COMPLEXITY PATTERNING: A LANGUAGE AND STRATEGY FOR THE TEACHING AND LEARNING OF COMPLEXITY COMPETENCE

Shae L. Brown JP
B.A/B.Teach (UNE), M.Ed (SCU), PhD (SCU)
Senior Student Advocate
LEXSA Student Association
Casual Academic, Faculty Education,
Gnibi College of Australian Aboriginal Peoples
SEAE Research Cluster

Abstract

Education is the main site for preparing young people for co-generative participation with the emerging future. Therefore, teaching and learning today needs to support students to gain knowledge and skills for effective responses to the challenges facing humanity. Complexity competence is one such skill, comprising complexity perception, thinking, knowing, and understanding, as well as practical strategies for application. This paper presents a project developed and implemented by the author for the teaching and learning of complexity competence. A simple patterns-based design called Complexity Patterning was developed and implemented as a language and educational process and strategy, to provide a foundation for reworking students' conceptual and practical engagement with and within complex phenomena. The patterning process can be adapted for any complex phenomenon of interest and focus, and has a low cognitive load, making it useful for a wide range of ages and groups. Complexity Patterning also forms an identity emergence approach to learning, and learning complexity, through using the relational becoming of identity as an experiential gateway phenomenon of focus. Initially emerging from attempts to disrupt reductive and linear temporalities in educational curriculum and practice, the patterns-based design was implemented with secondary students over several years in the developmental phase. The design and process were then refined and implemented with four cohorts of undergraduate students in a recent doctoral inquiry project. Complexity Patterning provides a sound foundation of complexity competence for practical application, as well as for further teaching and learning in a wide range of knowledges and disciplines. Through nurturing capacity for co-generative engagement with complex phenomena, Complexity Patterning supports human emergence as attractors of coherence, as purposeful patterners of a healthy future.

Keywords, complexity literacy, complexity competence, transformational education, pattern-based design.

Introduction

Life is increasingly complex, as are the issues and problems we all face. Knowledge paradigms and ways of living that engage with complexity and are also generative for the health of all species, are imperative (Bateson, 2017; Laszlo, 2017; 2018; Laszlo et al., 2017; Smitsman & Smitsman, 2021; Wahl, 2016, 2019). Complexity and health are inseparable, with health described here as a complex property that emerges from, as well as being the connective pattern within, complex phenomena (Wahl, 2016, 2019). We are at a crucial time in human history, with a window of possibility to purposefully learn and develop the

complexity competence to maintain and regenerate conditions for life to thrive (Laszlo, 2017, 2018; Smitsman et al., 2019).

Education remains a central site of learning. It can be an effective pathway to the emergence and spread of the knowledge and skills of complexity competence. However, many theorists and authors agree that education today needs updating, as it is still based on the industrial expansion of the 19th century (see for example, Alhadeff-Jones, 2017, 2020; Hall, 2020; Laszlo & Laszlo, 2007; Luksha & Kisner, 2020; Robinson, 2013; Smitsman et al., 2020). Education today risks failing to provide young people with the skills and knowledge required for the 21st century according to these authors, who recommend a complexity-based perspective and approach. Laszlo et al. explain that it is time *now* to move beyond the mechanistic, reductionist, linear thinking that is "not only hopelessly out of date but is increasingly irrelevant - even dangerous" (2017, p. 605). Curriculum that includes the direct teaching and learning of complexity competence is required.

The 2018 Global Education Futures Report (GEFR) places complexity thinking and understanding as one of the most widely needed capacities required for the 21st century (Luksha et al., 2018). Educational innovation that moves across the complexity barrier in content and practice is required for individual emergence, collaborative learning and collective wisdom (Laszlo et al., 2017; Smitsman et al., 2021). Laszlo clarifies that including complexity thinking and understanding in education is part of the "search for ways to curate the emergence of a thrivable planet" (2014, p. 581). A complexity focused approach to education can contribute to the understanding of processes and dynamics, and it influences conditions for coherence in settings of complexity and change (Alhadeff-Jones, 2012; 2013). Complexity competence focused education challenges reductionism, both mechanistic and colonialist, within all forms of knowledge. It includes a relational worldview, and a skill set based on engagement with entanglement, emergence, reciprocity and ethical co-generativity. Using design thinking through a patterns-based language and strategy, this project aims to contribute to the global movement in innovative and transformational complexity focused education (see for example Alhadeff-Jones, 2017; Laszlo, 2017, 2018; Smitsman et al., 2020; Smitsman et al., 2021).

Pattern Logic and Pattern Thinking

Within complex ecological phenomena, many different patterns can be identified. Fundamental flowform patterns such as spirals, branching and mycelial forms, circles, spheres, and toroids, are found at many scales. We see them in cells and body systems, plants, river systems, weather, planets, and solar systems (Meijer et al., 2021; Mollison, 1988). These patterns express processes of organisation and emergence; they are the fundamental patterns that hold the paradoxical coherence of chaos and order, from a subatomic to a cosmic scale. Recently galaxies have been found to exist and move in coherent patterns relative to each other, in a way that challenges the concept of randomness in the standard cosmological perspective (Müller et al., 2018). Patterns hold the relational logic of the known and unknown, the determinate and indeterminate, and the dynamics of multiplicity, non-linearity, and perpetual emergence. Across scale pattern logic includes the paradox of apparent binaries as relational dualisms. Form/flow, order/chaos, inside/outside, individual/whole are examples of this. These and many more are relationally patterned.

Describing the world's coming-into-being in terms of patterning, Meijer et al. (2021) describe the sub-quantum field as informing the quantum field, with harmonic fluctuations

self-generating localisation, manifesting time and matter. Toroidal and spiral pattern dynamics are described as fundamental, occurring fractally, indeed holotropically, from the sub-quantum or superfluid quantum space through to the cosmic (Diez Faixat, 2021; Meijer et al., 2021). The authors describe the sub-quantum field as informational, in terms of unified consciousness, with the term information, like patterning, describing phenomena at various and fractally related scales, both as a premanifest unity and as manifest particularity. This patterning process is multidirectional, with the co-emergence of entities from the intra-action of internal relationality (Barad, 2007), and the patternings of complex manifest life also imprinting upon the sub-quantum field (Laszlo, 2014b).

Pattern thinking is a way of knowing and understanding complex phenomena, including ourselves as inherently embedded and entangled. We can use patterns to express this co-creative relationality between human beings and all aspects of life (Yunkaporta, 2019). Indigenous peoples have used pattern thinking and design for this purpose for millennia (Yunkaporta, 2019). Ecologically inspired shapes, patterns and metaphors have been utilised in design for this purpose throughout history and across a wide range of cultures (Buenfeld & Clark, 2020). European indigenous cultures also utilised pattern languages for understanding relational complexity (Buenfeld & Clark, 2020). Complexity Patterning is a re-designing of this fundamental human knowledge, adapted for the educational environments of the 21st century.

