Dialogic and the Emergence of Criticality in Complex Group Processes

DONALD L. GILSTRAP
University of Oklahoma

This article suggests how Paulo Freire's ontology of subjective reality is influenced through nonlinear and non-deterministic perspectives of a world of open and irreversible rather than dynamically conservative systems. By problematizing the relationship of critical theory to complexity theory, we are able to generate an epistemology of criticality that recursively makes meaning out of our descriptions of human interaction. This epistemological challenge leads us to interpretive analyses that identify recursion as a catalyst for emergence in critical group dynamics in education. Equally, educators who are confronted with far from equilibrium environments can utilize the concepts of connected knowing, thematic investigation, dialogic, and interdisciplinary teams to reflect critically on the limiting aspects of near equilibrium conditions, contrasting them with the potentially transformative qualities of complex systems.

Introduction

> We are, therefore, the only beings capable of being both the objects and the subjects of the relationships that we weave with others and with the history that we make and that makes and remakes us… We are unaware of these

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> relationships to an extent that does not exist between any other living being and the world. (Freire, 1998, p. 75).

One of the dilemmas we face when interpreting schools of thought is the intrinsic aspect of analysis. In critical theory, the framework intends to challenge hegemonic aspects of society and culture while re-creating democratic, transforming, and pluralistic learning systems. Due to the critical nature of this methodology, scholars have reflected on critical theory and have argued that some segments have not been critical enough. (Apple, 2003; Giroux, 1988; hooks, 2000; Kincheloe, 2000). As a key example, in the mid-1980s, Doll (1986) opened the door for the study of the criticality of complexity theory in relation to curriculum development in education. Suggesting that previous interpretations of Piaget, Dewey, and Bruner's theories of child development were only partially supported—or were incorrect altogether--Doll (1986) argued against determinism in critical theory and returned to the scientific community. Doll (1986) discovered that Prigogine and Stengers (1984) presented a further developed epistemological foundation in their descriptions of dissipative structures and systemic emergence, providing an epistemology for the investigation of critical theory.

Since that time, scholars in educational research have also begun a new source of investigation into the criticality of complexity theory, as is evidenced by this selection of articles for JCACS. Although we certainly do not claim to have definitive answers to this investigation, the conversation is in process, and perhaps this manifests evidence of at least a partially critical dialogue surrounding complexity theory. This article intends to add to this conversation by drawing from the methodological frameworks of the transformative education of Freire (2000/1970)--and the historio-hermeneutic and scientific analyses of contemporary complexity researchers--as a means to interpret the criticality of complexity theory in relation to group processes. By using the coterminous lenses of critical theory and complexity theory to understand their relationships, this analysis helps lend support to the potentially critical nature of complexity theory in an investigation of our own educational dialogues.

One influential educator and philosopher of critical theory, Paulo Freire, has provided us with a form of criticality from which I will

repeatedly draw for the interpretive aspect of this article. Having struggled with his own personal paradox of co-option to the middle class while remaining in poverty as a child in Brazil, Freire went on to serve the poor as a labor lawyer, a proponent for universal suffrage, and as an educator of the illiterate. His actions led to his subsequent exile from Brazil, and only later in life was he able to return home to São Paulo as secretary of education. Freire introduced the developing world to a radical approach to self-emancipation through education. But he equally influenced educators in the industrialized world through the recognition that analogies to these societal disparities exist in our modern approaches to teaching and learning.

A critical investigation of Freire's methods can help elaborate this epistemological framework within complexity science research. Freire's poststructuralist interpretations of power struggles within societal settings illuminate the need for alternative approaches to research in organizational dynamics. Throughout his career, Freire focused on process in education (Freire, 1998; Freire et al., 1997; Freire, 2000/1970). He was quick to criticize banking metaphors of education where teachers would deposit knowledge in the empty minds of students. He argued against education that focused exclusively on objectivity, as these methods inspire conformity and lead away from the meaning making that emerges through critical reflection. And, perhaps most importantly, Freire seemed to argue continually for recursive process. Although he used the term infrequently, we see it emerging iteratively through the evolution of his writings, from thematic investigation and dialogic to co-intentional education. Complexity science highlights the recursive processes of human interaction in nonlinear, open systems rather than attempts to predict deterministic outcomes in closed environments. And it is in the emphasis on recursive process that we see a close connection between complexity science and Freirean criticality.

