The STEM Teacher's Bill of Rights

Abstract

This paper provides research to argue for whole-brain teaching in STEM courses. The philosophy of the pedagogical foundation of the argument rests on the precedents set by the U.S. neglect of any sociological problem with races. Issues of our deficit modeling in schools are used as an archetype to show how our educational system in the U.S. neglects right-brain activities in favor of left-brain dominance. A list of forty specific privileges that should be afforded a STEM teacher is presented as a framework for whole-brain teaching. This list is presented as a bill of rights of the STEM teacher. Ten rights each are listed under the groupings: Experimentation, Epistemology, Mechanical Measurements, and Valuing the Teacher and the Student.

Keywords

STEM; science; technology; engineering; mathematics; emotional intelligence; social intelligence; holistic; right-brain; left-brain; pedagogy; sociology

Introduction

This paper outlines a series of problems that arose for me as a STEM (science, technology, engineering, and mathematics) teacher working with two different populations at risk over the twelve year period from 2002 to 2014. One population was made up of alternative high school students and the other was comprised of incarcerated men and women. The problems arose from restrictions that our educational system places on teachers that keep them from helping students. I have watched a number of very good teachers become all but neutralized from doing what they knew was best for the students and instead following mandated procedures. You know what I am about to say. STEM teachers, like so many other teachers, feel that they had to test students too much, stay too shallow, teach too much information, and go into a mechanical mode to get the job done - like a machine with head activities only, rather than using feelings and heart. This paper will assert that one cause of these problems is a lack of attention to whole brain pedagogy in the STEM subjects and it will therefore recommend forty specific actions a STEM teacher should be allowed to do - rights - that our current educational system hinders.

Pedagogy is under siege both in the U.S. and on a global scale (Darling-Hammond, 2010). One major reason for this is a bent on the measurable and mechanical, with an attention to numbers and fiscal issues, without regard for long term or global effects on people (Stiglitz, 2002). As regards STEM activities, expedited, human-directed experiments that have not been thought out, and socially constructed beliefs that have sunken so deeply into the fabric of our thinking that we have forgotten to question them have come back to haunt us through educational inadequacy (Anderson, 1988; Rebell & Wolff, 2008; Wiggan, 2007; Wiggan & Hutchison, 2009). But if issues of pedagogy and sociological responsibility sound disparate – we have to step back far enough to see the common thread among them. At least one place where they converge is where unbridled, analytical, reasoning - or left-brain dominated thinking - lies behind the way educational administrators mandate accountability, and thereby squelch creativity. All of these problems suffer from the affliction of cold calculation without human heart, of excessive left-brain dominance. But, there is hope if we infuse current STEM courses with a balance to our modern technological age. If we look back to our roots when we used warmer thinking, in holistic terms, we can recast STEM lessons to address both sides of the brain. Former studies are currently being revised to treat the two sides of the brain as much more integrated than we thought (Gardner, 1993, 2008; Goleman & Boutsikaris, 2006; Goleman & Senge, 2007; Goleman & Whitener, 2005). The implications for education from this latest research is that whole brain lessons must constantly speak the language of the head and heart in a finely integrated way (Gopnik, 2012; Quale, 2011). We cannot patch up this problem by sticking extra topics of sustainability and human interest in amongst our hard science that implies humans must conquer nature. And we can no longer speak of teaching values education to children, while the reality of engineering and technology jobs are all about corporate greed. The true integration of whole brain STEM lessons must be authentically built to teach students to conduct themselves both intelligently and responsibly at the same time.

Historical Roots of STEM as seen through the Indigenous and Ancient

Our revision to our STEM programs must start at the philosophic level. We have the chance here to form a solid program because STEM teaching is not totally entrenched in the same lockdown position that reading and mathematics are, where testing dictates so much of the curriculum that there is little room to follow teacher/student instincts. Therefore, let us embark on an historical view. Molefi Asante (1991) stresses that the Afrocentric view sees *feeling*, *knowing*, and *acting* as an inseparable whole. He contends that there are deep remnants of the process of thinking in wholes that comes from the various, ancient African cultures that facilitate learning. Like Du Bois (2007), Asante asserts that epistemic beliefs that access the process of thinking in wholes span many, diverse cultures - they are by no means limited to African origins. In fact, scholars of epistemic belief systems can trace most ancient cultures to a point where they once taught more to the whole brain than they do now (Kuhn, 2004; Nisbett, 2003; Whorf & Carroll, 1964). It is a principle of intellectual endeavor that a student can learn best by seeing, on the one hand, analytical parts of a whole, and on the other hand the whole in its inextricable unity

