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Ecology of Mind: A Batesonian Systems Thinking Approach to Curriculum Enactment

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Abstract

This article proposes a Batesonian systems thinking and ecology of mind approach to enacting curriculum. The key ideas for the model include ecology of mind, relationships, systems, systems thinking, pattern thinking, abductive thinking, and context. These ideas provide a basis for a recursive, three-part model involving developing (a) depth of understandings, (b) abstractions as explanatory principles and models, and (c) abductive connections across disciplines and contexts. The model is further situated in classroom social contexts that are supportive of and reflect the key components of this model.

Keywords: curriculum design curriculum theory, curriculum enactment, ecology of the mind, pedagogy

Introduction

Education in the United States may be an extreme example of trivialized curricular enactment. The emphases on specific content, scripted curriculum, high-stakes testing, and many other educational "initiatives" typify a positivist, mechanist, and reductionist system of education in the United States and many other countries. In addition, certain seemingly basic concerns of education are not addressed. Students of all ages are not of real interest, other than as numbers and funding credits and as political fodder. Teachers are no longer valued for their diversity and abilities. And, relationships between teachers and students are reduced to approaches for manipulation and control. "Learning" is not learning at all, but memorization in order to score well on tests. Discrete bits of disconnected information under the guise of essential "core" concepts trump learning about how our world is

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made of relationships and patterns of all kinds.

This paper has been inspired in many ways by the work of Gregory Bateson, including the use in several of my own courses of the film, "An Ecology of Mind: A Daughter's Portrait of Gregory Bateson" (Bateson, N., 2010). The paper will examine several of his key ideas as foundation for a theoretical model for teaching just about anything. The key ideas in this paper, include (a) ecology of mind, (b) relationships and systems, (c) systems thinking, (d) pattern thinking, (e) abductive thinking, and (f) context. These six conceptual areas provide the basis for re-envisioning our enactment of curriculum and of teaching and learning. A model is then proposed from these core ideas. The final section provides some personal reflections on the difficulties and prospects of enacting such an approach.

An Ecology of Mind – *A Curricular Provocation*

> At the root, it is the notion that ideas are interdependent, interacting, that ideas live and die. The ideas that die do so because they don't fit with the others. You've got the sort of complicated, living, struggling, cooperating tangle like what you'll find on any mountainside with the trees, various plants and animals that live there—in fact, an ecology.
>
> Gregory Bateson (1991)

The focus of the teaching-learning context as suggested here is twofold. The first part is that whatever the subject matter, the way in which the ideas of the subject are approached is that of an "ecology". As Gregory Bateson (1972/2000, 1991; Bateson, N., 2010) suggested through his notion of epistemology (which he considered as the personal way in which an individual understands), our ways of thinking and learning are fundamentally an ecology of interactions among ideas. One of the challenges of such a view is that, as a personal ecology, making sense of our world is not limited to one specific subject matter separated from another. As human beings, we do not ordinarily think within the strictly limited confines of a particular subject. Children and adult "experts" (in almost any academic discipline), when left to their own approaches, utilize multiple contexts of experience and knowledge to solve problems and make sense of particular situations (Bloom, 1990, 2006).

The second point has to do with how the "curriculum" or teaching-learning context is enacted. If we see the context of ideas as an ecology, we need to engage with this ecology in a way that is compatible and consistent with learning as an ecology. In other words, we need to enact an ecological or, in more recent language, complex adaptive systems approach to establishing the classroom context. Students' ecologies of

learning need to take place as complex adaptive systems (i.e., as self-maintaining systems that aid survival). The way in which learning occurs needs to be meaningful and relevant to each individual in ways that promote continued personal growth and transformation over one's lifetime. The learning that takes place is not only the learning of certain ideas, but also the learning about how to continue making sense of the world. This type of learning is what Bateson (1979/2002, 1991; McWhinney, 2005) referred to as "deutero-learning". Bateson's sense of deutero-learning or learning how to learn is different from what is commonly discussed. This meta-learning is more closely tied to epistemology as a personal ecology, where our whole view of the world changes as we begin to think in ways that are similar to the ways in which the natural, ecological world operates. We begin to see everything as relationships, where everything is interconnected. Our typical approach to learning how to learn verges on the mechanistic, often reductionist and positivist, with a focus on step by step, linear approaches that still focus on breaking things into parts without understanding wholes. In the Batesonian sense, learning how to learn manifests as a complex adaptive system, where learning is fundamental to our survival. Such learning is organic, holistic, and integrated into our very nature as biological systems. Although these ways of thinking and learning appear to be hard-wired in human beings, our approaches to schooling not only do not capitalize upon and refine these ways of thinking, but also work to undermine them.