The efficacy of Complexity Patterning is based on two points. First, the design is formed from ecological patterns found in a range of complex phenomena (Gleick, 1987; Meijer et al., 2021; Yunkaporta, 2019). Secondly, people inherently use ecological metaphors to understand complex phenomena (Lakoff & Johnson, 2003; Yunkaporta, 2019). Because ecologically occurring patterns and entities are themselves elements of complex phenomena, they are more homologies than metaphors when used within a language for complexity.

The logic of Complexity Patterning includes time as a complex phenomenon. Conceptualising time as a patterning of diverse temporalities considers the past and the future as dynamically entangled in the present (Barad, 2007, 2017a, 2017b), which then offers re-generative and evolutionary possibilities (Laszlo, 2001, 2003, 2009, 2018). This perspective includes the viewpoint that the future is not completely determined by the present (Prigogine, 1997), and that the past is not finished, but is reworked in the present (Barad, 2007, 2017b). Such a complexity focused perspective includes the capacity to creatively engage with the dynamics of change, uncertainty and indeterminacy, turbulence, and chaos. It supports the ability to navigate contradiction, such as continuity and discontinuity among others, and approximations, all while seeking generative engagement and coherence within emergence (Clardy, 2020). Knowing time as a complex phenomenon supports understanding that we are inherently complicit as mutual co-generators of the emergent patterning of the future.

Pattern logic is also extended to the theoretical foundations of Complexity Patterning. Inspired by Edgar Morin's view that complex phenomena resist description by any one system of knowledge (1992, 2008), Complexity Patterning emerges from a diffractive relationality of diverse knowledges and ways of knowing. Complexity science, Indigenous Knowledge, and recent views in quantum field theory, form a patterning of peaks of resonance and troughs of dissonance. The resulting diffraction pattern is an interference or superposition of waves whereby differences and similarities are highlighted, with each knowledge relating rather than competing, and remaining rather than combining (Barad,

2007, 2014). Theoretical physicist Karen Barad describes all manifest life as diffractional patterning, with non-localised waves patterning to generate standing waves that express as localised particles (2007, p. 299). Fractal patterning of diffractive/interference waves is described as constituting all materialised holographic forms, from intensity changes and phase shifts in the quantum field, by Laszlo and Laszlo (2016). As a knowledge generation concept and metaphor, diffraction is described by Barad as reading diverse knowledges through one another for the emergence of new insights (2007). The relationality of the three knowledges mentioned above through the concept and phenomena of patterning, is one such insight.

A transdisciplinary and relational approach to knowledge of complex phenomena is put forward by Bielinskye et al. (2022), who describe this growing knowledge development as synergetics. The authors uphold that the recent Nobel Prize awarded to Syukuor Manabe, Klaus Hasselmann, and Giorgio Parisi, for "ground-breaking contributions to our understanding of complex physical systems" is an indication of the importance of transdisciplinary complexity literacy and understanding (2022, p. 56). They also express the challenge of implementing complexity thinking in today's educational institutions, adding that a synergetic approach to knowledge relationality could provide a significant contribution to new paradigm education.

The Complexity Patterning Design

The logic of relationality and dynamics within Complexity Patterning is isomorphically coherent with the pattern logic of life. Based on three ecological flowform patterns and one central metaphor that is given pattern status, the design and process of Complexity Patterning are simple enough for implementation with students of all ages and detailed enough to express the dynamics and states of complex phenomena (see Figure 1). The design is an introductory approach to engaging with what is described as "an infinite topological manifold of relata" by Murris (2022). Using ecological patterns and metaphors/homologies in this way is biocentric design, placing Complexity Patterning as process that engages in life in a way that supports the conditions conducive to life (Benyus, 2002, as cited in Laszlo, 2017). In short it is generative.

One of the four patterns, the spiral, expresses the temporal dimension. With seven phases fractally repeated on three levels, spiral pattern expresses time as a complex phenomenon, including entangled transtemporal dynamics and relationships. Spheres pattern expresses spatial and discursive arenas, also with three levels of fractal iteration. The tree/mycelium pattern expresses dynamics of connectivity and relationality across the spheres, through ebbs and flows of enablement and constraint. Tree pattern can also be expressed as mycelial connectivity, without demarcations of roots, branches and trunk. The fourth pattern, seed, has no internal detail. Seed expresses the turbulence of chaos, phase shifts and transformation, and the concept of legacy. Each pattern is a dimensional expression of the whole, and together with a wide range of ecological metaphors they express the relationships, dynamics, aspects, and elements of the phenomenon of focus (Brown, 2019).

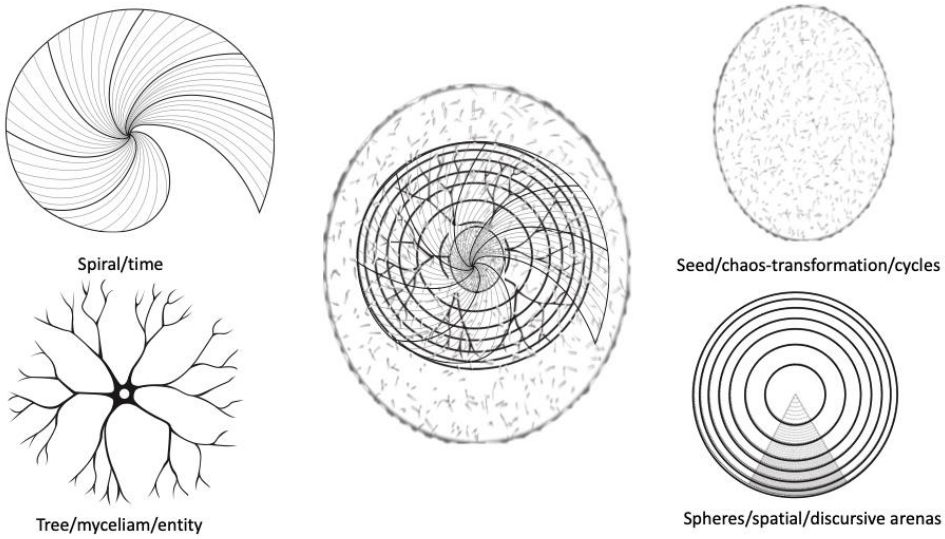

Figure 1. The Four Patterns of Complexity Patterning

Complexity Patterning forms a language and process for understanding complexity concepts in a way that meets the students where they are and can be adapted for very young as well as tertiary students. It enables complexity concepts to be visualised through ecological dynamics and relationality. This also supports learning about ecological and socioecological systems. Principles of scaffolded learning, and meaningful connection to students' lives and the wider world are used in the implementation of Complexity Patterning, by providing concrete examples and real-world applications from the start. When used as an identity emergence approach to learning, Complexity Patterning becomes a way to understand and experience ourselves as also a dynamic complex phenomenon, that is distributed through relationship and identifications, as well as embodied as individuation. Understanding ourselves as a local salient configuration within a wider non-local dynamic patterning is a way to experience complexity directly. This approach places learners in embodied relationality with other beings, entities, and species, and within phenomena generally.

