CHAPTER 12

From Learning Ecologies to Ecologies for Creative Practice

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Introduction

To perform any role requiring complex thinking and action involves being able to assess a situation, decide what action needs to be taken, and then pursue it using appropriate behaviours, tools and methodologies, monitoring the effects and results of one's actions and responding to the feedback received (Eraut & Hirsch, 2007, p.18). This process is at the core of what I am calling an *ecology of practice* that enables a person to create and achieve something of value within particular fields of knowledge and skill, contexts, situations and circumstances. The core proposition underlying this chapter is that performing a complex role involves the creation of an ecology of practice that enables a person to engage and interact with their environment and the things in it that matter to them, to solve domain-specific problems and communicate their learning through making and sharing new disciplinary artefacts. Their ecology of practice effectively projects them - as a whole sensing, thinking and dynamic organism - into their environment and, through skilled interactions they take in the reaction of the environment, they are then changed (Dewey, 1916). I am using Ingold's concept of environment namely "the world as it exists and takes on meaning in relation to [the person], and in that sense it came into existence and undergoes development with [the person]" (Ingold, 2000, p.20).

A second and related proposition is that creativity emerges while an ecology of practice is being enacted, through the ongoing purposeful interactions of a unique person with their unique environment as they strive to create value. When viewed from this perspective, our ecologies for achieving something of value constitute one of our most significant and fundamental acts of creativity.

This chapter extends the concept of learning ecologies and ecosocial systems outlined in Chapter 6 (Jackson, this volume) to the 'place of practice' or work environment. It explores and illustrates the propositions outlined above through the example of a geologist making a geological map. Although the representation is idealised and simplified it contains enough realistic detail to give practical meaning to the abstract concept of an ecology of practice. The ecological perspective being offered is grounded in the proposition that 'A properly ecological approach …… is one that would take, as its point of departure, the whole-organism-in-its-environment. In other words, "organism plus environment" should denote not a compound of two things, but one indivisible totality' (Ingold, 2000, p.19). '[T]his totality is not a bounded entity but a process in real time: a process, that is, of growth or development' (*ibid*, 2000, p.20).

Geologists and the ecosocial system they inhabit

In order to flourish, societies require people to educate and develop themselves to perform specialised roles like teachers, doctors, and engineers. Geologists are another example of a specialised role needed in a technologically advanced society. With their specialised knowledge and problem solving skills, geologists are able to study the earth, its rocks and landscapes and the processes that formed them employing a wide variety of methods. Using particular tools and techniques they are able to locate, map and quantify mineral, water and energy resources necessary to sustain societies and the global economy. The things they make, their maps and reports, document and communicate their understandings and are key cultural artefacts in their role as value creators in society. For example, they create value in the way they develop new knowledge about the rock and mineral resources of an area that can be made use of by society.

A geologist works within a specialized ecosocial system (Jackson, Chapter 6 this volume), the key features of which are outlined in Figure 12.1. They are employed by a commercial or public organisation whose purpose is to solve geological problems and create inventories of resources, for example geological mapping and survey work, mineral exploration, mining and engineering site investigations. Such organisations might be contracted to a larger organisation like a mining or engineering company, investment group, Government or World Bank. Through such relationships, the products of a geologist's work (like a geological map and report) might assume political or economic significance and possibly be subject to ideological and political forces in discursive regimes that the geologist will never know. Such complexity in the dynamics and evolution of an eco-social system, while important in an ecological sense, are beyond the scope of this narrative which focuses primarily on the work of a geologist as a single agent operating at the rock face of the ecosystem.

FIGURE 12.1 ABOUT HERE

The geologist's own organisation provides the immediate or proximal social-cultural environment within which work is undertaken, although much of the work will be conducted in the field which could be in physical and even social-cultural environments that the geologist has never experienced before. Work is overseen by managers and supported by the organisation with the resources, tools and facilities necessary to complete the work. Some of the specialist support might be outsourced to other service organisations in the ecosystem. The geologist is connected to a network of geologists inside and outside the organisation. They are likely to be a member of their professional body with its own standards, code of practice and CPD requirements. They will keep abreast of developments in their field by talking to peers, reading geological journals, attending conferences and engaging with resources that are publicly available on the internet.

Becoming a geologist

The geologist in formation becomes a part of this specialised ecosocial system when they study geology at university. To perform the role of a geologist, a person must develop a substantial body

of domain-specific knowledge and skills so as to perceive (observe, recognise, interpret and understand) the rocks, structures, or landscapes that they are studying. Their university programme provides them with opportunities for cognitive and practical development through real world, or close to real world, experiences. Learning extended over several years is achieved through a *cognitive and practical apprenticeship*. The cognitive apprenticeship (Collins, et al., 1989) enables learners to develop the knowledge and ability to perceive, imagine and reason to think and, to some extent, to act like a practitioner, while the practical apprenticeship enables learners to think and practice competently in the different environments and problem solving situations in which practitioners work. While a cognitive apprenticeship can be served in a classroom, a practical apprenticeship must be served in the authentic environments in which practitioners perform their role alongside more experienced practitioners.