(Bandura, 1971; Dewey, 1910, 1916/2005; Vygotsky, 1962, 1966/2002, 1979; Vygotsky & Cole, 1978). This is a pedagogical topic of conversation in the STEM education community at present – one which is necessary for the understanding of quantum physics (Greenstein, 1997). One study that crosses the teaching of STEM with African epistemic beliefs observes the need for both the analytic and holistic ways of thinking to be present to make a complete view of a scientific phenomenon (Melear & Pitchford, 1991).

> Hale-Benson reports that Black children are more feeling-oriented and people oriented and more proficient at non-verbal communication than White children. She quotes Asa Hilliard who reports that the core of the African-American cultural style is a tendency to respond to things in terms of the whole picture instead of its parts. The Euro-American, on the other hand tends to believe that anything can be divided. This is the positivistic or reductionistic view of the world, a view which drives the scientific enterprise. … So it is not without precedent that the Hale-Benson ideas are compelling, based on style alone, even without the African-American culture issue promoted by both Hale-Benson and Atwater. (Melear & Pitchford, 1991, p. 2)

Greene & Prichard (2004) suggest that there is an advantage to a synthesis between the teaching of science and Afrocentric learning, suggesting the need for both the analytic and holistic ways of thinking to be present to make a complete view of a scientific phenomenon. This study cites the National Science Teachers Association in suggesting that there be more cooperative learning in STEM classrooms. They line up with Asante is defining cooperative as involving more talking, more data gathering of real world problems, and less emphasis on one right answer.

Clearly the process of thinking in wholes is not unique to Afrocentricity. Holistic forms of education can be found both with modern indigenous populations such as the Hopi or the Aztecs (Whorf & Carroll, 1964) and most civilizations that have retained customs from antiquity such as many Eastern cultures (Nisbett, 2003). New charter schools and innovative teachers in both public and private schools are yearly incorporating right-brain activities into STEM lessons that do not superficially map into testable items on tests (Burton, 1999a, 1999b, 2010; Kelemen & DiYanni, 2005; Krajcik et al., 1998).

Overview of STEM Teachers' Rights

A discussion of STEM teachers' rights centers around the teaching of *observation* and *analysis*. The very essence of right-brain activity lies in the act of *observation*, whereby the act of analyzing, or taking apart, is the domain of the left brain (Goleman & Whitener, 2005). To purely observe, one must not think about that which you observe (Arnheim, 1986b). During observation, a person is in relation with, joining with, or otherwise given to that which you observe (Goethe, 1840/1970). Take for example, a STEM lesson where students are looking at the engineering process of color reproduction using computer technology. There are two aspects: printed materials and computer screens. In a lesson on this, I have students experiment with variations in color mixing to get desired colors. On printed material we observe that one can make all colors with the three primary inks: yellow, cyan, and magenta. On computer screens, we must use the primary colors: red, green, and blue. This is because printed materials are mixing physical substances, needing the darkening primaries; and the computer screens are mixing light, necessitating the lightening primaries. Many of the mixtures yield results that are counter to student expectations, except when students have worked with these media in software design engineering or have done a lot of color printing. Students who are not good observers have left brains that keep interrupting the experimental process of finding what works and these students take many detours in trying to produce a desired color. But to the careful observer - who is not thinking too much in the analytical, left brain - the process goes more smoothly and quickly. This exercise is one of many that I do in my STEM lessons to show students when they are more in the right brain doing pure observation and when they are 'thinking about' the experiment, more in the left brain. These distinctions are the basis for the STEM teacher's rights that I focus on in this paper. The rights deal with the privilege to spend the time and effort to separate awareness of right-brain versus left-brain activities. If the STEM teacher can make this investment, students can be reminded not to *jump to conclusions*. They can more easily be taught to follow the scientific method of investigating any phenomena. Jumping to conclusions is the opposite of good scientific reasoning and is often a simple case of going into the left brain and analyzing or making connections that are premature. Many times this can be avoided by staying with an observation a bit longer.