Complexity Patterning does not seek to be an accurate representational model; it is an educational process that is designed to enable the emergence of complexity competence. It is also designed to be implemented *with or without* the language and terms of complexity, as the dynamics and relationships of complex phenomena can be engaged directly through patterns and metaphor. This gives it a low cognitive load (Brown, 2019). In the developmental phase of this work with secondary students, Complexity Patterning was implemented without the language of complexity science, with complex dynamics simply described as patterning. This adaptability enables this work to be useful for a wide age range of students, as well as in professional and community-based settings. However, in this doctoral project, Complexity Patterning was linked directly with complexity science concepts and language for the undergraduate students participating in this inquiry.

The Provenance of Complexity Patterning

When I began secondary teaching in 2006, I observed that many of the students were acutely aware of the multidimensional connectedness and complexity of their lives and in the world. Many expressed understandings of uncertainty and increasing chaos, and concerns about the capacity of education to contribute to a healthy future. I also discovered that language and concepts for engaging with these dynamics and concerns were missing from the educational curriculum. I had designed Complexity Patterning previously to express the paradoxical and complex relationality of human individuality and entanglement across scale and realised it might provide an appropriate language to engage with complex multidimensional and multilevel dynamics with the students.

Beginning with the idea that science tells us that everything is energy, and everything is interacting with everything else all the time, we then considered the *everything* happening in the classroom and in our lives. Educational practices generally ignore or refuse to engage with anything outside the curriculum, yet we observed that much learning and becoming was occurring in these relational dynamics. We considered that energy is also information, and that we needed a way to think about, talk about and engage with the complex energy and information moving all around us. The patterning design was introduced as a useful way to do this.

The tree and spheres patterns were implemented as a cognitive tool to engage with the relational dynamics and power flows in the room; for participation in classroom culture as co-generative learning/becoming commons. The patterns were continually redrawn on the board at the front of the room, expressing different configurations each time. Using the patterning this way also enabled and facilitated experience of identity as a dynamic complex phenomenon that is locally salient and non-locally distributed. Navigating dynamics through the patterns and ecological metaphors/homologies generated identity safety in the classroom, enabling increased sentience and learning engagement. This supported group coherence, with all of us as elements of one patterning. Using the design this way supported respect for difference, though considering the diversity that enables ecological health. Such an identity emergence approach places both becoming and learning as co-mutual emergent complex phenomena. Students and teacher alike were encouraged to be purposeful stewards of our own patterning, towards purposeful relationship within our mutual patternings with others and the world around us.

Spiral and seed patterns are detailed here through implementation with the secondary students. Spiral pattern was implemented to engage with time as a complex phenomenon. After some young students expressed that they felt *already left behind* – as failures in their own lives - I sought to perturb the cognitively damaging dominance of mechanistic linear time upon the students' learning and becoming (Alhadeff-Jones, 2017). I sought to offer the students an experience of time that was expansive, entangled and emergently complex. While the narrow and reductively linear temporality of institutional education was assigned to timetables and goal setting, and released as a measure of the students' becoming, worth, and potential to participate and contribute. Becoming and learning were expressed through spiral pattern's non-linear phases and ecological metaphors. With this humantime expressed as complex configurations of spiral's patterning, the students were introduced to their becoming and learning as a lifetime transgenerational phenomenon, within which they could never be left behind.

With three levels of fractal iteration of seven phases, spiral pattern expresses time as multirhythmed and diversly complex (see Figure 2). The phases are not inherently

chronological, with a wide range of combinations of configurational salience possible in any moment. The internal boundaries of the spiral and spheres patterns are porous and adaptive, and engaged purposefully in implementation. More, or less, phases and spheres can be used, and they can be differently described. All the patterns express the relationships we perceive and include, and those we do not include, as also generative within the phenomenon of focus. Such a perspective highlights the inevitable reduction occurring with any abstraction of phenomena through human knowledge and reminds us that Complexity Patterning is always dynamic. Considering this, Complexity Patterning is implemented as a hand drawing activity that emphasises contingency, as well as the co-generative effects of our knowledge making practices.

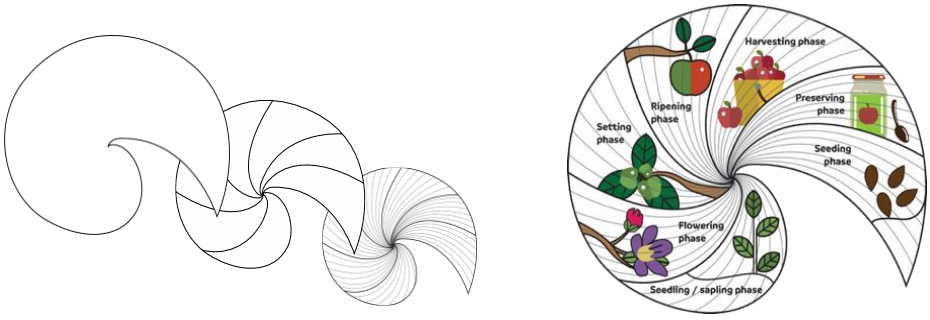

Figure 2. Spiral Temporal Patterning; Three Levels of Phases, and Metaphors for Each Phase

Spiral offers purposeful engagement with emergence, with all boundaries expressing the potential for transformational phase shifts or bifurcations. In this example, ecological metaphors of the lifecycle of a fruiting tree express detail of dynamic relational emergence. The spiral pattern can be applied to the temporal dimension of any phenomenon of interest, from an event, a project, a lifetime, or an era. It expresses the emergence of increasing complexity and coherence, contrasting with the linear and acquisitional growth concepts of size and quantity.

Seed pattern (see Figure 3) was implemented with the secondary students to express and engage with the concepts and experience of turbulence and chaos, with the creativity of uncertainty and indeterminacy, of phase shifts, and of cycles and legacy. With no internal detail, seed pattern expresses the dissolution of particular patternings and the transformational process towards a new configuration and coherence. It was placed in the centre of the four patterns and around the outside to express the co-generativity of chaos and order in the wider cosmos, which resonates with Laszlo's fifth syntony sphere (2020).

