Exploring emergence in complexity research: Comparison of emergence across projects

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Introduction

This symposium explores emergence in research projects that are dynamic and complex, where researchers are constantly changing the direction of the project as it unfolds. It presents a theoretical framework for such an exploration using the language of complexity in terms of concepts such as emergence, complex systems and enabling constraints. We weave the example of our symposium group processes to illustrate the concepts. We use the framework to compare three different projects which have given rise to emergence, i.e., the creation of a new phenomenon, and consider how these concepts echo through the varied research investigations. Researchers might find this framework liberating in research that is dynamic and complex.

We have chosen to combine all the presentations in the symposium into one paper because it enables us to display the multi-layered nature of complexity thinking.

Theoretical framework

Complexity thinking

Complexity thinking is a way of thinking and acting that is based on the assumption that we live in a complex world (Davis & Sumara, 2006) where inter-connections abound and they affect us in visible and invisible ways. Davis and Sumara assert that complexity thinking is not an explanatory system, but "an umbrella notion that draws on and elaborates the irrepressible human tendency to notice similarities among seemingly disparate phenomena" (p. 7).

Complexity thinking is part of "the study of the dynamic behaviours of complexly interacting, interdependent and adaptive agents under conditions of internal and external pressure" (Uhl-Bien & Marion, 2008, p. 3). Self-organising behaviour is common in the natural world and is characterised by a collective of independent agents that self-organise in a dynamic manner in order to create emergence—a patterned higher-order response to a threat or opportunity (Davis & Sumara, 2006; Wheatley, 2006). Biologists exploring the group behaviour of many species (fish, ants, bees, birds) noted that while the collective behaviour of these species was not predictable, neither was it chaotic. For example, starlings that flock in groups of thousands do not behave chaotically; there is a pattern to their flocking such that individuals operate in unison and do not collide with one another (see Figure 1). Studies of ecosystems as a whole show that they also change dynamically in response to external influences, and that while these changes are not necessarily predictable, they are not without pattern (Wheatley, 2006).

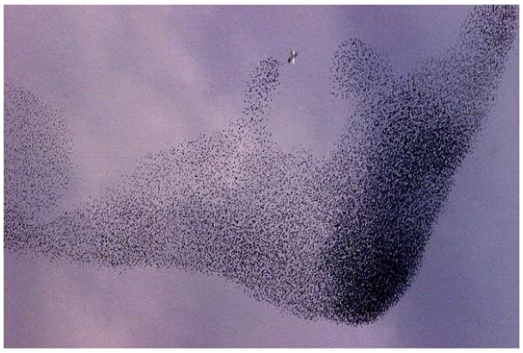

Figure 1: A pattern arising from starlings flying in unison in response to the presence of a predator (http://www.youtube.com/watch?v=XH-groCeKbE)

This symposium deals with a type of complexity referred to as complicity. This term was coined by Cohen and Stewart (1993) to refer to a class of phenomena where "totally different rules converge to produce similar features, and so exhibit the same large-scale structural patterns" (p. 414). Complicity is associated with highly complex systems that continually interact and influence each other directly and indirectly and implicates the observer as part of the interactions. It carries the connotation of entanglement and systems that are complicit co-emerge with each other, i.e., they change together but not necessarily at the same pace. Thus, systems whose relationships are characterized by complicity are simultaneously distinct and inseparable from each other.

Emergence and complex systems

Emergence refers to the creation of higher-level patterns (at system level) that arises from the complex interactions of agents that make up the system (interactions at sub-system level). Emergence suggests

- an outcome of higher-level complexity than the lower-level entities/agents/sub-systems that give rise to it, and
- one or more processes which involve the interactions of these lower-level entities in complex ways.

Outcomes of emergence can include a new system, new properties of a system or even a new phenomenon.

In this symposium, we focus on emergence related to complex systems. These complex systems are composed of agents or parts that interact on an on-going basis towards a common purpose or interest as shown in Figure 2. Unlike complicated systems, which are also composed of interacting parts that do not change as in a clock or a car, the nature of the interactions among the agents in complex systems are neither fixed nor clearly defined (Davis & Sumara, 2006) and therefore more fluid. As the system and/or its parts change, so too does the nature of the interactions. In the case of the symposium group, the authors are the agents and the group the complex system.