In his comprehensive investigation of critical theory, Stephen Brookfield (2005) explains:

> The legacy of critical pragmatism has encouraged a skepticism regarding any attempt to plunder methods and approaches that are apparently successful in one political context (such as Freire's approach to conscientization and

> problem-posing education developed in rural northeast Brazil) and then to parachute them into quite different settings (such as American colleges and universities). (Brookfield, 2005, p. 37).

In an attempt to avoid oversimplification and universal application, in this article I seek to ground Freirean approaches through hermeneutical analyses and interpretation that connect Freire's arguments with the nonlinear, recursive, and interconnected views of complexity science. First, I focus on these analyses as a framework for understanding rather than as a traditional "method." Borrowing from Freire's long-standing argument that method is a subjective term which cannot be used without context (Freire, 2000/1970; Macedo, 1997), I use the term method in this article as a loose interpretation or alternative view of traditional, structured methods. Through historical and interpretive analyses of poststructuralism, I arrive at an epistemological framework for viewing Freire in relation to contemporary works by chaos and complexity theorists. I then argue that educators shift from non-communicative reporting mechanisms toward connected knowing while incorporating dialogic and thematic investigation. The use of these patterns of human interaction feeds bounded chaotic systems where emerging individual views are shared during the process of dialogic. At the same time, rigor in the search for connected meaning becomes an interchange between the desire both to listen and learn in a critically reflective manner. As a critique of overspecialization, interdisciplinary teams viewed through a dissipative structures lens amplify the micro-diversity needed to lead groups toward transformative bifurcations in complex systems. This recursive process of thematic investigation, therefore, enables us to find connections between complexity theory and the critical philosophy of Freire when leading and describing group processes in education.

A Poststructural Problematization of Complexity Theory

> To deny the importance of subjectivity in the process of transforming the world and history is naïve and simplistic. It is to admit the impossible: a world without people… World and human beings do not exist apart from each

> other, they exist in constant interaction (Freire, 2000/1970, p. 50)

Throughout Freire's career, a long-standing argument against positivism emerged. Freire pressed for emancipatory education that, in his view, frees both the student and the teacher from the oppressive grasp of positivist frameworks; models he attributed to perpetuating the philosophies of domination in education. "You either teach students to conform to the world or you have them critically reflect on the world in order to create freedom" (Freire, 2000/1970, p. 34). Although criticized by even his most admiring students for his focus on race and class at the omission of gender in his writings (hooks, 1994), Freire's (1997) philosophy evolved into a poststructuralist interpretation of the importance of socio-cultural plurality in human experience. The critical nature of this poststructuralist view has also been embraced in the field of complexity theory.

An analysis of Giambattista Vico's early eighteenth century New Science as a metaphorical epistemology shows the historical significance of previous educational challenges to positivism. According to Fleener (2005), Vico's characterizations of the evolution of scientific thought debated missed opportunities to broaden a philosophy of science by reflecting on poetic logic. Described by Vico as an ancient wisdom, poetic logic placed emphasis on metaphors and images that lead to individual interpretations of meaning. Scientific philosophies grew to discount this epistemological framework, however, preferring to focus only on the structures of quantitative measures that could be applied objectively. An unfortunate consequence, Fleener (2005) contends, is that we subsequently supplanted reason as an axiom for all of the mysteries of the universe.

We see further historical evidence of this poetic logic in education, relating to Freire's argument for the inseparability of humans from their environment in the creation of knowledge. Doll (2005b) summarizes Whitehead's approaches to educational curriculum in the early twentieth century through a romanticizing process. This attempt to develop "personal interest... with training" by "playing with knowledge" focuses on creativity, experience, and interconnected themes in knowledge development (Doll, 2005b, p. 31), similar to the poetic logic of Vico. In

recent scientific works there have also been attempts to balance living systems with their environment. Although the language of reductionism permeates many of our current modes of educational research, some of the scientific community has begun to embrace science in more subjective terms, focusing on a dialogue with nature (Prigogine & Stengers, 1984; Prigogine, 1997) and as a study becoming "more like human experience" (Complex Systems, 1999, p. 89). Echoing poetic logic, this lens for understanding our relationship with the natural world, therefore, captures the self-referencing inherent in self-organizing processes.

