polarity in opening or closing the cell, but evidencing this understanding took on another form for me, that of the visual icon.

What I drew was a picture of transport through a membrane, with blockades and allowances for entrance that find their equivalent in fences and security key codes. To me, the picture of the cell membrane was that fence—and the “correct” components had to be set in place to get the needed molecular materials into and out of the cell. No different than my needing

to find the courage to “gain entrance” into college that first day at College of Novet, the biomolecules needed to fit the right conditions for the cell to allow them entrance into its domain. Life for me means going to college and getting away from the deli, while life for the cell means having its needs met. We both desire to live.

I wanted to *demonstrate* my knowledge of the translocation process—an active occurrence—and not simply regurgitate memorized terms. By drawing the cell membrane with arrows depicting entrance and exit, I was *manifesting* the process. Gilbert (1991) discusses the activity focus of science, a process whereby the learner uses models to “represent consistent, predictive relationships” of the physical world they acknowledge to exist. Gilbert writes that knowledge of the correctness, or inaccuracy, of the model can be equated with the transferability of the “rightness” or “wrongness” of the scientific understanding of the learner (p. 74). In my representation of the cellular membrane and the process of translocation, I demonstrated that I understood the various nuances of translocation with my arrows, their placement, and directionality within my drawing. For me, actively engaging with the particular concept at hand was creating that diagram, and drawing an accurate representation of the reality of translocation was proof of my understanding.

Having family in construction, I understood the importance of exits and entrances in buildings, and how arches, access ways, and dimensions were important in their designs. Thus, using analogous thinking (Lakoff & Johnson 1980, 1999; Holyoak & Thagard 1995; Miller 1996), I embraced my past and integrated it in my conceptualization of cell entry and exit. Kress and van Leeuwen (2001, 2003) explore the “broad historical, social, and cultural conditions that make and remake the visual ‘language’” (p. 5). The visual design, for them, is about communication of ideas and understood meaning(s). Having a grammar component, just as

language does, the design communicates well if the rules of grammar are followed. I followed the rules of grammar in my drawings with the use of carefully placed arrows to depict a process that would lead to a desired end. The arrows linked a beginning and ending in a type of ‘story’; in this case, the ‘story’ was the process of the translocation of proteins through a membrane, with the point of the arrow suggesting what the translocation process would lead to, from a prior initial beginning point. I added comments along the margins of my work to highlight the insights shown in the image.

Frederiksen et al. (1999) suggest the usage of models not only for teaching but also as a means to gauge student understanding of the physical world. They note a hierarchy of abstraction afforded by model utilization in the classroom, with a definitive selection of modeling choices coinciding with increased abstraction. With this model selection follows a concomitant construction of linkages, to, from, and between the chosen models. On the day of my cumulative exam, I found myself erasing and redrawing not only toward clarity of my vision but because I kept rethinking my model. I wanted to evidence directionality showing the three types of transport (uniport, symport, and antiport), but I did not want the image to become too busy. Meanwhile, I did not use a circle to symbolize the cell, although to me it most suggests cell structure, because my assignment was not to model the cell’s inner components (the endoplasmic reticulums, nuclei, etc.), rather it was process-oriented: to show under which conditions the cell allowed or denied entry or exit for biomolecules.

Clement (2000) suggest that model making, its process of generation, offers a view into the learner’s thinking, conceptualizing, and reconceptualizing of scientific ideas through iterations. They define *abduction* as the means by which the initial imagistic simulations of physical reality take shape in the form of a model, going beyond Peirce (1958) and Hanson

(1958), who used the term to describe the development of a hypothesis to explain some phenomenon, i.e., they defined a visual image as the key manifestation of reasoning and logic about some phenomenon. For Clement & Oviedo (2003), *abduction* also depicts knowing or understanding of the phenomenon in question, with “continuous alterations of the model” demonstrating changing views of the “true” reality” as seen by the community of learners (p. 10). Analogy usage contributes to the “general abduction of the construct but it is limited to providing components of the construct, whereas a model serves as an end product that not only can be revised but also exemplifies all the analog(y/ies) present” (p. 9).

I worked with analogies and models throughout my time learning about cell dynamics. The nutrient-bearing “machines” that ensured cell survival and the “fences” that allowed (or disallowed) biomolecular translocation were just the first step in my understanding of difficult concepts. I demonstrated this idea of abduction through my rendering and re-renderings of my cell model. I drew not one particular model, I made multiple drawings, erasing and redrawing as needed to explain my idea(s) more precisely. And finally it was the drawing/model I presented on the cumulative exam that evidenced my understanding of all the analogies I utilized as a means to understand the concept itself. The analogies got me to the model I drew, itself the result of a process of revision.

The cell I drew that day was still the same cell from my Book of Life analogy at Morewood, but another layer had been added. It went beyond the two-dimensional representation of a cell, with its component parts, the organelles, safe within its confines, and moved to a higher plane, invoking processes and the concept of life’s continuation via these processes. A living organism must take in nutrients for continued survival. This fosters energy changes, as nutrient intake equates to halting entropy, the disorder behind a cell’s eventual demise. Thus, as the

nutrients come into the cell, allowing for its continued existence, the living organism is moving against the ultimate entropical situation of disorder—death. Figure 21 does not reflect simple rote memorization of cell parts and their duties; my drawing represents the very movement necessary for the cell to exist, *for it to come alive*.

*I have seen the goodness
I've known the baddest around
I've opened my belt to trouble every day
Ain't looking for a fight
But you know I won't run away
from the full catastrophe of life*
—“The Full Catastrophe,” John Cougar Mellencamp

November 1993

“Jo, will you come into my office for a second? I need to speak with you.”

Not again. The last time I was called into Dr. Kagat's office I was told how bad I am, how inept—I bombed the entrance exams and my GREs betrayed me as a failure. I guess I just don't fit in. It looks like this whole grad school thing isn't working out after all...

“Excuse me, Jo, didn't you hear me? We should talk.”

I look up but when I meet Dr. Kagat's eyes they don't look as disappointed as I thought. The eyes see- another dimension of visual learning. I always check them to make sure I'm safe. Sadness, happiness, and especially disappointment, these feelings ooze from the eyes. And, me, I've seen a lot of sadness and disappointment—and little glimmers of joy.

Head down, eyes again cast low, I walk into hell. It smells old and stale. Dr. Kagat's office is overflowing with chemistry books and mountains of paper. I wonder how long his

name's been on the door. What a full life he must lead! Would I ever find my own path, make something of value?

"Have a seat, Jo. We need to talk about the recent cumulative exam, the one from September. I find it very interesting that your GRE and entrance exam scores were poor, and yet you passed this. Do you have any thoughts?"

"Did you just say I passed?" I lift my eyes from the floor and look Kagat in the face. "Which questions did I answer correctly? How many points did I get? What was passing?"

"You received full points for the question on translocation across a membrane, which is sufficient for a passing grade. I have to admit, I'm surprised—and I'm impressed. Your picture was literally textbook quality. In fact, I'm sure I've seen it before in some old texts. Are you going to continue with biochemistry? I think you should. You seem to have a knack for it, although organic chemistry seems to be a strong suit for you as well.... Well, I have other things to do so I'll leave you to your studies. Have a nice day."

What just happened? Dazed, I make my way to my next class, Inorganic Chemistry. It's interesting, and the textbook is lighter than most—maybe I'll be spared a few backaches—but where are all the women? It's almost exclusively men. At least the class has shapes, lots of them. Just look at those molecular structures! I've seen them before, in biochem at Morewood. And these concepts! Optical isomerism is so cool—symmetry along a mirror plane. It's like our bodies, all that symmetry. One big mirror down the middle of our bodies and—voila!—you have a duplicate on the other side: two arms, two legs, two feet and hands, all split down the middle by a backbone running from our tailbone to our head. It's so neat how we evolved from swimming little tadpoles to walking humans, how the neural network took full force and the tail became two legs. Two symmetrical pieces—very neat.

“JoElla Eaglin, I presume?”

“Yes.”

“Do you have any questions about the slides? I’m trying to explain how metals coordinate to their ligands. Coordination can be two ligands to as many as six ligands, as discovered at this point in time. What are your thoughts?”

“I was wondering if the bonding always follows a pattern, a symmetrical plan, so to speak, because that seems to be the case.”

“Yes, it does appear that way. Buckminster Fuller, the engineer, author, and designer, suggested that nature follows patterns. He said, ‘When I am working on a problem, I never think about beauty. But when I have finished, if the solution is not beautiful, I know it is wrong.’” Dr. Kagat points to the chalkboard, where he’s drawn ligands and more ligands, all following a precise mathematical function as they became bound to the substrate. “There is your pattern, Jo. There is your pattern.”

And just as Fuller suggested, it was beautiful. Molecular structures demonstrate beauty, order, and perfection. Counter to the chaos of everyday life, order is at the foundation of everything. You just have to look for it. And if you did, you would find the most beautiful things.

What I saw that day was something I needed to see: the perfect molecular structure of a metal, in this case molybdenum, with its six surrounding carbonyl ligands forming precise octahedral geometry—a pyramid going up to the sky, its base hooked to yet another pyramid aiming toward the ground (Figure 22). Perfectly surrounding the inner metal, the exact angles dependant only on the size of the atom’s radius, the octahedral formed an entity of linear mirror symmetry. In that structure, I saw order and a much-needed reminder that life was no accident,

that it had purpose and meaning. As I looked at that slide, I felt again as I did at Novet: secure in my command of the material as well as its relationship to the bigger picture. I felt assured that sooner or later all the moments of life would come together to offer a clearer picture of the world and my part in it.

As I look back now, I have to admit that all these experiences must follow some rationale, must have some meaning toward the makeup of who I am. Eisner (1998) writes that:

whatever we come to know about the world will be known through our experience. Our experience in turn is mediated by prior experience. Our prior experience is shaped by culture, by language, by our needs and by all of the ideas, practices, and events that make us human... [including] genetic capacities, those peculiar aptitudes or dispositions that constitute our intellectual thumbprint and distinguishes us from the rest of humanity. (pp. 47–48)

In my own learning, I build on experience (Dewey, 1934, 1938a/1998), using the cognitive scaffolds described by Marshall (2005), and the interlocking bridging mechanisms of Hummel and Holyoak (2002). Together these help me to grasp the intricate details of life and how they follow similar patterns to make up one big system.

Mary Catherine Bateson (1989) writes of *composing a life*, lending life the aura of music, making it seem inherently structured to bring what *is* into existence in the form of melodious song. My life, too, is a composition, perhaps not so melodious, but a song nonetheless. The composer John Cage maintains that music is driven by situational criteria. One of his most famous works, *4'33*, is comprised of three movements without a single note. Cage worked with the idea that music was composed of the sounds of the environment, and thus music was unique for each listener, dependent upon the individual, their location, their thoughts, and their experiences (Pritchert, 1993). In my past, I embraced the stuff of life that made me feel at

peace and hopeful amid a sea of gloom and misfortune: books, music, science, art. I wanted to create a new life apart from what I knew. Now I analogously link experience to the situational variables that compose a piece of music: some experiences are good, some bad, all influential. Looking back now I see and embrace this “full catastrophe of life.”

The recognition of the plurality of ways to know the world is an invitation to open not a Pandora's box, but one's mind.

—Elliot Eisner, *The Enlightened Eye*

Summer 1994

“Jo, are you sure you want to be involved with this program? So few of these students will make it to high school, let alone college. And these students are from all over the country—not your stereotypical Native Americans. Some live in cities, some in the country; only a small percentage are from reservations.”

“I understand, Ms. Hiawatha. To me, they're just students. It doesn't matter where they're from. I just love teaching, and this feels good to me. I want this experience.”

“But it takes someone special to work with these students, to embrace their backgrounds, not to ostracize them because of it. You must never forget where they came from. You have to get them where they are, Jo.” Fidgeting, praying for this job, I understood what she meant by this comment; she was the coordinator of the Native American Support Program, here at Midwestern, but she was more than that. I felt it. To her, this was a chance to help these kids, to offer them more than what they currently had. I knew this feeling. “I heard from Dr. Tieslason in the chemistry department and RJB, the organic prof, that you've done a lot with nontraditional students. Between the chemistry for non-science majors here, and the Chemistry

in Daily Life course at Colline College, it seems that your work with the Native American Support Program will be strong. I look forward to your involvement this summer.”

The most eclectic bunch was waiting for me when I got to class the following Monday: young kids with skin tones in all ranges except the “red” of Indians in the movies and clothes spanning from the popular teen brands to obvious hand-me-downs. In short, they were just good, old American kids. But, also, they were kids with problems, kids with fears, kids with wants and ambition. They reminded me of myself, lost souls full of potential just waiting for someone to give them a chance.

“Ms. Eaglin, where do you want these barrels? They smell like home to me.”

“Home? What kind of home smells like oil barrels?”

“On the reservation, there’s lots of fuel, oil, and burning rubber. When it’s really cold out, we’ll burn anything to stay warm. That, some beer, and a hot meal makes for a good night.”

Reservation—what irony in its luxurious connotations! Reservation, like at the Hilton.

That summer I was working for the Science Alliance, a consortium made up of representatives from local universities, laboratories, and industry to offer youth opportunities in the learning of science. The Science Alliance also worked with the Teachers Academy of Mathematics and Science to train teachers to become better in the classroom. The two years I spent at Northwestern earning my MS in chemistry were times of great enjoyment for me. I was learning chemistry, big chemistry, the kind that I thought assured my status as a scientist. But I was also becoming more of a teacher. For one, I needed the money—I was still nursing that same Cavalier—but I also loved working in classroom. So in addition to the classes I taught as part of my assistantship, I also took on extra projects during the summer.

I especially loved the unique opportunities to see new things and to be involved with new cultures and new demographic groups. It did not matter to me the ages of the students or where they were from. At that time, life was exciting, people were exciting, and I did not want to miss anything. I found a way to engage my love of people, my love of teaching, and my love of science, and educational missions seemed to find me. I had the honor of teaching summer workshops with grade-school students in the inner city, helping them become more prepared for general science courses once they hit high school. I tutored organic chemistry with ESL students from Mexico. I even performed magic shows at inner-city elementary schools. My work with the Native American Support Program and the Science Alliance was a part of that serendipitous magic. Teaching diverse groups just fell into my lap, and I was glad for it.

My goal for all my students in these diverse programs was to give them the foot up that I did not have. I was rather naïve, but in the light of Greene's (1988) work I see now that I was just trying to help them to "see things as they could be otherwise." I was glad for the chance to make a difference, even in the life of just one soul. I thought of the story of the woman reproached by a stranger for saving a starfish on the beach. "What difference will you make? The beach is full of fish like the one in your hand." As she throws the starfish out to sea, she tells him: "I will make a difference to this one." In my mind, my students were starfish—stars of the sea, full of promise. This is the curriculum of my life as a teacher: *I made a difference to that one. I hope, I pray.*

Final week of NASP summer classes

"Ms. Eaglin, this isn't working. I just don't get it. What do you consider important here? What should I know?"

“What should you know? You tell me what you know already. Don’t tell me what is according to me, tell me what is according to you.” Astronomy is the last section of our four-week course, rounding out chemistry, biology, and physics, and I wanted to make our assignment fun and different: Generate a visual depiction of the Big Bang Theory, without the use of text. But this student doesn’t seem to be getting it. “Tell me, Greg, what has meaning to you?”

“Life, Ms. Eaglin, life. That’s all there is. We are all part of the Great Spirit. We became confused; we lost sight of this great gift. We lost ourselves, our part in the balance of life. We are all lost souls just trying to remember where we came from. That is all there is.”

Greg holds up his work (Figure 23). It’s circles, lots of circles orbiting colorful centers. How did he come up with that? He nailed it. It’s like he took a bit from every field of science we touched on over these past four weeks and came up with a representation of how they all came together. I wonder if he knows they are linked. And I wonder how he knows. From the atom to the universe, is there a Grand Designer behind it all? Jo, sssh. Listen. Try it, Jo. Just listen.

