Complexity, conceptual models, and teacher decision-making research

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Abstract

Informed by complexity research and models for analyzing conditions in complex adaptive systems such as schools, I describe findings from a descriptive case study of influences on teacher decision-making about writing instruction in a high-stakes writing assessment grade. I highlight how the use of complexity as a theoretical framework for research provides a unique look at education systems, particularly looking at one teacher's decisions across a school semester. I focus specifically on two conceptual models from the field of human systems dynamics (HSD), one used as a conceptual framework for complex adaptive systems, and the other used as a retrospective analysis tool in describing and explaining underlying conditions at work at a particular time for a particular decision.

Introduction

When I first began my teaching career, one of the many challenges in learning to be good at my job was figuring out what that meant. What did it mean to be an expert teacher? My background in business management and operations systems analysis was useful. I understood that the larger education system had many interconnected parts and that these parts worked together in ways that clearly constrained what I could do. As a beginning teacher, I often received contradictory instructions and was required to perform tasks that did not make sense to me. I saw that policies and practices at the local, state, and federal level influenced my teaching. This long-term interest led me to develop research to discover how policies created far from the classroom influence decisions at the classroom level—even in unintended ways.

During one of my doctoral courses I was introduced to theories about complex systems and saw these as a potential theoretical framework for my research. Like Hetherington¹ who explored the implications of complexity thinking and methodology in educational case study research, I was interested in conducting a qualitative case study that took into consideration the complexity of educational contexts. This article discusses what I learned from conducting qualitative research in classrooms when I used complexity science as a theoretical framework². In fact, I found one particular approach from that body of work particularly useful—the field of human systems dynamics (HSD)³⁻⁴. HSD is a theoretically grounded yet practical approach to working in complex systems³ that proved useful in researching the classroom system I studied. The following discussion is drawn from a larger study of the decisions made by a high school writing teacher who was responsible for preparing students for a high-stakes writing test. I focus on how forces in larger educational systems influenced this teacher, specifically on how assessment policies influenced decisions about writing instruction.

The research study discussed here was designed from beginning to end focusing on complexity in schools. According to Cillier⁵ education systems are not just complicated, these systems are complex because they involve "living things, language, cultural, and social systems"⁶⁻⁴¹. The behavior of complex systems must be determined by describing relationships rather than rules⁶. For this study, questions were asked about how the system was defined and structured around literacy to determine relationships among subsystems and levels in the system from state to district to school. Data were gathered to determine who or what drives change in this particular school system. Questions were asked about "not just what people do but why they do it, how they might imagine things being different, and what they would really want to do"¹²⁻³ by asking questions about what the teacher was thinking and doing, and what was contributing to those thoughts and actions⁶. Interviewing and observing in the system over a period of time acknowledged that education systems are self-organizing, dynamic, and emergent⁶⁻¹⁰. Descriptions and explanations about the system from the district level to the teaching in a teacher's classroom were gathered to showcase the "multi-dimensional, non-linear, interconnected, far from equilibrium and unpredictable" nature of complex education systems¹⁰⁻¹⁸².

Emergence: Complexity and Organization
This study focused on one level in an education system, the teacher. However, focusing on one level with a complexity approach does not “reduce the multi-dimensionality, non-linearity, interconnectedness, or unpredictability” that are encountered at other levels of the system\textsuperscript{10,182}. A complexity lens can provide insight in understanding underlying relationships and patterns where they happen with teachers, classrooms, and schools as human systems because the whole is present in the parts\textsuperscript{11-12}. Thus, this research was designed to discover and describe relationships in this education setting, acknowledging that understanding context in education systems is absolutely critical\textsuperscript{3}.

Using complexity as the theoretical framework for this study influenced decisions from beginning to end from whom to interview to what questions to ask. In order to understand how a teacher makes decisions in the systems in which she works, the district language arts coordinator and principal were interviewed using a semi-structured interview protocol to learn about state, district, and school policies and practices around literacy. The classroom teacher chosen for this study, Ms. Anderson (pseudonym), was selected specifically as a purposeful sample\textsuperscript{14} because she taught in a writing assessment grade in a state where a high-stakes writing assessment was part of the state accountability system. She taught Regular English I (ESL), Regular English II (ESL), and Pre-AP English I in a high school in Texas where both English I and English II require a writing assessment at the end of the school year. She was interviewed across a fall semester using a semi-structured interview protocol and observations were done in her classroom and at grade level team meetings in order to learn about these systems. The research questions were:

- What does writing instruction look like in a writing teachers classroom(s) in a high-stakes testing context?
- What influences this teacher’s decisions about writing instruction?