In higher education, cognitive and practical apprenticeships are facilitated by teachers employing the signature pedagogies of their discipline. Signature pedagogies, 'are types of teaching that organize the fundamental ways of educating future practitioners, and are used to transfer skills of how *to think*, *to perform* and *to act* with integrity in their professional work' (Shulman, 2005, p.52). Such pedagogies encourage [?] *signature learning experiences* that enable learners to learn and work in environments that are identical or similar to the environments they will encounter in their future work as a practitioner.

Through signature learning experiences, the novice geologist developes the knowledge, skills and perceptual awareness needed to make a geological map. Placed in an unfamiliar field environment, they learn how to interpret and assess geological problems, decide what to do and act using appropriate tools and methodologies, mindful of the results of their actions and adjusting where necessary (Eraut & Hirsch, 2007, p.18). Making a geological map involves novice geologists using tools like a compass/clinometer, geological hammer and hand lens to take measurements, collect, describe and identify rock samples and record their observations in a notebook and on a base map. Through a signature experience. learners make use of the knowledge and skills they have acquired through lectures and reading, and develop new knowledge and skills in an experiential and embodied sense while in the company of peers and experienced teacher practitioners in the field. We might represent this signature pedagogy-signature learning experience dynamic as a learning ecology for the purpose of learning how to practice (Jackson, 2016; 2018 and Figure 12.2).

FIGURE 12.2 ABOUT HERE

At their best, signature learning experiences are facilitated through knowledgeable and experienced teachers through a process of 'guided participation' (Baker, 1999) in which learners are introduced and immersed in the problems and environments of the field:

> 'a theory of ecological learning emphasizes the value of meaningful co-participation in communal tasks, mutual respect from supervisors and peers, and responsiveness from the entire social environment. It suggests that students are capable of being relatively independent and self-directed learners; when they are given freedom and sufficient guidance to participate

> meaningfully in the authentic activities of a practice, they do not necessarily need to be controlled by an educator.'
>
> (Baker, 1990, p.83)

Through a combination of guidance, practical demonstrations and modelling by the teacher, observing and talking to the teacher and peers, and the messy trial and error process of immersion in field-based experiences of trying to make a geological map, the novice learns not only to make a map but to create an ecology through which future geological maps can be made. The point at which students of geology makes their own geological map, with little or no supervision, is an important milestone on their journey to becoming a geologist. It is the point at which they demonstrate that they can create an implement their own ecology of practice.

Ecology of practice for making a geological map

Making a geological map is a domain specific problem that a geologist will encounter in their work. Learning and the development of new knowledge are core to the work of the geologist and the framework developed for a learning ecology (Jackson, 2016; 2018 and Figure 12.2) also contains the key features of a geologist's ecology of practice (Figure 12.3). A geologist's ecology of practice is lived in their unfolding present but is connected to their past experiences of making other geological maps and studying geology as a subject, and what they learn can be incorporated into future ecologies of practice. Its purpose is to accomplish proximal goals, to learn about and understand the geology of a particular area and make a geological map and report.

A geologist's ecology of practice comprises themselves, their mind and body and all they can bring to the situation as they relate to and interact with their environment. Their ecology includes them interacting with a unique physical environment – the only place in the whole world where this particular map can be made. It contains the materials (rocks) and other resources including the tools they need to make the map. As they begin their project they enter a liminal space (Land et al., 2014; Savin-Baden, Chapter 4 this volume) with all the uncertainty of not knowing. Their ecology of practice affords the means of working in this liminal space and all the other intellectual and psychological spaces they need in order to progress to a higher level of understanding.

Their ecology of practice includes their work activities and the methodologies and the processes they employ using specific tools and technologies. Before they enter the field environment they will conduct research into what is already known. They gather the resources they need, such as aerial or satellite photographs and topographic maps, and use these to make preliminary assessments of the geology. When they enter the field environment, they will physically cover the ground, gathering and processing lots of information through skillful actions like locating the position of a rock outcrop on a topographic map or aerial photograph, measuring the dip and strike of bedding or other structures in rocks, breaking rocks and examining fresh surfaces with a hand lens and perhaps testing them with dilute hydrochloric acid, photographing and sketching outcrops and annotating their sketches with observations and interpretations. In these actions they are searching for geological evidence that they can interpret and to which they

ca give meaning; meanings that have been learnt through years of study and practical experiences in a range of environments.

FIGURE 3 ABOUT HERE

Implementing an ecology of practice

Making a geological map is like solving a giant jigsaw puzzle where most of the pieces are missing (there may be no rock physically to examine). The geologist's learning project is one of continuous inquiry driven by curiosity and the need to understand the geology of the environment. Their inquiry requires all forms of reasoning and the use of imagination to speculate and project from the known into the unknown to try to visualise and make sense of the patterns geologists see in the rocks and landscape. Using all their cognitive abilities, they strive to understand their problem while interacting physically, intellectually and emotionally with the physical spaces of their environment. As they work and learn, they construct, evaluate and refine a narrative to account for the geological history of the area; a story that embodies the evidence they have carefully gathered, and their own interpretations and theories and all the uncertainties and unknowns that drive further inquiry. They may well use sketches to help to visualise and explain their theories to themselves.

