Complex Learning and Teaching Across Cycles, Arrows, and Breaks in Time

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Abstract

Deep, meaningful learning is a complex, nonlinear system within larger organismic systems of living things. In addition, learning occurs over varying lengths of time across individuals and contexts. With people, we place them in institutions where learning is treated as a linear system within tightly regulated timelines. From the outset, socially constructed attempts at schooling face a major disconnect. In contrast, I will promote natural systemic processes of learning, which include the "ecology" of human learning and its corresponding patterns to the learning in ecosystems and evolution. Specifically, I will focus on how two Batesonian views of learning (i.e., symmathesy or mutual contextual learning and learning as personal epistemological development) are undermined by the assumptions of time that are embedded in our predominant institutions of schooling, such as (a) learning can happen in specific delineated, arrow of time, rather than through recursive cycles of uncertain time and (b) learning occurs along a linear trajectory, rather than with breaks and branching that deepen relational learning.

How do notions of time affect learning, teaching, and education, in general? This paper will meander through an examination of time using Tyler Volk's metapatterns of cycles, arrows, and breaks, as well as borders—pores and binaries. This examination will extend through three contexts including: (a) the context of schooling, (b) the context of teaching, and (c) the context of complex learning. The discussion will then lead into the notion of teaching for complexity and its implications.

An Introduction to Batesonian Metapatterns and the Cycles, Arrows, and Breaks of Time

In order to establish a "language" for the discussions in this paper, we should briefly delve into some of the specific terms and associated concepts that arise from Gregory Bateson's notion of "metapatterns."[1] Bateson coined this term to try to capture the notion of larger and more encompassing patterns of patterns. Metapatterns are not just a pattern you might see in numbers like a list of sequential prime numbers or even numbers. However, a Fibonacci sequence fits more within the notion of metapatterns, since these sequences appear across natural phenomena. Bateson never identified any specific metapatterns, which was typical of his approach to teaching others. He wanted the readers or members of his audience to explore the idea and come up with their own examples. Inspired by Bateson and the notion of metapatterns, Tyler Volk examined a number of metapatterns he felt were representative of the basic patterns that arose through evolution.[2] Volk's working definition for metapatterns involves two basic notions that metapatterns: (a) are evident across contexts, including those in biology, culture, technology, and mind; and (b) are functional in nature. Only some of his metapatterns are structural, which in those cases have structure—function relationships. The other patterns are temporal, but as such have functional characteristics. Table 1 provides a list of Volk's metapatterns.

Table 1. A list of Tyler Volk's metapatterns.[3]

Structural	**← Could be Both →**	**Temporal**
Spheres	BINARIES	CALENDARS & TIME
Sheets	ARROWS	CYCLES
Tubes	BREAKS	
Centers *	BORDERS (& Pores)	
Layers * • hierarchy • holon • holarchy • clonon		
NOTE: Capitalized metapatterns are used in this paper.		
* Centers & Layers may conceivably manifest as temporal, but for the most part are structural.		

Although the above table splits the metapatterns into structural or temporal, there are other ways these metapatterns manifest. All of the metapatterns can appear as metaphors and can be used metaphorically.

Four of these metapatterns are the focus of this symposium and paper, including: (a) calendars and time, (b) cycles, (c) arrows, and (d) breaks. In addition, other metapatterns that are used in this paper include: (a) borders and (b) binaries.

Calendars and time are patterns that are evident (a) in biological processes as biological clocks; (b) in culture and society as physical clocks and calendars, as cultural practices and art forms, and as cultural ways in which time is viewed (as linear or as cyclical or as both); (c) in technology as the time-keeping devices and mechanisms; and (d) in mind as our own idiosyncratic views and relationships with time beyond the purely biological clock level. In this paper, time and calendars will be examined in terms of the way time affects learning, teaching, and schooling.

Arrows are patterns of directionality, flow, movement, and relational dynamics, all of which are manifestations of time. In the physical sense, we use arrows to control traffic flow, to provide directions, to point out or communicate something, and to shoot for sport or food. However, arrows manifest in other ways, such as in the direction of chemical reactions, the direction of water or liquid flow, the direction of movement during earthquakes and other types of wave activity, and of relational dynamics in social contexts. Arrows can indicate linear flow or cyclic flow, as well.