Fleener (2005) and Doll's (2005a) discussions help support the use of poststructural interpretation to investigate critically the evolution of scientific thought. Freire (1998) notes, "science, a human activity that occurs in the history that women and men make with their practice, is not, for this very reason, an a priori of history" (p. 76). Utilizing the historical development of educational theory, therefore, helps us visualize how educational methods have been implemented in somewhat sporadic ways that leave little room for complexity theory. Whitehead argued the inductive method was actually a product of naïve Medieval thinking, as described in Doll's (2005a) analysis of Medieval education. Ramus, a pre-modern curriculum theorist, taught subjects through his belief that the encompassing generality of canon could be broken down into its many taxonomies, exemplifying the deductive method. Comenius equally argued for didactics in an effort to simplify understanding, which could be said parallels the concept of "dumbing down" education. In Doll's (2005a) view, these simplified educational units would then become canonical truths which students would "discover" by studying them, unbeknownst to the a priori methods that had been chosen previously by the teacher (Doll, 2005a).

Since many early Protestants in North America preferred the method of Ramus (Doll, 2005a) we can see how this style continued to influence the evolution of American educational practices for many years to come with our textbook approaches to knowledge. Even today, instead of emphasizing a higher cognitive focus on teaching and learning, we see policy derived regression toward the teaching of components; that a measure of true outcomes relies on the ability to succeed at standardized tests; and that, rather than recognizing the dynamic relationships that

can be fostered through the interdisciplinary approaches to learning that Freire (2000/1970) suggests, we are building high walls between many of the disciplines.

Fleener (2002) expands upon this type of reasoning in her poststructuralist argument against the logic of domination and its positivistic influences in recent history. In *Curriculum Dynamics: Recreating Heart*, she contends that the current decline in educational reform is a result of the movement in higher education to focus on the hegemonic aspects of content knowledge while omitting the value of human experience. As a result of this modernistic framework, Fleener (2002) shows how these value-hierarchies reduce our students to becoming competent in areas that dominant cultures view as important. Consequently, if students do not excel in these areas, they are viewed as incompetent, leading to fractionalized inequalities in our schools and colleges. As an example, Fleener (1995) describes many of the issues surrounding educational curriculum development as deriving from the industrial sector's complaint that educators were not training students to meet the technical needs of their jobs. What managers in the industrial sector failed to recognize, Fleener (1995) contends, is that "the role of schools is not to supply students with a body of knowledge to carry them through the rapid changes of a technology world but to provide them with the ability to continue to learn and adapt to the flux of our changing world society" (p. 13).

In similar fashion, Doll (2005a) argues that Bacon did not prefer the humanistic nature of method, but rather endorsed a philosophy that might parallel the method endorsed by Freire. Bacon's contemporary, Descartes, however, exonerated method as a means to discover absolute certainty. And we have since continued the quest for certitude but have failed in finding it. If we look at this from a different perspective, the Enlightenment philosophers actually were searching for meaning through experience by using the scientific method. Yet once they realized the apparent power of prediction, experience in understanding became a subordinate to linear determinism. Through this lens we can see why Laplace chose to take liberties with Newton's theories and create a model of the universe that resembled a clock. We can see why Poincaré stumbled upon the defying principles of chaotic determinism when computing geometric calculations, yet he still was unable to break

free from the clock-like metaphor of the universe that appeared to surround him (Peterson, 1993).

In a challenge to describe the current discourse and direction of critical theorists, Brookfield (2005) suggests several main components that have been and should be discussed when analyzing the criticality of critical theory in learning environments. These include such concepts as challenging ideology and hegemony, unmasking power and overcoming alienation, learning liberation and democracy, reclaiming reason, and racializing and gendering criticality. Doll and Fleener's works discussed in this section, as well as Kincheloe and Berry's (2004) work on bricolage, provide evidence of scholars in complexity science research who have addressed Brookfield's (2005) analysis of the criticality of the learning environment. In the next section, arguments will be made that show how the works of Freire and scholarship in complexity science share a coterminous relationship that exhibits characteristics of both critical theory and complexity theory.

The Emergence of Complex Criticality

> The investigation of what I have termed the people's 'thematic universe' – the complex of their 'generative themes' – inaugurates the dialogue of education as the practice of freedom. The methodology of that investigation must likewise be dialogical, affording the opportunity both to discover generative themes and to stimulate people's awareness in regard to these themes… I have termed these themes 'generative' because (however they are comprehended and whatever action they may evoke) they contain the possibility of unfolding into again as many themes, which in their turn call for new tasks to be fulfilled. (Freire, 2000/1970, p. 96, p. 102).