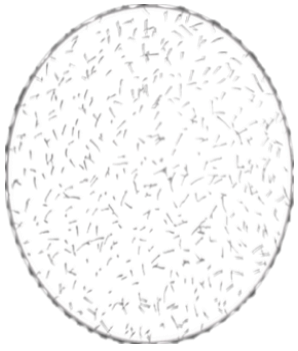

Figure 3. Seed Pattern

Connection grew between the engagement with the visual patterns on the board at the front of the room and the coherence of the classroom culture and learning for us all. Student engagement and academic achievement increased (Brown, 2019). The enthusiasm and positive feedback from the secondary students inspired me to explore the usefulness of the design in a more formal way through the doctoral inquiry process.

The Doctoral Inquiry Project

The design was implemented as Complexity Patterning with four cohorts of undergraduate students in a doctoral inquiry project. Two cohorts were Liberal Arts students from Long Island University (LIU) New York, who were in Australia for the Pacific/Asia section of their Global Studies Degree Course. The other two cohorts comprised Science undergraduates from Southern Cross University (SCU); one group studying a general Bachelor of Science and the other majoring in Regenerative Agriculture. The age range included young people who were recent secondary school graduates through to mature age students.

Complexity Patterning was applied to the phenomena within the students' studies. The LIU students were learning about intercultural communication and professional identity emergence connected to global sustainability projects with diverse peoples. The design and process were also engaged as a project management tool, for designing, planning, and managing projects in situations of complexity and change. One group of the SCU students was investigating food production and distribution systems, and the other was studying 21st century challenges within science knowledge and practice.

Inquiry Workshops with LIU Students

At the beginning of each workshop the students were introduced to simple patterns that are found within phenomena across scale. We considered images of cells, fruit, and the planet Earth providing understanding of spherical and toroidal dynamics. To introduce the tree/mycelial pattern, the well-known image of a mouse neuron next to a representation of the branching filaments of the universe was introduced, along with a depiction of the mycelial webbing of the internet (see Figure 4).

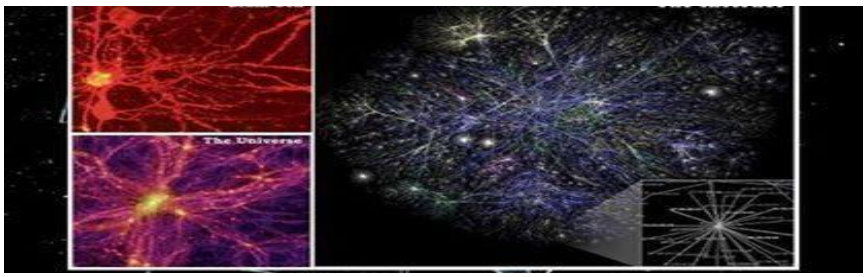

Figure 4. Mouse Neuron (top left), Representation of Universal Filaments (bottom left), Representation of Mycelial Webbing of the Internet (right).

How these ubiquitous patterns operate within complex phenomena was discussed before using them in the Complexity Patterning process. The branching/mycelial patterning was considered as efficient for the distribution and exchange of information, energy, and matter.

The spheres patterning as effective for forming functional boundaries; for holding energy, information, and matter in somewhat continuous form. In this way the students gained understanding of the patterns before using them. Including internet network webbing introduced cultural phenomenon as also complex and able to be expressed as patterns. Beginning with the patterning similarity of phenomena across scale stimulates a broad understanding of basic pattern logic and encourages wonderment and awe. Shared attributes and differences between similarly patterned phenomena were then open for discussion. One LIU student expressed their experience of engaging with branching patterns across scale:

> *I've learned about complexity and how many different things you could apply the understanding of it to. I really liked the image of the neuron and the galaxy, that's a very powerful image for me.*

We considered the branching forms of the human nervous system and brain neurons. Once it was discussed that human beings are also complex phenomena, the students developed the understanding that we are embedded somewhere in the middle of entangled scales of complexity. Discussions of simultaneous individuation and broadly entangled connectivity followed easily, with the complexity concept of paradox expanding with further discussions about the knowledge making process of drawing boundaries and defining entities. The concepts of autopoiesis (self-generativity) (Maturana &Varela, 1980, 1992) and sympoiesis (co-generativity) (Haraway, 1997) were engaged, leading to the co-generativity of humans and environment/culture. Once the students were discussing *themselves* as emergent complex phenomena, the idea of using simple spheres and branching/mycelial patterns to express their experience was introduced. A fundamental aim of Complexity Patterning is to provide the learning conditions for embodied experiential complexity perception and experience, before using the design to express the dynamics of other complex phenomena, or system of focus.

Tree and spheres patterns were the focus of the inquiry workshops, due to the students' curriculum, and the depth of engagement with complexity that is possible with just these two patterns. We engaged with the spheres pattern first, considering the widening yet inseparable spatial and discursive arenas describable within the phenomenon of focus. Other theorists have utilised nested concentric circles in a range of knowledges (see for example Bronfenbrenner, 1994; Davis, 2008). However, differences between these examples and Complexity Patterning include the permeability of all boundaries, the adaptive capacity for more or less spheres as required, and the use of three fractally iterative levels. Together the seven spheres and three levels generate complex configurations of patterning salience in any one moment, situation or manifestation. Tree patten was then introduced to express ebbs and flows of connection, enablement, and constraint, through the spheres arenas. Tree forms have been used in a range of knowledges also, from ancient knowledge systems to recent scientific perspectives. Here the tree form is used in a non-hierarchical way, with roots, branches and mycelial webbing moving within the three levels of seven spheres.

The terms *phenomena* and *system* were discussed, with complexity being considered the naturally occurring dynamics of phenomena, and a system a humanly demarcated and defined arena of complexity. This defining process was understood to be what was occurring when we used Complexity Patterning, as we chose what to pattern and what to leave out. Purposeful decisions of boundary making, and categorising emphasised the effects of our knowledge making practices in our participation in world-making (Barad, 2007). In this way our definitions of space, place, people, ideas, beliefs, and practices, and the entities of the

more-than-human world, were all considered carefully within the Complexity Patterning process, highlighting inherent ethical responsibility for the effects of knowledge making processes in our relationship with the phenomenon of focus. This is a perspective of human complicity as attractors within complex phenomena.

The spatial and discursive categories shown below were used for the workshops. The use of colour was encouraged, for expressing a range of relational qualities, and as coded meaning in the students' Complexity Patternings. The coloured spheres pattern on the right in Figure 5 was used to express the fuzzy and dynamic nature of boundaries within phenomena, and the fractal nature of the use of more than one level, with the repetition of all seven spheres.