This issue of separating and recognizing when we are observing and when we are analyzing is not something STEM teachers should encounter only once or twice in a technical discussion on learning and cognition. It is important. It lies at the root cause of a new direction for pedagogy. An education that respects both sides of the brain working in concert will have to give increased respect for the right brain. We are coming out of a period of history (Dewey, 1916/2005) that was dominated by left-brain analysis (see Figure 1 below). Our schools prize left brain reasoning over right brain intuition (Bruner, 1960). Our pre-teachers, especially in STEM, are taught to use the left brain more than the right. And our universities have this bias to a greater degree than the high schools and grammar schools. This is why I have delineated forty specific privileges – a teacher’s bill of rights. Every STEM teacher needs to be armed with a balanced method of learning and pass this on to students. The balance lies in equal respect for knowledge that arises from nonverbal, non-physical, unthinkable ideas as well as from well thought out, analyzed, conscious deductions and inductions. Audre Lorde speaks of how no one helped her to learn this way – she had to do it for herself:

> But eventually I learned how to acquire vital and protective information without words. … You always learned from observing. You have to pick things up nonverbally because people will never tell you what you're supposed to know. You have to get it for yourself, whatever it is that you need in order to survive. (Lorde, 1984, p. 83)

Intuitive education should incorporate this form of learning. Pre-service teachers need to have professors model a listening for the unsaid. In conclusion of this discussion of *observation* and *analysis*, let it be clear that the argument of this entire paper – though advocating for intuitive education – does not advocate intuition over analysis – it seeks to restore a balance of the two.

Observation versus Analysis	
Observation / Intuitive	**Analysis / Logical**
predominantly right-brain	predominantly left-brain
holistic, undivided	separated in parts
collaborative, group thinking	isolated, individual accomplishment
animated	inanimate
circle thinking in holistic concepts	linear thought in abstract concepts
descriptive, lateral language	articulate, didactic language
relationships, complexity	positivistic, fixed hierarchy
BEAUTY, qualities	MEASUREMENTS, quantifiable
hard to assess, hard to communicate, poetic	more easily tested meanings
necessary for: unanimity, union, solidarity, harmony, meditation	necessary for: reading, writing, building, categorizing, judging
remaining in a state of wonder and awe	naming, labeling, then moving on

Figure 1.

Observation and Analysis: A case in point

The sanction of educational taboos takes many forms. Teachers in general and STEM teachers in specific have long been taught a certain pedagogical way. Let us take a case in point – the teaching of observation and analysis of phenomena. Often in a STEM class a phenomenon is demonstrated or described. The student is then directed to *observe* the phenomenon. Discussion usually follows which *analyzes* causes and properties of the phenomenon. STEM teachers have been taught this very common sequence of moving from *observation* to *analysis*. Although this may seem quite normal, there is a blind spot, here – as regards intuitive education. If we were to keep education in the U.S. the same as it has been, there would be nothing more to say. But to shine a spotlight on the point where intuition has been glossed over, we would take a second look at how we handled the *observation* portion of this process. If the STEM teacher were taught to keep the *observation* quite separate from the *analysis*, and to give both observation and analysis an equal level of importance, pedagogy would have to shift toward teaching STEM more intuitively. Please note that many STEM teachers already do what I am about to describe. The purpose of this paper is to make it clear when we are and when we are not enhancing the right-brain activity of intuition.

To *observe* is an intuitive act. It requires no logic, no rationality. One uses senses or attention, only. To *analyze* requires no senses – just logic and rationality (Arnheim, 1986b). These two acts are mutually exclusive and activate opposite parts of us. If a teacher stays on the *observation* of an experiment, without going on to analyze it, then notices how beautiful it is, what colors, smells, shapes are there, how it makes one feel - the intuitive capacities are being exercised. If one then speaks of causality, why the experiment happened that way, what a student might predict, conclude, think about – the analytic capacities are being exercised. Neither the *observation* nor the *analysis* is more important, just as neither right-brain, intuitive nor left-brain, analytical thinking is more important. And, just as both intuitive and analytical paradigms are in operation during thought (Eisner & National Society for the Study of Education, 1985) – the student should be free to *observe*, then *analyze* – and move freely back and forth among these acts. The important thing is to keep them separate – mixing them is precisely the act of jumping to a conclusion without proper foundation. And the habitual way education in the U.S. mixes them and rushes past the stage of staying with an *observation* to get to the answer, the *analysis* cuts off further intuitions that may have been received by the student while staying still to remain with the state of *observing*. It should even be valid for a STEM teacher to ask for students to *observe* something, then move on, without analyzing it – though this almost never happens in the educational system in the U.S. So, let us then use this simple example where a STEM teacher does *observation* and *analysis* of some phenomena with a STEM class, and ask this question, “If some teacher education programs and some schools foster analysis over intuition, and possibly *analysis* over *observation*, why might this be so?"