Cycles are repetitive flows or actions, which again are manifestations of time. A clock with hands moves in cycles. The Earth spins creating cycles of dark and light and revolves around Sun creating cycles of the seasons. And, these cycles affect tides, currents, and wind patterns, as well as social and cultural activities and associated technologies found in clocks and calendars. But, the cycle of Earth rotating not only affect ocean tides, but also affects organisms living in tidal zones. Snails that move up and down marsh grasses in sync with the tides, will continue to move up and down the grasses in the same cycle of time after they are removed from the marsh and placed in a laboratory with no tidal fluctuations. My dog's clock goes off twice a day beginning at about 6:00 am until she goes to the dog park or for a walk, and again at 3:00 pm until she does the same. She starts following my wife and I around until we get the message. A slight adjustment occurs for seasonal changes in sun rise and set times. Cycles can be merely repetitive like seasons, the Kreb's citric acid cycle, the running of an engine, or the riding of a bicycle. But, they also can be recursive, such as in natural learning over time, as opposed to the way we tend to view learning as in small, linear, fragmented chunks of time (more on this later).

Breaks are divergences, transformations, and other splits in structures, time, space, and movement. The branching of a tree is a physical split that also occurs over time. A divergent thought is a process in time that splits off in a new direction. An organism dying or breaking some part of itself is a physical and temporal split. Time can be broken into fragments, such as in class periods in school or in quarters and halves in many sports. A wrestler being pinned or a figure skater falling are breaks in time and space. In some cultures, life and death are cyclical with people being reincarnated as other living beings or as beings in the spirit world. Other cultures view life and death as linear. You are born, then die, and that's the end. Or, there is another version where you are born, then die, then go to some other context (heaven, hell or some version of these).

Binaries are the simplest form of relationship and are the building blocks of more complex systems. Many organisms have physical sets of functional binaries, such as eyes, ears, nostrils, sex organs (testes and ovaries), appendages (pairs of appendages), and other organs or parts of organs (e.g., kidneys, left brain – right brain, lungs). Binaries are the

basis for sexual reproduction with males and females of the species. Binaries also are at play in dynamic situations, such as then tensions between two sides of an argument or as the precipitating factor that keep systems functioning. We breathe to bring in oxygen and remove carbon dioxide. The internal mechanisms rely on signals from the binary system to keep the cycle of breathing functioning. Computers function on binaries of 0 and 1. The binary of good and bad drives most religions and moral systems. But, binaries or simple pairings are just the beginning, More complex systems of relationships develop as the numbers increase to trinaries, quaternaries, and so forth.

Borders and their companions, pores, are separations, such as between the inside and outside or the conjunction of two entities or nations. Borders can be physical, imaginary, psychological, temporal, or metaphorical. As we will see, the way in which time is used can create borders. Borders can be obstacles or they can be regulatory mechanisms. They can separate functional processes, while maintaining contact with other aspects of the system. Cell membranes separate the internal processes from the outside. They also regulate (with real or purely functional pores) the flow of materials through the cell membrane. Borders can be created by the way in which we use and see time. Such borders can become problematic in many educational contexts, as we will see in the following discussion.

The Context of Schooling

The typical context for learning and teaching in the United States and many other countries tends to be at odds with the natural and complex processes of learning and with ways of providing supportive contexts of learning and teaching. In most K—12 schools, time is broken up into rather short and inflexible periods of time, which are defined by bells, especially in grades 6—12. Although elementary schools are somewhat more flexible, teachers are expected to spend a certain amount of time on each subject at specific times of day. At the university level, the bells may not be present, but the inflexible time periods are ever present. Time is a regulatory and control strategy much like the way time is used in factories[4] and prisons[5]. But, the way in which time is used in schooling inserts breaks into what otherwise might be a more lengthy and engaged learning opportunity. There are no chances to continue discussions or to continue an inquiry.