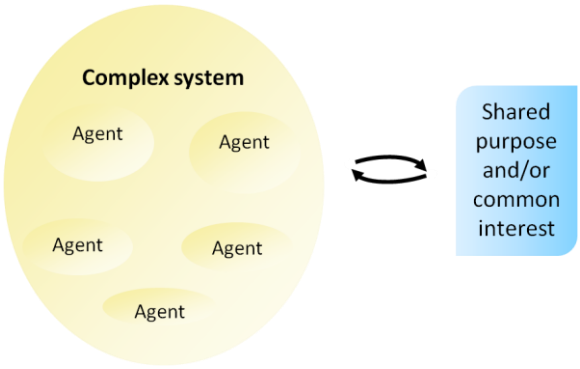

Figure 2: A complex system emerges when agents interact on an on-going basis towards a shared purpose and/or common interest

In a nested system, the agents and the system display self-similarity (Davis, Sumara & Luce-Kaplar, 2008), i.e., they share some characteristics that are similar regardless of which levels of the system we refer to. This means that interactions of agents at any one level generate patterns that can be discerned at the higher level. For example, patterns within collective social bodies emerge through the actions of individual agents or persons. Figure 3 shows the self-similarity of the fern in terms of its shape; its frond has a similar shape to its parts. Thus, a complex system exists in a nested and complicit (interdependent) relationship with its agents.

Figure 3: Self-similarity in a frond (Chris Jansen's private collection)

Nested and coupled systems of knowers and knowledge

All research involves knowledge creation that arises because of the interactions between knowers and knowledge. Davis and Sumara (2006) make a distinction between the two but argue that they are inseparable and mutually influence each other, i.e., they are coupled systems. They write that

> "a knower is a physical system that might be described as a stable pattern in a stream of matter; a body of knowledge is an ideational system and might be understood in terms of stabilized but mutable patterns of acting that are manifest by a knower." (p. 155)

In other words, both these systems are complex systems that co-emerge with each other; they change together because they are connected but not necessarily at the same pace. In the case of the symposium group, we each brought our individual experiences and our knowledge of research methodology and complexity thinking to generate shared knowledge which is being documented as group knowledge, thus effecting changes in both agents and system.

Figures 4 and 5 illustrate our conceptualization of the nested systems of knowers and knowledge as well as their coupled relationships. Figure 4 shows the possible levels in the nested systems of knowers and knowledge in an organization. Figure 5 shows how knowledge can move from one organisation to another as a knower learns from one setting and shares this knowledge in with other knowers in a different setting. This knowledge, in turn, can be transformed within this second organisation.