Relationships and Systems

> You live in a world that is only made of relationships.
>
> Gregory Bateson (Bateson, N., 2010)

Two ideas that at first glance may not seem to be very closely connected serve as the basis of thinking and learning as an ecological system and personal epistemology. These two ideas are relationship and system. "Relationship" and "system" describe the same basic "situation". Relationships are systems unto themselves, where information or materials cycle through them. At the same time, systems are comprised of multiple relationships. In a way this "situation" is a matter of scale between that of a relationship among two or more objects or beings and that of a system or systems comprised of a wide variety of relationships. Typically, when we think of relationship, we think of some connection between two or more people, objects, or ideas. We generally do not see that any relationship between two or more "things" is a system between these "things." It's like the standard story of getting a new pet dog in your house where you already have a cat. In order for the two pets to get along with each other or form a relationship, you put both of them together in a room. In most cases, both survive with

minimal bloodshed and emerge having established ground rules for relating to one another. Of course, this "relationship" expands to you and others in your family as the cat, dog, you, and your family all negotiate the terms of this more complex set or system of relationships.

From the previous example, a single "thing", such as the cat or dog, is a system in itself. But, what are the relationships? In such a "cat system" there are billions of relationships making up the cat. Each whisker is in relationship to the other whiskers, as well as to the nerve endings around the base of each whisker. These nerve fibers are in relationship with neurons in the brain, which in turn are in relationship with motor neurons and other neurons involved in cat cognition. Each part of a cell and each cell in each tissue in each organ is related to other cells, and these cells as tissues are in relationships with other tissues. Each organ has relationships with other tissues and parts of its own organ system; and all organ systems are in relationships with each other. The interesting attribute of both the cat-dog system and the system of cat or system of dog is that relationships of relationships across levels of scale establish systems that are larger than the sum of their parts. This classic principle of the complexity sciences (that the whole is larger than the sum of its parts) is due in part to this notion of relationships (Capra, 1996). While the reductionist view (that the whole can be understood as the sum of its parts) sees relationships between the parts, such a view does not really take into account the relationships of relationships. This iterative scaling of relationships (relationships of relationship and so on) allows us to develop understandings of wholes that are larger than the sum of their parts and that are dynamic and complex systems. The cat-dog relationship is something more than both the cat plus the dog. If you have a cat or a dog, you know there is more to your cat or dog than all of its biological parts and systems put together. The same holds true for each of us. Each of us is more than the sum of each of our biological parts.

In classrooms, each student is a bundle of relationships (Fleener, 2002) that involve multiple individuals, events, and various personal, social, and cultural contexts. The ways in which students act and participate in classrooms are a result of these relationships. Relationships also are embedded in the classroom itself, including the manifestations of the teacher's philosophy of teaching and the design of the classroom. These relationships are embedded within those of the school, those that reflect the philosophy of the principal, and those of other teachers. In turn the school is embedded in the social and cultural relationships of the community and the politics of the school district. As we increase levels of scale, the students – classroom – school – community – district are embedded in the national political and societal relationships of

schooling and education. The complexity of these intertwining relationships interact in varying ways that affect the systems of relationships across the entire scale. The ways many students engage with schooling, such as in "playing the school game," are a result of these multi-scaled relationships, much in the same ways as each of us are affected by our hegemonic relationships (Apple, 1993). This school game is based on the student trying to please the teacher, jump through whatever hoops are involved, and doing as little in-depth thinking as possible in order to get whatever grades (usually highly inflated) are desired. The relationships imposed on students, such as, obeying the teacher and conforming to the status quo of the school (Wood, 1990), are used to avoid deeper and more meaningful relationships, such as those that may result in deeper learning and creativity. The imposed relationship destroy more authentic mentorship-type of relationships. Such use of relationships to destroy other relationships is quite "ugly", as suggested by Terry Deacon (Bateson, 2010).