Figure 1. School vs. prison characteristics (from Abby White[6])

The chopping up of time into small blocks promotes linear approaches to teaching and learning. There is only a limited time frame, so teachers follow the most "efficient" and "shortest" path to an end. Lecturing, tightly controlled activities, and teacher-controlled discussions fit within the blocks of time that characterize schooling. The learning that occurs through such linear approaches is conceptually superficial. The subject matter focus runs along at a rapid pace, with no stops to loop around. Rote memory is promoted and meaningful understandings are lost. The more in-depth learning that occurs is about (a) how to be a zombie, (b) how not to question, (c) how not to think critically, and (d) how to follow orders. In universities, we experience the result. Students ask, "What do I need to do to get an A?" "Tell me what I'm supposed to do." "Can you give me your lecture notes?" If you ask and expect students to think deeply, they react in a variety of ways, from looking dumbfounded to rebelling. This is what a friend of mine's son, who was in middle school at the time, said defined a zombie: "Zombies are people who cannot think for themselves, they want you to be like them. …And, if you do what they say, your dignity flies out the window"[7] He was referring not only to other students, but also to teachers and other adults. And, he certainly seems to be correct in his assessment.

The Context of Teaching

Deep, meaningful learning occurs through recursive processes over various spans of time. On the other hand, the linear fragmentation of time in schooling presents contradictory and incompatible contexts for deep and meaningful learning. Any such learning that does occur is due in large part to the individual learners taking more time and putting more effort into the recursive processes of learning. Occasionally, individual instructors may take more time outside of classes. Some instructors create opportunities for recursive learning within short chunks of time, but this requires sacrificing the extent of content coverage. And, to further complicate the situation, instructors, especially in K—12 schools are under tremendous pressure to cover a lot of content in very short periods of time, which is also known as *teaching efficiency*.[8] Of course, very little learning of content occurs.

Here enters the "double bind"[9] of instructors at all levels of education:

If I create more time for students to learn more deeply and meaningfully	➔	I may incur the wrath of my administrators, not get a salary raise, and/or lose my job.
If I continue to teach in ways that cover extensive knowledge	➔	my students will not be able to experience deep, meaningful learning and will be short-changed.

Such double binds or damned-if-you-do-damned-if-you-don't situations seem only to have solutions that lead to nasty and unacceptable results. To deal with double binds in ways that do not lead into negative consequences, one must take create leaps to "meta" levels beyond the specific double binding contexts. Such leaps are not easy, are often quite frightening, and are even more difficult to "see." And, there is no nicely, predictable formulae for finding, taking, and successfully completing such leaps.

But, we can start with some questions to ponder:

- What do we really want for our students?
- Do students really need to learn the breadth of knowledge perpetuated by current curricula, course designs, and course descriptions?
- What are the advantages of "learning" a lot of shallow, fragmented information?
- What are the advantages of learning fewer conceptual areas in much greater depth?
- How can we change the way education takes place in order to provide for deep, meaningful learning at various levels of scale?

Pondering these questions may begin to help us find our own idiosyncratic ways to take "leaps." And, if we can find collaborators and co-conspirators among colleagues, students, and parents (especially in K—12 schools, but increasingly at universities), maybe we can start a revolution that encourages the leaps that can transform our learning contexts.

However, this revolution is not purely a binary between you and your school or your administration. This is a revolution embedded in multiple overlapping and intertwined contexts. These contexts include, among others that may be more specific to each reader's contexts, the following:

- Context of schooling as job training only.
- Context of institutional norms, politics, dynamics, etc.
- Context of state, provincial, or regional politics and dynamics
- Context of local, regional, and national societal norms, biases, worldviews, etc. → including devaluation of learning and education, anti-intellectualism, disrespect for educators, etc.
- Context of global norms, dynamics, pressures, etc.
- Context of economics at all levels of society
- Context of corporate interests and effects on education → schools and universities are becoming increasingly corporatized, where the bottom line is no longer about learning through teaching and research, but about money and profits for administrators and control over faculty, etc.
- Context of entertainment and the need for *constant* stimulation through social media, video, music, etc., along with expectation that classes be entertaining.
- Context of surveillance and its use by administrators, students, and non-students to intimidate and threaten faculty.
- Context of technology, including (a) as a replacement for in-person courses (with all of its implications for simplistic learning, mechanization of learning, and replacing full-time faculty with less well paid part-time faculty) and (b) as a goal rather than as a tool, and as disconnecting potential (i.e., technology has the

potential to disconnect people from one another; to disconnect student from teacher; and to disconnect students from broader and deeper senses of learning that include how to think, how to "be" in the particular discipline, and what identities one can create within different contexts of learning and working).