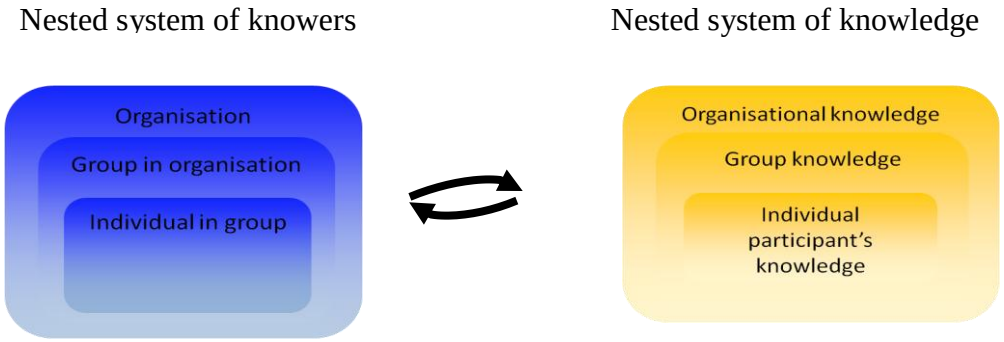

Figure 4: Possible nested systems of knowers and knowledge in an organisation

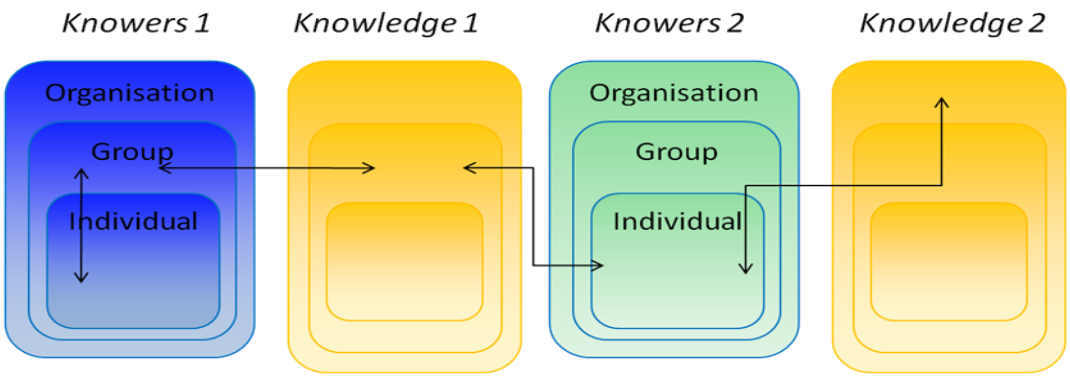

Figure 5: Diagram illustrating how knowledge can move from one organisation to another and be transformed

Enabling constraint

Emergence of new phenomena occurs naturally in highly complex systems and is brought forth in the on-going interactions of agents (Davis & Sumara, 2006). Since on-going interaction is an important feature of emergence, emergence cannot be scripted or forced into existence and we cannot fully anticipate what the outcome(s) will be. However, we can nurture emergence so that it unfolds in ways that are likely to reflect what we value. We can do this by setting up an enabling constraint. The question of how to occasion or foster emergence of new phenomena within a collective (for example, an effective learning community within a classroom) is a key challenge within education where psychological theories about individual learning are well developed but little is theorized about how to foster collective learning.

An enabling constraint refers to a set of conditions in a system which can (1) enable agents in the system to act creatively within the system's boundaries and (2) enable the system to respond to randomness in creative ways. Thus, an enabling constraint connotes a structure that is constrained and flexible and benefits both the system and its agents. Davis and Sumara (2006) describe an enabling constraint as

> "the structural conditions that help to determine the balance between sources of coherence that allow a collective to maintain a focus of purpose/identity and sources of disruption and randomness that compel the collective to constantly adjust and adapt." (147)

An enabling constraint is characterized by sufficient coherence and randomness in a system. In a classroom setting, this is the balance between constraints (the boundaries of what is acceptable and/or unacceptable) and freedom (to act in ways that are creative). Coherence is a feature of the system that relates to its agents' capacity to make sense of the system in which they operate or live. Randomness, on the other hand, is a feature of the system that relates to the unpredictability and uncertainty affecting the system from within and outside the system. The notion of 'sufficient coherence and randomness' carries the connotation of enough of each and a balance of both. However, what counts as "sufficient coherence and randomness" cannot be measured but can be sensed and is dependent on the teacher's, researcher's or student's judgment as knowers. In the case of the classroom, the enabling constraints can emerge in the patterns of social interactions that take place on a daily basis. In the case of this writing, the due date and conventions of writing act as an enabling constraint.

There are two sources of coherence in a system, i.e., its boundaries and the commonalities shared by its agents. A system's boundaries refer to both its internal boundaries which are boundaries within the system, and its external boundaries which are those that define the external limits of the system. Boundaries can take the form of physical limits, conceptual

boundaries, processes or rules. They can be imposed on the system and/or negotiated from within. However, boundaries in learning systems are dynamic in the sense that their forms can change. Some boundaries can be removed, new ones created and the strength of their coherence can vary over time. Despite their dynamic nature, a system's boundaries contribute to coherence as long as agents can recognize them.