Perhaps what makes the investigation of the criticality of complexity so intriguing is the focus on emergence within the critical system. Bak (1996) has performed many studies on self-organized criticality and has noted that, in an absence of external influences, the emergence of self-organization can lead to critical system states from internal

perturbations. And when a system reaches a critical state, there is a time for supercritical experimentation among agents within the system acting as a whole. Observation of this phenomenon is often absent or incomplete, because, while trying to appear more scientific, we impose subcritical methods of prediction on the system which lead it to simpler rather than more complex system structures (Bak, 1996). As defined by Mitleton-Kelly (2003, p. 42), "emergence in a human system tends to create irreversible structures or ideas, relationships and organisational forms, which become part of the history of individuals and institutions and in turn affect the evolution of those entities." Moreover, Osberg and Biesta (2007) have argued it is the very nature of this irreversibility in the creation of more developed, complex, and unpredictable system structures that lead to strong emergence. The interactions and interpenetrations of individual perspectives within group processes subsequently points to the summation of Freire's (2000/1970) work. The following sections will show how connected knowing, problem posing, thematic investigation, and dialogic interact to create a catalyst for the emergence of complex criticality within group processes.

Connected Knowing through Chaos

> So when members of the group are asked for information, their tendency is to equivocate and circumlocute, even in giving answers that we would give freely… Knowledge becomes precious and, therefore, hoarded… communication becomes constricted and convoluted, to guarantee that the precious hoard will not get into the wrong hands (Lakoff, 1990, pp. 146-147).

Chaos theory focuses on a system's sensitivity to initial conditions. Over time, very small fluctuations in a system can lead to unpredictable complex structural changes to the system, exemplified through the Lorenz Butterfly Effect of subtle turbulence in changing weather patterns. Mandelbrot Sets have shown the fractal nature of chaotic systems, where random and iterative calculations can exhibit high-level order. Furthermore, while bounded by a system's parameters,

continuing microscopic or macroscopic observations of the chaotic system leads to infinite levels of observable, complex order. Chaotic systems equally move in strange attractor patterns which exhibit behavior that are never repeated exactly with each iterative system loop.

The foundation of Freire's method encompasses the use of thematic investigation, a recursive process similar to that observed in chaotic systems. Thematic investigation relies on the process of problem posing education where reflection and action become critical to transformation. Likewise, chaos theory in education views critical reflection by the learner on his/her experiences as the most important self-referential aspect of the teaching/learning process. In this view, teaching becomes "ancillary" and is only one generative part of the complex learning process. The role of teacher shifts in educational focus to explore what is unknown rather than impart on students what is absolutely known (Doll, 1993). As a result, chaos theory in education relies on a process description of complex order and is a shift from discrete to relational forms of knowledge generation.

In effect, problem posing becomes a metaphorical strange attractor within the chaotic movement of the group environment. In group processes, Yukl (2000) describes self-managed teams as one of the highest levels of organizational development. Whereas teaching becomes ancillary in the complex classroom, work that is normally assigned by an administrator is voluntarily distributed among the group, usually facilitated by a team leader. The process of posing problems becomes a strange attractor pattern for the team, where each recursive loop of critical reflection changes the problem. And as a new problem emerges, the chaotic system moves subtly from its previous trajectory. Espejo (2003) notes that "it is only when this recursion happens that we have an autonomous social system, otherwise it may be argued that there is only a collective of people" (p. 57). Consequently, the ability for this phenomenon to emerge is sometimes limited by equilibrium-oriented communication patterns in education, where we speak as a "collective of people" rather than striving towards self-organizing criticality.

In "A Letter to Paulo Freire," Tarule (1997) articulates a need to refocus our view of communication towards dialogue that encourages connected knowing. One of the critiques of education, and perhaps

more so for higher education, is the disconnected communication patterns with which faculty tend to approach each other. As Lakoff (1990) has noted:

> The university alone trades only in language, discourse, communication. The university's only acts are speak acts… Truth and knowledge are linguistic entities, existing only through and in language. Only for the university is language an end in itself… We write and speak, but we do not communicate. This is our art. (Lakoff, 1990, p. 146).