Initial data analysis for this study was done using the constant comparative method\textsuperscript{5} using field notes and transcriptions from interviews, classroom and grade-level team meeting observations, and student and teacher artifacts. Data were coded and patterns were identified. Using these patterns, a secondary analysis was done using one particular model from HSD as an analysis tool to further describe and explain this teacher’s decisions about writing instruction.

**Research about complex human systems**

Horn\textsuperscript{12} describes the science of complexity as the emergence of a new paradigm to help us understand social systems and subsystems and their emerging behaviors. This paradigm challenges some of the foundational assumptions of positivism because complexity science assumes that human social systems are open, diverse, nonlinear, and interdependent\textsuperscript{8}. An explanation of each of these features of complex, adaptive, and self-organizing systems and the implications for writing instruction provides a brief but useful definition of complexity.

- Open-The whole and parts of complex systems are susceptible to influence. In a classroom, learners can be viewed as agents in multiple, layered, and overlapping systems, both inside and outside of schools. On an individual level, classroom interactions can clearly be influenced by peer relationships, family expectations, recent events on campus, and even the weather. On a larger scale, classroom interactions are also open to influence from external policy mandates, public pressure, availability of resources, and changing demographics.
- Diverse-Participants in the system are different across many dimensions-age, gender, language, ethnicity, race, sexual preference, and socio-economic status, just to name a few. The contexts and conditions that potentially might influence the system are also diverse.
- Nonlinear-Parts of the system interact in nonlinear ways. In other words, interactions between and among students and teachers are interdependent; each response influences ongoing interactions. It is futile to look for one “root cause” of an action because the influences are many and massively entangled. This nonlinearity, of course, calls into question any assumptions we may have about direct causal links between policy and practice.
- Unpredictable-Particular actions are not predictable, although patterns emerge over time. In schools, all of these diverse, nonlinear interactions make for unpredictable student (and teacher) responses-responses to one another, to the curriculum, to high stakes tests, and to teachers.
These attributes contribute to the continual emergence of new patterns in these complex systems. Some theorists use the term "self-organizing" to point to the fact that change is generated within these systems—from the interaction among these interdependent components or agents of the system. This perspective offers a powerful lens for the study of teacher decision making.

Lemke and Sabelli⁷ propose the development of a conceptual framework for analyzing education as a complex system, calling for a change in perspective. In their research on analyzing the effects of educational reforms they learned that education systems are complex and challenging systems to research and that using a complexity perspective acknowledges that changes in education systems are not independent. For example, in their research on interventions Lemke and Sabelli note that "proposed changes at the classroom level have implications at school and district levels (e.g., for teacher development, parental expectations, school resources, accountability, and so on) and need to be supported by related interventions across multiple levels". Complexity offers explanations and descriptions of how things actually are in many school systems—self-organizing, dynamic and emergent⁸. In encouraging complexity perspectives, Kuhn⁹ addresses complexity and education this way:

**Complexity and education may be brought together because in the language of complexity, such human cultural settings, productions and institutions as educational endeavor are complex and dynamic. Individual human beings (learners, educators, and administrators), various associations of individuals (classes, schools, universities, educational associations) and human endeavor (such as educational research) are multi-dimensional, non-linear, interconnected, far from equilibrium and unpredictable.**¹⁰⁻¹²

A complexity approach notes that there is complexity in this human system at all levels and that focusing on one level does not "reduce the multi-dimensionality, non-linearity, interconnectedness, or unpredictability encountered"¹⁰⁻¹² at the other levels. With human systems, the whole is present in the parts. Complexity offers insight into teachers, classrooms, and schools as human systems, looking at learning patterns and shifts in those patterns where they happen¹¹⁻¹².