- Contexts of philosophy and the philosophical orientations of thought and practice, including epistemological frameworks.
- Contexts of theory including those on learning and cognition, teaching, and schooling.
- Paradigmatic contexts and their effects on just about everything. For example, the dominant positivistic, mechanistic, and reductionistic paradigms affect all aspects of society. Such paradigms are inconsistent with the emerging paradigms of complexity and complex systems. And, a big problem is how insidiously positivism, mechanism, and reductionism permeate work within the complexity sciences.

These contexts, as described here, are not necessarily separate and distinctive. They embed or are embedded by others. They intertwine and overlap in ways that are indistinguishable. But, they function in ways that affect all aspects of global societies and global ecosystems. And, in terms of education, they establish the assumptions and guiding frameworks for thinking and practice. More specifically in terms of the themes of this paper and symposium, these contexts and their assumptions affect the way in which time is viewed and the way time:

- establishes borders that limit learning and teaching,
- is broken into fragments,
- is seen as strictly delineated arrows rather than as arrows of divergence and creativity,
- and is molded into linearity rather than recursive cycling.

The Context of Complex Learning

The views of learning discussed in the last section are based on very different sets of assumptions from those of learning as a complex system or as, Bateson would say, an ecology of learning and thinking. Fundamentally, the former views, which are rooted in positivism, mechanism, and reductionism, are based on assumptions of linearity and the memorization of content that can be disconnected from context and meaning.

Learning as a complex system is necessarily an autopoietic system that maintains the whole system. From such a view, learning is part of every biological system, including every individual organism. Learning from this perspective is essential to the survival of the organism over the short-term and to the survival of the species over many generations. Bateson considered learning to be a phenomenon that not only manifested in the head, but also throughout the organism, including its DNA. He saw DNA as a way of learning within the time spans of species existences.[10] In addition, he viewed all of cognition as complex sets of information feedback loops that extended throughout the body of an organism and to other organisms and outside environmental contexts.[11] A contemporary example is that

as we drive a car, we are getting all kinds of information flowing into our eyes, ears, hands, feet, and so on. Some of this information goes to the spinal cord and back out as a reflex reaction then on to the brain. Other information goes to the brain, where it may go through various looping processes then may or may not send back a reaction to the hands and feet. At the same time, the vehicle itself becomes an intimate part of this looping of information. The same processes apply to riding a bicycle or chopping wood, which was Bateson's favorite example.

From a more contemporary and elaborated perspective, Nora Bateson (Gregory's younger daughter) has developed a theoretical framework of learning she calls "symmathesy" or mutual, transcontextual learning.[12] The fundamental components of symmathesy are described in Table 2. However, it is important to note that symmathesy appears to be learning at the immediate contact point or level with the contexts within which we live. Although it contributes to what Gregory Bateson referred to as epistemology, which is a personal framework of knowledge rather than a philosophical enterprise, symmathesy does not appear to be concerned with learning at that level of conceptual development. Rather, symmathesy is the dynamic process of how people and other organisms, and the contexts, within which they live, learn together. It is learning about how to interrelate, how to function, and how to respond to change of all kinds.

Table 2. Nora Bateson's theoretical framework of learning, called symmathesy.

Aspect	Description
Context	Context is a slippery concept, which can morph, split, and intertwins with other contexts. But, in general, context is the sense of some set of features and conditions that work together coherently. An ecosystem is a context, as is an individual organism. The politics of a nation is a context, as are economics, culture, schooling, and so forth.
Calibration	Calibration is the way we adjust to changing circumstances and relationships.
Time	Time involves the cycles and sequences of events, the processes of living systems, and the use of past experiences to anticipate future events. Such timing is critical to the survival of systems.
Play	Play is a fundamental process of learning and creative problem solving. The play of two dogs is about developing trust and negotiating relationship. Play is found among artists, scientists, poets, and many other contexts of activity.
Bias	Bias concerns how perceptions and information input is filtered and morphed into various forms.
Stochastic Processes	Such processes can involve genetic mutations, random events, unexpected changes, or novel information input.
Boundaries	Boundaries of contexts are the connection points, where symmathesy occurs.