They use tools such as a hammer, compass, clinometer, camera, notebook, base maps, and aerial photographs to help to locate themselves in the landscape, sample the rocks, observe, measure and record information that is important and relevant to their map making. The physical and emotional experience of making a geological map, and the accompanying mental processes of perceiving, imagining, reasoning and reflecting enable them to build a picture of the geology and develop working hypotheses. Such concepts and theories influence future actions that enable them to test and evaluate their ideas and search for more pieces of their geological puzzle. In this way, ideas about the geology are tested, advanced or abandoned as they create new meaning.

Ecology of making

Making new cultural artefacts is at the core of the geologists meaning and map making process. We can view making a map as a process of spatially locating, connecting, integrating and representing materials and structures observed on the ground in a two-dimensional artefact. The idea of connecting is fundamental to an ecology of practice which involves finding patterns in lots of unconnected information and creating patterns with new meanings (Figure 12.2). Gauntlet (2011) offers three propositions about making as a process of connecting:

> ‘Making is connecting because you have to connect things together (materials, ideas, or both) to make something new; Making is connecting because acts of creativity usually involve, at some point, a social dimension and connect us with other people; And making is connecting because through making things and sharing them in the world, we increase our engagement and connection with our social and physical environments.’

(Gauntlet, 2011, p.2)

These propositions are all relevant to the geologist's map making, and the process of recognising and making connections is an important part of the ecological way a geologist thinks and acts. To make a geological map, a geologist has to interact in a particular way with the environment. Their body alone limits their ability to interact with their environment but they can, by using simple tools like a hammer and a hand lens, engage more deeply, for example, by breaking the hard rock and examining fresh unweathered surfaces with a hand lens. In this way, tools become an extension of the geologist's body and mind.

As they interact with their field environment, geologists think (perceive, imagine and reason) and record and assemble the information in particular ways and in a particular timeframe: they transform the information into an original synthesis – their geological map. While the social element is not so visible in the fieldwork, their work will be connected to other geologists, cartographers and editors as their maps and reports are prepared for publication, and ultimately their maps will be used by others.

Seeing and understanding that something has a possibility for connection, whether in advance or as the situation unfolds, are important in this process of making. The geologist does not connect random things, there being a thoughtful process going on which leads them to connect only things that are relevant and that can be used to develop their evolving understanding. They record accurately what they see on a field slip and in their notebooks (Figure 4). The process enables them to perceive patterns and relate and synthesize disparate pieces of information to create a more detailed picture of their puzzle which then enables them to search more purposefully for specific missing information. Notebooks containing field sketches can be like an artist's sketch-pad full of aesthetic and emotional value as well as scientific meaning and imaginative interpretations.

After the geologist has completed their work in the field, they reflect on what has been discovered as the day's observations - recorded in field slips, notebooks, digital photographs or video - are revisited and plotted on a 'fair copy' map (Figure 12.4). Such reflection is an essential part of the geologist's map and meaning-making process as they consolidate what has been learnt, develop or test theories and working models, and new insights and possibilities emerge as imagination and reasoning intermingle in this reflective space.

FIGURE 12.4 ABOUT HERE

Moving from the field to the office environment, these analytical and conceptual processes continue as rock samples are analysed and better understood. New artefacts and data are produced through these analytical processes. For example, geologists use microscopes to study the mineral composition, textures and structures of the rocks they have sampled using transparent slices of rock (30 microns thick). Thin sections (Figure 12.5) are important artefacts that enable rocks and minerals to be understood, characterised and classified. The geologist may also acquire geochemical or geochronological (dating) data for the rocks they have collected.

Producing the geological map is essentially a drafting process in which information is carefully transferred from field maps and notebooks onto a new base-map and digitized using the cartographic conventions and symbols of geological map making (Figure 12.5). The process of reworking this information can stimulate further thinking. But there is also an artistic element in the making of a map as pens or digital tools are handled and used to create the map. The final product is a beautiful artefact containing an accurate representation of the geology of the area explained in the image, the key and in an accompanying report, about the geological history and mineral resources of an area. The map and report are cultural artefacts that can be used to make decisions about how a landscape and its resources might be used in future, containing the affordance and information necessary for future action.

FIGURE 12.5 ABOUT HERE

How does a geologists' creativity feature in their ecology of practice?

This essay began with an assertion that an ecology of practice (or performance for that matter) is the means through which value is created. Such value is recognized in either the performance itself and/or the artefacts that are produced. A geological map and report which explain the map are the domain specific artefacts of the geologist's wholesome physical, intellectual and emotional relationship and purposeful interactions with their work environment and the materials (rocks and structures) that are in it, using the tools and other resources they have been trained to use. These artefacts are the physical manifestation of the value they create for themselves, their organization and any other clients, their disciplinary field, and ultimately society.