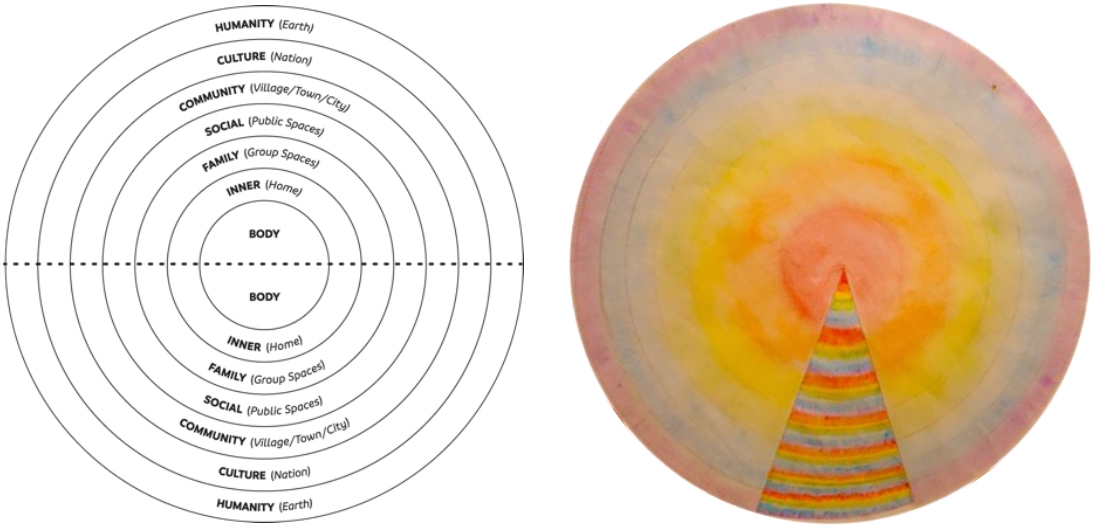

Figure 5. Spheres Pattern, with Spatial and Discursive Categories, and Colours Expressing Relational Dynamics, Showing Two Levels.

Seven spheres were designed initially to correspond with the seven orders of branching in river and tree branching forms (Mollison, 1988). This ecological observation introduced the tree/mycelial pattern (see Figure 6).

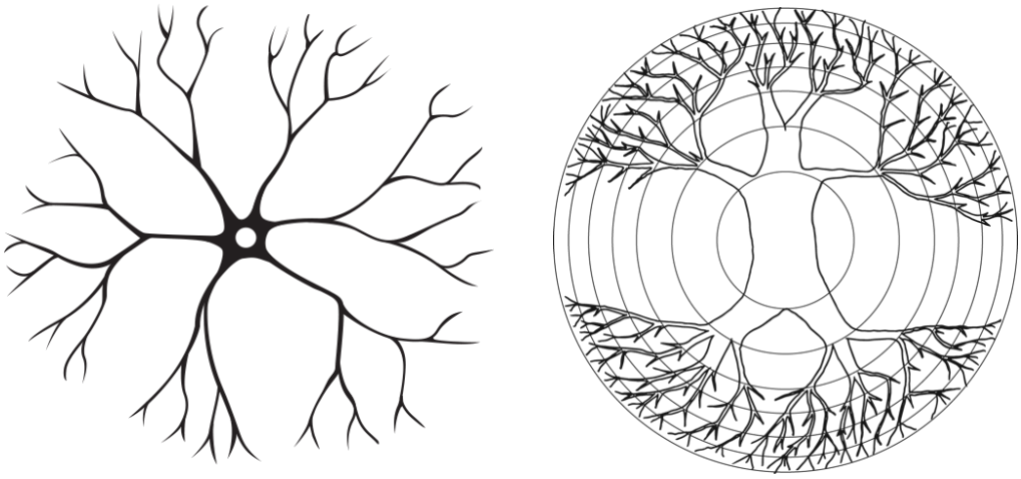

Figure 6. Tree/Mycelial Branching Patterns, one with Spheres Pattern

Spheres and tree patterns were implemented with the LIU students to engage with and express the complexity of their personal and professional identity emergence, as flows of affordance and constraint, both spatial and discursive. Understanding that across scale dynamics were operating, one student commented:

> *The design that you have here looks like a neuron, like the image of the universe when you showed us those two images, with the centre concentration of something and then it all webs out, so it's incorporating the same idea of complex dynamic systems that we are seeing here with identity and everywhere else.*

The inseparability of personal and professional identity emergence was discussed at length, giving the students permission to acknowledge the influence of the implicit and unspoken. As with the secondary students, this aspect of Complexity Patterning came as a relief for the students, as it became clear that there was nothing outside of complexity, and it was *all* mutually influencing. An example of my own professional/personal identity emergence patterning from the early stages of the doctoral project was shared with the students (see Figure 7). It clearly illustrated the meaning making and knowledge of complexity generated in the process of patterning, and that there is no correct way to do it, and that no artistic skills are needed. The students could easily see that they could not read my patterning without an explanation, and that I was choosing what was shareable knowledge and what was not. This demonstrated complete agency over any disclosure, creating identity safety in the room. Also, it indicated that there might be visible knowledge and information, and invisible knowledge and information, with any person, situation and setting of complexity.

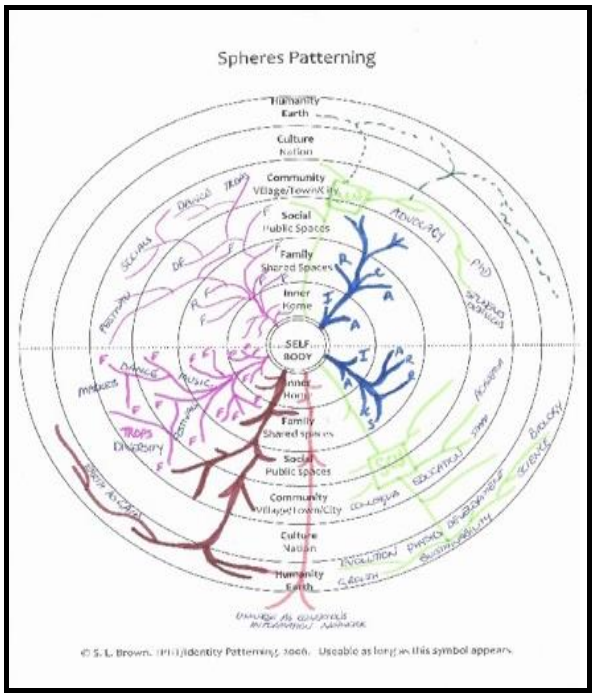

Figure 7. Author's Identity Emergence Patterning

The students were then invited to create their own patternings. In the process, a range of ecological metaphors were utilised to express the dynamics within the complexity. The use

of metaphors supported a narrative as well as patterning approach to complexity competence. As can be seen from the students' examples in Figure 8, the patternings do not constitute a *model* of complexity; they are an educational process and visual strategy for the enablement and expression of emergent relational knowledge, for the teaching and learning of complexity competence. The two-dimensional images shown below do not capture the multidimensional knowledge being generated, understood, and expressed by the students. They shared the coded information and meaning in their patternings, with a wide range of complexity knowledge expressed.