“Ms. Eaglin, do you see the Great Spirit?” Greg speaks softly, but his words feel so profound: “Here all is one, and one is all. The Great Spirit is everywhere, within and beyond. Do you see our Spirit? This is the Spirit of All that Is, Life.”

Although I recognize these circles from my own conceptualization of science, these are something more—they have feeling, are even richer with meaning. All this time I had been trying to teach Greg about the beauty of science, but now I can see how ignorant I was of it myself. I am not the teacher here; Greg is. Such profound intimate knowledge of life he has for a thirteen year old! I know the hierarchy of life’s organization, that cells lead to tissues, which give rise to organs, and then organ systems, and ultimately a complete living organism. I know what science has given me, but along the way to learning I’d somehow lost sight of life’s beauty. I recognized

that everything is alive—all breathed, worked, and lived—but I had forgotten about spirit.

Through Greg, I have been reminded. I remember.

“Ms. Eaglin, what do you think? Is not our Great Spirit beautiful, so very strong?”

“Yes, but why both—beautiful and strong? I think of strong individuals as having muscles, so that they can lift and move things at their command. Or they use their strength to manipulate others who are weaker than them. The beautiful are soft and kind, and need protection. They are beautiful inside and out. I don’t see strong people as beautiful, or beautiful people as strong. In fact, I have seen strong people hurt others, maybe not with their muscles, but most definitely with their minds. Those with power—the ‘strong’ of society—have used and abused others. I struggle with this.”

“No, strength is beautiful, and beauty is strength. We are all designed to be, to exist, and the Great Spirit knows our purpose and knows our part in the circle of life. When a life lives as it has been designed, it shows its beauty. And our strength comes from recognizing this beauty and living according to our design. What you are talking about is neither beauty nor strength but a lost soul, one who cannot see that he or she was tenderly made with purpose and meaning.”

Half my age, scraggly and thin, Greg is not someone many would consider to be strong or beautiful, but he is so self-assured. Greg is at peace. I want to know this peace. You can’t buy it at Walmart or find it easily in a society that idealizes perfection. The lost soul—the former anorexic—in me wants some of what he has.

“Where would you like this, Ms. Eaglin?”

“Do you mind if I take it to share with the other teachers in the program and get it back to you after NASP ends for the summer? All the parents are coming in for a final show, and I would like to have it on display then as well.”

“Fine, Ms. Eaglin. All good.”

Greg and the other students that summer taught me something invaluable: how to see the world through the eyes of another. I learned very quickly over those few weeks that as a teacher I would need to be aware of who my students were, what they knew, and how they envisioned their reality. As Dewey (1938a/1998) writes, teachers must “be intelligently aware of the capacities, needs, and past experiences of those under instruction” (p. 71). As a teacher I am not in a position to tell my students what *is* reality, nor should I be so rigid in my thinking. As Dewey (1934) writes, “if our conceptual experience is aborted for the sake of classification, our experience is attenuated; we do not experience all that we can” (p. 17). In the classroom, I want to make sure I allow for experiences of worth and value to all.

Greg also made me rethink my understanding of truth, that is, the truth that science offers. As Kuhn (1962) writes, “a scientific community cannot practice its trade without some set of *received beliefs*” (emphasis my own) but these components of “normal science” can then be used as “the base of assumption(s) that the scientific community knows what the world is like” (pp. 4–5). In this way, science and scientists can become closed to and even dismissive of alternate ideas and those who hold them: “normal science often suppresses fundamental novelties because they are necessarily subversive of its basic commitments” (Kuhn, 1962, p. 5). Greg demonstrated to me the downfall of this type of rigid thinking: I was missing so much of life. Rather than continue my “strenuous and devoted attempt to force nature into the conceptual boxes supplied by professional education” (p. 5), I knew I had to open my world to more. I realized how I took safety in the confines of science, its elite status, and my feelings of its superiority in its characterization of life, the reality that I thought was the one and only truth.

That summer, as I examined my desire to keep things orderly and “correct,” with no room for alterations, I began to sense changes in myself. I was beginning to look at what learning, knowing, and teaching *are*, and I began to wonder about the reality of my students and that of my own. As I look back now, I can see that this was a time of deep personal struggle, a paradigm shift that “emerge[d] only with difficulty, manifested by resistance, against a background provided by expectation” (Kuhn, 1962, p. 64). In my two years at Midwestern University, I pursued “truth” through the practice of science but I wasn’t entirely traditional in my pursuit. I used analogy and metaphor to learn the material and visuals to demonstrate that knowledge. And I was inclined to approach data broadly, always asking, for instance, about the outlier data, which was usually discredited as anomalous and therefore unimportant. This experience played into my newly developing ideas on teaching and learning, and how there must be more than one way to learn and to come to know. In education, the outliers do matter. At Midwestern I was straddling the fence: I was being trained as a scientist yet was engaged with teaching science to minority learners. I think it was the complexity of that situation, at that particular time in my life, that ultimately debunked the myth of capital-T truth which I hoped science to reveal. Beyond there is always more.

It was Greg—his drawing, his words, the intensity of his feeling—that really helped me to envision other ways of communicating knowledge, in particular in the field of science. As Eisner (1998) writes, “human knowledge is a constructed form of experience and therefore a reflection of mind as well as nature” and “the forms through which humans represent their conception of the world have a major influence on what they are able to say about it” (p. 7). When I read those words now, I think of my experience with Greg and take them as a call for integration, specifically for the inclusion of art via multiple forms of media in the classroom. As

Dewey (1934) writes, “art throws off the covers that hide the expressiveness of experienced things; it quickens us from the slackness of routine, and enables us to *forget* ourselves by *finding* ourselves in the *delight* of experiencing the world about us in its varied qualities and forms. It intercepts every shade of expressiveness found in an object and orders them to a new experience of life” (p. 104, emphasis my own). Only via divergent modes of both teaching and learning will I be given a glimpse “below the surface to the most enigmatic aspect of the human condition: the construction of meaning” (p. 15). Dewey (1934) sums up the need for integration succinctly when he writes, “Science states meaning; art expresses meaning” (p. 84).

I am ever thankful to Greg for his important role in my development as a teacher. I never did return to him the drawing that changed my view of life. He went back to the reservation before I could return it, and he left with me his Great Spirit.

I think searching is a beautiful thing. There is this thought that goes, If you search and search and stop searching, then ultimately you'll find what you need. But I think maybe if you don't search you wouldn't have the experience of searching and then won't find it at all. You have to search first.... It's the experience of living. We can have one experience that can change our whole lives.

—Marion Cotillard

Summer school & Lab time, 1995,

“How does it feel to be the first black female to earn a PhD from the Chemistry department of Midwestern University?”

Poor Tina. A reporter from the local station had found our research team to be very interesting and come to interview us in Doctor Aldo's cramped office. Microphone in hand, this newsman with no tact was sticking to us questions we, for the most part, didn't know how to

answer. But he has gotten me to see our group differently. I guess we are an eclectic bunch. I used to think we were just like anyone else here: students working toward a PhD. But maybe we are somehow different...

Take Jerry. He's "fresh off the boat"—actually, a plane—from Russia. His father, a physicist, allegedly paid off the KGB to bring his family to America. All it took was his stamp and coin collection to gain passage for himself, his wife, and their two sons—Jerry and his younger brother. Unfortunately, Jerry's wife had to be left behind. An MD, she couldn't be freed from Russia's grip. Despite the family's "gift" of stamps and coins, they'd been pulled from the plane before its departure; their documents, they were told, were amiss. Two hundred dollars somehow corrected them. Jerry told me that when he first arrived in the Midwestern city he would adopt as his new home, he kissed the ground and cried, "God bless America." A year later, matured by his experience, he became a U.S. citizen—and his last name shrunk from seventeen letters to just the first six. With the help of a low-interest student loan, he bought a house for his parents, brother, and himself, his credit line and debt assuring his assimilation to American culture. Unwilling to touch Russian soil again, Jerry eventually gave up his efforts to be reunited with his wife. He adopted a cat, a Russian blue, from the local shelter, and settled in, calm and confident of his freedoms in the U.S. of A. "God bless America, promise, and hope," he would sing as he pushed through the doors of the lab.

Now Ishmal, he's a different story. Twenty-one, still young and unsure of himself, he hovers around me and Jerry, seeking assurance for all that he does, his only goal being success. His family has high expectations of him, only the best will do. And Ishmal, though kind and soft-hearted, expects of himself something close to perfection. For the most part, he does well—then came Dr. James's quantum chemistry class. That class nearly killed me; Ishmal, he just died. I

had an A in the bank for biochemistry with Dr. Nehight so I could survive a C from James, but Ishmal had no such ace in the hole. He got a D in James's class and has to come up with two As to make up for it. On academic probation, he now seeks easy As, earning his family's condemnation for his lack of diligence.

Then there's Tina—she's the most interesting of all. She stands out, and she knows it. She has worked hard to establish her name at our school and has clearly seen some battles in life, but she never cries, at least not so that anyone can see. Like Jerry and myself, Tina is among the older students—and how I admire her! She seems fearless. She works, as do Jerry and I, separately, with a really tough group of cancer cells from the $B_{16}F_{10}$ family as well as some highly toxic drugs. Pregnant for a second time during her career at Midwestern, she now must stay clear of the micro lab until the baby's born. But Tina still works, her lab coat falling open over her big belly.

Together, the three of us—Tina, Jerry, and I—are invincible. Our work focuses on highly metastatic cancer cells of the B_{16} class known for forming colonies of ten in the lung tissue and transcending the limits of contact inhibition. Most cells make contact and stop dividing, but not the $B_{16}F_{10}S$ —they continue to propagate. Even propagation of the $B_{16}F_{1S}$, which are close cousins, would slow with a touch, with uncontrolled cell division ceasing, for instance, as space in the petri dish runs out. But not the $B_{16}F_{10}S$ —they are as bad as they come. They're the supervillains of cancer, and Tina is a superhero of biochemistry. Working with extremely toxic drugs that many in the biochemical field of academia hesitate to employ, Tina mustered all her biochemical knowledge to determine the best line of defense against these cancer cells: four-ball esters, tightly packed selective organic molecules known for disrupting cell division and growth, bolstered with a simple methyl group, a carbon hooked to three hydrogen atoms. The receptors

of the $B_{16}F_{10}$ cells had built up a defense against the esters, but Tina helped them to gain entrance by disguising them with this methyl group “cloak.” Like the Trojan horse, these methyl groups would gain entry into the cancer cell and then release the hidden armies within to strike the death blow. Rendered unable to enter the human cells and wreak havoc, the cancer cells would then wander aimlessly in the human body, completely vulnerable to the system’s “scavenger cleanup crews,” the T cells of the immune system. Cancer carcasses were on the menu, and the T cells helped themselves to as much as they wanted.

“Excuse me, JoElla, I learned from the chemistry department that you’ve worked with Tina a lot over the years.” The reporter has placed his microphone in front of my face. “What do you think of Tina, the first black woman to graduate from this chemistry department?”

Nervous and uncertain, I review in my mind Tina’s real accomplishments here at Midwestern. Tina unlocked the door to a mystery of cancer, but does this reporter really care? She designed a key to unlock the dark world of the mutated human lung cell, and she figured it out counter-intuitively, using a chemical that could cause cancer mutations to achieve the cancer’s demise. By cloaking it with a methyl group, she rendered the four-ball ester harmless to the human body while enabling it to enter the mutated $B_{16}F_{10}$ cells. It was a perfect adaptation that could stop the lethal biochemical process of uncontrolled cell growth. Tina had used her deep knowledge of the workings of the cancer cell to design a molecule that could enter it and destroy it. Her addition of the methyl group was a perfect fit for the receptor on the cancer cell. She had achieved brilliance in design.

“...How about you, Dr. Aldo?” The reporter moved on. “How does it feel to graduate the first black female here in the chemistry department?”

Dr. Aldo, straight-faced and so very serious, never likes dealing with things he considers insignificant, and this reporter is clearly taking up too much of his time.

“I’m glad you have time to spare on this ‘event.’ I know how important public relations are to the university. But I have to say that the accomplishment is in no way mine. It is Tina’s. Tina is a gifted researcher who worked with diligence and vigor. And by the way, I didn’t notice she was black; thanks for the irrelevant information.”

I had such respect and admiration for Dr. Aldo’s brilliance, his command of chemical reactions, and the awesome nature of his scientific presence. Kind, regal, and a bit on the shy side, he had trained many biochemists over the years and was well-known for his collaborative work with prestigious hospitals including Rush, Copley, and the Cancer Institutes of America. And although he was a respected figure in the biochemical community, he never looked down on his students. I never feared going to him for ideas and support; his door was always open. His response that day made a big impact on me, cutting through the superficial and determinedly focusing on the relevant. It brought me one step closer to the scientist, the teacher, and most importantly the person I wanted—and was—to be.

Dr. Aldo’s work was focused on the cause of much misery—inflammation. His theory involved the signals for the biochemical pathways, the greatest of which was NO, nitrous oxide, a simple molecule consisting of atoms of five and eight protons, respectively. Somewhere in most reactions, NO would be found; whether at the beginning, middle, or end, this elegant linear diatomic molecule would stimulate mechanistic reactions quickly and efficiently. It was long believed and held fast in the biochemical research community that concentration levels “pushed” a reaction forward. A set amount of some biochemical caused the cascade of processes necessary

for life to continue. Only when the reactions stopped did life cease. But concentration dependency is not the sole factor initiating these biochemical pathways; NO is that extra piece of the puzzle of life—the focal point of all reactions.

Nitrous oxide is considered to be the one soluble gas that involves itself with the inflammation response, the cyclic cascade that all cells will entertain sooner or later. Cells make up tissues, tissues comprise organs, and organs lead to organ systems. Those organ systems are the underpinning of the organism's survival: no systems mean no way to maintain the balance of the living organism, whether dog, cat, or fish. Life begins at the cell, but upon organization of the cells into greater entities, the full expression of life occurs. And as the cells organize to become a symbiotic organism whose sole purpose is continued existence by means of taking in energy and reproducing, threats to this higher purpose can arise. That is to say, when the environment becomes off-balance, the living organism must deal with threats to its existence.

When threats arise, whether actual or perceived, the cell is able to respond quickly thanks to NO, which because it is soluble in liquids moves throughout the organism more quickly and more efficiently than solid biochemicals. And because its structure is simple—one nitrogen and one oxygen—NO is easy to compose, without the lengthy procedures and high-energy expenditures necessary for larger, more complex biochemical signals. Macrophages—immune system responders that degrade adversaries to the organism—provide NO, as do endothelial (internal skin layer) cells, and some neurons that fire the muscles. The gas is everywhere evident in the body, offering the potential to relax muscles, reduce platelet aggregation, direct antimicrobial activity, and get the immune system's leukocytes to the task of degrading adversaries. Simply put, NO is the “director” of inflammation, the process that protects the organism from harm. However, it can also make mistakes. Autoimmune diseases, for

example, reflect inappropriate occurrences of inflammation. But NO remains our greatest assurance that if a threat to the living organism occurs, it will have the greatest chance of survival.

Using a series of simple experiments, Dr. Aldo searched out the secrets of NO. His discoveries epitomized the beauty of nature, its perfection as described by Buckminster Fuller (“If the solution is not beautiful, I know it is wrong.”). I remember him showing me the diagrams he’d drawn on his whiteboard and asking me to imagine what happens after the appearance of NO in a closed living system. In his drawings, the answers were evident—but there were also questions. In the world of biochemical potentialities, one chemical cascade might instigate another. That is, it might occur, but then again it might not. And it was less black and white than that, but infused with shades of gray. *Potential*—what a concept to grapple with. Like Shakespeare’s (1958/1992) Hamlet pondering “To be, or not to be?” In the world of biochemical cascades, “to be” means *life*, but the opportunities, the choices, the probabilities, all depend on the biochemical pathways chosen. One potential reaction would take precedence over another, and particular life paths would be formed. Simple, and profound, life became a certain way. There was no right answer, no set answer. There were only potentialities.