However, the word "relationship" is so ubiquitous that we use it without really thinking about what it means. At a basic level, any relationship involves some connection between two or more "things." In fact, as Kelso and Engstrøm (2006) suggest, 'it is clear that very little happens in mind, life, and matter . . . unless two or more separate things come together' (p. 140). These relationships or things coming together vary in the degree to which they involve some dynamic interchange or interaction. A "static" relationship seems to be impossible, since the whole notion of relationship is based on some kind of interaction. A characteristic of complex systems is that they operate out of equilibrium. Typically, if a system has entered into a state of equilibrium it has stopped functioning (Capra, 1996). However, we may have "stagnant" relationships, where the interactions have become predictable and solidified. Gregory Bateson (1979/2002) stated that a '. . . relationship is always the product of double description' (p. 124) or multiple description. Bateson's idea of double or multiple description is that a relationship is described or defined by each "thing" in the relationship (Hui, Cashman, & Deacon, 2008). People in a relationship define or compose that relationship through the dynamics of their interactions. The same sorts of double or multiple descriptions hold true for other relationships, such as the relationship among the Sun, Earth, and Moon or the relationship between a driver and her car. Each component of the relationship affects the other component(s) and the relationship.

What we have seen thus far are interactions among "things" as relationships and relationships of relationships across scales and contexts. This complexity of relationships is a matrix . . . (Bateson, 1991) or network (Barabási, 2010, 2011) of relationships. If we look at matri-

ces or networks of relationships, we generally find more significant nodes (Barabási, 2010; Bloom, 1995). These significant nodes tend to have more and stronger connecting relationships than other nodes (or "things"). The most cited author in a particular field, the most popular student in a school, or a key idea of interest to a particular child within a specific topic or theme are all significant nodes or central hubs of relationships within a network or matrix of relationships. The dynamics of such networks demonstrate how patterns of individual and group behavior occur, and how even weakly linked relationships provide for the incredible extension of connections and for the stability of social 'structures' (Buchanan, 2002).

The dynamics that are involved in establishing and maintaining relationships have been the subject of research in *coordination dynamics*. Kelso and Engstrøm (2006) have been investigating the coordination dynamics of what they call 'complementary pairs', which are ubiquitous across contexts and scales of living systems. From cells to organ systems up to individual organisms and groups of organisms to even larger systems, coordinated relationships between pairings of "things" drive functions and behavior. This notion of *coordination dynamics* is of central importance to functions across all scales of phenomena. In living systems, three basic aspects of such coordination involve: (a) heterogeneity or variation among pairings, (b) non-linear coupling or the cyclical pathways of information and/or material flow and exchange that maintains the pairs, and (c) oscillations or rhythms of information or materials exchange between the elements of pairings.

The notion of heterogeneity or variation is related to Bateson's (1972/2000; 1979/2002) notions of difference and changeability, particularly in the domain of living things. Even at the core of life we are made of the relationships between two pairs of heterogeneous elements of the DNA molecule. Various arrangements of these pairs of pairs account for the incredible variety of life at all scales and in all dimensions. Differences account for the functioning of each cellular structure, of tissues, of organs and organ systems, of each individual of a species, of the interactions of individuals within a species, of interactions between species, of ecosystems, and of the entire biosphere.

Non-linear coupling involves feedback loops or even more complex cyclical patterns of information flow between the elements in relationship. Again, Bateson's (1979/2002) cybernetic view of relationships involves complex, cyclical patterns of interconnections. Although we may think that two people in some sort of relationship are engaging in two-way communication, this appearance of bi-directionality is actually much more complex. Within each individual, complex interactions of

emotions, values, beliefs, and experiences of all kinds affect communication and are, in fact, communicated both implicitly and explicitly (Ruesch & Bateson, 1951/2008). At the explicit level, any kind of seemingly back and forth interaction is actually recursive, since each iteration builds upon previous interactions.

These recursive interactions over time are one part of the oscillations or rhythms of relationships. Cycles are by definition involved in sustaining any kind of system (Volk, 1995). These cyclical oscillations, rhythms, and loops of information and material flow provide for the continuity and stability of systems over time. Communication as one part of social relationships is deeply intertwined in various types of rhythmic and cyclical information flow, which may or may not be verbal. Glances, body language, body movement, eye contact, facial expressions, and emotional states are all part of the communicative complex.