This implies that in education we try to sterilize our experiences, and we tend to discount the critically reflective benefits of listening while treating ourselves as objects in the communication process. As a product of separating our experiences from others, the focus of our attention leads to separate knowing where we emphasize debate and "use a dialogue of 'report'" (Tarule, 1997, p. 12). Again we unconsciously attempt to educate not only our students but also our colleagues through the banking metaphor of education (Freire, 2000/1970).

Freire (2000/1970) describes these same types of individuals as those that try to impose positivism naïvely into human interaction:

> The investigator who, in the name of scientific objectivity, transforms the organic into something inorganic, what is becoming into what is, life into death, is a person who fears change. (Freire, 2000/1970, p. 108).

As Apple (2003, p. 115) contends, these empty conversations are the antithesis of Freire's method of dialogic, becoming "monologue masquerading as dialogue." Moreover, these communication patterns propagate what Ackoff (1981) describes as: "re-activism," where individuals move systems towards equilibrium; and "inactivism," where individuals attempt to prevent change, leading to closed systems.

However, Tarule (1997) suggests that connected knowing moves individuals away from communication patterns of reporting and towards rapport. "The speaker attempts to ensure that his or her colleagues in conversation are hearing and understanding his or her

perspective and he or she theirs" (Tarule, 1997, p.12). Each person focuses deeply on the meaning s/he is trying to convey, and at the same time re-creates his/her own knowledge based on the viewpoints of others (Gee, 1997). Doll (1993) similarly describes this process as recursive reflection where individuals reformulate their knowledge the deeper their explorations of meaning making become. The plurality of individual thought is iteratively contemplated and reprocessed by group members as they search for connectedness:

> In "negotiating passages" each part listens actively - sympathetically and critically - to what the other is saying. The intent is not to prove (even to oneself) the correctness of a position but to find ways to connect varying viewpoints. This engagement is a process activity, which transforms both parties. (Doll, 1993, p. 151).

Sheth and Dei (1997) extend this view of connected knowing, arguing for a renewed interest in collaborative writing which can lead to an increased awareness of the dialogical process. Connected knowing, therefore, transcends many of the linear deterministic frameworks for knowledge seeking, focusing instead on how we come to create meaning in our communication with others.

It becomes clearer that group processes that function through connected knowing can operate as chaotic systems within the larger complex adaptive system, such as the college or school. Espejo (2003), sees this as a process of reciprocal structuration, where flows of information both influence the structure of the social system while the system conversely influences individuals' social roles within it. Information flowing into this chaotic system can act as a basin of attraction to which the group continually moves. When groups begin to communicate through the use of connected knowing, information begins to flow into and within the system, causing it to become an open system. Individuals within the team discuss their interpretations of what they hear from external sources; they recursively reprocess information as each team member describes his/her interpretations of experience.

Complex Interpretations of Dialogic

> Only dialogue, which requires critical thinking, is also capable of generating critical thinking… The investigation of what I have termed the people's 'thematic universe'… must likewise be dialogical, affording the opportunity both to discover generative themes and to stimulate people's awareness in regard to these themes. (Freire, 2000/1970, p. 92, p. 96).

Complexity theory focuses on studying patterns and relationships through the phenomenon of self-organization. During this process, no individual element determines systemic outcomes, rather the emergence of a system's further complexity takes place when system elements interact collectively. Observations of complex systems are typically bounded by the parameters of the observer, implying that the observer becomes a participant in the complex system through his/her observation. Since differences exist qualitatively between and within complex systems, methods for studying them are normally limited to phenomenological description. Additionally, while observing a complex system, the more one tries to control the processes or structures of the system, the less descriptive his/her qualitative understanding of these systems becomes (Complex Systems, 1999).

Freirean method might describe this self-organizing phenomenon through the concept of dialogic which represents a process of group mediation "in order to name the world" (Freire, 2000/1970, p. 88). Expanding on connected knowing, dialogic is a give and take encounter where one must be a willing participant. In Karpiak's (2000) view, complexity based transformations of individuals cannot take place without them equally being willing to participate in their own experience of transformation; or, as Doll (1993) describes, that complexity in group processes is contingent on the willingness of the participant to describe and interpret his/her own reflections on meaning. Freire (2000/1970) also recognizes that this interaction in dialogic is a process of creation and re-creation. As with complex systems, there is a recursive process of self-organization where individuals return as a group to the subject of

investigation, and new meaning emerges through group interaction in the dialogical cycle.