Complex systems approaches are becoming more common in education research, for example, in the study of educational reform¹⁶⁻¹⁷, at-risk populations¹⁷, learning culture¹⁸, curriculum¹⁹⁻²⁰, and professional development²¹. Other researchers using complexity theories in education include perspectives on teaching and classroom practice in social studies classes⁹, considering small-group project based learning from the perspective of complex adaptive systems²², and analyzing teacher learning and learning communities as complex systems²³⁻²⁴⁻²⁵⁻²⁶. In another example, a recent review of the literature on teachers’ professional development practices highlights the need for a “complex conceptualization of teacher professional learning”²⁷⁻³⁷, drawing heavily on complexity theories. Also, many literacy researchers have published studies using complexity thinking across various topics²⁸⁻²⁹⁻³⁰⁻³¹. My research was designed to contribute to this wide array of educational research using complexity.

**Complexity and human systems dynamics**

I found the work of Eoyang in human systems dynamics³² particularly useful in studying teacher decision making. Complexity theories up until now have been mainly descriptive, but human systems dynamics not only describes but can also be used to explain how they work and how they can be influenced to bring about change. Eoyang³², in analyzing human systems, developed an integrated model of self-organizing human systems by bringing together principles from mathematics, physical and social sciences. The field of theory and practice emerging from Eoyang’s research³ has been applied in multiple disciplines and in multiple contexts. It continues to evolve, but two foundational concepts have been essential to my research about teacher decision-making. The first is "pattern logic," or the assumption that in complex adaptive systems, agents interact to generate patterns of behavior, discourse, expectations, etc., and that any agent within the system can look for those patterns, name them, interpret them, and generate options for action that may have the potential for shifting those patterns. The second foundational concept in HSD is that in all complex systems, we can identify the three underlying conditions for self-organization. These two concepts, or models, are described in detail below.

**Pattern Logic**

Although there are many definitions and representations of complex adaptive systems³³⁻³⁴ the Eoyang Pattern Logic model is represented as a process with a pattern-forming cycle. This provided the conceptual model for complex adaptive systems used in my research, and the Conditions for Self-organizing Systems model (described below) was used during data analysis as a retrospective analysis tool as a way to see and set conditions for patterns (see Figure 1). In Eoyang and Holladay’s work, a complex adaptive system "is a cluster of individual parts that interact with each other, and over time system-wide patterns appear… Those patterns then influence later interactions of the agents"¹⁵⁻¹⁶. The Pattern Logic model also incorporates foundational philosophies of perception and knowledge that are particular to the workings of human systems. The model is designed to capture, in both theory and practice, “the dynamics of human systems at all scales in ways that inform decision-
making and action taking in complex and uncertain environments. In Figure 1, the agents (people, groups, or ideas) are the circles at the bottom that interact with each other. The arrow at the right shows how, over time, the interaction of the individual parts creates a coherent pattern. After this pattern appears, it then feeds back into the individual agents encouraging those agents to adopt the pattern in future cycles. According to Eoyang and Holladay, because relationships between agents are in constant flux, “a stable, permanent reality is impossible; uncertainty becomes the rule.” Also, systems are not limited to members within the system as members of other systems may be shared and out of view. For example, “one individual agent may be a member of a team, and be influenced by patterns outside of the team inside the organization, by the patterns in his or her own family and community, even by political forces on a national or global level.”

There are many examples of complex adaptive systems in human interactions. In human systems, emergent patterns are generated when parts interact at the same time as “patterns influence parts and their interactions. The result is a self-generating self-organizing reality of human systems dynamics. This worldview applied to human systems requires different ways of thinking and is foundational for this study of teacher decision-making in a school context.

### Conditions of self-organizing systems (CDE model)

The second foundational concept or model developed by Eoyang that was particularly useful for studying teacher decision-making describes the three conditions of self-organizing systems. I will refer to this model as the Conditions of Self-Organizing Systems model or the CDE model interchangeably throughout the paper. This model is designed to explain self-organizing processes in human systems, although Eoyang has challenged scholars to engage in inquiry that may move this model from “the realm of conceptual … into the realm of computational modeling.” A pattern is defined as “similarities, differences, and connections that have meaning across space and time.” The CDE model is also designed to provide information on ways to influence or act upon the system, although only the piece designed to describe and explain the system was utilized for my research study. Thus, this model is used as a tool in this research study to describe and explain patterns in the similarities, differences, and connections in the data gathered from the participating teacher about the systems in which she is a part. Use of this model as an analysis tool provided insight into decisions that the teacher was making during my study at the moment the decision was being made.