Often the decision for a significant portion of the population to remain silent on a certain issue is not made consciously - it is made because society has internalized a socially constructed belief that is so subtly interwoven into the fabric of discourse and education, that alternative views are not even considered (Bell, 1994). Sometimes, the conscious effort of an elite group in power plan to cover truths about others so that a status quo may be preserved and perpetuate the superior position of the privileged few (Anderson, 1988; Lorde, 1984; Wiggan & Hutchison, 2009; Wynter, 2001). Although implied, it is not an objective of this paper to provide evidence that there exists a historical trend to suppress the purely subjective experience of observation in the study of STEM education and to gradually enhance the analytic acts of: naming, labeling, citing, dissecting, and the explaining of phenomena. It is, however, the purpose of this paper - regardless of the reasons that society may or may not have moved in this direction up until now – to lend voice to the latest trend which may be going quite the opposite way. Many researchers are now arguing in favor of the swing away from the unsustainable, analytic exploitation of nature and society (Bell, 1994; Blake, Darensbourg, Butler, & Lewis, 2010; Carnoy, Gove, & Marshall, 2007; Curry, 2000; Darling-Hammond, 2010; Harry & Klingner, 2006; Hilliard, 2000; Hochschild & Machung, 2003; Ladson-Billings, 2009; Loewen, 1995; Lorde, 1984; McIntosh, 1988; Rebell & Wolff, 2008; Smith & Hungwe, 1998; Stiglitz, 2002; Wiggan, 2007, 2008; Wiggan & Hutchison, 2009). Movement in education toward a respect for processes that observe nature in unfettered operation (Boorstin, Luce, & Daniel, 1983; Bortoft, 1996; Carter, 2008; Kuhn, 2004) or society in forms that model the holistic and sustainable (Diop, 1974; Houston, 2007; Stone, 1976; Teresi, 2003) are already underway. In terms of specific pedagogical acts that teachers do or do not have as a privilege – the point of this paper is that teachers and pre-service teacher programs lag research findings in their sophistication as they communicate the art of STEM pedagogy. Although this list is largely subjective as it comes from my personal experience and therefore may not represent the objective mean of experiences in pre-service teacher programs and STEM classrooms, the research that I cite as the corresponding points to my personal observations and conjectures is mainstream and current. If I am in error, it may be in that the list of privileges sounds prescriptive or even pedantic; and for that, I apologize.

The Role of the Experiment

In order to place perspective on the issue in teaching as to what role scientific experimentation plays, I need to turn to a similar sociological issue that has been breached – in the hopes of encouraging current pedagogy to breach this issue of the *role of the experiment* in schools, as well. In the early history of education in the U.S., issues of fairness to styles of learning for different sociological groups came to the fore (Dewey, 1910, 1916/2005). During the controversy over the education of Blacks following a long period of nationally-sanctioned slavery, W. T. DuBois (2007) openly disagreed with the way Booker T. Washington wanted industrial training to stand in the stead of higher education of the intellect. It was an implicit recommendation that Blacks be considered to be educated if and when they assimilate to White culture (Horvat & O'Connor, 2006). In both of these cases, there is a question of Blacks not being looked at for who they are. The complaint was that they were being looked at through the lens of the White culture. And further, it is asserted that this lens comes with a load of baggage – not the least of which is projection of a host of cultural mores that all but took the legs out from under the Blacks in the U.S.

The two ways of thinking that are taught to STEM teachers is similar to the way the U.S. has handled our neglect of our race issue. But in this drama, the dominant White culture is played by analytical thinking, and the neglected Blacks are played by observational, intuitive thinking. The taboo that DuBois (2007) and Wiggan (2007, 2011) had to battle was the unspoken assumption that Blacks were not capable of higher intellectual activity. In STEM education, the taboo is the unspoken assumption that the act of receiving an intuitive idea is not a valid form of knowing and thinking. Thus, as the lens of the Whites demand Blacks to demonstrate intellectual prowess within a biased cultural definition almost guaranteeing lesser performance, so does the analytic way of performing STEM experiments in the classroom ask questions of nature that are already biased and constrained to receive only the analytic parts of the answers. It is in this way that Blacks are silenced, and likewise, pure observations are reduced to "non-scientific" commentary. So, rather than articulating a general description of the way our educational system is biased toward analysis and against intuition, I have delineated specific examples in the form of a bill of rights. Thus, we may ask, "What are these privileges STEM teachers may rightly demand, if we are to move toward a whole-brain education?"