A second source of a system's coherence is the commonalities that agents share or the system's internal redundancy. These commonalities are facets that agents in a system share and respond to in similar ways. When there are enough agents that share and respond to enough common facets, agents can carry out another agent's role when the latter is unable to do so because the other agents know enough about the role to carry it out; this enables the system to remain viable. Internal redundancy can be created by allowing agents in a system to interact sufficiently with each other and share knowledge; these internal interactions among agents are referred to as neighbour interactions.

When neighbour interactions are organized in a decentralized or scale-free structure, this structure of interactions balances the efficiency and robustness of the knowledge flow (Davis & Sumara, 2006). There are two features in interactions with a decentralized structure: (1) an emphasis on interactions and decision-making that are local or short-range (Johnson 2001) and (2) sufficient weak links (Davis & Sumara, 2006) among the agents. Local interactions and decision-making among agents enable them to share knowledge and respond to each other efficiently, thereby contributing to the system's coherence and internal redundancy. The presence of weak links among agents increases the robustness of the system as a whole by drawing upon the system's internal redundancy to facilitate continued flow of knowledge and decision-making capability when necessary, e.g., in the event of disturbances that incapacitate an agent's ability to perform its role. Thus, a decentralized structure for interactions among agents enables agents to be simultaneously responsive to and independent of each other.

Randomness in a system can arise from the neighbour interactions of the system's agents or from the system's interactions with other systems; these are often described as internal or external perturbations respectively. The former generates randomness from within the system because it is each agent that determines its own response(s) to the interactions. The system constrains but does not determine the agents' responses and therefore does not know in advance what its agents will do. The range of varied responses among interacting agents counts as the system's internal diversity, which, in turn, enables the system to respond to external perturbations in a variety of ways.

Thus, when agents in a system perceive their conditions as an enabling constraint, the system's structure emerges as an enabling constraint. Under these conditions, the system as a whole is capable of responding to internal and external environments in ways that can be creative and mutually beneficial to itself and its agents. Within educational settings, this capability means that both the system and its agents can collectively create the power to creatively negotiate constraints such as time, curriculum and finances that influence life in these settings. In the case of the symposium group, when Hanin, Chris and Elaine planned the presentation, we realised that it was possible to illustrate the nested nature of our work where we as a group presented holistically and, at the same time, addressed the need for us to present individually. Thus, our presentation involved on-going interactions among the group as well as the detailed presentation for each member.

Comparing emergence in three different projects

This symposium highlights three different projects where emergence has unfolded. Although the three projects were all informed by complexity thinking/theory, they were all very different in their purpose, scope as well as the emergent phenomena that unfolded. Using the theoretical framework, we summarise some of the features of the projects in Table 1 and elaborate on each project below.

Whose project?	What was the project about?	What was one of the emergent phenomenon?	At what level of which system did emergence unfold?	What were some factors that contributed to an enabling constraint?
Chris	A professional development project for leaders from 20 non-governmental organisations	A self-sustaining professional community	System of knowers at group level	• Appreciative inquiry framework • Redundancy and diversity among participants • Regular focus group & range of activities
Hanin	A teaching and learning project to occasion a new game of chase with children at an early childhood centre.	A new game	System of activities at activity level	• Systems of knowers, knowledge, activities • Centre context • Framework for playing games of chase
Elaine	A ECE Centre of Innovation project to investigate teachers' practice of using 'central character story' as a teaching tool.	A research tool for documenting teachers' tacit knowledge	System of knowledge generation at group level	• Writing limited to one page only • Only one focus in each "one-pager" • Co-emergent language and practice associated with tool

Table 1: Comparison of three different projects involving emergence

Chris writes: Emergence of a leadership focused professional learning community

The aim of this research project was to increase leadership capacity in adolescent-focused non-government organisations (NGOs) through the development of a professional learning community. Managers in these organisations explored their leadership beliefs, values and how they expressed these in their leadership roles using an appreciative inquiry (AI) methodology (Jansen, Cammock & Conner, 2011).