Freire's dialogic also focuses on moving beyond connected knowing through what Doll (1993) describes as rigor. Dialogic suggests that the search for connected meaning becomes an interchange between the desire both to listen and learn in a critically reflective manner, not only to others but to one's own voice. Moreover, it is a study of "rigorous discipline" that relies on an individual's motivations towards reflection (Freire, 1998). When incorporating rigor into group processes, individuals must consciously be aware of the assumptions that have led to their current perceptions of knowledge. "Due to the cathartic force of the methodology, the participants of the thematic investigation circles externalize a series of sentiments and opinions about themselves, the world, and others, that perhaps they would not express under different circumstances" (Freire, 2000/1970, p. 118). Rigor is a disciplined approach where groups must constantly search for and reflect critically on these assumptions. Equally, the use of rigor can be extended by bringing in the opinions of others outside of our normal frames of reference.

Amplifying System Diversity in Dissipative Structures through Interdisciplinary Teams

> In this way, the themes which characterize a totality will never be approached rigidly. It would indeed be a pity if the themes, after being investigated in the richness of their interpenetration with other aspects of reality, were subsequently to be handled in such a way as to sacrifice their richness (and hence their force) to the strictures of specialties. (Freire, 2000/1970, p. 120).

Scientists have recently turned to complexity theory to address the anomalies of reductionism and the over specialization of the scientific community (Complex Systems, 1999). As Lakoff has observed, "we do less communicating with colleagues in other fields at our own institutions" (Lakoff, 1990, p. 148), and McLaren (1997), in his postmodern challenge "Freirean Pedagogy," furthers this view in his

critique of modernism. He argues we have become obsessed with a framework which leads to specialization and perpetuates our disconnected searches for truth. Through a complexity science lens, we can see that this over emphasis on specialization could be said to push individuals to act as multiple closed systems within a complex adaptive system that consequently loses its ability to consume external energy. As a result, the complex system's abilities to transform internal perturbations into positive bifurcations begin to dissipate. Doll (1993) describes this environment most poignantly:

> Teaching machines and programmed learning control change in restrictive, incremental units, purposively designed to avoid error… [In] a post-modern view… change is seen in transformative, not incremental, terms; and errors are seen as necessary actions in the process of development: the motors which drive development (Doll, 1993, p. 20).

Freire (2000/1970) also challenges this focus on over-specialization through the use of interdisciplinary teams to prevent the perspectives of individuals within groups from becoming myopic. Each of these team members reflects on the same theme but views it from his/her own knowledge and experiences (Freire, 1998). The use of interdisciplinary teams and outside members are catalysts for generating and analyzing themes that emerge during the process of thematic investigation. Freire is describing a method for bringing people with different backgrounds together, a method he applied successfully in his work in urban school settings (Sieber, 1997). Mitleton-Kelly (2003) has described this process through endogenous co-evolution, where the evolution of individuals and groups within an organization relies on the interactions of each for development to take place. Metaphorically, we can view this as the essence of a complex system, containing disparate but interrelated parts acting congruently. Moreover, this method focuses on system diversity, similar to dissipative structures.

Dissipative structures theory has been most widely attributed to the 1977 Nobel Prize Laureate, Ilya Prigogine, in collaboration with his long-time colleague Isabelle Stengers. When systems are near equilibrium,

they exhibit features of--and can be measured through--the traditional linear deterministic methods of classical mechanics. However, if a system is driven into a far from equilibrium state through internal or external perturbation, such as with thermodynamic systems, it has the potential to move beyond the edge of chaos into a bifurcation point. Relying on microscopic diversity of the system's elements, these bifurcations constitute a transformative split of the system where one or more higher level ordered structures emerge. Osberg and Biesta (2007) describe this theory through strong emergence, unique from the contemporary concept of emergence in that something radically novel is created during the process. In dissipative structures, irreversible transformative changes take place at both the microscopic and macroscopic levels not as a result of randomness, but rather because the system's microscopic diversity has been amplified (Stacey, 2003).

Interdisciplinary teams highlight these characteristics of dissipative structures. Teams composed of a number of different subject specialists provide redundancy during thematic investigation. Each team member will embrace and re-analyze the themes from their own perspective even repeating the same process other team members have already experienced. As Prigogine and Stengers (1984) note, this redundancy provides the dissipation of entropy at high enough levels to feed bounded chaotic systems. Metaphorically, the hyper-consumption of an exponential amount of views interpreted by different subject specialists can lead organizations to bifurcate to new, highly developed complex systems (Freire, 1998; McLaren, 1997; Prigogine, 1980; Prigogine & Stengers, 1984; Sieber, 1997). Conversely, similarity among individual elements moves a system towards equilibrium. By bringing a group of people together from different backgrounds, therefore, we are able to amplify the diversity of the group, leading to potential transformative outcomes of the group's experience.