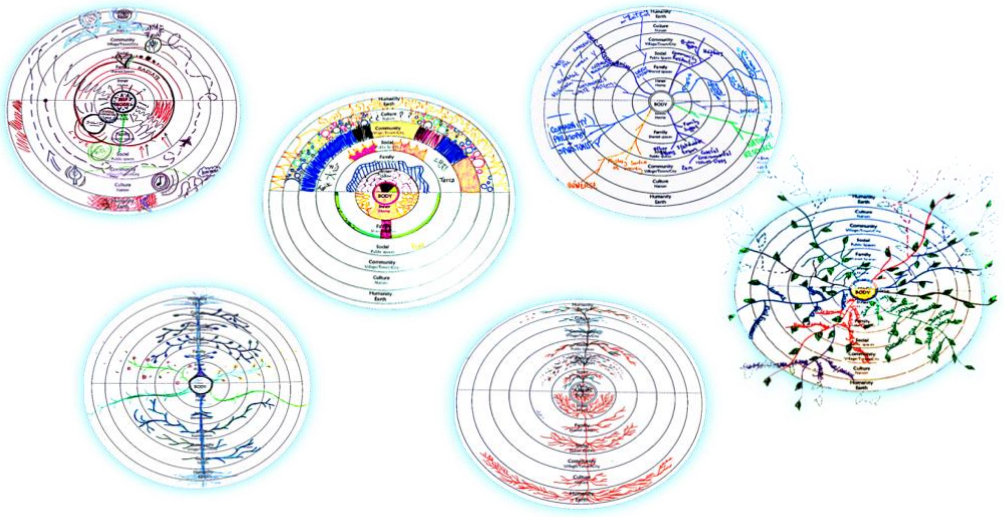

Figure 8. Student Identity Emergence Patternings.

There was a focus on using Complexity Patterning for self-knowledge, before moving on to using it for understanding cross-cultural communication with diverse peoples and cultures. Using the patterns to manage life's flows purposefully was discussed, and we concluded that being aware of influences, enablement and constraint, effects, and emergence, may assist in maintaining the coherence required for long term contribution to their areas of interest and passion.

Student feedback on the patterning process indicates their experience of increasing agency in their emerging identities. One student shared:

> *It's soulful, when I was mapping this out I kind of just mapped out how my life should be in a way, like I made these little squiggly lines and stuff that I need to grow on and stuff that I need to close off to become who I need to be, stuff I need to worry about, what makes me who I am, so it was really helpful, now I just have a set of things that I know are more important.*

Another student commented:

> *I really like your description of complexity. You know it's often times very vague, and it's used like 'oh its complex' and it's used as a way of estranging the idea from yourself. I like that you made it like the complexity that I know, that I deal with every day, and what I am is complex.*

These comments reflect the effectiveness of using the most familiar phenomenon of all, the students' own lives, as the first example of complexity. This relates strongly to the research

undertaken by Yoon et al. (2019) which concludes that familiar phenomena are the most effective for teaching and learning complexity knowledge. Using the students' identities and own lives also bypasses the issues discovered in the research by Stella (2020), whereby complexity was considered by students as a negative state to be avoided.

When asked about the Complexity Patterning workshop, students gave the following feedback. It is important to note that this was, for all but one student, their first experience of direct learning about complexity. One student commented:

> *Perspective is a big part of this, and anything, like things that we deem as not so important or sort of like a marginal issue, you could put that in the centre you know and you could go out from there, so I guess in terms of complex dynamic systems, you could turn absolutely anything into a complex dynamic system, because everything is a complex dynamic system, and this shows that very clearly.*

Another student added:

> *I think it's really cool how everyone, and everything is connected, and you could make one of these for any object, you could make one for this water bottle, and you could connect it to the universe, and connect the universe back to it.*

One student had experienced an introduction to complexity in another course, and when asked to compare and contrast the two approaches they said:

> *This is more rooted in understanding life, this is another way, another way of seeing life, and then beyond life, like meta-life.*

We discussed the usefulness of Complexity Patterning for intercultural project planning and management, and an example of how it might be used was shared. The relationality of two people, two groups or two entire cultures, were considered in terms of the interference or diffraction patterning of two complexity patternings. This concept soon expanded to more than two.

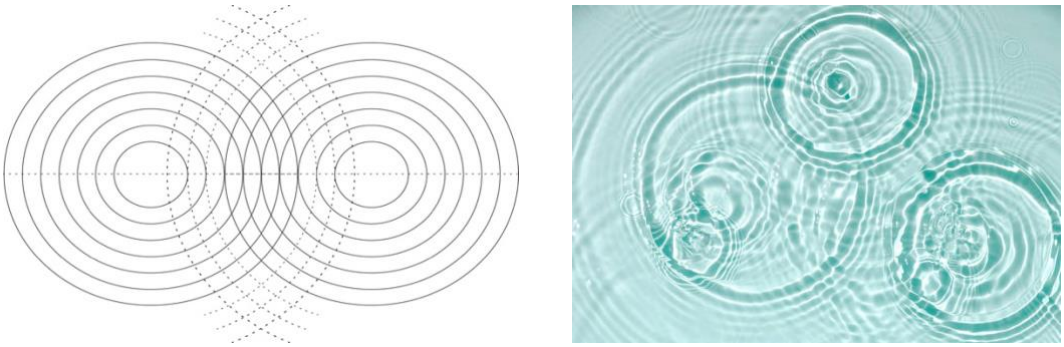

Figure 9. Diffraction Patterning Expressing Complex Relationship

The students were enthusiastically interested in the opportunity to use the design and process for this purpose, indicating that they were already generalising the learning and projecting its possibilities. One student concluded:

> *It helps you have a grasp on it all. In terms of projects, you can look at a project in a sustainable holistic manner and see how it will affect all of the different spheres of society and the nation and the world, instead of just looking at band-aid solutions.*

I observed that the students were comfortable with multidimensional and complexity thinking, and simply needed a conceptual language to grow their knowledge. All the students' comments indicate that emergence of complexity perception, thinking and understanding was occurring. By way of validation, three months later the students in workshop one attended a lecture on mining in Australia at Southern Cross University and sought me out to tell me that the lecturer had mentioned complex systems and said that it was "difficult to understand and hard to articulate". The students explained to me that they all understood it very well due to engaging with Complexity Patterning. This indicates the transferability of the knowledge.

The spiral and seed patterns were introduced to the students at a very introductory level. Seed pattern with a focus on the phase shifting experience of the dissolution of patterning into a chaos state, and the reorganising and repatterning into another configuration. The spiral pattern introduced the concept of complex time. Spiral is based on the perspective that we need complex temporalities as much as we need complex spatial experience, a view supported in the work of authors such as Alhadeff-Jones (2017, 2020), Barad (2007, 2017b), Rifkin (2017), and West-Pavlov (2012).

