Becoming Systems Thinkers: Increasing Social Capital Through Network Weak Links

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Abstract: The purpose of this study was to describe the emerging patterns of connection between students and complexity science concepts as learning occurred.

"The whole is greater than the sum of the parts." We say this to students, and write this in adult education literature. But do we teach students to understand the sources of this understanding (math and natural science) or what it means as an expression of emergence? Emergence is one of the many concepts arising from general systems theory and cybernetics (Capra, 1996) synthesized today in complexity science (Mitchell, 2009). The World Economic Forum [WEF] executive summary (2013) extols the contributions that complexity science has made to the understanding of our accelerating interconnectedness, because complexity scientists step back and look at how all the parts of an ecosystem interact and form a coherent pattern of the whole. Since this perspective is a major departure from traditional science (Capra, 1996; Mitchell, 2009; WEF, 2013) most people are unfamiliar with the precepts, and the WEF report says this needs to change. This new way of looking at phenomena, to understand how interactions among parts contribute to emergent behavior, may help to answer pressing contemporary problems (WEF, 2013). Rimanoczy (2010), in dissertation research chaired by adult educator, Lyle Yorks, determined that innovative systems thinking is essential in business environments to foster sustainability initiatives and this need creates an imperative for adult educators. And yet, there is very little attention to systems thinking in adult education literature. Much discussion of complexity science exists in neuroeconomics (Mullett & Tunney, 2013) and the cognition literature that studies self-organizing consciousness, and complexity as a mediator of high level cognition (Barrouillet, Lepine & Camos, 2008). In higher education, the pedagogy of teaching complex adaptive systems understanding is discussed in informatics, and math and science related disciplines, like Nursing, as discussed by Hodges (2011). The ideas are well established in segments of psychology and sociology (Castellani & Hafferty, 2009), the foundational disciplines for education. Why should this knowledge be withheld from adult educators? In the healthcare disciplines, complex adaptive systems content is usually reserved for graduate education (Lindberg, Lindberg & Nash, 2007), but the majority of healthcare system workers hold a BS or AS degree. Should they be deprived of knowledge that explains the rationale for system safety initiatives or innovative treatment protocols?

Fenwick (2006) critiqued adult education pedagogies as being too grand, and not local enough. She recommended an ecological approach derived from complexity theory that centers caring encounters, aiming to enhance attunement of interconnections at multiple systems levels. In the same year, Karpiak (2006) used complexity science as framework to study self-organization in the adult developmental process of social workers undergoing change. AERC has included work on complexity science as framework for research on embodied learning (Swartz, 2010), as a latent theme in 1/3 of the transformative learning conference presentations (Sprow & Swartz, 2010), and as an emerging theme in that field (Taylor, 2012). It is well represented in "The Handbook of Transformative Learning" (Taylor & Cranton, 2012). But the larger adult education literature is silent about complexity science. Undercurrents show up related to workplace education and connected with ecological systems in environmental education (Kasworm, Rose & Ross-Gordon (2010). When 'systems' are addressed, it tends to be structural systems of power or oppression (Merriam, Cafarella & Baumgartner, 2007) as they are confronted in radical and emancipatory education (Elias & Merriam, 2004). This perspective is not discussed in conjunction with complexity science.

Theoretical Framework

Human beings learn in multiple ways, forming networked patterns of connection, conceptualized in complexity science in the language of the organism or system self-organizing (Kauffman, 2000; Mitchell, 2009). An adult educator would call this process 'adult learning'. These dynamic, self-organizing systems (such as people) evolve through interaction with their environments, at multiple scales of experience, moving toward greater complexity. This means they form new networks of patterns, learn and evolve, spontaneously, *without being directed*, using their natural capacity to process and respond to many forms of information. In dynamic systems, the process of self-organization is always sensitive to initial conditions (Kelso, 1995). When new learning begins, it starts with the ordered pattern that already exists for each individual and builds on that pattern to greater complexity and a new pattern of order in a nonlinear fashion (Kelso, 1995). Pedagogically, this perspective on learning argues for identification of basic content, with a smorgasboard of options for approaching that content and multiple opportunities for interaction among learners. For example, this course described by this case study always included a popular culture option for exploring new concepts. Self-assessment in relation to goals (more holistic thinking, more complex maps) was emphasized over grading against a standard.