But, as I mentioned, NO has a dark side. Rather than act as a signal molecule, leading to the cyclic cascades that ensure the machinery of life keeps running, it can wreck havoc, alter structures, cause the misconformation of a protein. The most important thing I learned about NO from my year of biochemistry at Morewood was that its linear nature allowed it to supplant oxygen and bind to the heme unit (the iron) of hemoglobin. In most cases, oxygen slides into the heme unit one molecule at a time until a total of four are compactly situated in the fine structure of the heme iron. As the oxygen molecules come in, the blood changes color from the

deoxygenated blue of the veins to the warm, life-giving red of the arteries. A proximal histidine amino acid then secures the oxygen diatomic molecules to the heme unit. I think of this structural change to the hemoglobin protein as the lid on the jar securing life's continued existence.

Without this oxygen binding, the organism would be starved of its life force and eventually die, which is why NO can be so dangerous. Because of its similarities to oxygen, it can also coordinate to the heme unit, causing the same conformational change to the hemoglobin protein structure. With this binding, again the lid on the jar would close, but the living organism would receive not life-giving oxygen, but nitrous oxide. In these cases, NO offers nothing to the living organism—no promise, no hope, just slow asphyxiation.

I can see this process in my mind (Figure 24), from the illustrations in my notes and my Voet and Voet text (*Biochemistry*, 1993, p. 223). I see where O₂ should bind, and I see how easy it is for NO to slip in and take its place. Even the proximal histidine can't block it. Nothing can block a molecule of such similar structure to oxygen. My notes scribbled along the side of my text (Figure 23) describe this battle for the heme:



My notes also include graphs whose curves, though scribbled and messy, are obvious. One is “good,” one is “bad.” The bad curve evidences the catastrophic bind of NO to the heme in hemoglobin. Because it is drawn below the good curve, it suggests a very low percentage of oxygen in the gaseous state for the living organism, pO₂. The “good” curve, designating O₂ bound to the heme in hemoglobin, has greater height to suggest that the partial pressure of O₂ is

enhanced and would lead to continued life for the organism. The battle for life could be lost due to NO, a simple, linear molecule that is both lifesaver and potential purveyor of doom.

When at its best, NO reminds me of Dr. Aldo. Potentialities are what Dr. Aldo saw in the biochemical cascades. He wanted to determine how to manipulate cascades for the good of the living organism, pushing one pathway over another, to foster a positive, life-giving cyclic cascade. And he took these ideas of potentialities and manifested them in his hopes and desires for his students: Tina, Jerry, Ishmal, and me. Per Deweyan thinking (1902, 1938a/1988), he fostered experiences that would increase the potential for our individual success. As he did with his chemicals, he worked intimately with us, while paying attention to the unique characteristics that made us who we were as individuals.

XI. THE LAST STEP: THE CONTINUED SEARCH

A tree gives glory to God by being a tree. For in being what God means is to be, it is obeying Him. It “consents,” so to speak, to His creative love. It is expressing an idea which is in God and which is not distinct from the essence of God, and therefore, a tree imitates God by being a tree.

The more a tree is like itself, the more it is like Him. If it tried to be like something else, which it was never intended to be, it would be less like God, and therefore it would give Him less glory.

For me to be a saint means to be myself. Therefore, the problem of sanctity and salvation is, in fact, the problem of finding out who I am and of discovering my true self. Trees and animals have no problem. God makes them what they are without consulting them, and they are perfectly satisfied.

With us it is different. God leaves us free to be whatever we like. We can be ourselves or not, as we please.

—Thomas Merton, from my child’s First Reconciliation handbook

December 1994

“Is it Christmas yet, Jo? Where are my cigarettes? Can you light one up for me? Is it Christmas yet, Jo? Do you have the tree up yet?”

“Grandma, no, it’s not Christmas yet. The tree was up two days to go.”

It smells in here. I can’t tell what’s worse, the Lysol or the cigarettes, but either way I’m gagging—struggling for air, struggling for life. The disinfectant and the arsenic-laced smoke, both are killers. And these white walls? They’re meant to be calming, but I know better. All these machines, buzzing and pumping, a mess of lights and dials, disturb any sense of serenity. Hospitals are not places of serenity. No one I know finds serenity here or ever recovers. Gram’s throat cancer is terminal.

So I’m here, again—in hell. I need to run. How fast can I run? How far can I run? Far or fast enough to escape?

“Is it snowing yet, Jo? Do the lights show yet? Are they on? Tell me Jo, what color are the lights?”

Gram’s losing her cigarette. It falls from her mouth no matter how hard she tries to close her lips around it, those chapped, old, colorless lips. Nothing can save that cigarette. It falls, and so does my sense of hope. She reaches for it, grasps the red-hot ember between her forefinger and thumb. She burns. Doesn’t she realize she’s burning? Acidic cigarette smoke mixed with burning flesh. She burns. Doesn’t she feel it? Doesn’t she feel anything anymore?

I do. I need to feel life—the warmth, the heat, the beauty all around. But right now, all I feel is death—cold, black, and dark. So dark. My soul is crying out, will shrivel and collapse if I don’t run soon—run for my life. Whatever chance I have at life depends on this, my very soul depends on it.

“Grandma, let me help you. I’ll tap the ashes into the dish for you.”

An odd mix of sweet and sour permeates my nostrils, the smell of the tapioca pudding mingling with the carbon-laced ashes and other chemicals of her Cambridge, the knock-off brand she took up when she could no longer afford her Winstons. Crusty, sweet, filthy, sugary—these things make up the toxic soot in her dessert dish.

“How are you feeling, Gram? Can I get you anything—water, Kleenex, a cracker?”

“All is well, Jo. All is well.”

Who is she trying to kid? Me? Herself? She’s dying. All is not well. Doesn’t she know?!

“Is it Christmas yet, Jo?”

“No, it’s not Gram.”

“I’ll wait. Till then, Jo, a piece of advice for you—live! Just live! I wish I had. I wish I had worried less, lived more. Why did I diet, give up all that ice cream? Why did I think it so important to be a certain size, a certain weight? It makes no sense, not now, not then.

“I wish I had tried out that new hairstyle—the one with the choppy cut. I so wanted to try those new CDs everyone is going on about. And I wanted a boom box to play them. I wanted to get lots of CDs, and a rack to hold them. Did I tell you I love to dance, Jo? You should have seen me dance. I didn’t dance enough. I was graceful and beautiful; I could turn Grandpa’s head. Boy, how I could.”

My gags mix with tears. Her cigarette is wet, nearly out, but a flicker of embers persists. Perhaps when her cigarette dies, so will she. How long can one hang on with only “I wish I had” to cling to? What kind of life required dying to realize one had never lived?

“Jo, I missed so much. I missed it all. Do you think in Heaven I’ll be able to dance? Do you think God will let me dance? Will He make sure my hair is done right? You know, I would love to have it naturally curly like yours—so easy to maintain, so bouncy. When I get to Heaven, will God get me some help with my hair? Who will I be in Heaven? Who was I here on earth? Do you think I became the girl God wanted me to be? If I would have taken those chances, would I have been the girl He meant for me to be? What was the meaning of my life? Did I say or do something, anything that had a purpose? Did I mean anything to anybody, Jo?”

“Gram, I am sure there’s a beauty parlor in Heaven; I mean, how else could everyone in Heaven look so luminescent, so beautiful, so angelic? God has to take care of everything up there, and I bet you there’s loads of ice cream. Gobs and gobs of your favorite—mint chocolate—always in supply. Like that Kitchen Sink you and Mom ate at Colonial—a never-ending dish, with hot fudge and whipped cream. Only the good stuff, full of cream and sugar.

You and Grandpa used to finish up a Sink just like that. I swore you two inhaled it. Grandpa's in Heaven now putting in your order."

I could swear the tears flowing down my face and into my mouth have a hint of chocolate to them, maybe a little nut.

"The two of you will finish off that Sink and you can put that bumper sticker on your car to tell the world of your success. I think it'll look great on the back of your convertible, the red one you always wanted. I'd wear a scarf to keep your hair in place. Wind and curls don't mix. I can't tell you how many bad hair days I've had because of the wind. And in a convertible there'll be a lot of wind. Your curls will lose their bounce and your hair will look like a rat's nest, teased out, and sprawling all over the place. Trust me, I know."

"Jo, is it Christmas yet? You know how I love Christmas."

"No Gram, it's not. Two more days, just two more days."

"I'll wait."

And she did. On Christmas day, as the sun rose, so did she. Heaven-bound. She had a hair appointment and, trust me, she never missed a hair appointment. If her roots showed, so would she at the local hairdresser. Grandma never revealed her real hair. Come to think of it, I don't know what her "real" hair color was. She kept her locks impeccable—cut, style, and color.

The two days Gram waited to die helped me to remember how to live. Never would I say, "I wish I had." Her advice was spot-on, and a reaffirmation of what I had already come to discover on my own: to just go for it. I finished out the year and my MS at Midwestern with renewed vigor. I grabbed opportunities and pushed the boundaries of life in honor of her, and in recognition of my own growth and the battles I had won. My determination was powerful and

uplifting. I was no longer skittish, fearful, like a trepid animal coming out of the darkness to grab a bit of food in the light of day. I had a new mantra: *I am. I did it.* This ability to change lives, to effect lives, to offer support and courage to become what one may be, fostered my desire to get a PhD in education. I still loved the ‘order’ and ‘assured’ nature of chemistry, but I realized, that there were more important things than this mistaken belief of mine. It was teachers that helped me reach my potential, to become the ‘Jo’ that I was capable of. And, I hoped that I may be able to help another, as I too was helped, encouraged.

To this day, I continue my journey to discover who Jo is, who Jo was, and what got her here. And I think a life such as mine, one full of both suffering and success, should be examined. I wonder, what was it inside me and what supports were in place to propel me forward? What made the young Jo defy expectations and set off to College of Novet? What made her follow Marge to Morewood College and take on science and math? Where did she find the courage to go to grad school? Why did that lost little girl with the cards stacked against her keep pushing forward, against the wind, immersed in the catastrophes of life? Where did she find that courage, that drive, that desire?

I am in awe of that girl, but I also still feel her pain. Like she did, I sometimes want to crawl back into bed, accept depression, just give up. But then the more mature woman inside me takes that little girl, holds her tightly to my chest, and comforts her as a mother would. I smooth her hair and rub her head, and tell her to find the courage to move forward. I allow her to smell those hospital odors, see all that pain, be confronted by death; but I also tell her to balance that pain, to see its higher purpose, to see its importance in her life. There is a purpose, I tell her. She and I together remember Gram’s lament, “I wish I would have,” and with that memory reverberating deep inside our hearts, we, together, go forward.

Little Jo, that precious child I hold so close, how I love her, how I admire her! She was very brave. What a courageous soul she was, and she's still inside me, no matter how old I become. I cherish her youth, her innocence, her passion for life. In a way, I am thankful for her suffering because she keeps me on track toward the Light. Because of that little girl, I am where I am today. She was the one who set course to College of Novet. Her strength, her running toward a life she knew in her heart could be, that is what bolsters me. I am not my grandmother. Nor am I what my family projected for me. I am *me*. If, as Saint Merton suggests, I had "tried to be like something else, which [I] was never intended to be, [I] would be less like God, and therefore... give Him less glory." Thus, the greatest task I have ever undertaken was discovering my true self. And for me that all began when Jo put her boat to sea.

And now as I humbly record here the most impactful experiences of my life, I can see how these moments are intertwined with concepts I have learned on the road to this PhD. I feel in the depth of my soul what Greene (1988) meant when she talked of seeing things as they could be otherwise. I understand Bateson's (1989) notion of the composed life, for in the writing of this dissertation I took the time to truly recollect and organize those moments of my life into a coherent piece. I have grown aware of those Deweyan (1934, 1938a/1998) experiences that made me who I am, and I appreciate the greatness and breadth of Schubert's (1981, 2009) idea of curricula, for I partook in these endeavors; they too made me. The literature I read over the course of my studies is now alive for me. This dissertation serves to demonstrate the concepts they fostered. They first were a part of me, and now they are part of what I make, this dissertation, part of the cascade of life.

And thus I end this dissertation, fully aware of the irony of the notion that it can end. This is my life's work, a reflection of my various engagements with the curricula of life. My hope for

this work is to affirm permission for me and for others like me *to be*. In the world of academia and in general, I want our voices to be heard and to be counted. This dissertation is a communication of the merits of allowing for all ways of learning and knowing. It speaks to the strength of the soul in becoming what God meant it to be. As well, this is the story of me, once part of the working class community, currently struggling to be a good teacher, utilizing my past as a point for understanding the students who enter my classroom door the best I can. And working with my socioeconomic background, embracing it, and buoyed by its place in my past, I hope to offer academia another lens as it moves forward to help the precious souls that enter our classrooms. This is my story, an unending one. This is my students' stories, as well unending. Until the very last breath, I run, I write, I live. As do my students, in their individual ways. This dissertation is just the beginning—the beginning of a wonderful book of life, mine and those who I am fortunate enough to teach and to learn from.

<u>Selective serotonin reuptake inhibitors (SSRIs)</u>	
•	<u>Citalopram (Celexa)</u> : usual dosing is 20 mg initially; maintenance 40 mg per day; maximum dose 60 mg per day.
•	<u>Escitalopram (Lexapro, Cipralex)</u> : usual dosing is 10 mg and shown to be as effective as 20 mg in most cases. Maximum dose 20 mg. Also helps with anxiety.
•	<u>Paroxetine (Paxil, Seroxat)</u> : Also used to treat panic disorder, OCD, social anxiety disorder, generalized anxiety disorder and PTSD. Usual dose 25 mg per day; may be increased to 40 mg per day. Available in controlled release 12.5 to 37.5 mg per day; controlled release dose maximum 50 mg per day. Less cycling in patients who are bipolar.
•	<u>Fluoxetine (Prozac)</u> : Also used to treat OCD, bulimia, and panic disorder. Long half-life; less withdrawal when medication is stopped. Dosing is 20 mg to a maximum of 80 mg.
•	<u>Fluvoxamine (Luvox)</u> : Although primary used in the treatment of OCD, a doctor may prescribe it for depression. Initial dose is 50 mg, increasing by 50 mg every 4-7 days. If daily dose is greater than 100 mg give in equally divided doses or give larger dose at bedtime not to exceed 300 mg.
•	<u>Sertraline (Zoloft, Lustral)</u> : Also used to treat panic disorder, OCD, PTSD, social anxiety disorder, premenstrual dysphoric disorder. Dosing is 50-200 mg per day and should be titrated up.