Systems Thinking

> The system is a point of view – natural for the poet, yet terrifying for a scientist!
>
> Gerald Weinberg (1975/2001, p. 52)

> An animal that learns is one which is capable of being transformed by its past environment into a different being and is therefore adjustable to its environment within its individual lifetime.
>
> Norbert Wiener (1948/1961, p. 169)

As discussed, relationships are systems and relationships among relationships are systems of systems. This understanding is the foundation for systems thinking or ecological thinking (Capra, 1996). Systems thinking as a conceptual focus arose from cybernetics and its ensuing elaboration in systems theories, even though such ideas can be traced back to Socrates and Plato (Plato, -347 BCE) and in early Asian and aboriginal cultures (Ermine, 1995; Guenther, 1974; Laozi, -600 BCE; Ross, 1992; Wilson, 1998). The power of systems thinking lies not with just thinking about one whole system, but rather with the whole of interacting systems (Morin, 2008). Table 1 (for all tables see appendix) lists the overall characteristics, foci, thinking process, and concerns involved in systems thinking.

Young children's thinking is characterized by these foci and processes of systems (Bloom, 1990, 1992), but the longer they stay in school, the less they continue to think in this way as the emphases change to linear approaches and to remembering fragmented and disconnected content (Bloom, 2006; Waldron, Collie, & Davies, 1999). Earlier attempts at teaching systems thinking at the upper elementary

school level have been shown to be effective in children's learning about social problems (Roberts, 1978), but such approaches to thinking have rarely been adopted in schools and have received very little attention as the subject of educational research since that time.

Pattern Thinking

> *The best hope for our species lies in learning new patterns of attention to each other and to the biosphere, patterns that grow out of curiosity and respect and allow for wonder and learning.* Mary Catherine Bateson (2004b, p. 5).

> *We share the universal human characteristic of curiosity with many other life-forms, especially higher mammals. This instinct exposes our brains to new experiences and builds new regions to deal with them within the overall pattern hierarchy. These new regions can become resources, generating inputs to other inputs from other regions to find new patterns on a higher level of abstraction.* L. Andrew Coward (1990, p. 160)

Pattern thinking is fundamentally at the core of all human thinking, in which the brain functions as a pattern recognizer (Anderson, Bothell, Byrne, Douglass, Lebiere, & Qin, 2004; Coward, 1990). However, even with this basic functionality, much of the way we approach thinking and learning does not take full advantage of our capabilities as pattern thinkers. **Table 2** summarizes the overall characteristics, foci, thinking processes, and concerns involved in a more fully developed sense of pattern thinking. A fundamental operational view of pattern thinking involves a recursive approach through (a) recognizing patterns, (b) analyzing the functions and/or meanings of these patterns, (c) analyzing how these patterns are situated within one or more contexts, (d) finding these patterns in other contexts, and (e) using (applying, testing, analyzing, etc.) these patterns across contexts.

Although we have known that the brain functions as a pattern processor for some time, very little work has been done to develop this area in terms of learning. Beyond the early classic works of Bateson (1979/2002) and Coward (1990), the major emphases in this area have been in research on categorization (Varela, Thompson, & Rosch, 1991) and the more recent work in the revision of schema theory (McVee, Dunsmore, & Gavelek, 2005). However, these research areas have not developed the idea of pattern thinking as an approach to learning. The only application of pattern thinking arose in semiotics over two decades ago. In this application, Thomas (1987) describes a four-step pattern thinking approach:

1. ***Replication*** – Aligning with subject matter disciplines
2. ***Historical Association*** – Organizing historically (over time)

3. ***Correlation*** – Correlating knowledge claims across disciplines and contexts (epistemological)
4. ***Coalescence*** – Attempting to unify knowledge from across disciplines by focusing on relationships and meta-relationships

The basic functional or operational characteristics of this approach involve (a) making connections (or emphasizing relationships), (b) expanding connection-making across contexts (i.e., extent or abduction in this paper's model), (c) developing broad explanatory principles (i.e., abstraction in this paper's model). Although relationships and principle development have been a concern of educators for some time (Bransford, Brown, & Cocking, 2000), we have not been very successful at implementing these emphases.