The AI process is based on a number of assumptions and principles that have been thoroughly articulated in the literature (Hammond, 1998, Cooperrider, Sorensen, Whitney & Yaeger, 2000). This process is most commonly applied as an organisational development tool. However, in this project, we used AI as both a capacity-building change process and as a research tool. Reed (2004) describes how AI, a form of practice developed primarily for organisational development, can address the criteria expected of research and explains how an AI approach can transform and add to traditional research expectations. She applauds, as a research tool, the two key broad themes of AI methodology – 'focus on the positive' and 'inclusivity' – characteristics that distinguish it from other processes (p. 70):

> "Appreciative inquiry focuses on supporting people getting together to tell stories of positive development in their work that they can build on" (Reed, 2004, p. 42).

AI research as such is commonly described as being 'research with' instead of 'research on' (Reed, 2004). Information collected during the investigation is generated and utilised in the learning space, rather than taken away to be analysed, and contributes to the developing knowledge of the participants and to the growth of the PLC as a whole. In this sense, the process relative to investigation findings is more about data creation and data synthesising than about data collection (Reed, 2004).

Over fourteen months, the participants met for a half-day focus group every two months to experience activities such as peer interviews, group reflection on literature and speakers as well as collective sense making and collaborative coding of the emerging themes in the project. All learning experiences that were implemented in this project were informed by AI processes (Jansen, Cammock, & Conner, 2010). A major change in the project was the reframing of the initial steps "Initiate, Inquire, Imagine and Innovate" (Watkins & Mohr, 2001) because we soon realised that although these provided an effective overall structure, we needed to be much more flexible in the processes and experiences that would become a part of the project in order to honour the themes of inclusivity and collaboration. Hence we modified our frame for the project to align with two broad themes; 'focus on the positive' and 'inclusivity'. Within this broad philosophical stance, we were then able to customise the process with a high degree of flexibility, and also engage with the participants as they co-constructed their own learning process.

The project gave rise to several incidences of emergence, one of these relating to the system of 'knowers', i.e., the individuals involved in the community. Initially a range of participants were invited into the project; they then referred a number of their colleagues who also met the criteria of being a manager of an adolescent focused NGO in Canterbury. As part of the AI process described above, the participants were then able to co-create all aspects of the project including the questions explored, the experiences used to do this, the length of the project, the analysis of the collective data and the creation of findings. A range of innovative learning processes were developed in this way during the project (Jansen, Cammock & Conner, 2010).

At the end of the research project in March 2010, the participants decided that they wanted to continue their collective processes as a self managing and sustaining professional network. The co-emergence of this professional network is still in progress. It has the potential to not only continue to nurture the leadership of those involved but could also be influential in the wider youth development and education sector, e.g., in terms of advocacy and collaboration.

The emergence of this NGO leadership network beyond the duration of the project suggests the potential of integrating the framework of complexity into professional learning processes (Jansen, 2011). In particular, the creation of enabling constraints to occasion emergence provides an interesting perspective on this project. As discussed earlier, one form of enabling constraint is to provide sufficient coherence and randomness in the structure of the project. In this case, coherence was provided by the AI principles that were agreed upon. This constrained the project to focus on (1) the positive, i.e., what was working and (2) collaboration, i.e., all decisions were to be made in consultation with all participants. These two principles acted like touch stones, non-negotiable parameters within which randomness could come into play.

This randomness resulted from the second principle of AI where all aspects and processes in the project were negotiated. This meant, for example, that the initial plan of online forums and learning sets of 3-4 people were abandoned in favour of half day focus groups on a regular basis. It also allowed a wide range of new materials, literature, topics to enter the process, developed a sense of 'research with, not research on' which then lead to a sense of freedom and creativity for participants. This allowed not only individuals to act as agents of

change for their own workplaces, but to work as collective agents, as participants of this group, to collectively generate new ideas and find ways to implement them. Both of these enablers gave rise to a sense of collective ownership:

> "The wonderful thing about our group is that we created it and we own it, it hasn't been set up by someone else on our behalf which is normally what we experience in this sector." NGO Manager

Another source of enabling constraint was the balance of internal redundancy and internal diversity. Internal redundancy was provided by the selection criteria which focused exclusively on adolescent focused NGO organisations rather than funders, government organizations, etc. It also focused only on the managers of each organisation, not other leaders amongst their staff teams; managers said that this focus led to a sense of collegiality, connection and support. On the other hand, internal diversity was provided by including a range of NGO organisations from a range of settings including education, recreation, and residential and community therapeutic support. The diversity was also visible in the different genders and ethnicities represented. The initial lack of familiarity amongst participants gave rise to a creative edge in the process, and the sense that the participants did have a lot to learn from each other. By actively balancing these enabling constraints in this project, the leaders and I were able to occasion the emergence of an ongoing professional learning community.