Table 1 – Antidepressants: Selective Serotonin Reuptake Inhibitors (SSRIs)

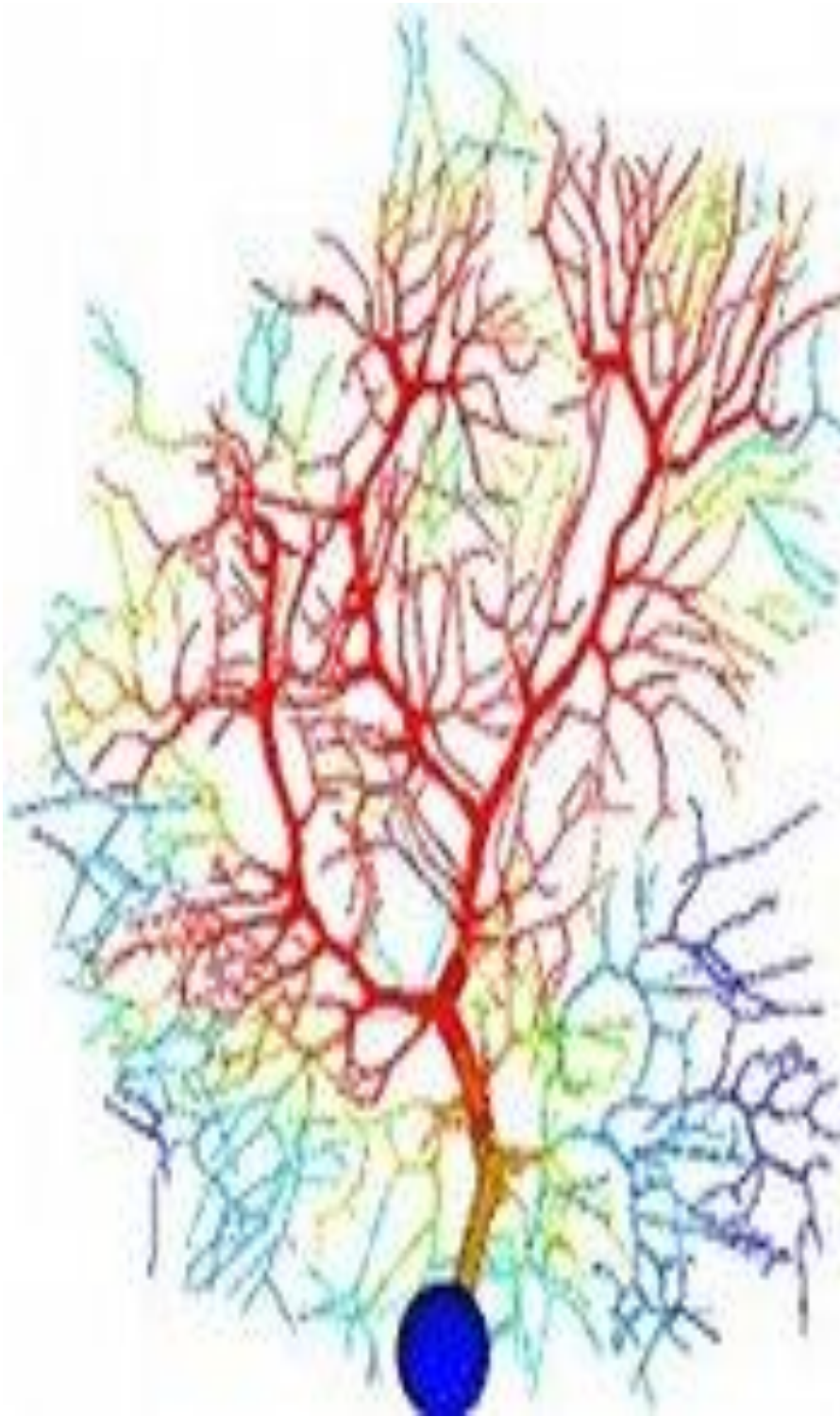
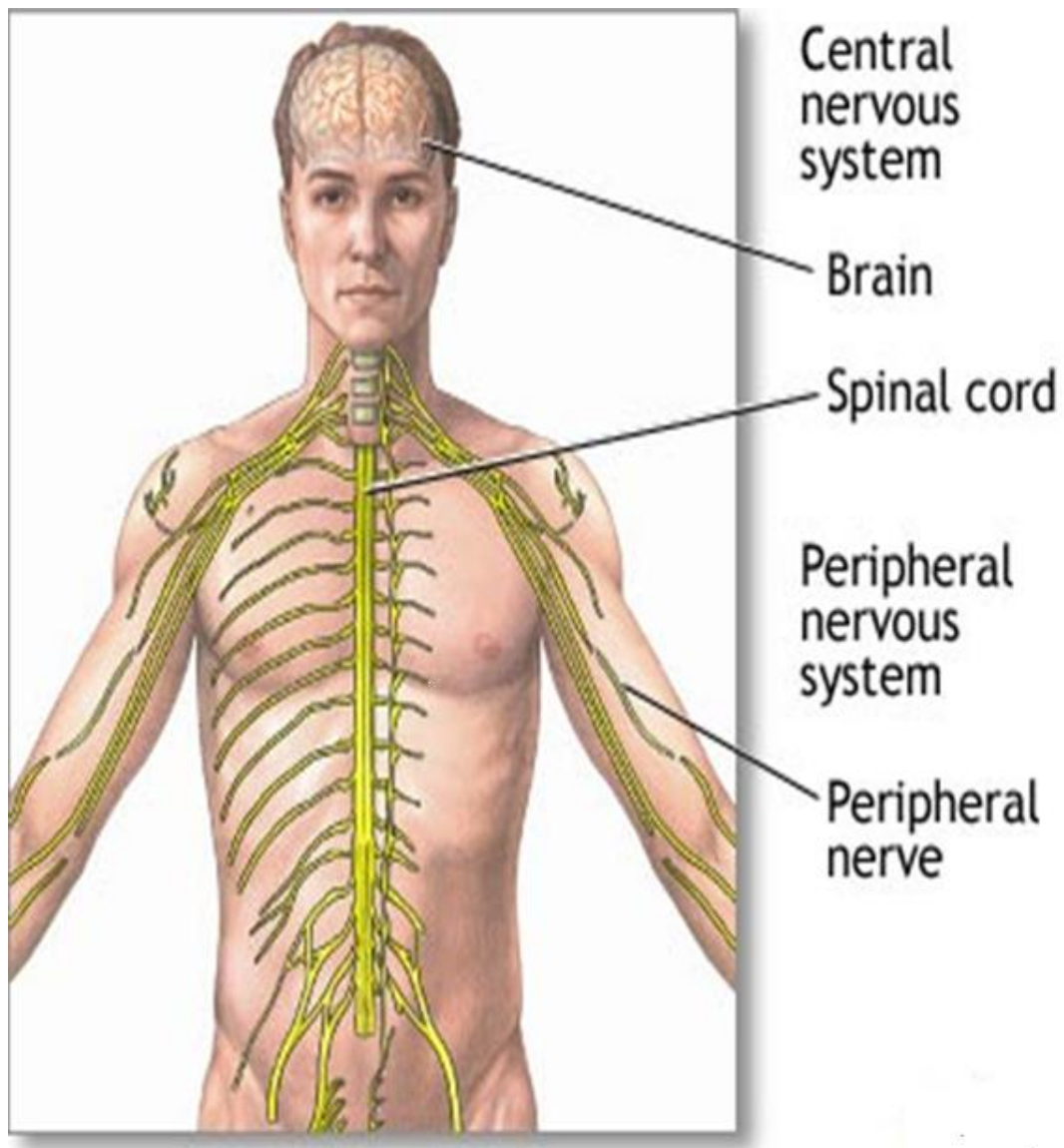
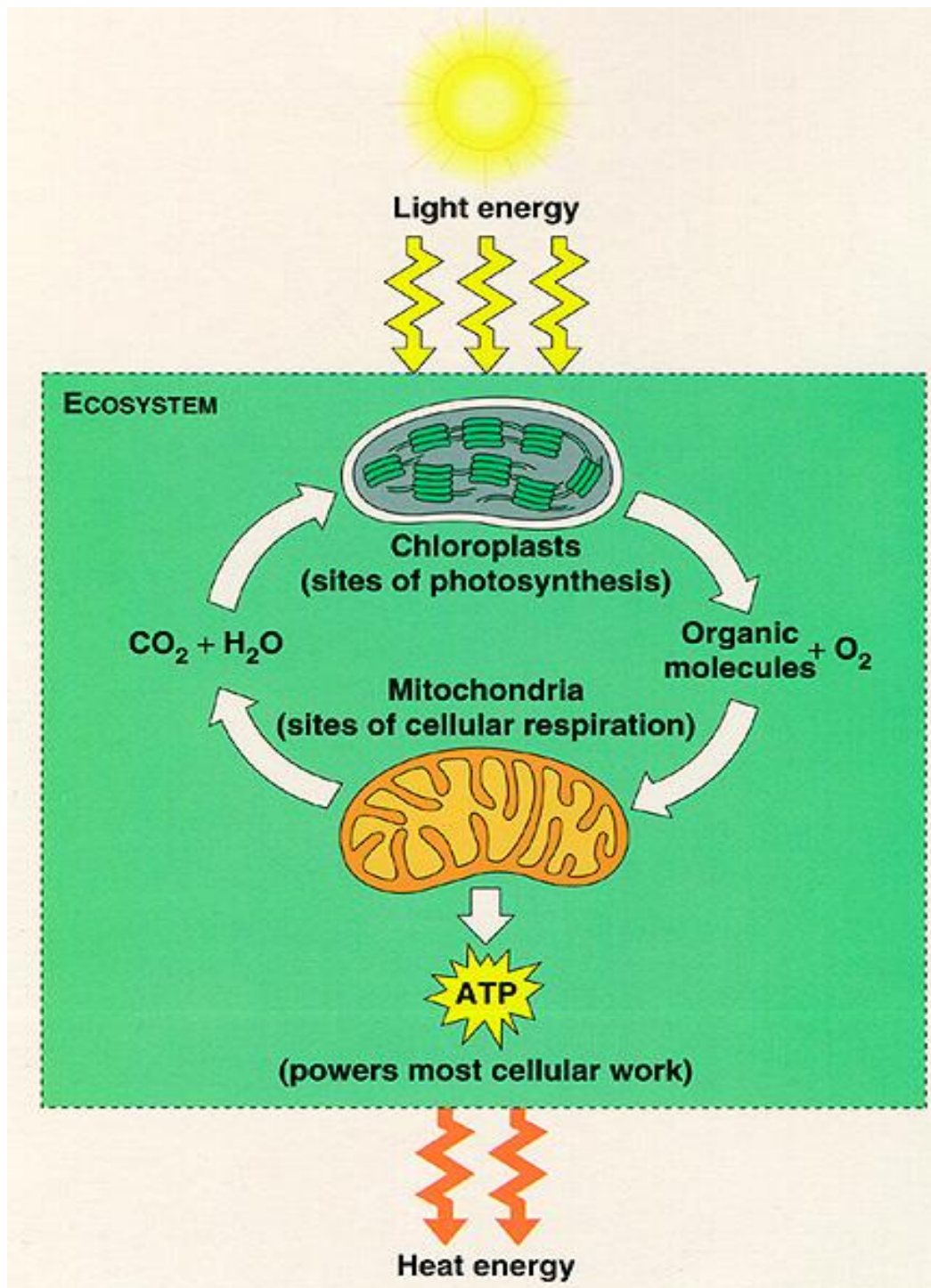


Figure 1- Neuron comprised of dendrites and axons



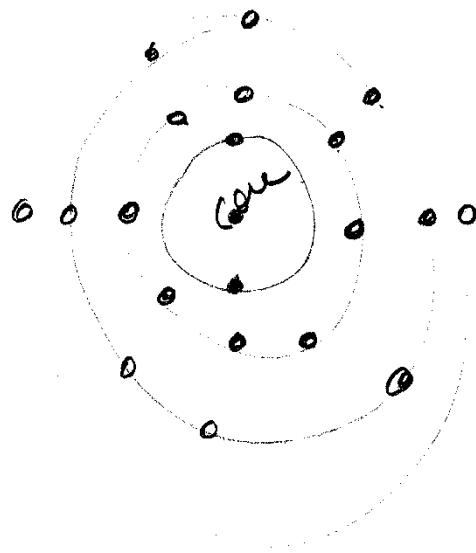
<http://www.pediatrrix.com/body>

Figure 2 - Central Nervous System

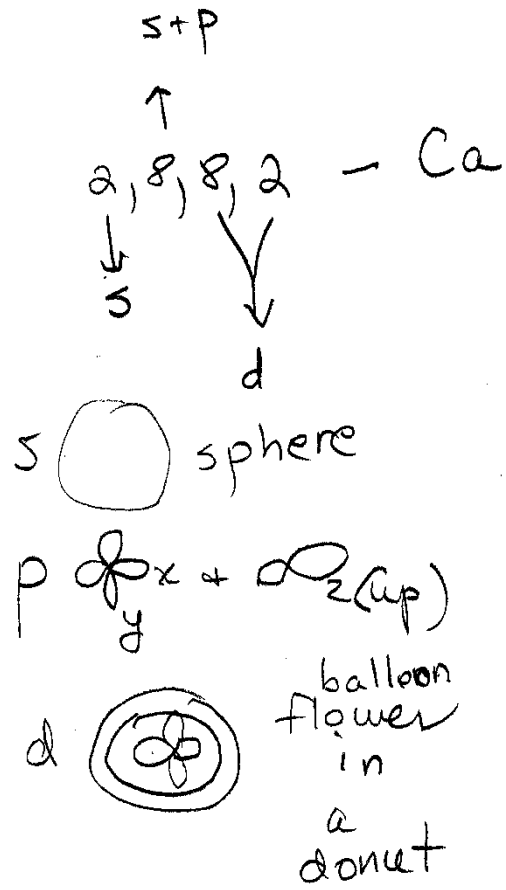


http://fig.cox.miami.edu/Faculty/Dana/105F00_13.html

Figure 3 - The Circle of Life: Photosynthesis & Respiration



Atomic
Model



Solar
Model

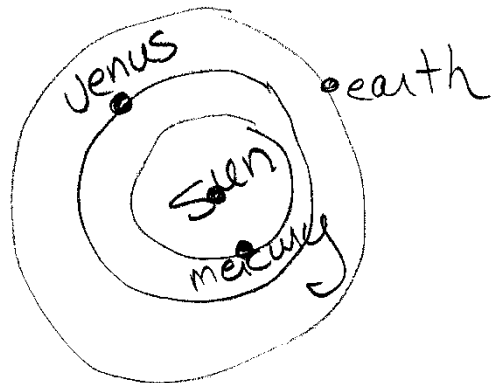


Figure 4 – Orbits Among Us

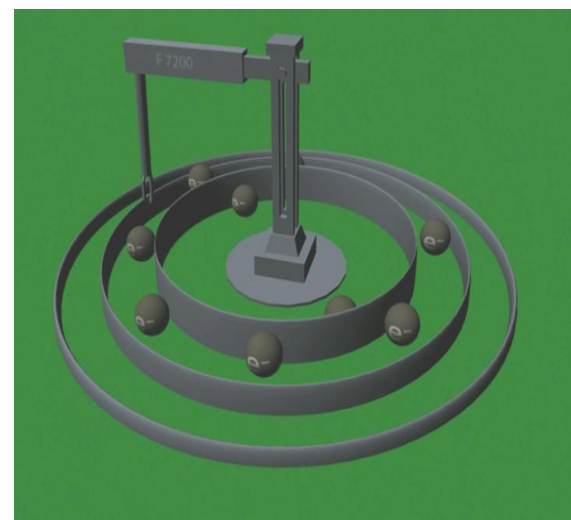
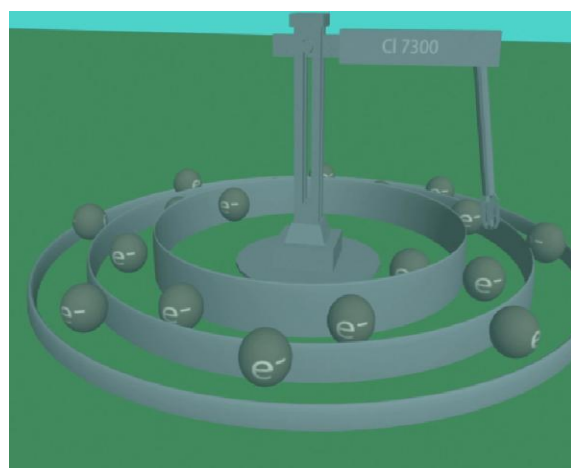
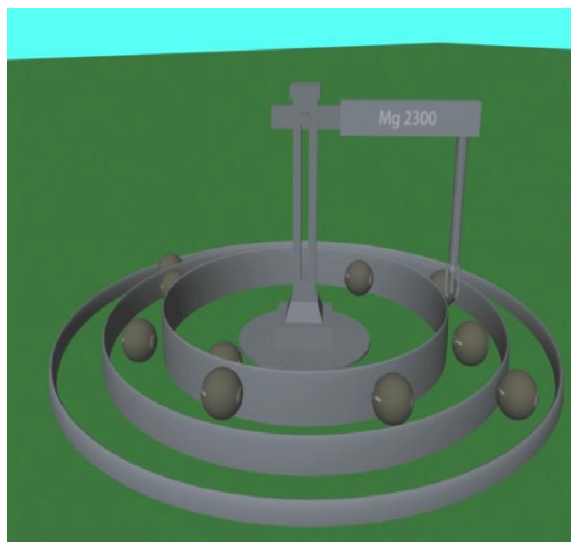