STEM Teacher Bill of Rights #1 - #10: *Rights During Experimentation*

1. *I may be permitted to observe an experiment without thinking of what it means.*
2. *I am allowed to receive what may be valid, scientific impressions from an experiment that are too large or complex to articulate.*
3. *I may perform an experiment and allow that it was designed to research the wrong question.*
4. *I may be aware of the danger to constrain what my students see by describing my analysis before the student is done observing.*
5. *I may be aware of the danger to hurt nature by experimenting.*

6. *I am allowed to end a lesson knowing I may never understand it because the full explanation is too large for my conscious mind.*
7. *I am allowed to listen to my students as if their commentary is sometimes revealing deeper truth than mine.*
8. *I am allowed to watch for the effect I may have on an experiment, just by observing it.*
9. *I am allowed to talk about the chance that there are non-physical causes to physical effects.*
10. *I am allowed to accept both research-based, physical effects – as well as – intuitively-based, whole ideas – and test them out scientifically as equally possible sources of evidence.*

Ways of Knowing

Our culture has a blind spot toward finding things out while our minds are not engaged in analytical, deductive or inductive reasoning. We do not accept that our consciousness can receive impressions that are scientifically valid – and that these impressions are inextricable from every experience we have (Wynter, 2001). We try to explain scientific phenomena as if we can be totally objective – like machines. We act as if nature and society have an existence that can be seen by us only through telescopes and microscopes. We want to reduce the role of our consciousness to physical, measurable workings – by projecting our current analytical, mechanical view of the world onto it, as Wynter argues:

> YOU CANNOT SOLVE THE ISSUE OF "CONSCIOUSNESS" IN TERMS OF THEIR BODY OF "KNOWLEDGE." You just can't. Just as within the medieval order of knowledge there was no way in which you could explain why it is that certain planets seem to be moving backwards. Because you were coming from a geocentric model, right? So you had to "know" the world in that way. Whereas from our "Man-centric" model, we cannot solve "consciousness" because "Man" is a purely ontogenetic-purely biological conception of being, who then creates "culture." So if we say "consciousness" is "constructed" who does the constructing? You see?
>
> …
>
> Obviously then, just as the medieval order could not even consider that the Earth was not the center of the universe – because they looked and saw everything "moving" and so on and so forth; also, because they don't feel the goddamn Earth move, you know! [Laughter]
>
> So that's what I mean when I say the Black situation and the homosexual situation are parallel. We are the only ones who are socialized in such a way that we cannot trust our own "consciousness." Because it's very difficult to ever contradict the norm, whatever is the norm. (Thomas, 2008, p. 2)

Thus, the issue of ways of knowing must be left open to culturally relevant learning and teaching that includes the human-cultural tendency to *generalize commonality* of ideas from deductive and inductive left-brain thoughts – as well as to *synthesize universality* of ideas from purely intuitive right-brain sources. Let me pause for a moment to clarify between commonality and universality. Goethe (1840/1970) differentiates that the analytical left-brain act of noticing traits that are in common across objects is a mechanical process that can leave the objects separate and without relation to each other. But, the act of seeing universality among objects is to see relationship of the whole as imbued in each part. A commonality among seeds of a tree is that they all separately have a shell in common, whereas a universality of seeds is the presence of the whole tree in every seed.