The CDE model is described in detail below. This model contains three meta-variables representing conditions that influence processes for self-organizing in a human system.

**Container** The first meta-variable is called container (C) and represents any conditions or parameters that bind the agents of the system “close enough and long enough that they will interact to create a new pattern.” Containers can be physical, conceptual, or social — anything that is similar in the system. For example, in an educational system a physical container can be a classroom, a school building, or a state boundary. A conceptual similarity may be a shared idea or philosophy of teaching and learning or a shared language. A social boundary may be age or participation in a school club. A conceptual container may be a classroom, a school building, or a state boundary. An exchange is a connection that carries energy.

**Difference** The second meta-variable in the CDE model is difference (D). This variable is designed to capture all the differences that may influence change in a human system. Differences can be any kind as long as they are significant to the agents in the system. Differences can show a pattern as it emerges, but differences can also show potential for change in the system. “At any given moment, in any given human system, at any given scale, an indeterminate number of differences articulates the systemic pattern and holds the potential of the system to change.” The differences that matter are the differences that influence self-organizing processes and are sometimes called “differences that make a difference.” In one example, state or local policies in schools are sometimes put in place over the summer when teachers are not at work. Sometimes these policy changes require teachers to adjust room assignments, teaching assignments, lesson plans for instruction, curriculum choices, or other parts of their work quickly at the beginning of the school year. Some of these required changes may be small, but others may require major decisions by those affected by the changes. In another example, a collaborative teaching partner may get sick and go on an extended leave from school leaving the remaining teacher to adjust to the loss of a colleague in various ways. The main idea, though, is that some differences make a difference to the agents in the system and some do not.

**Exchange** The third meta-variable in the CDE model is exchange (E). An exchange is a connection that carries energy,
resources, or information among or between the parts of the system. Exchanges show connection between parts of the system and provide information about relationships during the entire self-organizing process. Eoyang and Holladay call exchanges the "engine for self-organizing change"\textsuperscript{4,29}. For example, a school newsletter may be distributed once a semester to the parents through the regular mail in English. This exchange of information may be delivered in alternative ways (e.g., e-mail, posted on a website). It may be delivered more or less often (e.g., once a week, once a month, twice a semester), and it may be translated into other languages depending on the demographics of the student population. Any of these would be a change in an exchange that may influence the school as a self-organizing system in a variety of unpredictable ways.

The CDE model helps name and explain underlying relationships that influence the process of emergence in self-organizing human systems. Change in one (C, D, or E) results in changes in the other(s) as they are connected and dependent on each other. It is also important to note that the model is scale free (not hierarchical)\textsuperscript{4} and can be used at multiple scales in human systems. For this research, the model was used at the level of the teacher.

The Conditions of Self-organizing Systems model has been used in research to analyze complexity in various disciplines. For example, researchers used the model to study international relations and foreign policy\textsuperscript{36}, social policy\textsuperscript{37}, and education\textsuperscript{35-38}. In education, Patterson et al.\textsuperscript{35} used the model in their work with schools as a way to teach agents in a complex school system to notice, understand, and influence patterns around change in schools. They learned that when agents in the system know how to recognize patterns that represent conditions for self-organization in the system, those agents can then make decisions and take action to shift one or more of the conditions which could influence the emergent patterns. In other research in schools, high school English teachers used their understanding of containers, differences, and exchanges as conditions for self-organization to make decisions that influenced learning in their classrooms, particularly for English language learner\textsuperscript{38}.