Abductive Thinking

> It is abduction which enables me to draw my instances of a given regularity from a vast range of different universes of experience.
>
> Gregory Bateson (1991, p. 150)

Abduction occurs regularly in human cognition, but is not addressed for the most part in educational literature. Abductive reasoning, originally proposed by Peirce (Stanford Encyclopedia of Philosophy, 2001/2010), has been utilized in semiotics and anthropology and served as a major mode of thinking for Gregory Bateson (1979/2002; 1991). Abduction is a reasoning process that examines how certain ideas "fit" across contexts. In considering that abduction needs to be taken into account, Thagard and Shelley (1997) have described a number of characteristics and results of abductive thinking that address knowledge transfer. Although deduction may be involved in the process of explanation building, from Thagard and Shelley's perspective explanation itself is not a deductive process, but primarily an abductive one. At the same time, hypotheses and explanations are layered. In order to reason about hypotheses as layered ideas, abductive reasoning is required. This process can lead to creativity and the development of revolutionary hypotheses, which are not possible through merely deductive or inductive reasoning. Further potentialities for developing relationships across contexts are always present. Another aspect of abduction involves the notion of simplification in that as ideas are addressed across contexts there is a process of simplification. Such simplification is required for the abstraction of explanatory principles and models.

In the model to be described shortly, abduction is "built in" to the entire process of teaching and learning. Transfer of knowledge, rather than being something separate from the rest of what occurs in the educational context, is something that becomes a natural part of the process of thinking and learning.

Context

> The notion of "context" is primary and fundamental for all communication. No message or message element—no event or object – has meaning or significance of any kind when totally and inconceivably stripped of context.
>
> Gregory Bateson (1991, p. 143)

> Context and relevance must be characteristic not only of all so-called behavior (those stories which are projected out into "action"), but also of all those internal stories, the sequences of the building up of the sea anemone.
>
> Gregory Bateson (1979/2002, p. 13)

Context is the essential ingredient in learning in that it provides meaning and relevance. Context itself is made of networks of relationships that provide the fabric for how specific "ideas" are situated. Ultimately, all contexts are 'contexts of meaning' (Bloom, 1990, 1992, 2006), whether we are referring to those contexts that are cognitive, social, cultural, physical, biological, or ecological. Such contexts are fuzzily bounded ecological systems, where ideas and/or materials interact in complex, non-linear ways. For contextually-rich curriculum enactment (as learning experiences), all of the relevant contexts need to be included. The contexts to include can come from students and teachers, as well as culture and social situations.

In much of schooling, the contexts of subject matter content are reduced, sometimes to the point of almost being entirely decontextualized (Kress, 2000). Curricula also tend to focus on learning "about" something as separate from one's experiences, which is another form of decontextualization. Students' own questions, curiosity, interests, and experiences generally are not part of the curricular experience in schools. Addressing contexts in enacted curricula needs to include the more formal contexts of subject matter areas, the ways that students naturally make connections, and the ways that extend one's understandings of interrelations. In addition, students' personal and social contexts of meaning need to be addressed as they make sense of whatever they are studying. Such contexts of meaning include connections to previous experiences, emotional reactions, aesthetic reactions, value judgments, imagery, humor, and other aspects of our cognitive contexts (Bloom, 1990, 1992, 2006; Bruner, 1990; Eisner, 2002; Koestler, 1967/1968). The richness of the interrelationships provided by such wide ranging and overlapping contexts provides not only for more meaningful and relevant learning, but also for possibilities of emergent understandings, creative insights and expressions, empathy, and a whole array of human potentialities.