In a geologist's ecology of practice, there are many affordances for, and tangible expressions of, creativity. Some of these expressions emerge in the artefacts the geologist makes to record and represent the geology they have observed in the field (field slips, notebooks, maps and report) which can be used and valued by other people who have the knowledge to understand their meaning. Creativity is embodied in the narrative they create and communicate through their reports, which convey their understandings of the geological history of a particular area carrying their own interpretations, theories and synthesis. Through words and illustrations, they create a story that both describes (represents symbolically) and accounts for the geology of the area, interpreting, hypothesising, connecting and integrating the factual pieces of the geological puzzle into a new and sometimes original synthesis.

However, much of a geologist's creativity is embedded in a narrative that is rarely told: the narrative of their making. Ingold has much to say on the making of cultural artefacts that grow through a unique person interacting in a purposeful and goal directed way with their social, cultural, physical and psychological environment.

> what people do with materials [*i.e. geological materials NJ*]……. is to follow them, weaving their own lines of becoming into the texture of material flows comprising the lifeworld. Out of

this, there emerge the kinds of things we call buildings, plants, pies and paintings' *and in our narrative geological maps and reports [NJ]*.

(Ingold, 2011, p.97).

Creativity associated with the creative acts of people who are expert practitioners, for example the geologist in this narrative, is called pro-c creativity by Kaufman and Beghetto (2009), in their four-C categorisation of creativity. But also relevant to the geologist's practice is what these authors term 'mini-c' creativity, the novel and personally meaningful interpretation of experiences, actions and events made by individuals. Central to the definition of mini-c creativity is the dynamic, interpretative process of constructing personal knowledge and understanding within a particular socio-cultural context. A field geologist will draw on their creativity as they engage in their challenge and create new value as they make new geologically meaningful artefacts.

In his systems view of creativity, Csikszentmihalyi argued that 'creativity results from the interaction of a system composed of three elements: a culture that contains symbolic rules, a person who brings novelty into the symbolic domain, and a field of experts who recognize and validate the innovation. All three are necessary for a creative idea, product or discovery to take place.' (Csikszentmihalyi, 1997, p.6). While this synthesis can be mapped onto the ecosocial system within which the geologist works (Figure 12.1), it omits the important dimension of individuals working on particular challenges, within particular contexts, situations and environments, which ultimately determines the nature of what emerges. The ecological perspective adds important dimensions to Csikszentmihalyi's systems model.

Geologists, like all knowledge workers, are generating and processing large amounts of complex information and with such complexity the devil is always in the detail. Such detail can only be adequately appreciated by geologists as they engage in their work. Only they will know when and why they connected things in a way that transformed the way they perceived something and created new meaning, triggering new imaginative ideas that spawned new actions and outcomes. Such detail usually remains hidden, which is why understanding creativity is so illusive. It might be revealed in the story of how the geologist makes their map. Rogers' concept of a creative process 'the emergence in action of a novel relational product growing out of the uniqueness of the individual on the one hand, and the materials, events, or circumstances of their life' (Rogers, 1961, p.350), is entirely consistent with the way creativity emerges during the making of a geological map. As the geologist moves through and perceives the landscape, interacting with the rocks and materials it contains, accessing flows of information through their senses they interpret what they see and improvise their next moves.

[*Geologists NJ*] ……. are itinerant wayfarers. They make their way through the [*landscape*] bringing forth their work as they press on with their own lives. It is in this very forward movement that the creativity of the work is to be found. To read creativity 'forwards' entails a focus not on abduction but on improvisation (Ingold 2010, p.3). To improvise is to follow the

> ways of the world, as they open up, rather than to recover a chain of connections, from an end-point to a starting-point, on a route already travelled.
>
> (Ingold, 2011, p.97).

Ecology of integrative thinking

An ecological model of practice must engage with the thinking aspect of practice. When we explore and try to solve a problem, challenge or opportunity, we use our perception, imagination and our critical ways of thinking in a synergistic interplay. Pendleton-Jullian and Brown (2016) represent thinking as a continuum (Figure 12.6) in which imagination has the potential to connect to both perception and reasoning in a pragmatic way.

> In our framework for the pragmatic imagination, the role of the imagination has expanded from a simple imagination versus reason dichotomy to an entire spectrum of activity from perception, through reasoning, speculation, experimentation to the free play imagination we associate with artistic creativity
>
> (Pendleton-Jullian & Brown 2016. p.73).

FIGURE 12.6 ABOUT HERE

Interactionist (ecological) model of creativity

Dewey (1916; 1934) believed that action and creativity are brought together through human experience, defined precisely by the interaction between a person and their environment:

> When we experience something, we act upon it, we do something with it; then we suffer or undergo the consequences. We do something to the thing and then it does something to us in return
>
> (Dewey 1916, p.146)

Dewey developed this argument into a model to describe what happens when a person interacts with their environment to create new value, which Glaveanu et al. (2013) summarise in these terms:

> Action starts…… with an impulsion and is directed toward fulfillment. In order for action to constitute experience though, obstacles or constraints are needed. Faced with these challenges, the person experiences emotion and gains awareness (of self, of the aim, and path of action). Most importantly, action is structured as a continuous cycle of "doing"(actions directed at the environment) and "undergoing" (taking in the reaction of the environment). Under-going always precedes doing and, at the same time, is continued by it. It is through these interconnected processes that action can be taken forward and become a "full" experience.
>
> (Glaveanu et al. 2013, pp.2-3)