The other aspect of learning that arises from symmathesy involves Gregory Bateson's notion of epistemology as a individual or social framework of knowledge. From this

perspective, learning from symmathesy contributes to one's own knowledge frameworks, as do personal and social learning from interests and activities and personal and social learning from school coursework or other formalized settings.

The nature of our personal epistemologies, even though it may not have been referred to in this way, has generally been viewed as being comprised of school-type conceptual knowledge. However, our epistemologies are comprised of much more, including, (a) emotions, (b) values, (c) aesthetics, (d) imagery, (e) metaphor, (f) experiential knowledge (including memories of personal experiences and the automated scripts we develop in negotiating our cultural contexts), (g) humor, (h) interpretive frameworks and beliefs, and more.[13] All of these aspects of our epistemology are intertwined within one another in various combinations. And, our epistemologies are not static and solid as we may view a philosophical treatise on epistemology. Our epistemologies may have some coherent and continuing characteristics, but for the most part everything is morphing and recombining in different ways over time and across contexts. Scientists, whose careers are based on creating knowledge, are subject to the same epistemology aspects. Their work is embedded in their own emotions, value, aesthetics, and personal interpretive frameworks, which at times can affect they way they interpret events and various phenomena.[14]

Complex learning from the perspectives of symmathesy and epistemology leads to an overall view of learning as multiple interacting loops of dealing with information in conjunction with the contextual contacts. Some of this informational flow functions at the level of how we deal with self, others, and various environments. Other informational flows contribute to our epistemologies, which, for a tree, could be the knowledge of where it is and who is in relation with it (what other trees and species of trees, what fungi, what animals, etc.). Last night my dog and I went to a dog-park-people's party for a chili cook-off. My dog and I arrived a little late. As we pulled up, my dog looked confused, as if she could not figure out where we were going and why. But, as soon as we started to walk up to the house, her nose dropped to the ground (symmathesy) and she began wagging her tail and pulling excitedly. Ordinarily, she is quite nervous about going into strange buildings. However, she knew exactly who (epistemology) was in the house.

As we will see in the next section, some of the processes we use to develop our epistemologies include a triad of looping processes. One involves developing *depth* of understanding, which is fundamentally the interlinking of relationships through a variety of processes, including inferring, deducing, etc. The second is developing *abstractions* or models, explanations, analogies, metaphors, and so on. And, the third is the transcontextual process of *abducting*, which tests and applies the relational and abstract features to other contexts.[15] In complex learning at the level of epistemological development, these three sets of processes are or at least should be intertwined. In my early work,[16] there is evidence that such processes were at play as a natural matter of course among children. In fact, children's thinking seems to be characterized by such patterns of thinking.

Teaching for Complexity

Teaching for complexity is a challenge, especially within the contexts described early in this paper. Systems of education are not meant to encourage this type of teaching or learning, except in very specific contexts, such as in doctoral research, in the rare undergraduate thesis research, in Reggio Emilia schools (mostly preschool), and a few

other types of schools and programs scattered around the world. These examples provide time for individuals to explore and inquire, to play with ideas and materials, to learn from one another (e.g., fellow students, teachers/professors, and others). Learners have time to go into depth, think abstractly, and test ideas in different contexts.

Teaching for complexity involves finding ways to create "time" for exploring, inquiring, discussing, going into depth, abstracting, abducting, and so on. The creation of time is a process of negotiation with students and finding creative ways to delve into the processes of complex learning.[17] Maybe it requires covering less material. Maybe we need to rethink what "homework assignments" really mean. Maybe we can negotiate to meet the whole class or the class in smaller groups for longer periods of time on other days in exchange for cancelling the equivalent scheduled class meetings. In K—12 schools, it may require negotiating with principals and other teachers. Maybe some teachers can coordinate projects across subject matter classes. In elementary schools, principals may need to be convinced that teaching a transcontextual topic will meet all of the "standards" and testing objectives.