Inquiry Workshops with SCU Students

In a final brief example, the third and fourth cohorts of doctoral workshop participants comprised first year Bachelor of Science students at Southern Cross University in Northern New South Wales. The third cohort, numbering 130 students, were studying Regenerative Agriculture and engaging with a Farming Systems course, looking at food growing and supply chain systems. This Bachelor of Science degree with a Regenerative Agriculture major is the first of its kind, both in an Australian university and internationally. This doctoral project also contributed to the positioning of complexity thinking as fundamental within the Degree's design. The fourth cohort of students, comprising 260 first year Bachelor of Science undergraduates, were introduced to Complexity Patterning as part of their Science and Global Challenges course. The design and process were used to express the students' learning and understanding of challenges in the sciences. These workshops did not begin with personal identity exploration, they moved directly into using Complexity Patterning to engage with academic topics.

Below is a selection of students' comments, expressed at the end of the workshops.

One commented:

> *We can use Complexity Patterning to develop a model of the relationships which impact our environment by asking questions of 'influences', by evaluating the themes and patterns which occur. Combining the spheres pattern over layered with the tree pattern you can create the patterns of influence, as this is a complex system these patterns will continually change. This process can work equally well on any topic, and I see that it will have a great use in transformation.*

Another shared:

> *I can see how someone could make a life's work around this. [It has] opened quite a few neural pathways.*

A third expressed:

> *Having just come from the complexity thinking session, I realise that complexity is so much more complex than previously appreciated! Phenomena also overlap; the social sphere surrounding how a farmer 'is' within their land is impacted by the expression of the land in which they are. Eddies of one phenomenon connect, mingle, and alter the other.*

And another concluded:

> *I just stumbled across this paper around how farmers who lack ecological literacy will more likely reach for chemical interventions. Sounds like complexity understanding could be a founding principle in regenerative agriculture.*

These comments indicate the emergence of complexity thinking and understanding occurring as the students used Complexity Patterning to gather, generate, organise, and express information into knowledge for further learning. There is no doubt that Complexity Patterning would be more effectively engaged as a two-day, or three-day workshop, or integrated into curriculum. This became evident in the students' interest in exploring the material in more depth and applying it in detail to a project or other situation. However, the students' engagement was not constrained by this limitation, with enthusiastic participation within the time available.

Implications of Complexity Patterning for Transformational Education

There is growing understanding of the connectedness of all of life within academia and beyond. Ideas of connectivity are expanding, from the inter-connection of individualised entities to include the internal connectivity that in-forms the co-generativity and co-evolution of all of life. In this project, such relationality is conceptualised as an organisational patterning that expresses form and flow, with overall coherence contributing to the conditions for healthy and thriving communities both human and more-than-human. There is a clear need for this relational knowledge to be integrated into education, and suitably effective teaching and learning strategies are urgently required. Complexity Patterning is one approach and strategy; it is a contribution to creating the conditions within education for this relational and embodied thinking and understanding to emerge. The inquiry workshops demonstrated the capacity of Complexity Patterning as an introduction to this knowledge.

Complexity Patterning offers an approach to transformational education that can contribute to the skills and understanding required by young people as they go forward into the opportunities and significant challenges of life at this time. Its potential for expansion in the field of education is evident in this project. Complexity Patterning can be the basis of curriculum for all ages and can be incorporated into teacher training education also. There is an opportunity for complexity competence to be amongst the graduate attributes for every course of tertiary study. It can support a wide range of students to complete their studies with

a foundation of complexity competence, to then bring into any area of further learning and specialisation.

We have the chance to not only radically redefine ourselves, but to redefine our relationality with and within phenomena. It is necessary to move from anthropocentric domination and destruction, to a co-generative emergence of thrival for all species and ecocultures (Laszlo 2001, 2003, 2018), to purposefully choose our place as a custodial species (Yunkaporta 2019). It is time for learning to be purposefully co-responsible and co-evolutionary (Smitsman et al., 2020; Smitsman & Smitsman, 2021), to be integrated within a complexity focused approach to education, together with the explicit teaching and learning of complexity knowledge and skills. As a language and strategy for embodied and purposeful complexity competence, Complexity Patterning is a useful and necessary contribution to the education required for the challenges of today and tomorrow.

References

Alhadeff-Jones, M. (2012). Transformative learning and the challenges of complexity. In E.W. Taylor, P. Cranton & Associates (Eds.). *The handbook of transformative learning: Theory, research, and practice.* John Wiley and Sons Inc, New York, (pp. 178-195).

Alhadeff-Jones, M. (2013). Method and complexity in educational sciences: Introduction to the special issue. *Complicity: An International Journal of Complexity and Education*, *10* (1/2), i-vii.

Alhadeff-Jones, M. (2017). *Time and the rhythms of emancipatory education: Rethinking the temporal complexity of self and society*. Routledge, London.

Alhadeff-Jones, M. (2020). Time, power and the emancipatory aims of adult education. In F. Finnegan & B. Grumme (Eds.). *Power and possibilities: Adult education in a diverse and complex world.* Brill Sense, (pp. 117-130).

Barad, K. (2007). *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. Duke University Press, North Carolina.

Barad, K. (2014) Diffracting diffraction: Cutting together-apart. *Parallax*, *20*(3), 168-187.

Barad, K. (2017a). No small matter: Mushroom clouds, ecologies of nothingness, and strange topologies of spacetimemattering. In A. Lowenhaupt, N. Tsing, E. Bubandt, E. Gan & H.A. Swanson (Eds.). *Arts of living on a damaged planet: Ghosts and monsters of the Anthropocene.* University of Minnesota Press, (pp. 103-120).

Barad, K. (2017b). Troubling time/s and ecologies of nothingness: Re-turning, re-membering, and facing the incalculable. *New Formations, 92*, 56-86.

Bateson, N. (2017). *Small arcs of larger circles: Framing through other patterns*. Triarchy Press, Bridport.

Benyus, J. (2002). Innovations inspired by Nature. In *Doors of Perception 7: Flow* (Conference in Amsterdam – 14 -16 November). http://flow.doorsofperception.com/content/benyus_trans.html>[retrieved]?

Bielinskye, A. O, Kiv, A. E, Prikhozha, Y. O, Slusarenko, M. A, & Soloviev, V. N. (2022). *Complex systems and physics education.* Proceedings of the 9th workshop on cloud technologies in education, 2021. Kryvyi Rhi, Ukraine.

Bronfenbrenner, U. (1994). Ecological models of human development. In G. McCulloch & D. Crook, (Eds). *International encyclopaedia of education,* 2nd ed. vol. 2, Elsevier, Philadelphia, (pp. 793-828).

Brown, S. L. (2019). A patterning approach to complexity thinking and understanding for students: A case study. *Northeast Journal of Complex Systems*, *1*(1). Article 6.