Figure 5 - Images: Magnesium, Chlorine, Fluorine – Electron Orbital Diagrams

$$\begin{aligned}
 K_p &= \prod_i (y_i P / P^\circ)^{\nu_i} \\
 &= \prod_i y_i^{\nu_i} \prod_i (P / P^\circ)^{\nu_i} = \\
 &\quad (P / P^\circ)^\nu K_y
 \end{aligned}$$

Figure 6 – Equilibrium constant for standard state chemical reactions, focus on pressure



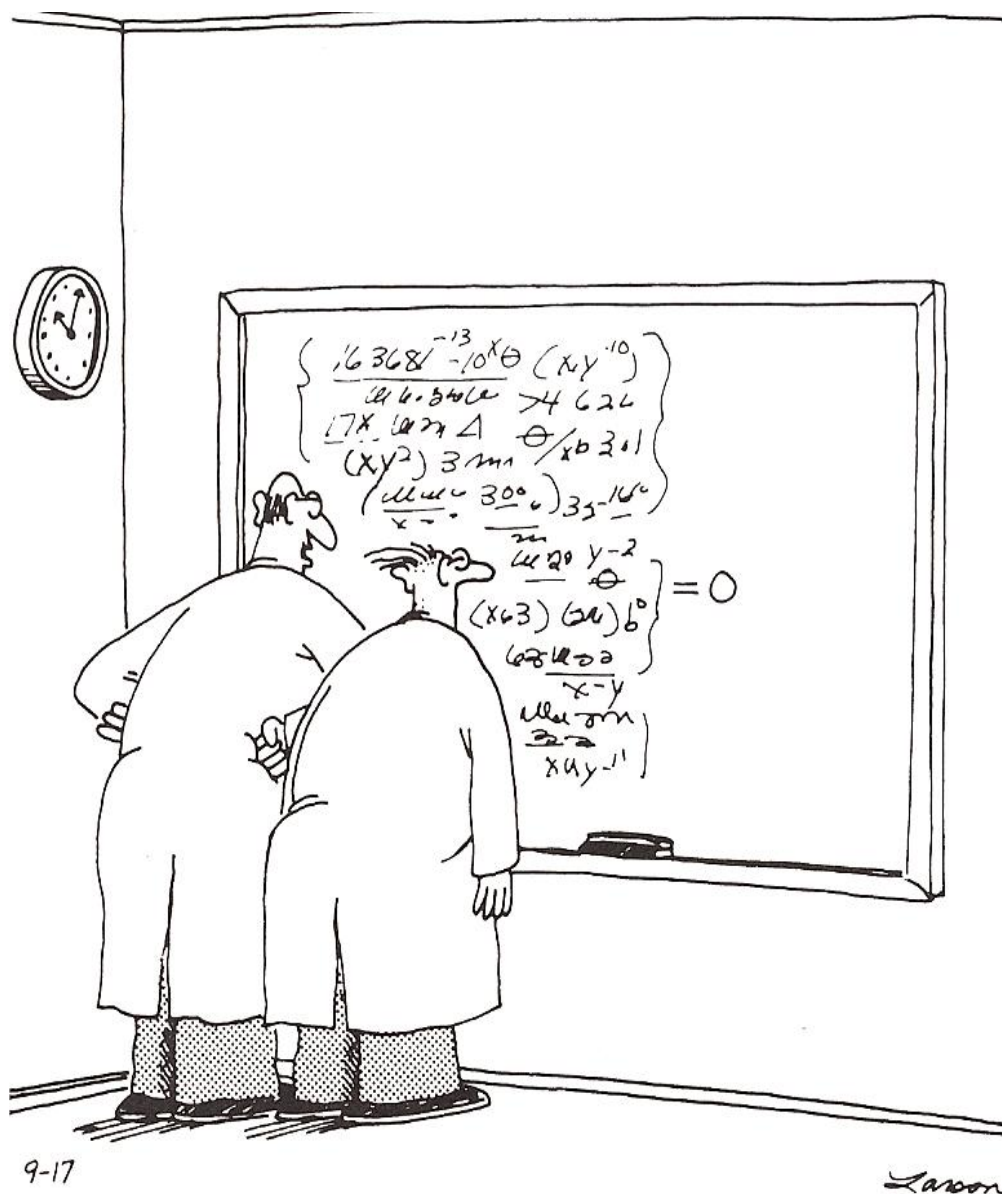
Figure 7 – Equilibrium constant for the Soul, to stay



Amputating for ischaemic gangrene

Deciding where to amputate can be difficult. The lower you amputate, the greater the chance that the patient will walk again afterwards. But there is also more chance that the tissue through which you amputate will not be viable, so that his stump will become infected or gangrenous.

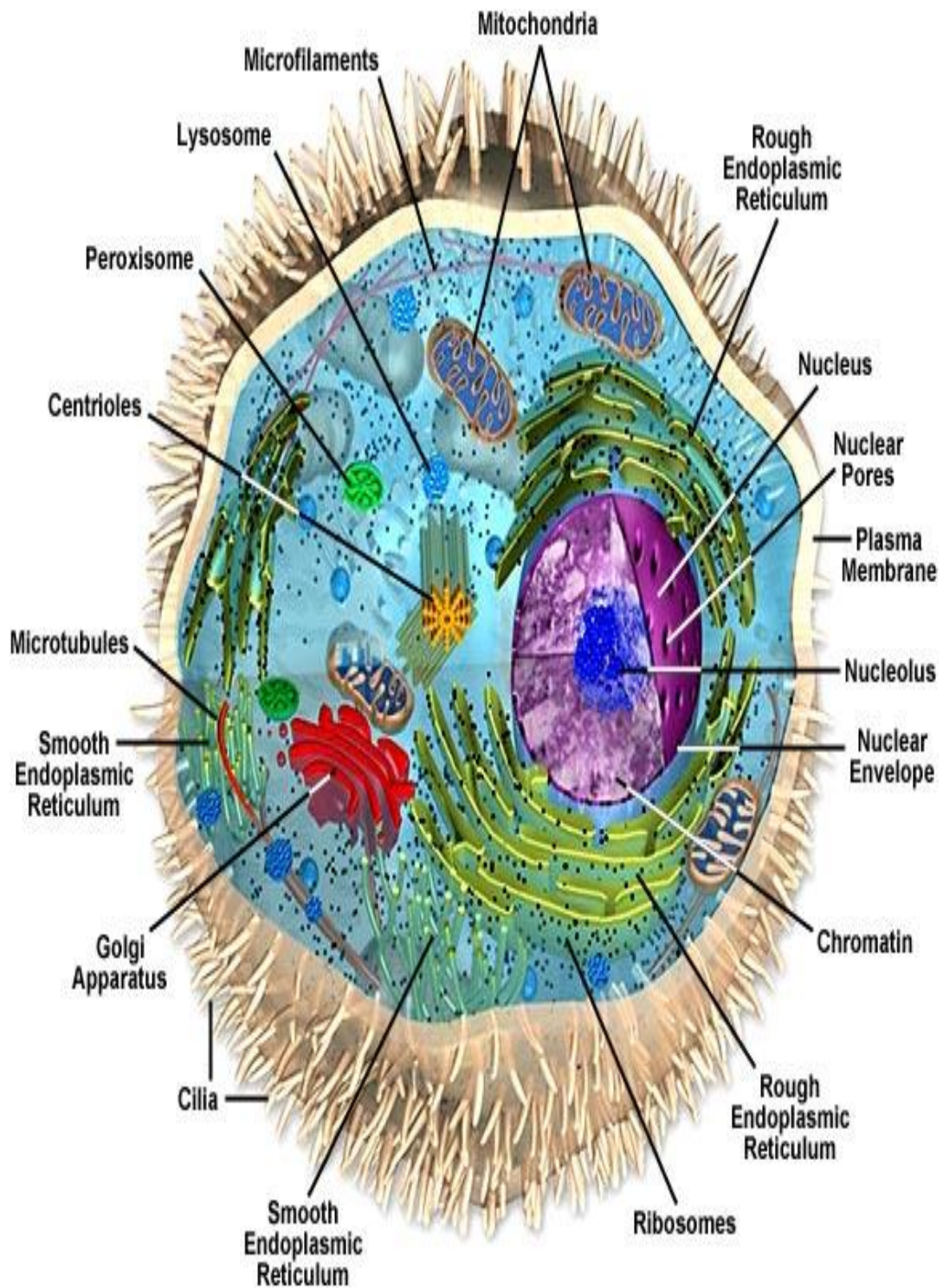
Figure 8 – or go



No doubt about it, Ellington—we've mathematically expressed the purpose of the universe. Gad, how I love the thrill of scientific discovery!

THE FAR SIDE © 1984 FarWorks, Inc. Reprinted with permission. All rights reserved.

Figure 9 – THE FAR SIDE from *The Living World*. George B. Johnson



<http://micro.magnet.fsu.edu/cells/animals/animalmodel.html>

Figure 10 – Lots of Circles, Some Perfect, some Stretched Out, but All Contain & Do Something

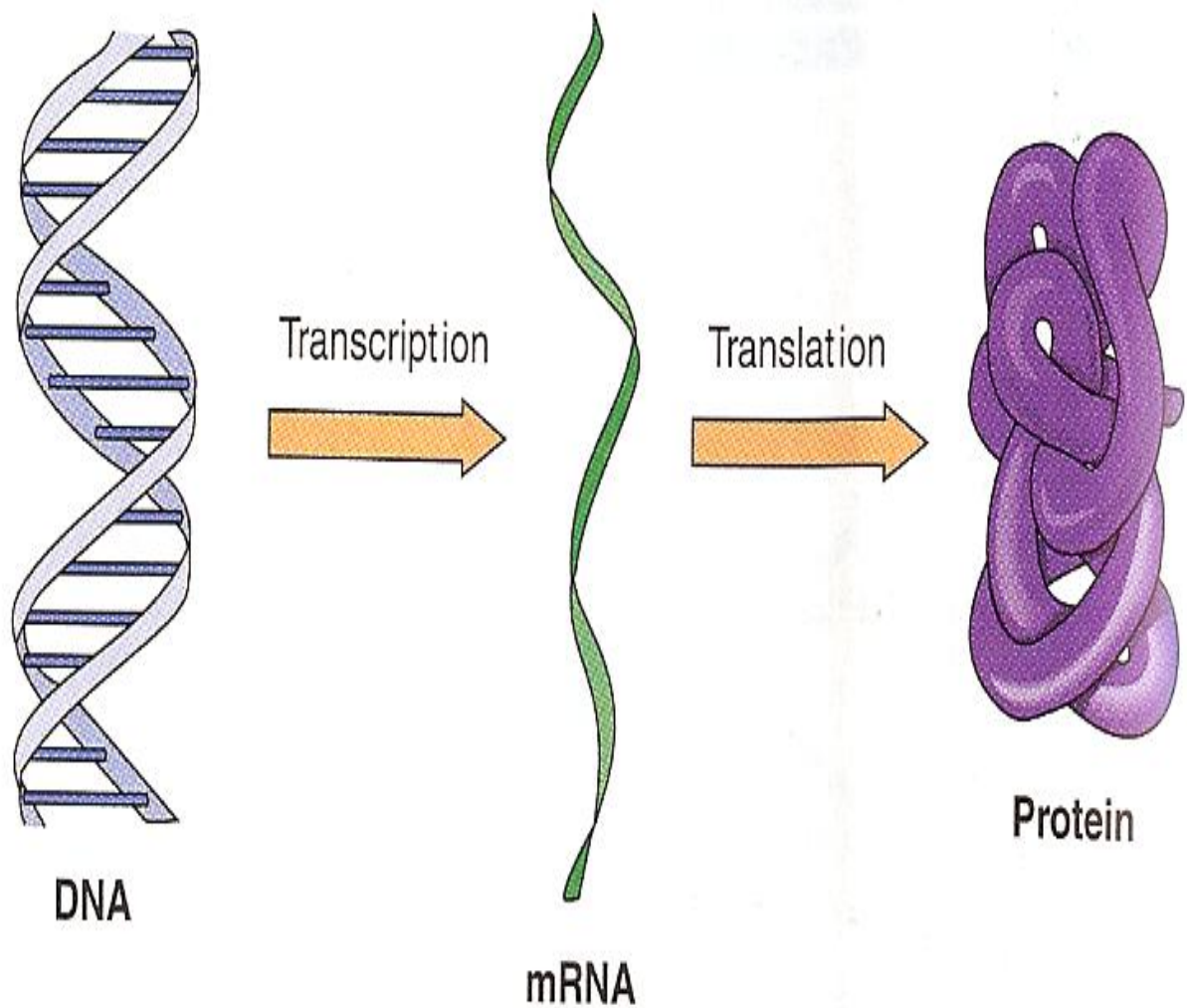


Figure 8.11 The central dogma of gene expression.

Through the production of mRNA (transcription) and the synthesis of proteins (translation), the information contained in DNA is expressed.