Use of CDE model in research of teacher decision-making

A complexity theoretical framework informed by Eoyang’s Pattern Logic model was used as a foundation for the design and implementation of my research. The initial data analysis phase yielded many patterns about Ms. Anderson’s teaching and about what influenced her decisions about writing instruction. For example, for research question one, about what writing instruction looks like in a writing teachers classroom(s) in a high-stakes testing context, I found a variety of patterns, such as: (a) Ms. Anderson used a variety of resources and new ways to teach her class, (b) Ms. Anderson promoted choice, audience, and discussion in her classroom, and (c) Ms. Anderson modeled herself as the kind of learner she wanted her students to be. Other patterns were found for this research question as well. For research question two about what influences this teacher’s decisions about writing instruction, I also found patterns, such as: (a) Ms. Anderson’s opportunities to write curriculum for her school, district, and for outside of school curriculum influenced her decisions about writing instruction, (b) Ms. Anderson was influenced in a variety of ways by testing practices at all levels of the system — state district, school, and grade level, and (c) Ms. Anderson’s instruction was influenced by her beliefs about students. Other patterns were found as well.

The CDE model was used in this research as a data analysis tool. Any of the patterns found in the initial analysis phase could be examined more closely using the CDE model as a retrospective analysis tool to speculate about or explain what conditions may have been at work at a particular time and place for a particular decision. I chose to focus on the pattern that testing influenced Ms. Anderson’s decisions about writing. Once I chose a pattern to analyze, I reviewed the data that contributed to the pattern of interest looking for points in time where Ms. Anderson identified a challenge, tension, or constraint that led to a decision. HSD uses the word tension as it is used in physical systems (like the tension in a rubber band)\textsuperscript{4}. Tensions emerge where there are differences and tend to influence decisions made in the system.

Through this process I chose three decisions made by Ms. Anderson that the initial data analysis showed to be directly or indirectly related to testing policies and practices. These decision points represented three scales of decisions, a policy decision (why), a curriculum decision (what), and an instruction decision (how). I then analyzed these separate decisions using the Conditions of Self-organizing Systems model to try to identify, describe, and explain conditions that may have triggered or generated the decision at that point in time.

Use of conditions of self-organizing systems model for analysis
In order to show how I used this model as an analysis tool at this point in my research, I describe the analysis of Ms. Anderson’s decision to use a series of lessons culminating in concept maps (a curriculum decision). This decision point was identified in the initial analysis as a decision that was influenced by multiple patterns noted in the data. One pattern was that Ms. Anderson’s experience with curriculum writing influenced her decisions about writing instruction in her classroom. This teacher decision was also indirectly influenced by End of Course (EOC) testing requirements by the state because one of the factors included in this decision related to particular types of questions on the EOC test that required a written answer. Also, particularly for Ms. Anderson’s Pre-AP students, a testing influence on this decision was consideration of the type of AP writing those students would be required to do on future AP tests. This particular teacher decision also was influenced by curriculum in that it revolved around the type of lessons that would benefit students most for particular requirements from the curriculum for the course – analyzing themes in literature, providing textual evidence, and embedding quotes.

**CDE analysis.** In previous years, Ms. Anderson required students to write an essay after analyzing the theme in a novel using textual evidence to support their thesis, a requirement of the curriculum. This year she chose to have students create concepts maps instead. For my analysis of this decision I chose three containers (C) identified from the data that pertained to this decision. One container was the English department chair and Ms. Anderson planned together for Pre-AP English I on a regular basis. Although Ms. Anderson chose to incorporate concept maps for all of her classes (Pre-AP and regular), the fact that she had the English department chair to work with on this curriculum piece for her Pre-AP classes was an important factor. A second container was the nature of writing assignments in this course. The third container was curriculum criteria as Ms. Anderson had definite ideas about how curriculum fit into her decisions for her classroom. For each container I identified in the data three differences (D) and three exchanges (E) that were relevant to this decision. Following is a CDE analysis of this decision (Table 1).