The Model

> One perspective of relations in the curriculum reveals the connections among the emergent patterns of the curriculum process. Here the curriculum might be conceived as the actions and products of these interactions and evolutions as it unfolds, the "path created in the running" rather than the racecourse itself.... Relations in the curriculum … are the internal and evolving processes of classroom interactions and unfolding of experiences rather than the planned curriculum … developed by the experts. This perspective of curriculum relations emphasizes the process rather than treating the curriculum as a product or "thing."
>
> M. Jayne Fleener (2002, pp. 171-172)

In curriculum theory circles, we have moved from thinking about curriculum as a sequenced package of what should be learned to broader notions of contexts of learning and the effects that differing contexts have on schooling. This more inclusive view of curriculum seems to at least stem back to the work of Froebel in the early 1800s (Froebel, 1912). The conceptualization of the approach I am suggesting here is not a prescriptive one, but rather a set of principles that promote interactions with ideas and experiences. Curriculum (or the learning experience) is one that values emergence, diversity, curiosity, and questioning. The model (see Figure 1) expands upon an earlier version where the "work" in the learning environment emphasizes developing (a) deeper understandings (that involve probing relationships, systems, patterns, and context); (b) principles, models, and explanations (that also involve relationships, systems, and patterns at an abstract level); and (c) transcontextual and trandisciplinary understandings as processes of abduction (Bloom & Volk, 2007; Volk & Bloom, 2007).

The model in Figure 1 represents some of the major aspects of enacting a systems thinking curriculum. Any two-dimensional figure is limited in terms of representing a dynamic, non-linear, multi-dimensional, and multi-contextual set of systems. And, Figure 1 is a case in point. A certain degree of imagination is required and is probably necessary anyway . The enactment of curriculum is personal in its connections to the teacher and social in its dynamics and connections to students and the greater social contexts. As a result, the figure is more of a gestalt for sparking ideas about the enactment of any curriculum.

The outer box represents the social contexts of the classroom and beyond. These contexts are consistent with a Batesonian systems thinking approach. The relationships within the classroom are valued and nurtured in ways that help develop community (which is important, but beyond the scope of this paper; see the following references for further information: Calderwood, 2000; Lave & Wenger, 1991; Ro-

goff, Turkanis, & Bartlett, 2001; Wenger, 1998). Engagement is not just something expected of students, but is a characteristic of the community, where the students and teacher are engaged in the activities described in the inner box under "Basic Activities" and "Major Thinking Processes." A sense of being "genuine" also is valued and manifested. The teacher is another person and participant, who also happens to be a mentor, model, or whatever other metaphors fit with the situation. At the same time, students are encouraged to move out of playing the school game and to move towards becoming more genuine participants in the community. Both the "roles" of the teacher and the students need to be consistent with developing reciprocal relationships that can maximize personal growth and transformation (Bateson, 1972/2000; 1991). The emphasis here needs to be on the compatibility of both roles, rather than on one role, such as that of the teacher, which Bateson called a 'half-baked approach' (Bateson, N., 2010). Of course, the entire curriculum enactment needs to be embedded in personal relevance and meaning. As much as possible, students need to be encouraged to explore ideas and develop products that they find relevant and meaningful. From the teacher's perspective, such an emphasis may mean stepping out of the pattern of prescribing specific assignment products and modes of presentation. Maximizing student control over what and how to present is important in helping to support relevance and meaning.

The inner box focuses on the enactment of curriculum. The "provocations" are starting points, triggers, or central attractors that can stimulate further exploration and inquiry, as well as new emergent themes. An overall recursive approach is depicted for (a) developing deeper understandings, (b) formulating abstractions and explanatory principles, and (c) exploring how these deeper understandings and abstractions work or "fit" in diverse disciplines and contexts (i.e., abduction). Within this approach a variety of activities and thinking processes can be incorporated for working within these three major aspects of the model (i.e., depth, abstraction, abduction). At the same time, the major conceptual emphasis of this entire approach is on developing understandings of relationships, systems, contexts, multiple perspectives (double/multiple descriptions), and the ecologies of ideas.

At the bottom right of Figure 1 is an outgoing arrow to "Knowledge Production (public audience)". Much of schooling is based on students consuming knowledge rather passively (Marshall, 1992). This part of the model adds further relevance in encouraging students to communicate their ideas to public audiences. Communicating to the public is not difficult with present technologies. In all of my courses, from freshman to doctoral courses, students post projects to specific websites (such as the one for my freshman "Ecology of Mind" course called "Ecol-

ogy Mind Systems" at http://ecomind.wikidot.com). The fundamental ideas that are communicated to students include: (a) that they have insights and knowledge, which are worthy of being shared with a global audience and (b) that the rules of the game (of schooling) are no longer the same, where projects and writing are created to communicate to large audiences. In fact, we may be able to start shifting the game plan to one that no longer is about jumping through hoops and going through the motions, but rather is about deep meaningful learning that is personally rewarding and potentially transformative.