Figure 11 – The Gene Dogma

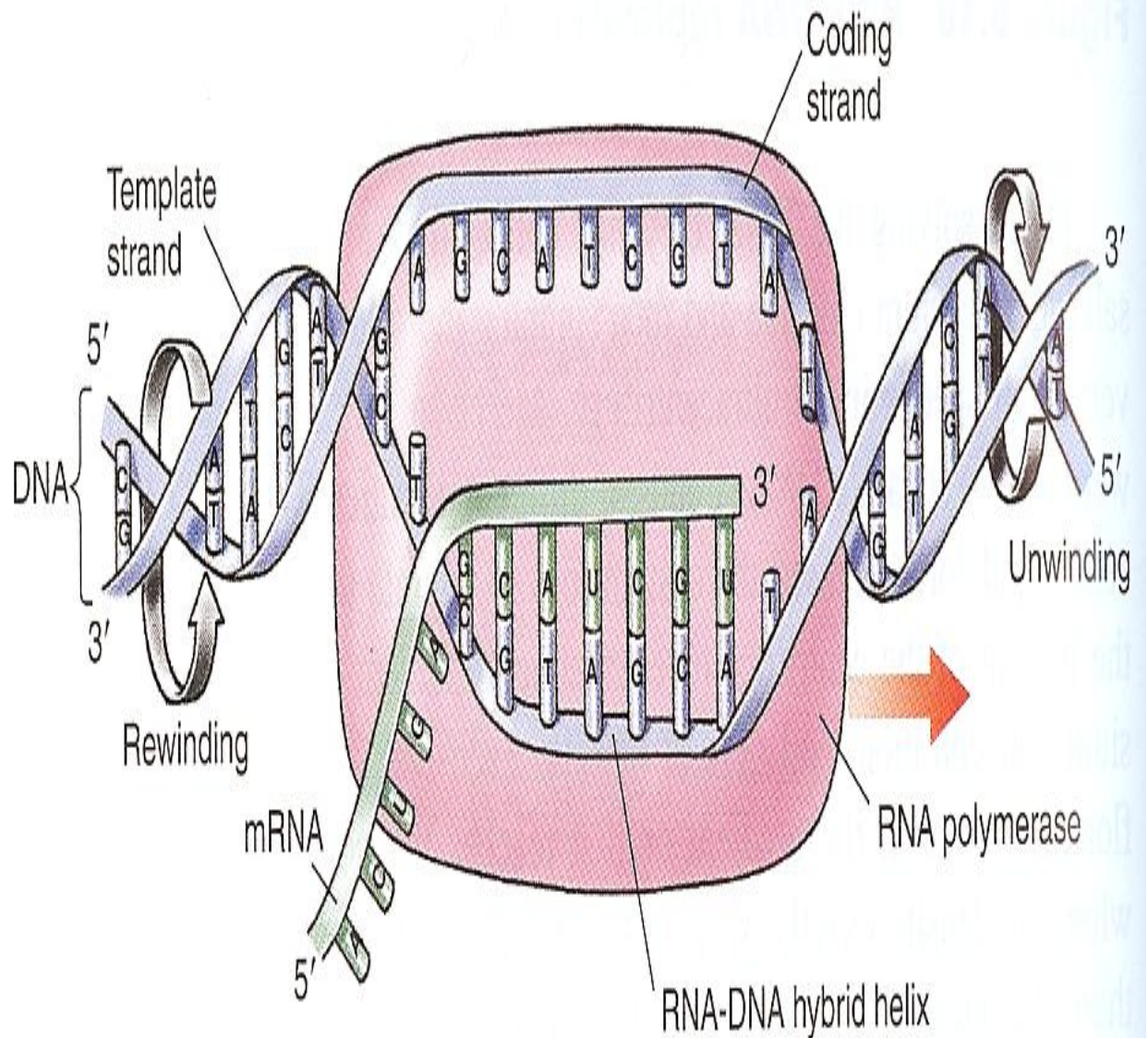


Figure 8.12 Transcription.

One of the strands of DNA functions as a template on which nucleotide building blocks are assembled into mRNA by RNA polymerase as it moves down the DNA strand.



Figure 12 – Transcription: The Making of the Photocopy

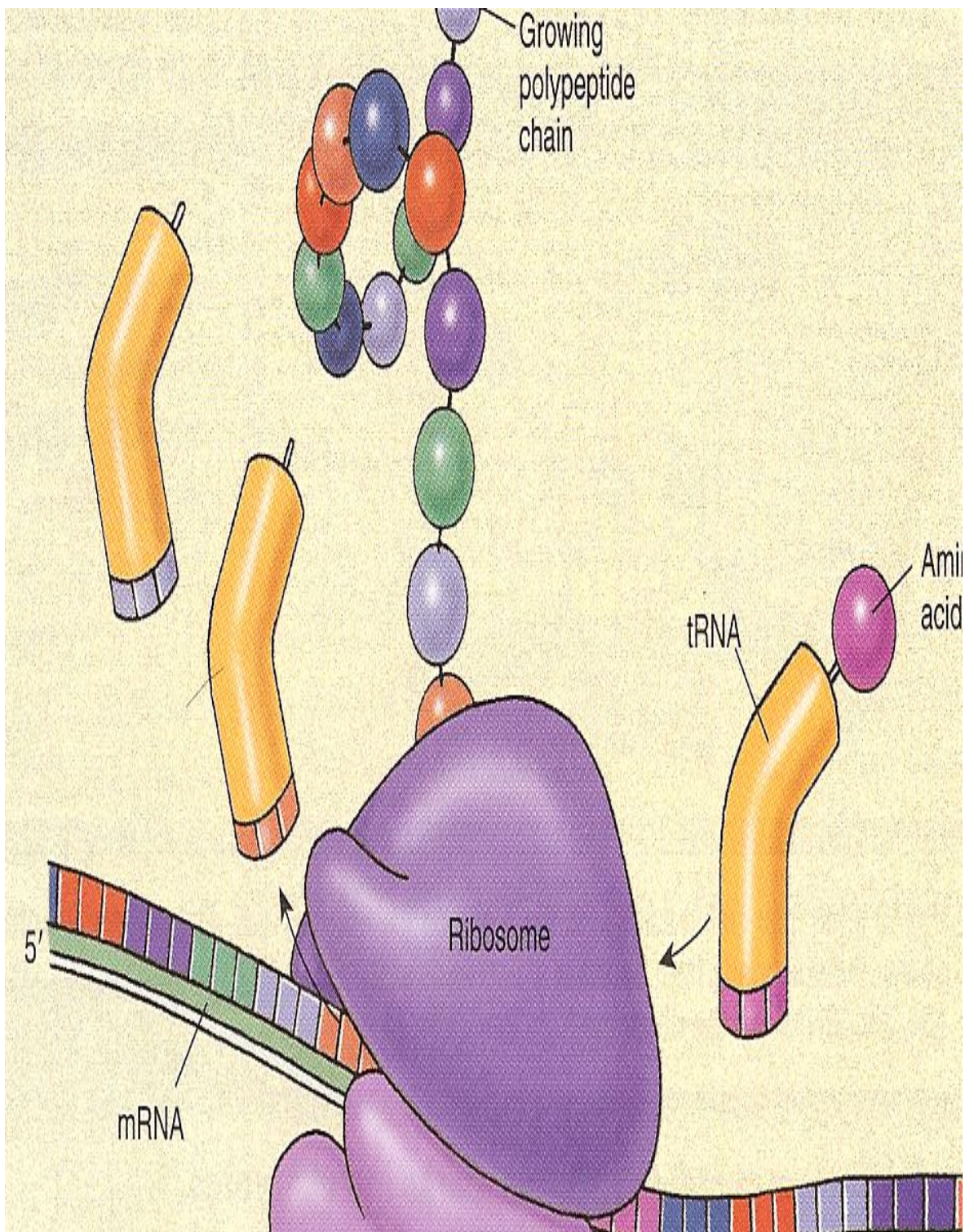


Figure 13 – Translation: Machinery & Photocopies/Blueprints to Make Precious Things



Figure 14 – DNA: Stairway to the Man on the Moon



Figure 15 - Twisted

FORM FITS FUNCTION

Introduction to College Chemistry--- Due next class period.

NAME _____

I. For this assignment, utilize the models provided, and generate the structures listed on the board in a 3-D format. That is, make the actual compounds as seen in your 2-D handout provided. After making the following compounds, draw them in a 2-dimensional format for your own use. Upon drawing the structures, make note in your drawings of their molecular shapes (that is note if they are octahedral, trigonal bipyramidal, etcetera), their bond lengths (such as a carbon to hydrogen bond and its length in Angstroms, etcetera), and the angles that are involved in the structures (such as in a tetrahedral, all angles are 109.5°). Make your work as accurate as possible using a protractor or ruler if necessary.

II. After completing the above work, use the Internet or other sources (for examples, the CRC handbook in the library, or your text) to find current uses for the compounds you have drawn. List three uses for each of the above compounds.

III. Lastly, looking at the structures above that you have drawn, and making careful note of their specific shapes, answer the following questions:

- 1) What do you think is meant by the "form fits the function?" HINT: Think of a bird's wings.
- 2) For the drawings you have done above, can you think of other items in life that have some semblance of these shapes? Name five items that are comprised of any of these shapes.
- 3) Can any of these shapes be seen in your artwork? That is, do you see these shapes in any of the technology you use, in your actual pieces of work, etcetera? List two items that are relevant to your specific work, or field of study.
- 4) What is an enzyme? What is meant by "lock & key fit" when discussing the process by which enzymes work?

Figure 16 – Form Fits the Function Lab Instructions

Bonding Electron Pairs	Lone Pairs	Electron Domains	Shape	Ideal Bond Angle	Example	Image
2	0	2	linear	180°	CO ₂	
3	0	3	trigonal planar	120°	BF ₃	
2	1	3	bent	120° (119°)	SO ₂	
4	0	4	tetrahedral	109.5°	CH ₄	
3	1	4	trigonal pyramidal	109.5° (107.5°)	NH ₃	
2	2	4	bent	109.5° (104.5°)	H ₂ O	
5	0	5	trigonal bipyramidal	90°, 120°	PCl ₅	
4	1	5	seesaw	180°, 120° (173.1°, 121.6°)	SF ₄	
3	2	5	T-shaped	90°, 180° (87.5°, < 180°)	ClF ₃	
2	3	5	linear	180°	XeF ₂	
6	0	6	octahedral	90°	SF ₆	
5	1	6	square pyramidal	90° (84.8°)	BrF ₅	
4	2	6	square planar	90°	XeF ₄	
7	0	7	pentagonal bipyramidal	90°, 72°	IF ₇	

Figure 17- Molecular Shapes

Bondlength (pm) and bond energy (kJ/mol)					
Bond	Length	Energy	Bond	Length	Energy
H--H	74	436	H--C	109	413
C--C	154	348	H--N	101	391
N--N	145	170	H--O	96	366
O--O	148	145	H--F	92	568
F--F	142	158	H--Cl	127	432
Cl-Cl	199	243	H--Br	141	366
Br-Br	228	193	H--I	161	298
I--I	267	151			
			C--C	154	348
C--C	154	348	C=C	134	614
C--N	147	308	C≡C	120	839
C--O	143	360			
C--S	182	272	O--O	148	145
C--F	135	488	O=O	121	498
C--Cl	177	330			
C--Br	194	288	N--N	145	170
C--I	214	216	N≡N	110	945