> It's the creation of a place from which to reflect. We have developed an inspiring, creative, exciting space to share (NGO Manager).
>
> This group has been like an oasis in the desert for me, I have benefited so much from having this opportunity to meet spending this time focussed not on my organisation, but on me and what makes me an effective leader (NGO Manager).

Hanin writes: Emergence of a new game of chase

The aim of this research was to create a situation where preschool children could co-create games of chase. It combines design-based research (Joseph, 2004) with a self-study methodology and involved taking the role of a volunteer teacher at an early childhood centre.

The research was informed by and contributed to a theoretical framework with three coupled views of curriculum. These were the structural, process and content views of curriculum. The structural view consisted of three nested and loosely-coupled systems of curriculum, knowers and knowledge (Hussain, 2010). The process view discussed a theory for occasioning emergence by setting up conditions for this emergence to take place and is similar to the theoretical framework used for the symposium. The content view was a framework for playing games of chase. It identified a small number of key assumptions and important knowledge in games of chase, including necessary restrictions such as not hurting or scaring others while playing. The content-related framework provided clear boundaries in terms of the restrictions and embodied randomness by enabling children and teachers to enact the games in many possible ways as long as it did not breach the restrictions.

There were several factors in the research that contributed to what could be interpreted as enabling constraints in the sense that these factors embodied both coherence and randomness. One was the overarching theoretical framework which enabled me to be flexible in my decisions and actions while ensuring that I engaged in on-going considerations of the values and issues for individuals and groups in the research. Another was my inter-twining roles as a teacher-researcher-curriculum designer. At any one time, the weighting of these relative roles was flexible, and I was able to adapt and choose which roles to take depending on the situation at the time. Thirdly, I was given autonomy and freedom to work with any children

and other teachers as part of daily life at the centre. The teachers were able to participate if they chose to.

I taught 3- and 4-year olds at the centre four mornings a week for fourteen weeks. The centre's curriculum counted as a source of internal redundancy because the children, teachers and I knew that it was based on play and on following children's interests. At the same time, there was decentralization within the curriculum because children could choose and change the nature and level of participation in the games of chase at any point in time and contribute to the games in many ways; this enabled the children to choose the ways they responded to each other and the activities around them. Children could therefore be considered to be individual as well as collective agents of curriculum generation. In addition to games of chase, there was a flow of knowledge across activities as we talked about the games we played, watched videos of these games, incorporated elements of our games into other activities such as storytelling, art and craft and mat time, and vice-versa. In total, there were 79 episodes of activities that were directly and indirectly related to games of chase that can be counted as sources of neighbour interactions.

Initially, many children were not familiar with games of chase. As we played more games, the children became familiar with the rules and learned to change the rules (and that it was ok to change the rules). The children and I played three main games of chase. We started with *tag*, followed by *What is the time Mr(s) Wolf?* and finally *Big A, Little A*. For each game, we started by playing a simple version and over time varied the ways we played it; hence there was internal diversity within each game we played. When a new game was introduced, this was in addition to the previous game(s). We also developed a routine that was repeated for each game episode. This routine involved putting on tag belts and discussing how we were going to play before started playing, and these counted as sources of internal redundancy in curriculum related to games of chase.