<table>
<thead>
<tr>
<th>Containers</th>
<th>Differences</th>
<th>Exchanges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) English department chair plans together with Ms. Anderson for Pre-AP classes</td>
<td>• Consistency in planning calendar for Pre-AP • Coherence with curriculum for all Pre-AP English I students (not used by any other teachers in the school) • Coordinate use of lesson plans for various concept map activities – grammar and Ender’s Game</td>
<td>• Collaborate often in the hall and after school • Share ideas and resources for all curriculum units for Pre-AP • Share ideas for other English courses taught by Ms. Anderson</td>
</tr>
<tr>
<td>2) Nature of writing assignments</td>
<td>• Engage in lengthy writing projects from idea to publication • Incorporate different types of writing – literary analysis with embedded quotations • Incorporate school initiatives – critical writing and project-based learning</td>
<td>• State and AP curriculum requirements • Outside of school – professional development, professional books, National Writing Project (NWP) colleagues • Internet through The Teaching Channel, blogs, etc.</td>
</tr>
<tr>
<td>3) Curriculum criteria</td>
<td>• Provide foundational thinking for future learning (literary analysis and analyzing themes) • Fits multiple rigorous requirements – learning by doing • Consistency with state standards and assessment requirements (particularly to provide textual evidence and writing similar to short answer and crossover questions on the EOC)</td>
<td>• State curriculum requirements • State reading and writing assessments • Voluntary professional development</td>
</tr>
</tbody>
</table>

To show the type of data that was used to create this table, here is an excerpt from a transcript of Ms. Anderson’s thinking about her decision to use concept maps this year. During an interview, I asked her where the series of concept map lessons came from and if these lessons were something the rest of her grade level team members were using. She replied that she and her neighbor English I Pre-AP teacher (the English department chair) were doing them and described her thought processes about this decision.

[I]t came from a combination of things but it was the idea of a Teaching Channel … videos. One of them is laying the foundation and she’s talking about literary analysis and then the other one is pattern holders … then I read a blog … of a teacher who is talking about a concept map … that was his culmination project that matched with this work … and then there’s another blogger who [wrote] … about bringing creativity back into the English classroom. I had come across that before but then actually Kylene Beers referenced him because he took her signposts stuff and was showing how he had his kids use the signposts, and they do concept maps all the time … and so all of that thinking basically helped me decide how I wanted my kids to show me that they could analyze a theme in a novel using the signposts and using textual evidence.
Other data (classroom documents, curriculum documents, grade level team meeting notes, transcripts from other interviews on this topic, etc.) were also used to analyze this decision.

The CDE analysis showed that there were several reasons why Ms. Anderson chose to use concept maps with her students. For one, she was searching for new resources. When she came upon these lessons in her search, there were enough similarities in the lessons with the curriculum for all of her classes and with the requirements for the EOC tests at the end of the semester that choosing to incorporate concept maps in her curriculum for all of her classes was an effective teacher decision. The fact that Ms. Anderson still had the English department chair available to collaborate with her on these concept map lessons (they were also incorporating close reading lessons together) made it possible for her to also include concept maps into her Regular English I and Regular English II classes even though there were no other teachers of those classes using these lessons. A difference that made a difference for this decision was that the concept map project required higher level thinking from all of her students in all of her classes than what she had done in previous years, filling a need in her curriculum while also fitting in with a school initiative on critical writing identified in a previous interview.

Also, this analysis provided additional insight supporting patterns from the initial data analysis. For example, the analysis provided more descriptive and explanatory detail on this particular curriculum decision that affected Ms. Anderson’s Pre-AP and Regular classes through sharing ideas and resources in various ways with the English department chair. This supported a pattern from the initial analysis that Ms. Anderson valued collaboration with her colleagues. The analysis also supported initial patterns noted that writing needed to fit the needs of students, that writing assignments needed to involve the writing process and have purpose, that writing assignments must also consider curriculum requirements, and that resources were available from a variety of places to support this idea. Other patterns from the initial analysis of data corroborated in this analysis were that (a) curriculum should have multiple purposes, (b) curriculum needs to fit state curriculum and assessment requirements, (c) curriculum resources can be found from outside of school sources, and (d) curriculum should provide foundational learning for students.

The CDE analysis of Ms. Anderson’s decision to use concept maps this year showcased how an idea emerged out of her self-organizing process in response to many factors, curriculum requirements, school initiatives, and EOC testing requirements, to name a few. This specific instance also helped to see the pattern more clearly that Ms. Anderson’s instructional decisions were significantly influenced by state curriculum and state testing requirements, among many other things.