Sociology also informed the process. Bourdieu (1986) advanced the idea of using social capital to promote cooperative movements. His work stressed class conflict and distinguished between the resources available to an individual and the social structures that enable their access. Lin (2001) also wrote about social inequalities, asserting that most resources are located in the hands of a few, and proposing that an individual's social capital is determined by their networks' reach into the social hierarchy. Strong links (similar people who interact frequently) and weak links (less well acquainted individuals) are both at play in creating productive social capital. Rural sociology research (Fisher, 2013) demonstrates the role of social capital in transforming passive information into usable knowledge, indicating that trust provides an essential catalyst. Regular and consistent contact, associated with high levels of trust result in bridging of social capital and knowledge transfer. Complementary research from complexity science indicates that weak links are key stabilizers in networks and complex systems (Csermely, 2006). These ideas about social capital and network links were useful in planning a course that would present challenging material to a diverse group (community college through 2nd year doctoral students), with no pre-requisites and high demands for student interaction and participation.

Methodology

Research design: Qualitative, descriptive, single case study. ***Rationale for choice of methodology:*** This was a particularistic interest in discovery with a key, unique case, drawing on the researcher's particular local knowledge of the population, and knowledge of the topic. A holistic perspective was sought to gain an in-depth understanding of the situation. Interest in the process or pattern emergence was more important than particular outcomes (Merriam, 2009). ***Research question:*** How does an extremely diverse group of learners, in an upper division elective course about complexity science, make patterns of connection among each other, to turn passive information into useful knowledge? How does this group make patterns of connection with the course content, to become better systems thinkers? ***Modes of data collection:*** Multiple types of writing were generated throughout the course of the class, since writing is an essential underpinning of social organization and interaction, as well as of learning. Types of writing included weekly discussions of readings postings on electronic discussion boards; a collaborative sharing board for a concept analysis in popular film assignment; first thoughts papers from each class meeting; various mind maps developed in and out of class and shared in class during exercises; written products of in class group exercises; extra material found by students and shared with the class; and final written synthesis papers on student topics of choice. ***Means of analysis:*** Document analysis as emergent method, as described by Altheide, Coyle, DeVriese, & Schneider (2008), guided the process, including thematic analysis of content and discourse as well as analysis of documents in action: how they contributed to network development, communication across boundaries, and learning. Kokotovich (2008) classification of non-hierarchical mind maps and the adapted Hung (2008) systems thinking rubric also were used.

Findings

Network Development - At the first class meeting, undergraduate students, particularly the lower division, pre-licensure nursing students, expressed some concern that they might not be able to keep up, since the texts were very ‘scientific’ and there were doctoral students in the group. Group discussion attempted to reassure them that they had more science background than most of the doctoral students, and that all students were new to complexity. Emphasis on the flexible nature of assignments, multiple choices in each weekly lesson, a strong popular culture thread, and absence of quizzes or exams were reassuring. Everyone stayed. At the second class, students built trust among themselves as they challenged faculty with detailed questions about math and science details. Learning from the responses that faculty’s understanding was broad, not deep, and that familiarity and big ideas were more important than comprehension of calculations, built trust between students and faculty. That seemed to be a turning point, after which students connected with the material individually, and connected more with each other.

Students’ first graded written papers were a pair about chaos as exhibited in the popular film, “Dark Knight”. Each student wrote a brief reflective paper about the topic prior to reading content about chaos theory. After reading theory, they shared new findings on a discussion board that all students could draw from in writing a second, more informed brief reflection on the same topic. While students did not respond directly to each other’s postings, a continuous thread of thoughts developed, where it was evident that effort was made to both share one’s own insight, as well as connect or elaborate on the previous posting. Interestingly, there were no repetitive postings. Doctoral students were a bit more likely to deepen the theoretical connection, but never in an intimidating way. Students were free to use each others’ ideas in their papers, but no one did this. In terms of network development, this process of sharing on the board evidenced development of trust and respect, across their academic differences.

By the time the class met for the third time, doctoral students expressed how impressed, and sometimes intimidated, they were by the undergraduate students’ postings on the weekly readings discussion boards. This expression was met with amusement, and in that class, group forming for activities began to cross boundaries as well. Students created map drawings in class, and at the next meeting, shared mind map diagrams in a walk-around gallery that generated a lot of discussion. A surprising degree of personal revelation was present in the mind maps.

In online discussions of weekly readings and explorations, weak links (connections between people who don't know each well) were extended into new networks as they made meaning of readings about complexity science by sharing stories of family and personal challenges. In this way, the newly forming networks contributed to knowledge creation, and connections with the content contributed to network development. These were intersecting positive feedback loops. In-class products that cut across educational status boundaries were the creative mind maps that fell outside the boundaries of formal knowledge distinctions. In the face-to-face setting, weak links extended into new networks around the themes of self-control, frustration with authority at work, and creative plans for making major career and life changes.