The final game of *Big A, Little A* was the emergent game that the children, teachers and I co-created. It arose from a complicity or an entanglement of influences, e.g.,

- the chasing and tagging aspects of the game came from *tag* and *What is the time, Mr(s) Wolf?;*
- the elements of creeping and freezing came from the game, *Creep up on Granny*, which was introduced by two girls who had learnt it at a birthday party;
- the idea of having characters in the game emerged from children's interest in socio-dramatic play;
- the introduction of bugs as characters in the game was based on a curriculum focus on bugs, which was, in turn, a result of teachers noticing, recognising and responding to the children's interest in the bugs that were in the centre's garden.

In this research, the agents-as-knowers were the children, teachers and myself. There were two levels of complex systems of knowers that emerged. The first level was the groups of players which emerged when we played each episode. This complex system was dynamic as children joined and left the game at any time during the episode. The practice of putting on tag belts provided coherence to our games because it helped us to identify who were playing at any one time. The discussion we had before playing each episode also counted as a source of coherence because it helped us develop an initial shared understanding of the rules of the game episode although it did not stop us from changing those rules during the game.

Over time, a community of players emerged as a second level of system of knowers. This community co-emerged with some shared knowledge and practices in relation to games of

chase. These included (1) the game-playing routine as practice and the knowledge associated with the roles of tag belts and discussions, (2) the knowledge that games involved playing by the same rules, and (3) the knowledge that we could agree to change the rules while playing.

This research shows that there were multiple outcomes of emergence in terms of systems of knowers and knowledge. The enabling constraints helped us to play games in many ways and to create a new game while ensuring that we played in ways that were socially acceptable. However, it was the on-going interactions during play that determined that nature of those games we played and created.

This research suggests that complexity thinking can be useful in a curriculum that is intentionally generative and values experience, play and children's interests. This raises the question of how teachers can teach complexity thinking. One possibility is to teach it as an implicit curriculum (Eisner, 2002) by deliberately weaving complexity thinking into a setting's norms and structures. This implication has significance beyond games of chase and the early childhood context.

Elaine writes: Emergence of 'one-pagers' as a tool within practitioner-research

The aim of this project was to investigate teachers' practice of using 'central character story' as a teaching tool. Central character is a way of using themes/characters to generate a range of activities for teaching and learning.

I worked as a research associate to support two teacher researchers (Kay Henson and Helen Smith) in a kindergarten to report on an innovation in their teaching practice. Funded by the Ministry of Education's Centres of Innovation programme, the project involved working with the teachers over a two year period. When I joined the team they had already been working on the project for a year and had gathered a lot of data. In our initial meetings, the teachers expressed some concern that the data they were gathering, while valuable, was not enabling them to share the more creative and insightful elements of their work.

The language of complexity thinking enables the following description of how we, as a team of three researchers, proceeded to write our final report (Henson, Smith & Mayo, 2009). In retrospect it is clear that the first step entailed building relationships so that as three agents, we learnt to trust each other and form a system where communication was open and barriers to open conversation were overcome. Effectively we were developing a collective system where my theoretical knowledge and their practice-based knowledge were able to mingle comfortably as we generated ideas. This development involved lots of conversation, the sharing of key ideas and fears related to the project, and fun as we talked about our pets, families and enthusiasm. In retrospect, we were building a pattern of communication where our differing areas of knowledge were explored deeply and in quite challenging ways because we had come to trust each other. We began to write about our key conversations and ideas in brief notes so that we could compare our thinking. These notes emerged later as our main data source.

We had a significant problem in collecting data which led to an enabling constraint that served us well. Kay and Helen were deeply knowledgeable about early childhood education and their innovation in particular. I found I could not keep up with their ideas and could not see how, given the time constraints, we could be effective in documenting our conversations and the great ideas that emerged in discussion. Nor could I see how I could share the knowledge they needed in order to write fluently about these ideas. The challenge was to document our key ideas at the same time as moving toward more analytic and critical thinking about the teaching innovation.

The breakthrough came when we agreed to record our emerging ideas and agreed on who would record them (this was individual participant knowledge as illustrated in Figure 4). The enabling constraint was that the documents could not be more than one page long. We called them "one-pagers" which became our key data source. Since we were tracking teaching thinking, the one-pagers provided evidence of how ideas were changing and evolving.