These authors argue that creativity, regardless of whether it is in work that is explicitly or implicitly creative, should be viewed from an interactionist perspective. Drawing on Dewey's interactional model, they examined creative activity within five domains: art, design, science,

scriptwriting and music composition, exploring the generalities and specificities of the doing-undergoing cycle in each domain and across domains. The study revealed 'a patchwork of similarities and differences between the five domains'. Table 12.1 summarises the characteristics of interaction and undergoing identified for the field geologist using the format used by Glaveanu et al. (2013, Table 3 p.12).

TABLE 12.1 HERE

Through an ecology of practice, the elements of a geologist's cognition and bodily actions work together in a merry dance through field, laboratory and office environments, through many different activities (skilful mapping, perceiving - observing, recording, sketching, interpreting what is found, gathering and processing other sorts of complex information, writing, cartography, discussions with peers and much more). The knowledge and understanding that is developed is codified in the domain-specific artefacts that are made. Through the challenge of making a geological map, the intermingling of perception (observation), imagination (speculation and conceptualization to aid interpretation), reasoning (analysis and judgement to aid interpretation), reflection (to aid learning) and emotion, offer endless possibilities for creating new understanding and meaning.

Creativity is involved throughout the process of making but it is so embedded in the whole practice that it is well-nigh impossible to isolate and say that this particular bit of thinking and action is creative and this is not. Ingold, (2011, p.91) argues that, 'Rather than reading creativity "backwards", from a finished object to an initial intention in the mind of an agent, this entails reading it forwards, in an ongoing generative movement that is at once itinerant, improvisatory and rhythmic". The synthesis of this generative movement are the meaningful artefacts resulting from the geologist's ecology of practice. These artefacts 'emerge in action' as 'novel relational product[s]' (Rogers, 1960) growing out of the ecology of practice. Thus, creativity does not happen by chance, but emerges because the creator – indivisible with their environment –weaves together particular pieces of information, ideas and material things to create new meaning. The artefacts produced are the physical manifestations of the new value that has been created.

Through their own unique history, learning, actions and behaviours, geologists shape their environment but they are also shaped by their environment and the unfolding problems it poses, as they repeatedly perceive, imagine and try to solve them:

> every practitioner has to improvise his or her own passage through the array of tasks the performance entails…… the wellsprings of creativity lie, not inside people's heads but in their attending upon a world in formation.
>
> (Ingold, 2018, p.124)

Concluding remarks

The general argument underlying this chapter has been that anyone performing a role that requires them to learn, in order to understand and deal with the complex situations they encounter or create, develops an ecology of practice that enables them to interact in a meaningful way with their environment. In the case of the field geologist, their ecology of practice enables them to engage, through their skilled actions and use of mediating tools, with the domain-specific problem of making a geological map. It also enables them to harness all their senses, cognition and psychological processes in their map making experience, an experience that is fundamental to their identity as a geologist. As they walk through the landscape, each step, and where it takes them, is a development of the one before and a preparation for the next because they do not know what they might encounter (Ingold, 2010, p.98). Complex sensory experiences and intense inter-mingling of the physical, intellectual, imaginative and emotional states of being, enable the geologist to form deep relationships with their work, the place – the landscape and the rocks in it - the tools they are using to interact with the landscape, and the artefacts that unfold as they work. Their emotions contribute to the investment they are making in their own meaning-making process and encourage feelings such as pride, satisfaction or dissatisfaction, and joy as they pursue and accomplish their goals.

This emotional investment on the part of geologists is contrary to the principle of scientific objectivity that requires scientists to remain emotionally detached from what they study (Ingold, 2018 and pers. comm.). But perhaps this emotional investment is necessary in order to create the strong intrinsic motivational forces that enable the geologist to sustain their engagement with their challenge and to think and act creatively. In this way, an ecology of practice enables the practitioner to blend their scientific and artistic ways of being to create new value that is recognised by peers and other knowledgeable practitioners in their field. Ecologies of practice are thus the means by which people integrate themselves, while connecting and relating themselves to the world they are attending. Through a practice ecology, scientific knowledge and methods, imagination, past experience and current action are creatively combined:

> Science, when it becomes art, is both personal and charged with feeling; its wisdom is born of imagination and experience, and its manifold voices belong to each and every one who practises it….. And where scientific pathfinding joins with the art of inquiry….. to grow into knowledge of the world is at the same time to grow into the knowledge of one's own self.
>
> (Ingold, 2018, p.71).

This creative process of growth is what Ingold (2014; 2018) calls 'undergoing', a process that was first recognised by Dewey (1916; 1934). The ecologies we create in order to achieve something difficult and challenging are the means through which we actualise ourselves and fulfill our own potentials as we strive to create new value in the world we are attending and, in the process, we recreate ourselves as a direct consequence of our experience: we become the better person we strive to be.