Connections with Content - In writing first thoughts at our first class meeting, most students had a general understanding of complexity as an expression of many interconnected parts forming a whole. Some described this as a web (also in title of one of the texts). A few students had noticed that evolution was covered in the readings and expressed some wondering about God. One student had noticed the concept of similarity across scale. One expressed metaphors: 'herding cats' and 'squishy gears with changing points of intersection'. A few had not started reading. Despite these differences, all students could identify a complex problem from their professional life, or community. From economics, to healthcare safety issues, to community violence, these abstract concepts were 'real' and practical to students from the beginning.

Reading the first week was fun and engaging. Then it became more difficult. There was clearly some fear of science concepts, and some of the 'math' in the two primary texts. The fear was expressed as some frustration and irritation at the second class, and discussions of fear in the first "Dark Knight" papers and on the related discussion board. When the three most challenging concepts were each summarized in single sentence form, by faculty during class, students were able to discuss examples as illustrations. This achievement seemed to set them free to follow concepts as they presented as understandable, rather than just as they presented chronologically in class. The result was that after the first month of class, highly individual patterns of learning and application were beginning to emerge. As that happened, students began to help each other by sharing their sense-making processes with each other, without needing to impose content.

Students set their own high standard. While they did not have to write about theory in the first Dark Knight paper, all of them did. The second paper then became a place to take a different point of view at a different scale (macrosystem rather than individual characters), or to explore specific concepts, like the Butterfly Effect; or even get into different theories, like dynamic systems or self-organization. The film analysis helped each one create a glossary of what they understood, much better than a published glossary of terms could have done.

Because ecological biology is tied to evolutionary biology, there were inevitably discussions about evolution and religion. Amazingly, the creationist students found that science reinforced and supported their religious beliefs. Reading about the environment, and applying natural cycles of destruction and creation to real life situations, seemed to enhance this effect.

Developing Systems Thinking - Initially, each student mapped the interconnected concepts they hoped to explore in the course. Only one doctoral student had experience with mapping. The most sophisticated maps were circular. Many were linear. A few were only lists. Only rudimentary systems thinking was present. A few weeks later, after in class exercises and learning about feedback loops, but not specifically studying mapping, the more complex hub and spokes design was common, and a few students produced hierarchical maps that implied directional flow. After studying non-hierarchical maps for a graded mapping assignment, most students produced complex hub and spoke or hierarchical designs showing flow, a few demonstrating feedback loops. A couple created highly unique, artistic representations of concepts, for example a detailed heart drawing used to illustrate the interaction effects of personal life elements. With the final, guided social network analysis, following the ecologic network activity in class, students produced highly complex, non-hierarchical maps showing multiple feedback loops. Several were able to find and use free map creating software online.

Students with more formal education were better at expressing evidence of systems thinking in writing, which is what the Hung (2008) rubric assesses. The original intent was to have them self-assess all written products using the rubric, but it proved to be too difficult. They could, however, understand the rubric in relation to their maps. Linearity and interconnectivity were the easiest concepts to grasp. With the final maps, most students moved to the high end of the 5 point scale on those items. Positive and negative feedback processes were discussed and re-explained multiple times. Although a simple idea, noticing them in action was challenging. Given an example of a loop, students could all identify whether it was positive or negative. In analyzing a situation independently, most identified some feedback loops accurately, but few were able to identify most of the loops describing a system's behavior. In small groups, their combined knowledge was more effective with this skill. Causal loop understanding was similar. Most students described some causal loops in their final paper topical discussions. A few identified most of the important causal loops. Understanding of intercausal relationships among parts progressed to at least mid-level for all students. Although students clearly understood 'whole systems' as dynamic entities, content learning did not focus on time delays, and this was the weakest area of understanding. As an evaluation of learning, the rubric showed remarkable gains in systems thinking, especially since 'systems thinking' was not specifically taught, other than sharing the rubric. A further measure was the continuing interest shown in the topic, as 4 of the 5 adult education doctoral students (psychology, arts, business, and training backgrounds) decided to consider incorporating an element of systems thinking into their dissertation research.

Implications for Adult Education Theory and Practice

Complexity science / systems thinking resonates with many students today, because of the hyper-connected world we live in. It is not necessary to have a strong math and science background to understand and use the theory. Using popular culture lessens the intimidation factor that numbers can create. Students who are traditionally deprived of exposure to this pervasive and influential paradigm are capable of expanding the reach of their social capital by learning the theory, and their weak links across status boundaries in a non-traditional classroom can self-organize into networks that turn passive information into useful knowledge. Adult educators should give consideration to learning more about this paradigm and considering how to incorporate it into their teaching and research. Linking to already familiar theory (such as social capital theory) could enhance that process.

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