Personal Reflections

> This course makes my brain hurt.
>
> Female student in a university freshman seminar called "An Ecology of Mind"

For me, this model and approach are still works in progress. I have been implementing and revising some version of this model for more than a decade, and maybe even for decades earlier as I played with related rudimentary ideas. Many of the ideas for engaging students are not new, even though much of the complexity in education literature places ownership from works in the 1990s and more recently. However, inquiry, engaged learning, emergence, and other concepts discussed here date back to many educators and scholars, including the works of Arthur Koestler (1964/1969; 1967/1968), Loris Malaguzzi and the Reggio Emilia Approach (Bonavita, 2005), George Herbert Mead (1932/2002), John Dewey (1938/1997), Friedrich Froebel (1844, 1912), and many others. More recent work has been exploring complexity sciences and systems thinking in education with a great deal of insight (Davis, Sumara, Luce-Kapler, 2008; Fleener, 2002; Meadows, 2008; Sweeney & Meadows, 1995; van Merriënboer & Kirschner, 2007), yet developing approaches that can used and adapted by teachers in diverse social and cultural contexts are still in progress. At the same time, some of these approaches have fallen into the seductive trap of mechanism and positivism (such as van Merriënboer & Kirschner's [2007] 10—step approach to complex learning).

The difficulties in enacting the approach in this paper involve the "buy in" from students. University students have been exposed to more of the trivialized expectations and actions of schooling, including being (a) "managed;" (b) valued as memorizers of disconnected, meaningless, and irrelevant information; (c) viewed as objects and numbers with little value as unique individuals; and (d) "successful" for going – through – the – motions, putting in as little real effort as possible, and pleasing the teacher. These patterns of relating to schooling are deeply en-

trenched. I have found that some students relish opportunities to step out of these patterns, while others are intensely resistant. Explicit discussions and activities that expose them to new ways of engaging in learning situations do little to help many students rethink these patterns and transform themselves.

Bateson and his colleagues introduced the notion of double binds (Bateson, 1972/2000, 1991; Bateson, M. C. 2005; Gibney, 2006) into the psychological literature in the mid-20th Century. As I continue to ponder how to enact this curricular model, I find myself in numerous double binds. Do I enforce rules about attendance, computers, handheld devices, etc? How will the introduction of rules undermine the very essence of developing a systems thinking community? On the other hand, what effects will allowing students the "freedom" to disengage have on their own learning and growth? Disengagement by some affects the whole as much as engagement, but in different ways. Some students say they want more structured assignments, since it does take a great deal of responsibility and ownership away from them. Current systems of schooling are increasingly based on "customer satisfaction" (e. g., student course evaluations) and reward teachers for how well they satisfy the customers (e. g., ratings on annual reviews, tenure, promotion, and merit pay increases). Such systems do not support learning that can (and should) provide opportunities to transform, grow, stretch, and see new possibilities. However, in these double binds and difficulties lie potentialities for changing the way we enact curriculum, the way we teach.

As it turns out, the topics of patterns, double binds, and relationships seem to have the greatest impact on my freshman students, especially those who have taken personal journeys of exploration into these topics. A young woman reflected that:

> as an 'artist' it helped me view the world differently. So, much of the ecology of the mind can be related back to art . . . Relationships made [me] see the world differently. Double binds open my mind to all of the hard situations we face daily. Patterns showed me parts that work together to create a whole.

A female anthropology major said that, "the patterns and relationships had a big effect on me because the[y] have a large impact on how we live our lives." A young man whose major is biochemistry said that the course, "helped me see things from a different angle. I now recognize double binds when they occur and think about possible solutions . . . " Another female dancer and elementary education major, reflected that she:

> can see and understand more patterns and more complex relationships . . . [and that] there is no such thing as "separate." Everyone has always said to me that we're all connected, but no one defined the difference between that and the non-existence of separation.