STEM Teacher Bill of Rights #11 - #20: *Rights of Epistemology*

11. *I am allowed to not know – often.*
12. *I may keep the ability to generalize commonality (I learned as an adult), separate from the ability to synthesize universality (I knew as a child).*
13. *I am allowed to receive new ideas while speaking – and note how they are better than what I was going to say.*
14. *I may look at the same person or event and see NO connections one time – and NECESSARY connections by looking once again.*
15. *I am allowed to rate my own impressions on an equal basis with research evidence, until proven wrong.*
16. *I may be inspired by a belief prior to its arrival in my conscious mind where I check it out analytically to see if it makes sense.*
17. *I am allowed to hear a student and believe in her or him, before actual understanding takes place.*
18. *I may connect to my student on a level that is deeper than analytic comprehension.*
19. *I am allowed to expect wisdom from myself, my student, or the next unexpected event in my classroom.*
20. *I am allowed to be turned in a new, useful direction at any moment.*

Researchers, such as Kumashiro (2000), argue that there is a need for new kind of teaching; one where the teacher does not know or control how students will act, but instead, moves into unknowing, unconscious – the unthinkable – a space where the teacher does not aim for students to *understand* some critical perspective, but instead, the teacher aims for *effect*, by engaging students in a relevant aspect of critical theory that students apply to their lives, use to deconstruct knowledge, and critique the unsaid. But this deconstruction is smothered by humankind's latest mechanistic view that holds to the idea that facts are true if, and only if, we can measure some physical attribute of nature (Kuhn, 2004). Much pseudo-research has passed by the discernment of the U.S. public by quoting statistics that seem to measure the intelligence of humans in order to compare races (Gardner, 1993, 2008). Often the study begins by asking loaded questions – projecting an over-simplified view into the 'research' that constrains the answers that are published – like the question of a person's race. "One drop of African blood meant that a person was Black, a pronouncement that carried a stigma and negative social consequence with burdens that were too heavy to bear. The irony is that all human beings share a common origin, human beings share 99.9% of the same Deoxyribonucleic acid [DNA]" (Wiggan, 2011, p. xvi).

STEM Teacher Bill of Rights #21 - #30: *Rights to Value Perceptions more than Mechanical Measurements*

21. *I may love and respect technology, instrumentation, and mechanized measurement without disrespecting*

the unseen, immeasurable, and non-physical.

22. *I may assign as much importance to immeasurable patterns of similarity in the human – as I assign to the measurable.*
23. *I may assign as much importance to immeasurable patterns of similarity in nature – as I assign to the measurable.*
24. *I am allowed to make assumptions based on synthesis of diverse aspects of nature – before I measure them to verify my assertions.*
25. *I may judge the book of nature by her cover – or even a single page – then, at a later time, investigate her many parts to verify my argument, in other words I may seek scientific truth of the whole in one part.*
26. *I am allowed to state that I cannot measure – and do not understand – how the light coming from innumerable stars in the sky can simultaneously occupy the tiny space of the iris of my eye – and then separate into distinct images of the stars.*
27. *I may seek new ways to know about space and time – infinity and eternity – though they are immeasurable.*
28. *I may acknowledge evidence of a group consciousness of: bees, ants, termites, slime mold, epigenetic control of human DNA, and perhaps human beings – without being able to measure a physical component of evidence.*
29. *I am allowed to resist testing my students and suggest non-measurable, non-invasive evaluations of them.*
30. *I may acknowledge human analytical progress of the last several thousand years – while at the same time – acknowledging ancient intuitive abilities that have been lost, temporarily.*

Perhaps the single, most-abused privilege of the teacher and pre-service teacher is the false social construction that education is about information rather than transformation (Darling-Hammond, 2010; Delpit, 2006; Delpit & Dowdy, 2002; Freire, 1998a, 1998b, 2000; Freire & Freire, 1994). The role of pedagogy is to make connection above all else – relationship is paramount in teaching, otherwise the separateness of our human physicality – the fact that we live in different bodies, with different physical characteristics, and varied gender, ethnicity, sexual preference, even personality - is an unbearable hurdle to coexistence - “I must establish myself as not-you. And the road to anger is paved with our unexpressed fear of each other’s judgment” (Lorde, 1984, p. 169).

New teachers sometimes see pedagogy as an art or skill of imparting knowledge. This issue of transformation too easily slips out of sight in pre-service teacher preparation programs because of the need to address the pressures of teaching so many facts and skills that will appear on high stakes tests (Darling-Hammond, 2010; Ladson-Billings, 2009). But some experts in education feel that issues of student transformation – the path from being powerless to being empowered – will offset, and eventually set right, the political agenda of education (Apple, 2004; Delpit, 2006; Delpit & Dowdy, 2002; Freire, 1998a, 1998b, 2000; Freire & Freire, 1994). Thus it is that STEM education can draw on culturally relevant examples to make parallels for diverse students to relate.