Implications

Learning as a decontextualized, objective, mechanistic process is a primary characteristic of current educational practices and of schooling. In contrast, educational practices and schooling, which are based on learning as a complex, subjective, and organic process, manifest as an ecology of learning and teaching. In the latter case, an ecology of learning and teaching is a radical departure from current views of teaching and learning. The fragmenting of time into chunks of 33 minutes, 45 minutes, 75 minutes, or whatever, do not work for a learning space where time meanders as students explore curiosities, investigate questions, and ponder possibilities. Some of the temporal assumptions that underlie the positivist—reductionist—mechanist approaches are depicted in contrast to the complexivist—Batesonian assumptions that underlie attempts at teaching for complex learning are listed in table 3.

Table 3. A few contradictory assumptions about *time* in teaching and learning.

Positivist—Reductionist—Mechanist Assumptions	Complexivist—Batesonian Assumptions
• Learning occurs through linear sequences of steps over discrete periods of time.	• Learning occurs through non-linear, recursive processes over unpredictable periods of time, which can extend through a lifetime.
• Efficiency is important.	• Efficiency is of no concern.
• Rote memory is the least time-consuming.	• Deep, meaningful learning is time-intensive.
• Learning as information processing with underlying sense of computer processing speed and precision.	• Learning as ongoing, recursive processing of interrelationships across contexts as necessarily messy and uncertain psychological—social—biological processes.
• Learning can occur within short, tightly delimited periods of time.	• Learning occurs over unpredictable periods of time.
• Fragmentation of time is not an issue nor is dealing with fragmentation of content since parts (fragments) can be compiled to	• Fragmentation of time interferes with the ability to think transcontextually and holistically.

understand the whole.

In a Reggio Emilia school I visited in England, children from ages 2 to 4 moved through activities in various perturbations of time. Here is an excerpt from a paper written about this visit:

> Just as the Madeley School creates contexts of meaning and learning that support and engage the children in their own explorations and creations, the Madeley School also creates the potentialities for the pulsations and flow of children from one context to the next. As I mentioned earlier, the children moved through the school like blood pulsating through the body, clustering together like cells entering capillaries, and then moving more quickly between contexts. It would be interesting to diagram the flow of children throughout the school. I'm sure the result would look similar to other social systems… ants, bees, various businesses, organizations, etc. But, which levels of organization would most closely match those of the Madeley School? Some organizations are hierarchically organized and highly structured. Other organizations are more holarchically organized with distributed control and are less highly structured. The Madeley School seems to fall more towards a holarchy and self-ogranizing system. The teachers maintain some control of the boundaries of acceptability and set-up certain organizing centers ("attractors" or interest/engagement/activity centers), but within that the children are self-organizing. What are the dynamics of their self-organizing activities?
>
> As children move through the environment, they pause at particular "stations" or activity or thematic contexts. The length of pauses seemed to vary from seconds to close to an hour or maybe even more. During these pauses the children engaged quietly or in conversation with the teacher and/or other children about the topic or some story that emerged at the moment. Children paused to paint, to create objects with clay, to explore objects and living things at the microscope station, explore making sound on a Hapi Drum (hollow steel ball cut with tongues of various tones), various shaped manipulatives, and so forth. Contrary to the belief of local authorities and many others, young children, like those at the Madeley School, do engage with topics and activities over extended periods of time…. when they have a choice. But, even shorter periods of engagement are not of lesser value, since they return to the same activity after leaving to explore something else. When they return, there is a recursion not just a repetition. They return adding new ideas and perspectives. Maybe they need time to process their ideas… down time to ponder or just let things sit. When they return to the activity, there's a freshness and familiarity mixed together.[18]

Time pulsates and flows in cycles and recursions, and even seems to split into divergent streams, as children explore and learn in ways that are consistent with their own rhythms and interests. We have lost something about the rhythms of learning within our own educational institutions. The corporate agendas have taken over with their push for efficiency, testing, and textbook publishing. And, standards are a camouflaged way of driving efficiency, testing, and publishing. Covering the standards requires the fragmentation of knowledge and the squeezing of time into tightly linear segments.

Somewhere along the continuum from a total revolution in education to micro-revolutions in our own classrooms and courses, there are possibilities for promoting complex learning and thinking. We need to begin to see the malleability of time, where time can meander through bells and administratively rigid scheduling. Maybe part of the solution at the micro-level is a psychological one, where we imagine time as meandering, cyclical, and stretchable. We can engage our students in the same imaginative world of time

expanded and twisted. But, on the ground level, we need to reduce the breadth of coverage (a) by eliminating the content that may not be as critical and (b) through transcontextuality, where multiple contexts are seen as overlapping and intertwined.