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Figure 12.1 The geologist's ecosocial system.

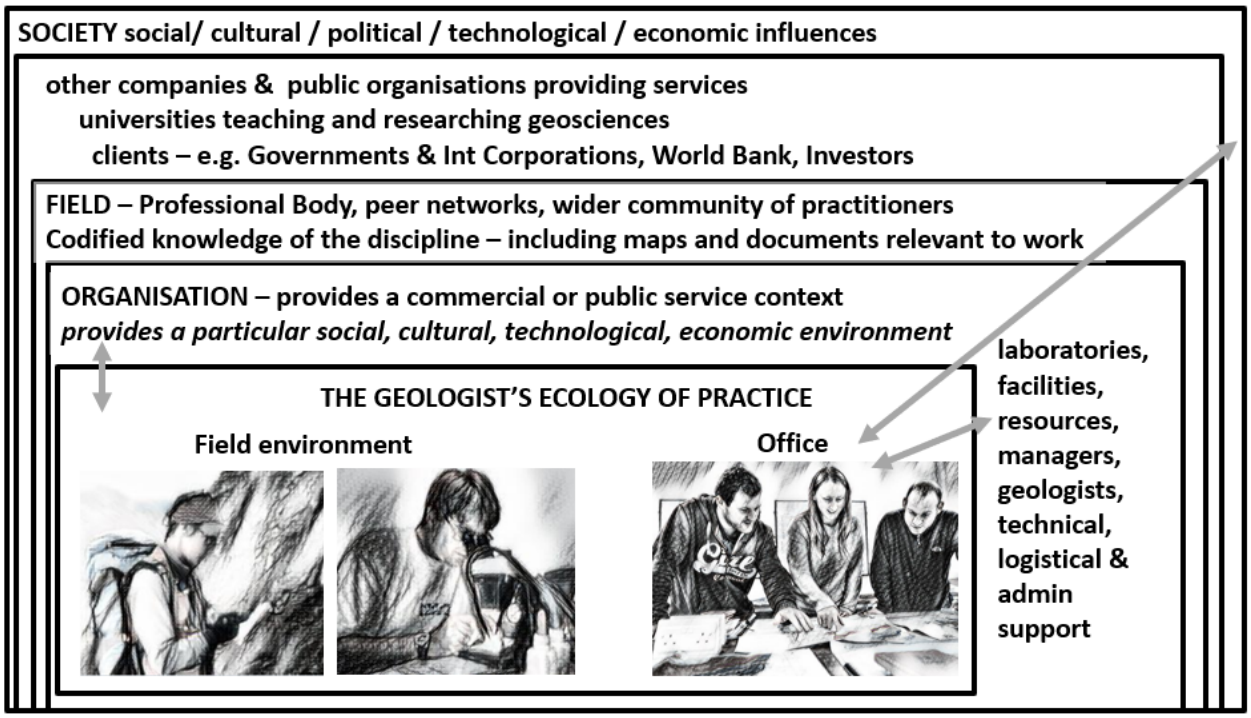

Figure 12.2 Teacher-learner-environment relationships and interactions in a learning ecology in which novice geologists are learning to make a geological map (after Jackson 2016, 2018). The components of the ecology (everything shown in this diagram) do not stand in isolation: they can and do connect, interfere and can be incorporated into each other.