A male chemistry major said, "I realized I can not be so mathematical. I realize the world is more than just numbers, but a set of relations. There is more beauty than I realized." In these few excerpts from students, we can see the beginnings of transformation. Even the students who were not as engaged as others talked about similar impacts on their thinking. An engineering student said, "I now analyze the big picture instead of just the small details." A somewhat opposite reaction from an environmental science student: "I have begun to look at the little things in life. I have a better appreciation." From seeing the small and the parts to the whole, students' thinking seems to be affected. To varying degrees, what seems to happen is what Catherine Bateson (2004a) refers to as "epistemological shock." Such a shock involves reverberations of ideas that do not fit within one's own assumptions about and epistemological understandings of how the world works. All of a sudden the idea that the world is not about "numbers," but about relationships was an epistemological shock for our young chemistry major. So, maybe curriculum enactment, teaching is not about asserting our control. Do we need to "make" students "learn?" Is it even possible to make someone learn? Maybe what we need to do is focus on providing opportunities for students to engage on their own terms, for epistemological shocks to occur, and for transforming or transmuting the school game into a path of learning that is relevant and meaningful.

Conclusion

The above analysis demonstrated that the focus of the teaching-learning pedagogy has two major roles. First, the way in which the ideas of the subject are approached by the learner is that of an "ecology", essentially our unique ways of thinking and learning are fundamentally an ecology of interactions among ideas. Second, we need to reflect on how the "curriculum" or teaching-learning context is enacted. If we perceive ideas and the process of meaning-making as an ecology, we need to engage with this new construct in such a way that is compatible and consistent with learning as an ecology of mind.

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Appendix

Table 1. Summary of systems thinking

OVERALL CHARACTERISTICS	
Systems thinkers are Generalists	
FOCI	**THINKING PROCESSES**
Whole & Multiple Interacting Systems	Non-Linear Thinking - cyclical, recursive
Relationships - relationships between parts, wholes, & processes	Questioning - posing penetrating & discriminating questions
Feedback Loops & Other Non-Linear Processes of information & material flow	Polarizing - examining oppositional pairs, tensions, dilemmas, & other binaries
Transformation - change processes	Modeling - explanatory principles
Parts - all parts are important, but the sum of them is less than the whole	Evaluating - critical examination of assumptions, variables, qualities, states
Relevance & Usefulness - outcomes not as important as relevance or usefulness	Stochastic - random variation is critical
CONCERNS	
"Difference" is critical to understanding	Identity of systems is based on difference
System Survival is a Selection Process	Uncertainty is part of nature of systems
Multiple Perspectives understanding	Complexity of variables and processes
Boundary Problems - artificially creating reductionist separations	Stability - based on relationships, not on goals or end-products; it is not linear

NOTE: This table is compiled from the works of Bateson (1979/2002); Checkland (1985); Daellenbachand & Petty (2000); Paucar & Pagano (2009); Roberts (1978); Ulrich (2003); Weinberg (1975/2001); Werhane (2002)

Table 2. Summary of pattern thinking.

OVERALL CHARACTERISTICS	
Pattern thinkers are Generalists	
Pattern thinking contributes to a distinctive Worldview & Paradigm	
Pattern thinking is Analytical & Aesthetic	
Pattern thinking is Transcontextual & Transdisciplinary	
Patterns are the material of Neuronal Function	
FOCI	**THINKING PROCESSES**
Patterns – in space, time, & mind	Recognizing patterns
Relationships	Analyzing Functions & Meanings
Connections	Analyzing from Multiple Perspectives
Functions	Situating patterns in Context
Meanings	Locating patterns in Different Contexts
Adaptation	Evaluating & Testing
Complexity	Modeling
Recursiveness	Organizing
Models	Categorizing
Understandings	Associating – analogs, metaphors, etc.
Similarities & Differences	Thinking Abductively

CONCERNS
"Difference" is critical to Pattern Recognition & Understanding

NOTE: This table is compiled from the work of Bateson (1979/2002); Bloom (2004, 2006b); Bloom & Volk (2007); Coward (1990); Hofstadter (1979); Lakoff & Johnson (1980); Thomas (1987); Volk & Bloom (2007); Volk, Bloom, & Richards (2007).

Figure 1. A model of the overall patterns for a systems thinking–ecology of mind curriculum approach.