Reworking and revisualizing time can provide opportunities for the ecology of learning to flourish. In natural ecosystems, time manifests in daily patterns of light and dark, in seasonal patterns of sun intensity and temperature variations, in semi-random patterns of rain, in reproductive cycles, in patterns of wind or currents, in patterns of nutrient availability, in patterns of energy flow, and in tidal fluctuations in marine environments. What are the temporal patterns within the ecology of learning and thinking? Some of these patterns include:

- Cycles of sleep—awake
- Cycles of energy levels throughout the day
- Cycles of mental clarity and brain fog (at least for me)
- Nutritional cycles
- Ebbs and flows of concentration and focus
- Stochastic events and divergent flows of thought
- Variable ebbs and flows of curiosity and interest
- Variations in a social (learning) group's cycles, ebbs, flows, and divergences
- Variations in mood and emotion
- Variations in confidence and self-efficacy

As teachers, we experience these same patterns. But, there are differences in the dynamic. As disseminators of knowledge, we can get caught in the traps of squeezed time and deadlines. However, if we see our courses and classes as communities[19] (or ecosystems), we can develop more conducive approaches to learning, where communities of practice are characterized by the development of identities, meaning, and practice.[20] The roles of students and teachers in such communities can vary to accommodate temporal fluctuations and the needs of the community. Some useful metaphors for the dynamic of classrooms as communities are depicted in table 4.

Table 4. A few metaphors for the roles (or identities) of students and teachers in classroom communities.

Roles as Students	Roles as Teachers
• *Dancer* – learning as dance and play. • *Apprentice* – Learners moving toward being mentors. • *Explorer* and *Inquirer* – learners who are driven by curiosity and interest. • *Novice* – A beginner in some domain (or habitat).	• *Choreographer* – a great metaphor for visualizing time and teaching. • *Mentor* – not as concerned with deadlines as with moving students along. • *Guide* – a way of helping students find their ways through the territory. • *Nurturer* – much like the way older trees take care of younger trees in forest ecosystems in which time is synchronized with fluctuations of all kinds.

If we begin to see classrooms as social and ecological communities, we can pay attention to the patterns of energy, interest, and engagement as students and teacher navigate through conceptual territories along with their other epistemological features. We can engage at levels of symmathesy, where learning is mutual (and shared among students and teacher) and learning occurs as we engage physically, psychologically, and socially.

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END NOTES

[1] Bateson (1979/2002)

[2] Volk (1995)

[3] Volk (1995); Volk & Bloom (2007); Volk, Bloom, & Richards (2007)

[4] Marshall, Sears, & Allen (2007); Sears & Marshall (1990) – The factory model of schooling is an artifact of the industrial revolution where schools were seen as training grounds for work in factories. The hidden or implicit curriculum included training to be obedient, to not question authority, to follow rules, and to conform to the expectations of those in authority.

[5] Anderson (2016); Gray (2013); White (2017)

[6] White (2017)

[7] Bateson, N. (2016), page 73.

[8] Pinar, Reynolds, Slattery, & Taubman (1996)

[9] Bateson (1972/2000, 1991); Sluzki & Ransom (1976); Bateson, M. C. (2005); Gibney (2006)

[10] Bateson (1972/2000, 1979/2002, 1991)

[11] Bateson (1972/2000, 1979/2002)

[12] Bateson, N. (2015, 2016)

[13] Bloom (1990, 1992, 2014)

[14] Bloom (1988); Feynman (1985); Mullis (1998)

[15] Bloom & Volk (2007, 2012)

[16] Bloom (1990, 1992)

[17] Bloom (2012, 2013a, 2013b, 2014)

[18] Bloom (2016), pp. 4—5

[19] One fruitful perspective of community arose from studies of apprenticeship communities. Such a perspective has moved into looking at the implications for such communities in schools and classrooms. SEE: Calderwood (2000); Lave (1988); Lave & Wenger (1991); Rogoff, Turkanis, & Bartlett (2001); Wenger (1998)

[20] Wenger (1998)