Figure 18 - Bond Lengths & Energies

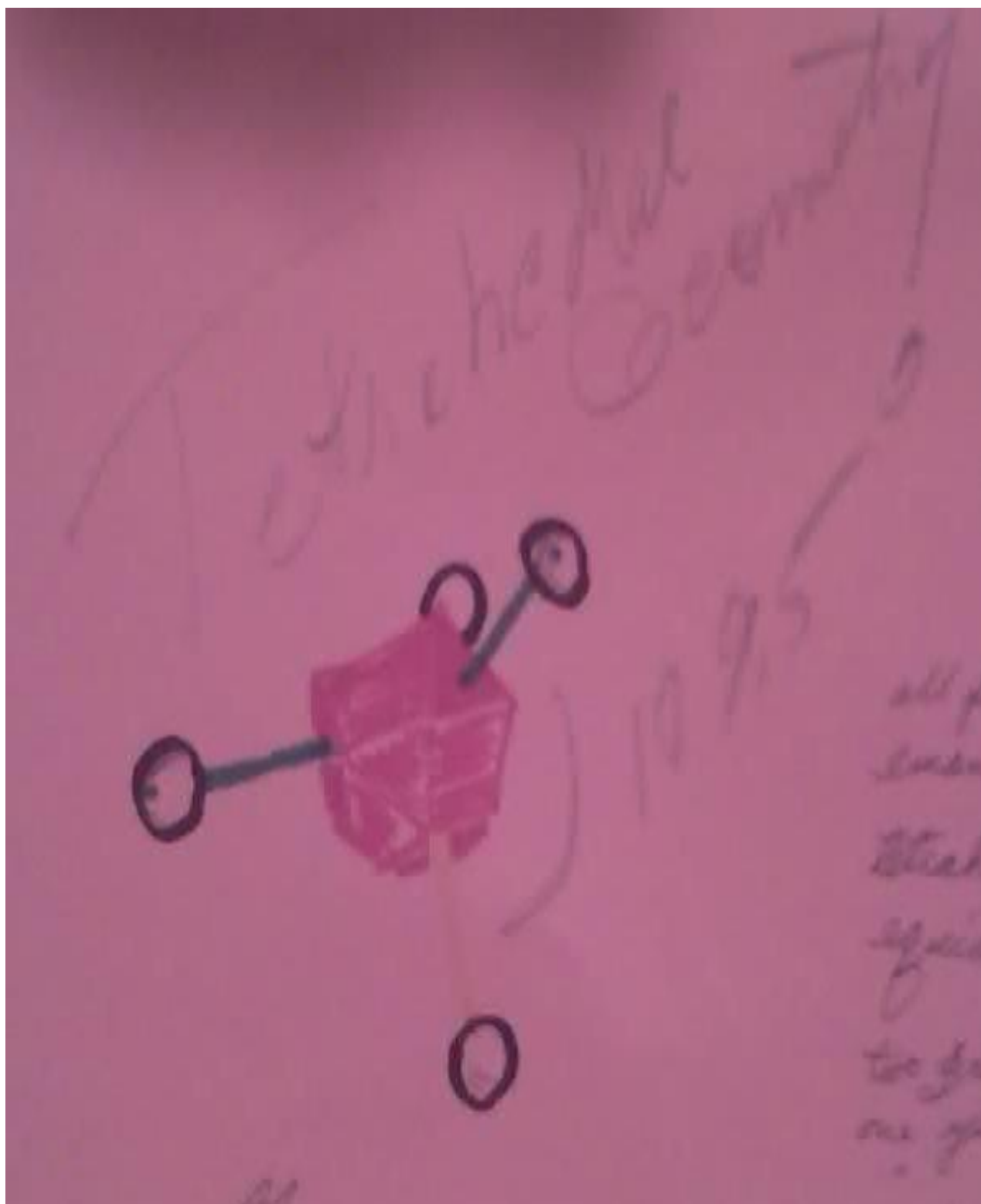


Figure 19 - Molecular Modeling Drawing – Methane – Tetrahedral Geometry

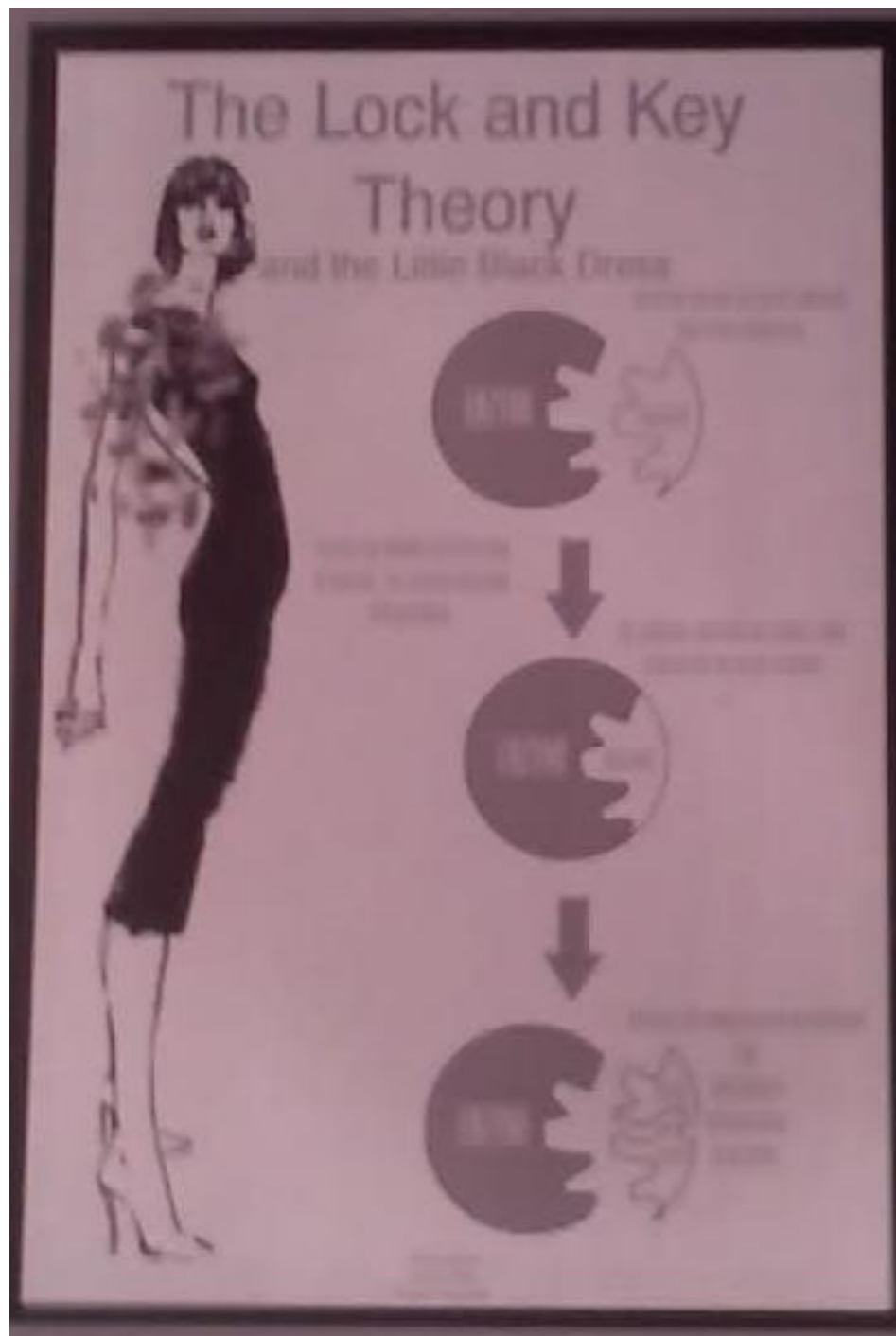


Figure 20 - The Lock & Key Theory

& the Little Black Dress

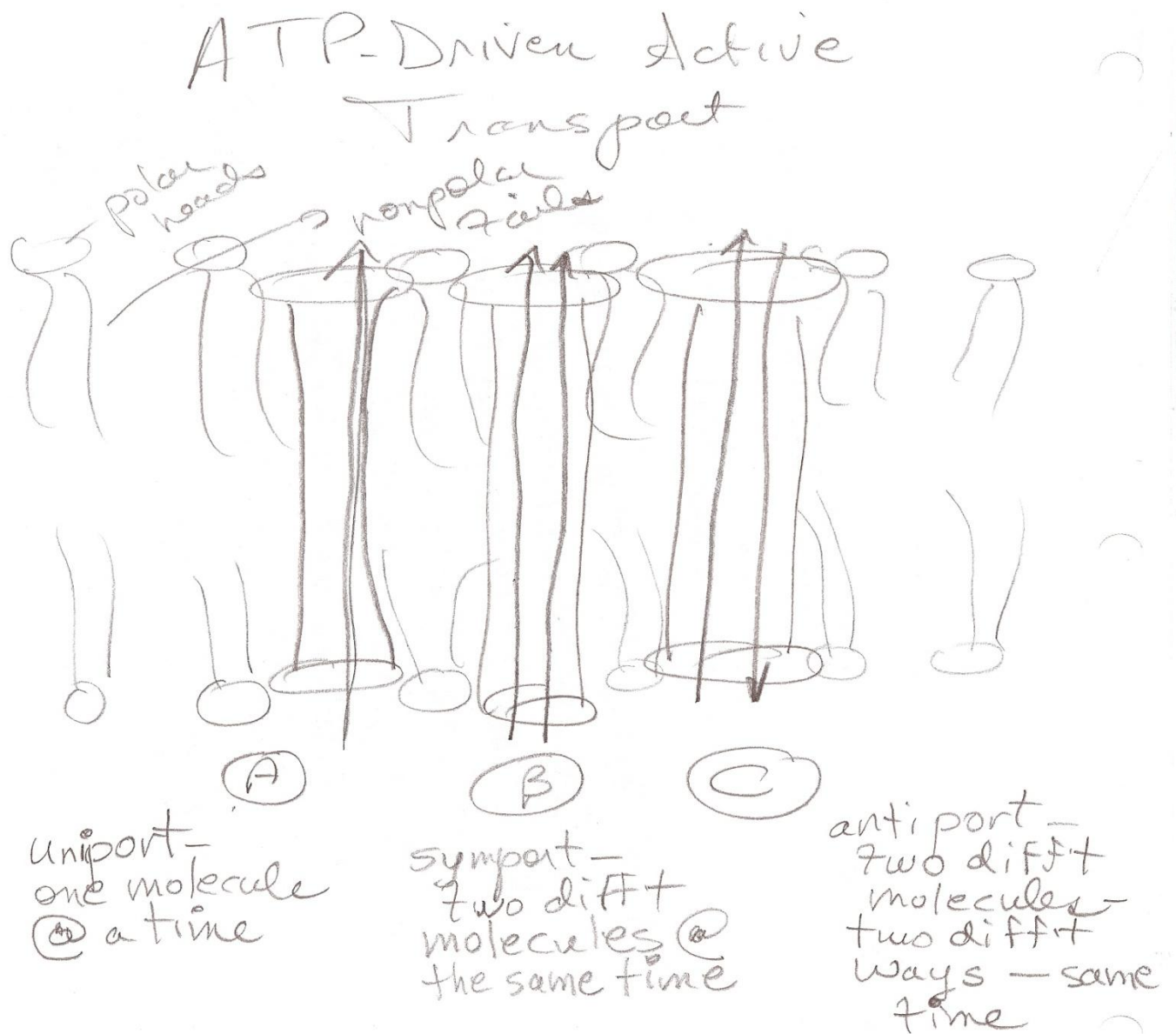


Figure 21 – Cumulative Response on Translocation across a Membrane --My Response in Pictures

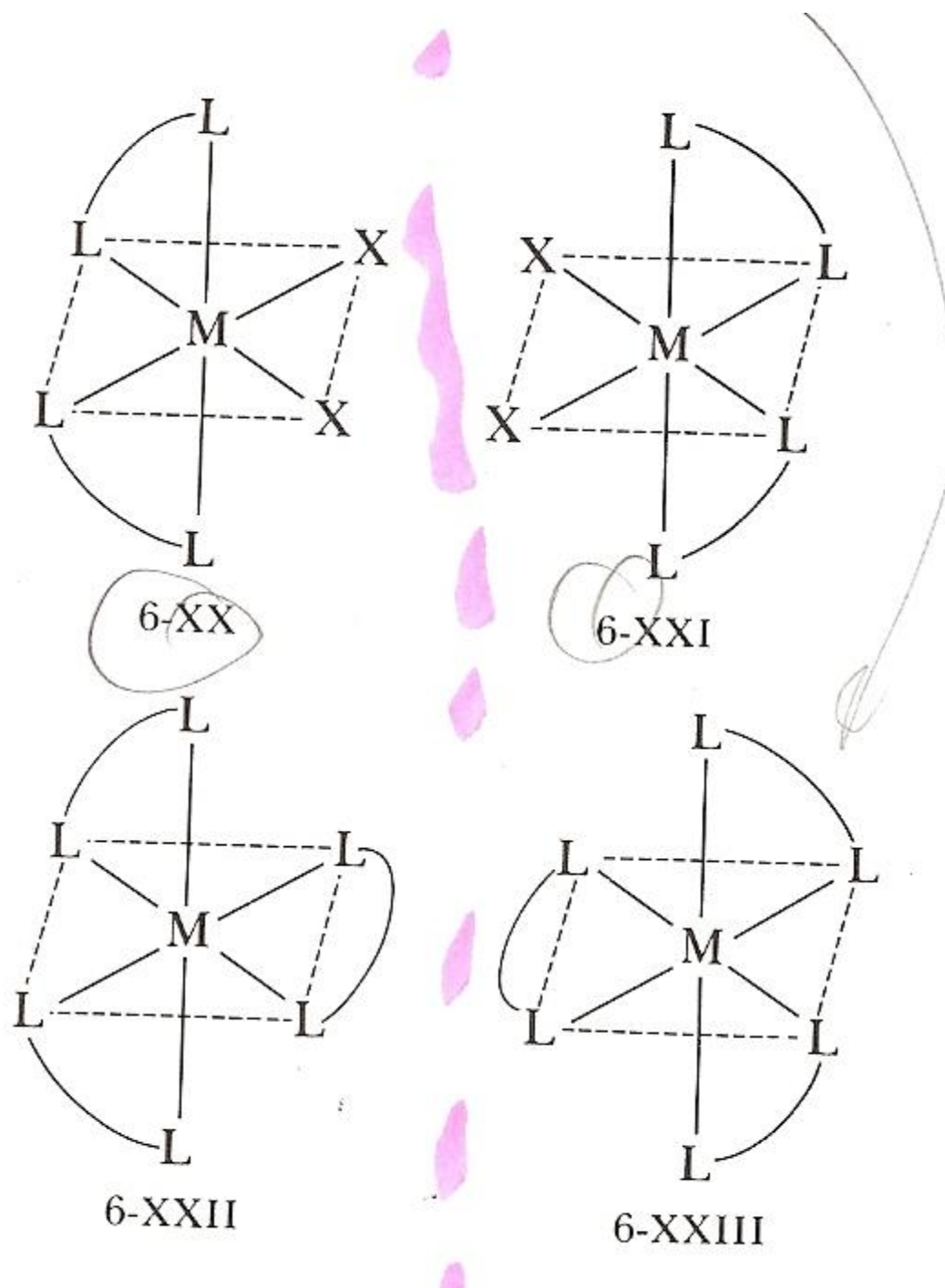
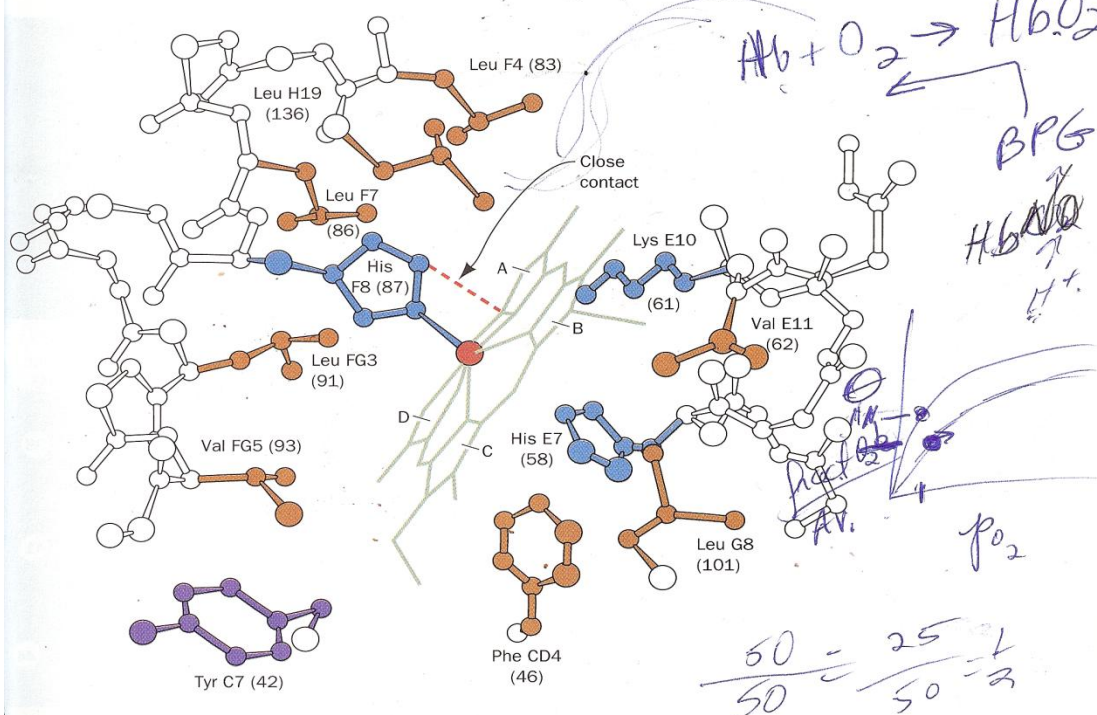


Figure 22 – Symmetrical Molecules



Figure 23 – The Great Spirit



group and its environment in the unliganded α . Only selected side chains are shown and the carboxylate group is omitted for clarity. The F helix is on the left side of the drawing. The close contact between the proximal His and the heme group that inhibits the T-state hemes is indicated by a dashed line. [B. R., Lee, A. W.-N., and Karplus, M., *J. Mol. Biol.* 142 (1983).]

The T conformations occurs mainly in the $\alpha_1-\beta_2$ symmetry related $\alpha_2-\beta_1$ interface, which contains the C helix and FG corner of α_1 , respectively, the FG corner and C helix of β_2 . The quaternary change results in a 6-Å relative shift at the $\alpha_1\text{C}$ face (Fig. 9-14). In the T state, His FG4(97) β is in contact with Thr C6(41) α (Fig. 9-13a and 9-17, left), while in the R state it is in contact with Thr C3(38) α , back along the C helix (Figs. 9-13b and 9-17, right). In both conformations, the "knobs" on one subunit fit snugly with the "grooves" on the other (Fig. 9-14). An intermediate position, however, would be selected because it would bring His FG4(97) β and Thr C6(41) α too close together (knobs on knobs). Hence the transition, which are joined by different but equivalent hydrogen bonds in the two states (Figs. 9-18 and 9-19), is a binary switch that permits only two stable conformations of the subunits relative to each other. In contrast, the quaternary change causes only a 1-Å shift at the proximal contact so that its side chains maintain the

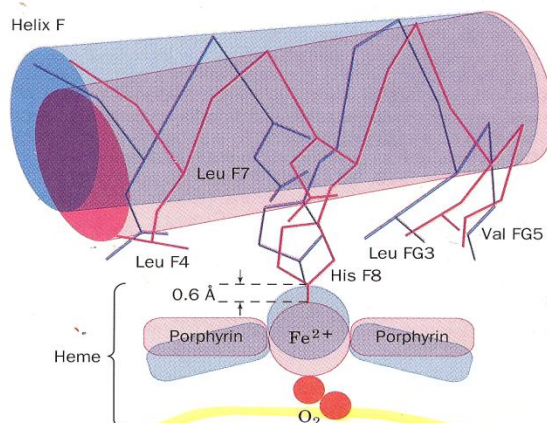


Figure 9-16

The triggering mechanism for the T $\rightarrow$ R transition in Hb. In the T form (blue), the Fe is 0.6 Å above the domed porphyrin ring. Upon assuming the R form (red), the Fe moves into the plane of the now undomed porphyrin where it can readily bind O_2 and, in doing so, pulls the proximal His F8 and its attached F helix with it. The Fe— O_2 bond is thereby strengthened because of the relaxation of the steric interference between the O_2 and the heme.

Figure 24 – The Battle for Life

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IMAGES

Figure 1 – Neuron comprised of dendrites and axons

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Figure 2 – Central Nervous System

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Figure 3 – The Circle of Life: Photosynthesis & Respiration

Retrieved on October 15, 2009 from http://fig.cox.miami.edu/Faculty/Dana/10500_13.html

Figure 4 – Orbitals Among Us

Own work, found in old notes.

Figure 5 – Images: Magnesium, Chlorine, Fluorine – Electron Orbital Diagrams

Student Artwork, Introduction to College Chemistry class.

Figure 6 – Equilibrium constant for state chemical reactions, focus on pressure

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Figure 7 – Equilibrium constant for the Soul, to stay

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Figure 8 – or go

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Figure 9 – THE FAR SIDE

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Figure 10 – Lots of Circles, Some Perfect, Some Stretched Out, but All Contain and Do Something

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Figure 11 – The Gene Dogma

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Figure 12 – Transcription: The Making of the Photocopy

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Figure 13 – Translation: Machinery & Photocopies/Blueprints to Make Precious Things

Johnson, B. (1997). *The Living World*. Madison, WI: McGraw-Hill Higher Education.

Figure 14 – DNA: Stairway to the Man on the Moon

Student Artwork, Introduction to College Biology class.

Figure 15 – Twisted

Student Artwork, Chemistry & Society class.

Figure 16 – Form Fits the Function lab instructions

Own work, Introduction to College Chemistry.