> When I first heard of the term ‘feminist pedagogy,’ I thought it meant dealing with women, girls, etc. Now, after talking about this for the first time with the others in the group, I think it means so much more than that. I don’t think of it as just a female thing. I think it concerns issues of power and how we as science

> teachers, and others in science, use our power and the possibilities of how we can share that power with our students. (Capobianco, 2007, p. 11)

Students can associate to parts of nature that are being passed over by comparing them to sociological movements that were ignored. And most importantly, they can be shown root causes like the ways the human mind learns best in studies that show the balanced approach to intuitive and analytical thinking (Arnheim, 1986a, 1986b; Burton, 1999b; Eisner & National Society for the Study of Education, 1985; Haskins, 2009; Kelemen & DiYanni, 2005; Krist, 2010; Pariser, 2008; Smith & Hungwe, 1998) in order to offset, and set right, the future of our world.

STEM Teacher Bill of Rights #31 - #40: *Rights to Respect My Ability to Teach and Know What Students Need*

31. *I am allowed, as a teacher, to question everything – model learning by deconstruction – for my students.*
32. *I may include every diverse natural species, diverse sociological form of expression, diverse ways of knowing.*
33. *I may aim more at the transformation of my students through the experience they have in my class - than the information they may receive.*
34. *I am allowed to integrate related subjects during my lessons – even if it strays from the curriculum.*
35. *I may accent aspects of the curriculum that I love, so that I model real connection to my material.*
36. *I am allowed to find where my students connect and have relationship to the material and modify my approach so that it respects that which is relevant to their culture.*
37. *I am allowed to have fun – and respect students for wanting to have fun.*
38. *I may let my students forget lessons, so that they pick them up later – perhaps with fresh insights.*
39. *I am allowed to forget what I am doing, or fall down on the job – then be picked up by my students – in other words, be vulnerable enough to put myself in their hands.*
40. *I am allowed to respect silence - when a student cannot or does not wish to articulate an impression – and model to the class how to leave room for possible non-language moments of higher order learning.*

Conclusion

The existence of the right-brain intuitive trait of comprehending whole ideas of the pre-operational child can be established based on Piagetian observations of early childhood cognitive development (Piaget, 1950). An additional school of thought corroborates the existence of the child's ability to apprehend whole ideas without prior analysis from the work of Vygotsky (1966/2002, 1979; 1978) and Bandura (1971). This argument describes how the child cannot manipulate abstract groups that are separated from a whole grouping and relates to the concept of wholeness as portrayed in the theory of Complementarity in Quantum Physics (Bohr, 1949). Since this connection shows a case where pre-operational children, who intuitively think in wholes, are not merely lacking the ability to perform formal operations, but are actually employing a useful way of knowing. I will question whether the pre-operational stage embodies ways of knowing that may be worthwhile to nurture throughout schooling and indeed, throughout life.

The framework of a pedagogy that is supported by the bill of rights listed above must culminate, however, in stressing that the purpose of this paper is to underscore the need for right-brain intuition to be nurtured in the classroom alongside of left-brain analysis – not in any way to replace it. As Arnheim describes below, intuitions are not trusted because we erroneously believe that their source is not valid and that they are not verifiable by analysis:

> One reason why intuition has been treated with suspicion by those who believe that knowledge should be acquired only by intellectual means is, as I observed earlier, the way in which the results of intuition seem to fall from the skies like a gift of the gods or of inspiration. Add to this now the misleading belief that when a situation is apprehended as a whole it comes across as an indivisible unity, a holistic totality, an all or nothing like a flash of light or a mere feeling. According to this belief, intuitive insight is not accessible to analysis, nor does it require it. (Arnheim, 1986a, p. 26)

Although intuitive abilities are avoided in today's schools (Babai, Sekal, & Stavy, 2010; Burton, 1999b; Danovitch & Keil, 2008; Haskins, 2009; Jaeger, 2007; Johansson & Kroksmark, 2004; Kelemen & DiYanni, 2005; Krist, 2010; Quale, 2011; Smith & Hungwe, 1998; Tretter, Jones, Andre, Negishi, & Minogue, 2006; Watson & Kelly, 2005; Yair & Yair, 2004), intuitively received ideas can be inspected by analysis. The mind is constantly operating with whole-brain - intuitive and analytic - ideas working in concert.

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