These documents were shared (with delight and enthusiasm at times because they varied from tightly written text in 8 font to single scribbled sentences that declared a simple insight). By sharing these, we were building collective knowledge which, of course, impacted on our personal knowledge. Over time, the one-pagers became more collaborative and analytical as we explore our accumulation of ideas; we wrote one-pagers that synthesized our group knowledge as illustrated in Figure 4.

Thus, the one-pagers served as a tool that enabled our thinking to evolve at the same time that our pool of data was accumulating. We as knowers, both individually and collectively as a group, were changing alongside our emerging pile of documentation. Mayo, Henson and Smith (2010) describe the process of emergence in more detail as an example of group knowledge.

We found that others in the wider community also eventually adopted the notion of one-pager writing in that parents and visiting teachers also contributed one-pagers to the project. This shows that the idea had spread to the wider community that encompassed the kindergarten. It also illustrates how ideas from a project can spread sideways to other projects through networks of communication (see Figure 5). The one-pager idea has, for example, appeared in Chris' writing because I have carried the idea as part of my knowledge into groups within the College of Education. A conference presentation (e.g., Mayo, Henson & Smith, 2008) is an example of how group knowledge can be documented and shared so that it is made accessible to other groups of people and systems of knowledge.

One-pager writing is a methodological tool that sits comfortably within the discourses of post-structuralism, complexity thinking and practitioner investigation. Stronach and Maclure (1997) write that it is

> "the unruliness of knowledge that challenges us now ... It is irresponsible to continue to privilege the escape clauses of a foundational appeal. ... Given the inherently disordered nature of discourse, how are individuals to understand and accept the disorder ...?" (p. 98)

One-pager writing enables the tacit knowledge of practitioners to emerge and for the changes to be documented in ways that caters for the unruliness of practice while at the same time fostering ongoing conversations that build on the random events of a busy teaching space. Over time, one-pagers developed and became creative tools to address the messiness of discourse. Individuals developed their skills in writing and documenting their ideas. By sharing these, collective knowledge emerged and as a consequence the knowers also changed. All these changes were facilitated by conceptualising knowledge and knowers as loosely-coupled systems that work in concert with each other. We had become more self-confident about articulating ideas (individual knowledge) in ways that built connective understandings (group knowledge) which could impact on organisational knowledge (because we were able to share our insights and learning with various institutions).

Significance of this symposium

This symposium uses complexity thinking to contribute to a theoretical framework for research that is dynamic and complex. Although the projects presented here are diverse, we have been able to compare the approaches taken and consider their commonalities. For example, we have shown how the enabling constraints took different forms in the projects.

There are many instances where such approaches are suitable and valuable, e.g., evaluating processes of on-going professional learning. We anticipate that other researchers will find this methodological approach liberating; it is not constrained by pre-set research protocols, but provides a mechanism to use new information from within the data *as it arises* to create new research directions and routes to explore.

However, given that outcomes of emergence cannot be fully anticipated in advance, this symposium also raises the question of how, as researchers, we can ensure that these outcomes are ethical and meaningful for the individual agents and the collective system. This is an important question within complexity thinking which foregrounds ethical responsibility and reflexivity (Davis & Sumara, 2006) because, as researchers, we are complicit or entangled in the possibilities that we create or bring about in our settings since they unfold well beyond the duration of our physical presence at the setting. We have not attempted to solve this in these examples, rather we continue to use this question to guide our thinking and actions as they change.

This paper has shown examples of both emergence and enabling constraints at two levels within self-organising social systems. Complexity thinking can enable a discourse for fresh thinking about social interactions. Using the discourses of complexity thinking allows researchers in a variety of social sciences to develop theory that explores patterns to do with how relationships among individuals inform and shape the collective. Further, we have shown that, by identifying the conditions for emergence, it is possible for practitioners (for example, teachers, facilitators and practice-based researchers) to identify enabling constraints that can shape the ongoing patterns of interaction within classrooms, groups and the sites of action research. Far from being controlling, this kind of shaping builds on the expertise and insights of the participants in the larger collective; this approach to thinking about how to develop and improve social relationships has the potential to be highly democratic, productive and enabling.

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