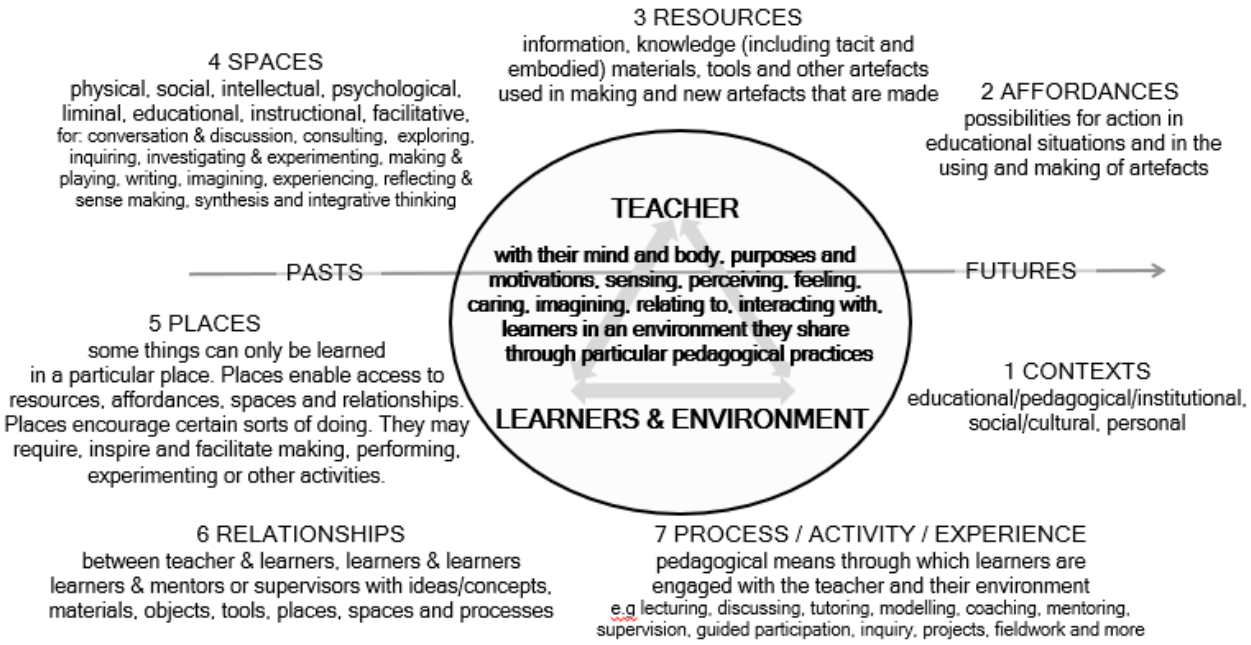

Figure 12.3 A field geologist's ecology of practice for making a geological map.

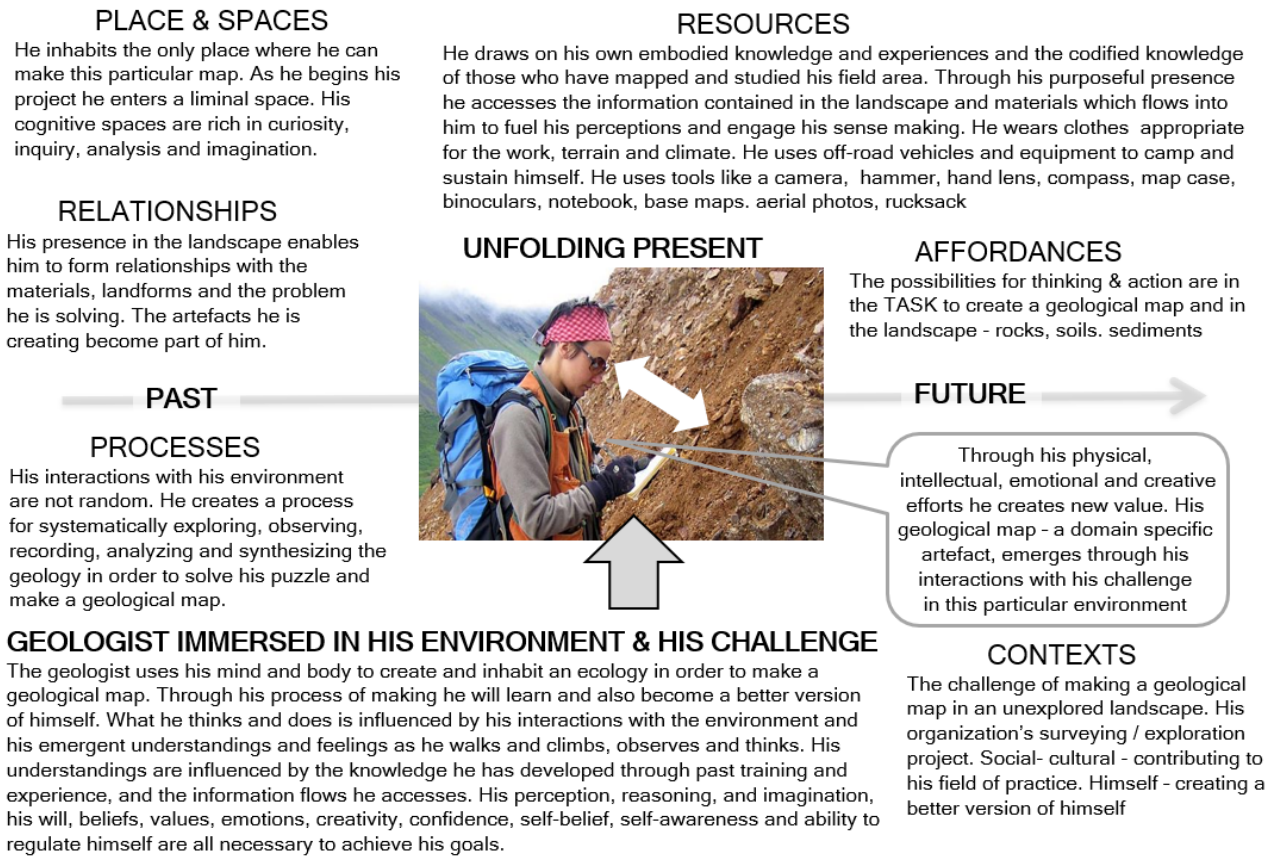

Figure 12.4 Geological artefacts created during the making of a geological map. (*Left*: field slip – a base map on which to make marks, symbols and notes to represent the geology being observed or inferred. *Top right*: notebook for recording observations, sketching geological features and jotting down ideas and interpretations. *Bottom right*: fair copy map produced from field slips and notebooks after analysing the field work.)

Figure 12.5 Artefacts created during a map making project. *Left*: Thin section of a rock showing minerals and textures that enable the rock to be categorized and its formation understood. *Middle*: Digital map. *Right*: Geological report accompanying the map.