Figure 17 – Molecular Shapes

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Figure 18 – Bond Lengths & Energies

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Figure 19 – Molecular Modeling Drawing: Methane – Tetrahedral Geometry

Student Artwork, Introduction to College Chemistry.

Figure 20 – The Lock & Key Theory

Student Artwork, Introduction to College Chemistry.

Figure 21 – Cumulative Response on Translocation across a Membrane –

Own work

Figure 22 – Symmetrical Molecules

Cotton, E., Wilkinson, G. & Gaus, P. (1967/1987). *Basic Inorganic Chemistry*. 2nd Ed. Hoboken, NJ: John Wiley & Sons.

Figure 23 – The Great Spirit

Student artwork, Native American Support Program – Science Section.

Figure 24 – The Battle for Life

Voet, D. & Voet, J. (1990). *Biochemistry*. New York: John Wiley & Sons.

LYRICS

Tracy Chapman, Fast Car

Retrieved on Sept 9, 2010 from <http://www.metrolyrics.com>.

Cyndi Lauper, Hat Full of Stars

Retrieved on Sept 9, 2010 from <http://www.metrolyrics.com>.

Jewel, What You Are

Retrieved on November 19, 2010 from <http://www.lyricsmode.com/lyrics/j/jewel/#share>.

Rascal Flats, Why?

Retrieved on November 11, 2010 from <http://www.elyrics.net/read/r/rascal-flats-lyrics.html>.

John Cougar Mellancamp, Full Catastrophe of Life.

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TABLE

Table 1 – Antidepressants: Selective serotonin reuptake inhibitors (SSRIs)

Baum, R. (2004). The Darkness of Depression. *Chemical & Engineering*

NAME:

JoElla Eaglin Siuda

EDUCATION:

Ph.D., December 2011

University of Illinois – Chicago, Illinois

Field of Study: Curriculum Design and Instruction

Department of Education

M.S., December 1995

University of Illinois – Chicago, Illinois

Research Advisor: Dr. Paul R. Young

Field of Study: Chemistry/Biochemistry

B.S., June 1993

Elmhurst College – Elmhurst, Illinois

Major: Chemistry/Biochemistry

A.S., June 1990

College of DuPage – Glen Ellyn, Illinois

Field of Study: Elementary/Secondary Education

TEACHING/EDUCATIONALEXPERIENCES:

1996 – Present

Illinois Institute of Art – Chicago, Illinois

- Associate Professor – Human Biology, Chemistry and Society, Introduction to College-level Chemistry, Introduction to College-level Biology, Math Fundamentals I, Math Fundamentals II

- Science Department Chair – Coordination of a team-centered science department involved in implementation of a science curriculum for the visual art student

- Director of Faculty Development – Execution of a new program to provide collegiate faculty assistance and support

9/01 – Present

Koraes Elementary School – Palos Hills, Illinois

- Developer/Teacher and Advisor – Design and implementation of an integrated mathematics and science curriculum for 6th–8th grade honors and enrichment students

5/01 – 9/03

Art Institutes Online – Pittsburgh, Pennsylvania

- Facilitator – Teaching of online College Math I and Introduction to College Chemistry courses

1/96 – 2/98

Columbia College – Chicago, Illinois

- Science and Math Department Instructor – Development and teaching of a science curriculum based on current, relevant topics in everyday life; also responsible for implementation and teaching of a new environmental science series offered as a minor

- (ECO) Environmentalists of Columbia Organization Advisor –

Development of an alternative means of fostering interest in the stewardship of our world as well as promotion of the new Science and Math Department minor

1/96 – 1/98

Waubensee Community College – Sugar Grove, Illinois

- Allied Health and Sciences Instructor – Teaching of general chemistry laboratory for nursing students

- 8/96 – 8/97 Lourdes High School – Chicago, Illinois
- Physical Science Instructor – Teaching of honors and average PS courses in an alternative manner so as to induce greater student success and involvement
 - Science Club Moderator – Development and presentation of an in-house science magic show coordinated by the Science Club for recruitment purposes
- 8/93 – 6/96 University of Illinois – Chicago, Illinois
- Chemistry Department Teaching Assistant – Classroom assistance in undergraduate natural science, general chemistry, organic, inorganic and biochemistry discussions and laboratories
 - Chicago Science Alliance Coordinator/Instructor – Involved in implementation of the first Chicago Science Van aimed at bringing various scientific technologies into urban secondary institutions (in cooperation with the Teachers Academy for Math and Science and Chicago State University)
 - Native American Support Program (NASP) Instructor – Development and teaching of a hands-on science curriculum aimed at high-risk students
 - Saturday Honors College Instructor – Development and implementation of science-based curriculum designed to encourage minority high school students to seek further education
 - Research Assistant – Development of novel anti-cancer and anti-AIDS drugs
- 2/92 – 6/93 Elmhurst College – Elmhurst, Illinois
- Chemistry Department Teaching Assistant – Directing of undergraduate organic chemistry laboratory sections
 - Laboratory Technician – Design and implementation of a student-based water analysis facility, Analytica, and development of a manual for later classroom use
 - Chemistry Department Coordinator – Creation and coordination of laboratories for undergraduate organic, inorganic, analytical, and biochemistry classes

COMMITTEES:

- NCA Special Task Force, Illinois Institute of Art, Chicago, Il
- Honors Committee, Illinois Institute of Art, Chicago, Il
- Internet Offerings Committee, Illinois Institute of Art, Chicago, Il
- Technology Committee, Illinois Institute of Art, Chicago, Il

EXPERIENCES:

- | | |
|-----------------|--|
| 9/02 – Present | <p>NSTA/Exxon Mobile – Springfield, Illinois</p> <ul style="list-style-type: none"> • <u>Key Leader</u> – Involved with creation of communications and professional development networks in every state to facilitate standards-based teaching and learning of the sciences |
| 6/02 – Present | <p>Art Institutes Online – Pittsburgh, Pennsylvania</p> <ul style="list-style-type: none"> • <u>Curriculum Design/Advisor</u> – Generation of online sciences curriculum that is inquiry based and laboratory supported |
| 12/99 – Present | <p>McGraw-Hill Publishing – Rochester, New York</p> <ul style="list-style-type: none"> • <u>Editor</u> – Review of the American Chemical Society book <i>Chemistry in Context</i> |
| 6/06 | <p>U.S. Department of Agriculture</p> <ul style="list-style-type: none"> • <u>Website Inclusion</u>: X-Treme Textile Recycling – Student work and concept statements on website |
| 10/05 | <p>NSTA Regional Conference – Chicago, Illinois</p> <ul style="list-style-type: none"> • <u>Guides Manager</u> – Recruitment and coordination of student guides at Navy Pier and Sheraton locations |
| 10/03 | <p>U.S. Department of Education – Washington, D.C.</p> <ul style="list-style-type: none"> • <u>Reader</u> – Aided in the decision making for acceptance of proposals for subsidizing through the Department of Education |
| 9/02 – 9/03 | <p>ACS – Washington, DC</p> <ul style="list-style-type: none"> • <u>Advisor for LAN</u> – Offered guidance on crucial national issues involving the scientific enterprise |

- 1/99 – 1/07 NeoScience Corporation – Rochester, New York
- Designer/Writer – Designed in-class science laboratory kits for commercial sale involving everyday materials (e.g., oils, soda pop)
- 8/98 – 9/02 Chicago Public School System – Chicago, Illinois
- Reviewer – Review of the CASE exams in biology, chemistry and physics
- 8/98 – 9/02 The Illinois Institute of Art at Chicago – Chicago, Illinois
- Coordinator for IIHFD – Coordinator for hosting of the international IIHFD conference
- 4/93 – 8/93 Medi-Physics – Arlington Heights, Illinois
- Laboratory Technician – Aided in production, quality control, and shipping of various radiolabeled pharmaceuticals
- 1/91 – 2/91 National Environmental Testing/EPA outpost, Midwest – Bartlett, Illinois
- Laboratory Technician – Designed and aided in implementation of an S.O.P. for improved Ag recovery on atomic absorption spectrophotometers

PUBLICATIONS:

- 4/08 • Co-editor of college-level science textbook
- Cannon, C., Jenkins, S., Budy B., Siuda, J., & A. Cherif. *Organic Chemistry for Liberal Arts and Communication*. (2008). Boston, MA: Pearson Custom Publishing.
- 3/08 • Co-editor and co-contributor of college-level science textbook
- Cherif, A., Aron, R., Michel, L., Jenkins, S., Movahedzadeh, F., Jedlicka, D., Siuda, J. & J. Mayoral. *Foundations of Modern Biology & Chemistry*. (2008). Boston, MA: Pearson Custom Publishing.
- 3/08 • Co-editor and co-contributor of college-level science study guide
- Cherif, A., Aron, R., Michel, L., Jenkins, S., Movahedzadeh, F., Jedlicka, D., Mayoral, J., & J. Siuda. *Foundations of Modern Biology & Chemistry*. (2008). Boston, MA: Pearson Custom Publishing.
- 4/07 • Co-editor and co-contributor of college-level science laboratory guide

Cannon, C., Jenkins, S., Budy, B., Siuda, J., & A. Cherif. *Catalyst: The Prentice Hall Custom Laboratory Program for Chemistry*. (2007). Boston, MA: Pearson Custom Publishing.

3/07

- Contributor

Varelas, M., Pappas, C., Tucker-Raymond, E., Arsenault, A., Ciesla, T., Kane, J., Kokkino, J. & J. Siuda. (2007). Identity in activities: Young children & science. In Wolff-Michael Roth & Kenneth Tobin (Eds.): *Science, learning, identity: Sociocultural and cultural-historical perspective*. (203-242). Rotterdam, Taipei: Sense Publishers.

11/04

- Illinois Science Teachers Association Journal, *Spectrum*

Publication: The Power of Patterns: The Periodic Table as a Tool in the Learning of Chemistry – The Integration of the Arts in the Curriculum

11/04

- Illinois Science Teachers Association Journal, *Spectrum*

Publication: The Power of Patterns – Chad Winters, Graphic Artist/student; compilation of student work from the Introduction to College Chemistry course—artwork, front cover

10/98

- Illinois Science Teachers Association Journal, *Spectrum*

Publication: MAN and EARTH—Darren Urbaszewski, my student in Human Biology class of Summer of '98—artwork, front cover

CONFERENCES:

11/10

- Illinois Science Teachers Association Conference

Presented: *Integration of Arts and Science in the Curriculum*

4/08

- American Chemical Society Convention

Presented: *The Power of Patterns: The Periodic Table as a Tool in the Learning of Chemistry – The Integration of the Arts in the Curriculum*

4/07

- National Association of Research in Science Teaching Conference

Presented: *Affordances of Class Murals for Learning Science*

3/07

- 2YC3 Consortium

Presented: *The Power of Patterns: The Periodic Table as a Tool in the Learning of Chemistry – The Integration of the Arts in the Curriculum*

- 11/06 • Lilly Conference
Presented: *The Power of Patterns: The Periodic Table as a Tool in the Learning of Chemistry – The Integration of the Arts in the Curriculum*
- 10/06 • Association of College and University Biology Educators Conference
Presented: *The Power of Patterns: The Periodic Table as a Tool in the Learning of Chemistry – The Integration of the Arts in the Curriculum*
- 11/05 • National Science Teachers Association Conference
Presented: Set-up and presentation of more than 85 student art pieces from Introduction to College Chemistry at Navy Pier
- 10/05 • National Association of Biology Teachers Conference
Presented: *Arts Integration in the Global Curriculum*
- 11/04 • 24th Annual Lilly Conference on College Teaching
Presented: *The Power of Patterns: The Periodic Table as a Tool in the Learning of Chemistry – The Integration of the Arts in the Curriculum*
- 11/04 • National Association of Biology Teachers Conference
Presented: *Which Tea Is Good for Me? Learning Science Is a Cup of Tea*
- 10/04 • American Chemical Society Conference
Presented: *The Power of Patterns: The Periodic Table as a Tool in the Learning of Chemistry – The Integration of the Arts in the Curriculum*
- 3/03 • National Science Teachers Association Conference
Presented: *Which Tea Is Good for Me? Learning Science Is a Cup of Tea*
- 10/02 • National Association of Biology Teachers Conference
Presented: *Which Tea Is Good for Me? Learning Science Is a Cup of Tea*
- 10/02 • 22nd Annual Lilly Conference on College Teaching
Presented: *Responsibility Judgments in the Classroom: An Attributional Theory of Motivation in Student Success*
- 9/02 • Association of College and University Biology Educators Conference
Presented: *Creative Projects in the Classroom*
- 2/02 • National Science Teachers Association Conference

- Presented: *Examinations in the Biochemistry of Soft Drinks*
- 10/01 • Illinois Science Teachers Association Conference
- Presented: *Examinations in the Biochemistry of Soft Drinks*
- 10/01 • National Association of Biology Teachers Conference
- Presented: *Fizz & Pop: The Physical and Chemical Properties of Carbonated Soft Drinks and Learning Activities with Everyday Oils*
- 3/01 • Illinois Science Teachers Association – Science in the South Conference
- Presented: *Examinations in the Biochemistry of Soft Drinks*
- 3/01 • National Science Teachers Association Conference
- Presented: *Learning Activities with Everyday Oils*
- 10/00 • National Association of Biology Teachers Conference
- Presented: *The Power of Analogies in Teaching Biology and Learning Activities with Everyday Oils*
- 10/00 • Association of College and University Biology Educators Conference
- Presented: *The Power of Analogies in Teaching Biology*
- 3/00 • Illinois Science Teachers Association – Science in the South Conference
- Presented: *Learning Activities with Everyday Oils*
- 10/99 • Illinois Science Teachers' Association Conference
- Presented: *Using Computers in Teaching Biology and Learning Activities with Everyday Oils*
- 10/99 • Association of College and University Biology Educators Conference
- Presented: *Semester-long Creative Projects: An Educational Instrument for Maximizing Student Learning and Understanding of Science and Mathematics*
- 10/98 • Illinois Science Teachers' Association Conference
- Presented: *Introducing the Concepts of Light and Laser Through a Guided Inquiry Approach for Conceptual Change*
- 2/98 • Illinois Association for Secondary Curriculum Development

Presented: *Business Entity, DNA Fingerprinting, and Introducing the Concepts of Light and Laser Through a Guided Inquiry Approach for Conceptual Change*

PENDING

PUBLICATIONS:

- *Spectrum* – Learning Activities with Everyday Oils
- *Bioscene* – The Use of Analogies in Teaching Biology
- *Bioscene* – Semester-long Creative Projects: An Educational Instrument for Maximizing Student Learning and Understanding of Science and Mathematics
- Co-author of the college-level textbook *Biology: The Living World Around Us*

PROFESSIONAL

DEVELOPMENT:

- Completion of iOptimize Long Distance Learning Course Awarded certificate 12/04 – Facilitator in the Online Classroom
- Completion of Socrates Long Distance Learning Course
Awarded certificate 3/01 – Facilitator in the Online Classroom

INSTRUMENTATION:

AA, Cell Fluorimeter and Cytometer, GLC, HPLC, IR, MS, NMR, UV/VIS

ACHIEVEMENTS:

2009	Sabbatical – Winter 2009
2005	Faculty of the Quarter – Fall 2005
1999	Membership into the International Institute for Human Factor Development (IIHFD)

1994	University of Illinois Special Merit Award in Teaching
1993	Prepcki Award for Excellence in Chemistry
1993	Induction into Omicron Delta Kappa Leadership Society
1992	American Chemical Society Organic Chemist of the Year
1991	Induction into American Chemical Society
1991	Induction into Beta Beta Beta Biology Society
1990–1993	Elmhurst College Honor's Society
1990–1993	Elmhurst College President's List
1988	Induction into Phi Theta Kappa – College of DuPage
1987–1990	College of DuPage Dean's List