Although I have only included one example of using the Conditions of Self-organizing Systems model as an analysis tool, using this model to analyze these decision points provided more detailed description and explanation of a variety of decisions made by Ms. Anderson during this study. The purpose for these additional analyses was to look more closely at a pattern found during the initial data analysis that state testing influenced Ms. Anderson’s decisions about writing instruction by using three scales of influence—policy, curriculum, and instruction. These analyses provided additional insight into the conditions at work in this system that helped shape decisions at each of these levels for Ms. Anderson. Analysis of all three decision points showed that high-stakes testing was extremely influential in decision-making at all of these scales, supporting a finding in the research.

**Discussion**

Using a complexity lens and HSD tools for analysis of decisions helped make visible many patterns in this unique education context. For example, patterns showed that for Ms. Anderson collaboration was important, writing assignments needed to meet the needs of students, and it was important for her to know what students were learning, to name a few. Also, many agents were identified using this lens as influential in her decision-making process. These included a wide variety of people outside of school, colleagues, contextual factors, and teacher’s beliefs about teaching and learning that interconnected in complex ways to influence teaching decisions for her. Use of a complexity lens made visible many of these influences and connections that would not otherwise have been noted. The lens also provided data on the unique context for Ms. Anderson and the differences that made a difference for her in her work and in her ability to make decisions. The patterns showed those differences included these important factors: she was treated as a professional, she used a flexible framework for class instruction, she was a continual learner, she had the ability to integrate multiple factors, and she saw the big picture when making decisions.

Use of the CDE model as a retrospective analysis tool in conjunction with a complexity research framework provided me with a way of thinking about the complexity involved in deceptively simple decisions that teachers make on a daily basis. Looking for containers, differences, and exchanges helped me identify, describe, and explain possible influences on a particular decision at a specific point in time that may have triggered or generated decisions made by Ms. Anderson. In this case I chose decisions related to tensions noted about testing policies and practices although this type of analysis could be used for any decision at a moment in time. This analysis was useful in helping me answer my research question about what influences teachers’ decisions about writing in a high-stakes testing grade and contributed to the findings from this research study.

The use of a complexity lens and HSD conceptual models provided data that led to several major findings in this study. They include: (a) teaching is a complex adaptive nonlinear decision-making process, (b) there are networks of influence and networks of decisions that affect decisions that teachers make, (c) influence can go both ways, from the system to the teacher and from the teacher to the system, (d) teacher beliefs are not static, (e) HSD offers descriptions and explanations of decisions made by
teachers, (f) use of HSD models offers a step towards understanding underlying conditions that are in place that potentially explain decisions that teachers make, and (g) contextual factors are important in understanding teacher decision-making. These findings would not have been possible without a complexity lens and the use of HSD conceptual models.

Complex systems theories helped to describe the “individual, surprising, and not a little perverse” context for Ms. Anderson in her decision-making for her classroom. Even though analysis from this research study was not predictive, knowledge gained from this research shows the overall features of how change takes place in the work of a particular teacher and how she fits into her individual educational system. From this research I learned possible reasons why she made the decisions that she made, what she was thinking when she made them, and how she was planning to go forward in helping her students reach their goals for the school year and for their future lives. This type of detailed knowledge can inform future decisions about how to train teachers to make effective decisions about their work from the types of coursework offered in universities to professional development provided in schools. This type of detail about education systems and what similarities, differences and connections influence what emerges in the system has the potential to inform policy decisions about education in general.

Although “we cannot have complete knowledge of complex systems,” use of this framework and these analysis tools have the potential to provide researchers with more detailed knowledge of complex systems such as schools. Even though the descriptions and explanations were partial, based on the frameworks used, these descriptions can provide some of the “qualitative features of the change process that may not be intuitively evident to a linear logic of cause and effect.” In this study I learned that teaching is a complex process taking place in complex human systems called schools and was able to describe and explain potential conditions that triggered or generated decisions made by this particular teacher in her context. A complexity lens informed by the Pattern Logic model and analysis tools such as the Conditions of Self-Organizing Systems model show promise as concepts and tools for research in complex systems. As educational researchers we must acknowledge that an understanding of complex systems is critical in educational research if we are to learn more about how schools work and how to improve them.

References