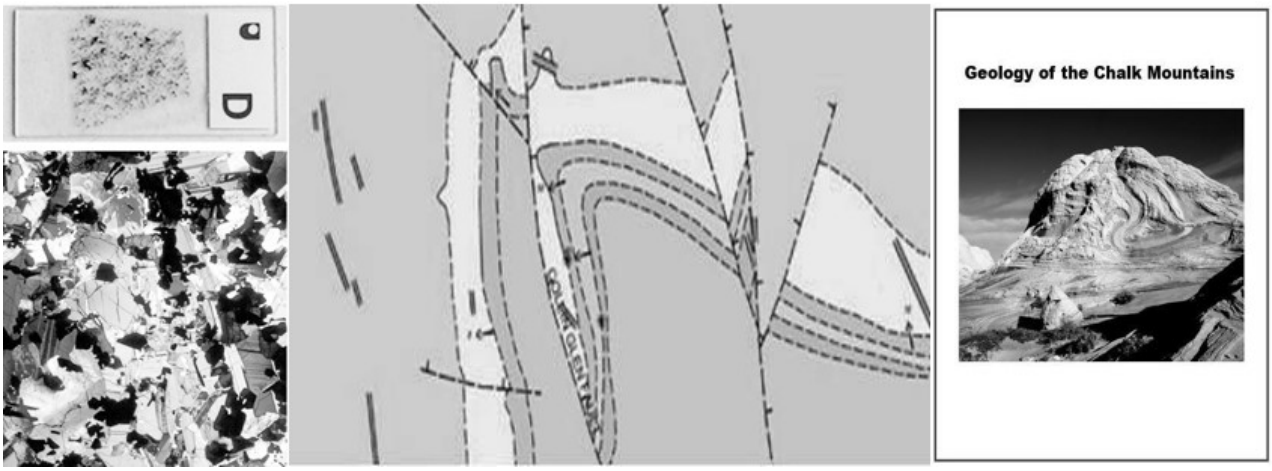

Figure 12.6 The cognitive spectrum (Pendleton-Jullian and Brown 2016 p.73)

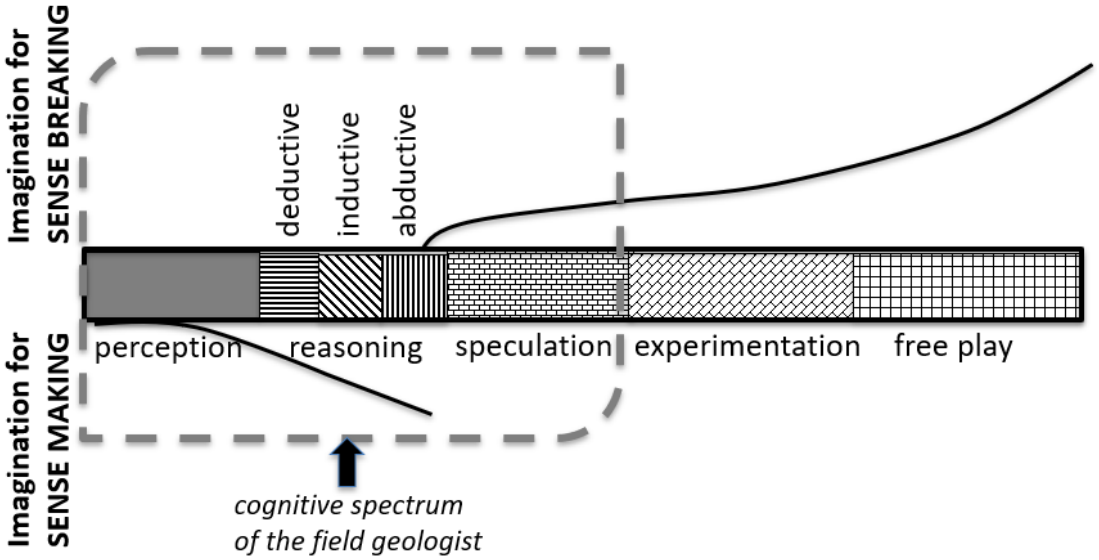

Table 12.1 Applying the interactionist model developed by Dewey (1916, 1934) and summarised in (Figure 12.7) [after Glaveanu et al. 2013, Table 3 p.12]

		FIELD GEOLOGIST
TRANSFORMATION	**Impulsion**	To solve a geological problem/task
	Obstacle(s)	Not knowing/understanding Physical terrain/accessibility Weather Budget
	Doing	Skilled map making using methods/tools/means of the geologist
	Undergoing (material)	CREATION OF NEW VALUE Production of artefacts eg. geological map, notebook, reports
	Undergoing (personal)	CREATION OF NEW VALUE Learning and developing - becoming a better version of self
	Undergoing (social)	CREATION OF NEW VALUE Company / colleagues/ clients
	Emotions	(Dis)satisfaction, frustration, anxiety, joy, pride and many more feelings as the geological map is made and work progresses towards feelings of fulfillment