Buenfeld, G., & Clark, M. (Co-curators) (2020). *The botanical mind: Art, mysticism and the cosmic tree,* [Video]. YouTube. Camden Art Centre, London. https://www.youtube.com/watch?v=DYnH11reoXM

Clardy, A. (2020). The ontological foundation for studying the future. *Foresight*.

Davis, B. (2008). Complexity and education: Vital simultaneities. *Educational Philosophy and Theory*, *40*(1), 50-65.

Diez Faixat, J. (2021). Toroidal dynamics of energy-consciousness in evolution. In D. K. F. Meijer, F. Ivaldi, J. Diez Faixat & A. Klein (Eds.). *Mechanisms for information*

signalling in the universe: The integral connectivity of the fabric of reality revealed, (pp. 3-15). Researchgate. http://researchgate.net/publication/353804793
Gleick, J. (1987). *Chaos: Making a new science*. Penguin Books.
Hall, R. (2020). Another world is possible: The possibilities for a transformative post-capitalist education. In S. A. Hamed Hosseine, J. Goodman, S. C. Motta & B. K. Gills (Eds.). *The Routledge handbook of transformative global studies.* Routledge, London, (pp. 114-128).
Haraway, D. J (1997). The virtual speculum in the new world order. *Feminist Review*, *55*(1), 22-72.
Lakoff, G., & Johnson, M. (2003). *Metaphors we live by*. University of Chicago Press, Chicago (Original work published in 1980).
Laszlo, A. (2001). The epistemological foundations of evolutionary systems design. *Systems Research and Behavioural Science, 18*(4), 307-321.
Laszlo, A. (2003). Evolutionary systems design: A praxis for sustainable development. *Journal of Organisational Transformation & Social Change, 1(*1), 29-46.
Laszlo, A. (2009). The nature of evolution. *World Futures*, *65*(3), 204-221.
Laszlo, A. (2014). Connecting the DOTS: Thrivable systems through the power of collective intelligence. *Systems Research and Behavioural Science Systems Research, 31*, 586-594.
Laszlo, A. (2017). *Systemic innovation in a world of uncertainty*. Institute of Technology Buenos Aires.
Laszlo, A. (2018). Education for the future: The emerging paradigm of thrivable education. *World Futures: The Journal of New Paradigm Research*, *75*(3), 174-183.
Laszlo, A. (2020). Connecting to the holotropic quantum universe. In E. Laszlo, *Reconnecting to the source: The new science of Spiritual experience – How it can change you, how it can transform the world*. St Martin's Press, New York.
Laszlo, A., & Laszlo, K. C. (2007). Fostering a sustainable learning society through knowledge-based development. *Systems Research and Behavioural Science, 24*(5) 493-503.
Laszlo, E., & Laszlo, A. (2016). *What is reality: The new map of cosmos and consciousness*. Select Books, New York.
Laszlo, A., Luksha, P., & Karabeg, D. (2017). Systemic innovation, education and the social impact of systems science', *Systems Research and Behavioural Science*, *34*(5), 601-608.
Laszlo, E. (2014b). *The self-actualising cosmos: The Akasha revolution in science and human consciousness.* Inner Traditions, Rochester.
Luksha, P., Cubista, J., Laszlo, A., Popovich, M., & Ninenko, I. (2018). *Report: Educational ecosystems for societal transformation*. Global Education Futures 2018. https://s3.amazonaws.com/kajabi-storefronts-production/sites/53047/themes/936020/downloads/WQCqizZRQ6AcD5Oaia4A_GEF_april26-min.pdf
Luksha, P., & Kisner, W. (2020). Transformation into a new educational paradigm and the role of ecosystemic leadership. *Cadmus, Promoting Leadership in Thought that Leads to Action, 4*(2), 182-198.
Maturana, H. R., & Varela, F. (1980). *Autopoiesis and cognition: The realization of the living*. Reidel Publishing, Dordrecht.
Maturana, H. R., & Varela, F. (1992). *The Tree of Knowledge: The biological roots of human understanding*. Shambhala, Boston.
Meijer, D. K. F., Ivaldi, F., Diez Faixat, J., & Klein, A. (2021). Mechanisms for information signalling in the universe: The integral connectivity of the fabric of reality revealed. Researchgate. https://www.researchgate.net/publication/353804793
Mollison, B. (1988). *Permaculture: A designer's manual*. Tagari Publications, Sisters Creek.

Morin, E. (1992). *Method: Towards a study of humankind Vol 1. The nature of nature* (J. L. R. Bélanger, Trans.). Peter Lang. (Original work published in 1977).
Morin, E. (2008). *On complexity*. Hampton Press, Cresskill.
Müller, O., Pawlowski, M. S., Jerjen, H., & Lelli, F. (2018). A whirling plane of satellite galaxies around Centaurus A challenges cold dark matter cosmology. *Science, 359*(6375) 534-537.
Murris, K. (2022). *Karen Barad as educator: Agential realism and education.* Springer, Singapore.
Prigogine, I. (1997). *The end of certainty: Time, chaos, and the new laws of nature*. The Free Press.
Rifkin, M. (2017). *Beyond settler time: Temporal sovereignty and Indigenous self-determination.* Duke University Press, North Carolina.
Robinson, K. (2013). (May 11), *How to escape education and flourish* [Video], Ted Conferences.
Smitsman, A., Baue, B., & Thurm, R. (2021). *Blueprint 9: Educational transformation – 7 transformative learning perspectives for regeneration and thrivability. R3.0,* Heureka.
Smitsman, A., Laszlo, A., & Barnes, K. (2019). Attracting our future into being - The syntony quest. *World Futures, 75,* 194-215.
Smitsman, A., Laszlo, A., & Luksha, P. (2020). Evolutionary learning ecosystems for thrivable futures: Crafting and curating the conditions for future fit education. *World Futures, 76*(4), 214-239.
Smitsman, A., & Smitsman, A. (2021). The future-creative human: Exploring evolutionary learning. *World Futures, 77*(2), 81-115.
Stella, M. (2020). Mapping the perception of "complex systems" across educational levels through cognitive network science. *International Journal of Complexity in Education, 1*(1), 1-19.
Wahl, D. C. (2016). *Designing regenerative cultures*. Triarchy Press, Bridport.
Wahl, D. C. (2019). January 7, 'Health as a holistic pattern and a qualitative indicator of regeneration', *Medium*. https://designforsustainability.medium.com/health-as-a-holistic-pattern-and-a-qualitative-indicator-of-regeneration-307bba354f61
West-Pavlov, R. (2012). *Temporalities*. Taylor & Francis, London.
Yoon, S. A., Goh, S., & Yang, Z. (2019). Towards a learning progression of complex systems understanding. *Complicity: An International Journal of Complexity and Education, 16*(1), 1-19.
Yunkaporta, T. (2019). *Sand talk: How Indigenous thinking can save the world*. Text Publishing, Melbourne.