Thematic investigation also focuses on an investigation of reality, and learning to lead group processes perhaps requires a frame of reference that Freire (2000/1970) describes as co-intentional education. In his view, reality does not exist independently of our being. Rather, we are "co-intent on reality": in discovering reality, critically reflecting on it, and recursively making meaning out of it. Emerging individual views, therefore, become pluralistic shared experiences. We move from a

framework of being in the world to a process of becoming part of the world. This same framework can be incorporated into complexity theory in our descriptions of human interaction in group settings. It is through co-investigation with our colleagues that we are able to reflect on and increase our awareness of our own reality. Through our investigation of meaning in process-oriented, interdisciplinary teams, we re-create reality while becoming more aware of the group's holistic nature.

This method of thematic investigation is, therefore, exemplified in an interdisciplinary team environment, as individuals reprocess information from the micro to the macro system level. Again we see Freire's description of group processes involving recursion, self-organization, and self-referencing. Problem-posing reflections lead to recursive dialogue as an "emergent themes" method, metaphorically and methodologically similar to Freire's (2000/1970) decoding method. The dialogue that takes place in what Freire calls "thematic investigation circles" becomes a reciprocal relationship built on mutual trust and a faith in the ability to re-create the organization (Freire, 2000/1970).

I suggest that Freire's philosophical and methodological frameworks uniquely parallel the main concepts of dissipative structures theory and, perhaps, provide generative metaphors for our analyses of complexity theory. His critiques of both the right and the left, the revolutionaries and the incumbent power forces, the urban and the rural, highlight this amplification of microscopic diversity in a system by bringing all groups together. Additionally, Freire (2000/1970) argued that teams composed of outside members are integral to the process of thematic investigation. He showed the importance of individuals in each of these groups to reflect critically and collaboratively in order to change the condition of the world. Most importantly, the developmental result for Freire was a truly transformative experience, not only educationally, but one of complete transformative existence of both the individual and of the society.

Conclusion

This article is not intended to implement Freire's ideas as universal techniques for leading group processes. As Freire (1997) notes, "there is no contextless Freireian method that can be used as a template" (p. xvi).

The knowledge gained from this article, most importantly, is expected to strengthen the relationship between the critical poststructuralism of Freire and the recursive and emergent aspects of complexity science, while simultaneously providing support for the criticality of complexity theory. It is the focus on our communication patterns, thought processes, and interconnected relationships with others in how we lead and participate in group processes that resemble attractor patterns for constantly recreating our own histories and understanding.

In writing this article, I have attempted to show historical and hermeneutical analyses of the problems presented with positivist educational research and approaches to group processes by focusing on the criticality of complexity theory. I suggest a new, critical perspective of connected knowing that increases our chances for the phenomena of complex systems to emerge. A chaos theory and dissipative structures approach also highlights the recursive group processes that lead to higher levels of critical meaning making through thematic investigation and dialogic. And, equally, I contend that the use of interdisciplinary teams provides deeper, more generative, and more highly developed methods for reflecting on problem-posing education.

In ending this article, I would like to reinforce Doll's (1993, 1986) focus on recursion by returning not to the Conclusion but to the Preface of Pedagogy of the Oppressed. Richard Shaull eloquently summarizes Freire's belief in the world that:

> Man's ontological vocation… is to be a Subject who acts upon and transforms his world, and in so doing moves toward ever new possibilities of fuller and richer life individually and collectively. (Freire, 2000/1970, p. 32).

As we investigate future approaches to educational research, I challenge each of us to question how we might investigate further the criticality of complexity theory. Perhaps, by incorporating the philosophy of Freire into the development of our critical and complex systems *Weltbilden*, we will be able to recognize further a transformative and critical web of learner focused meaning making; a web in which all of us are active participants in the learning process.

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About the Author

Donald Gilstrap is an Associate Professor and Associate Dean of Libraries for Technical Services at the University of Oklahoma. His main areas of research and scholarship focus on complexity theory in leadership and organizational dynamics, as well as nonlinear change in international educational settings. The author can be reached at gilstrap@ou.edu.