A sociomaterial model of the teaching-learning continuum

Reinhard Zürcher
University of Teacher Education, Austria (reinhard.zuercher@phwien.ac.at)

Abstract

It is widely accepted today that the range between informal and formal learning can be conceptualized as a continuum. Since substantial models are not available, the specific features of this continuum depend on one's preference. In this paper, I will propose a model for the continuum that defines its constituting variable 'formalization' and thereby its points and ends. Because the parameters of the learning process can reach different degrees of formalization, the continuum is split into sub-continua for each parameter. In a second step, the perspective on learning is expanded to the general teaching-learning process, with the consequence of complementing the learning continuum with a teaching continuum. In order to argue for entangled teaching-learning states and to address questions of materiality and causality, I draw on sociomaterial theories. Finally, some consequences for (adult) education research are discussed.

Keywords: informal learning; informal teaching; teaching-learning continuum; sociomaterial theories; (adult) education research

Introduction

From Dewey's introduction of the term 'informal education' (Dewey, 1899) until today, education researchers have not managed to formulate a consistent theory of informal learning (and of the learning continuum from informal to formal learning) that allows for a quantification of degrees of formalization of arbitrary learning processes. At present, the question 'How informal or how formal(ized) is a specific learning process?' can hardly be answered with convincing arguments. Reasons for this lack of a theory can be found on the one hand in history, as the terms informal and non-formal learning evolved in diverse educational contexts (Colley, Hodkinson, & Malcolm, 2003, pp. 4-17), and on the other hand in the rather arbitrary attribution of specific learning processes to these contexts. Moreover, real learning processes have proved to be of enormous complexity, they are hybrid, indeterminate, deal with fluid boundaries and

'messy objects' (Fenwick, 2010b), and their status of formalization cannot be described through static and more or less subjective definitions of informal, non-formal and formal learning, for which the definitions of the Commission of the European Union (2001, pp. 32-33) are a well-known example. Their specifying dimensions 'context', 'structure', 'certification' and 'intention' are suited for the purposes of educational policy, but as they represent a selection fraught with a certain arbitrariness and are not derived from any overarching theory, they are of little use to research (for a more detailed discussion of this point and of the debates about (in-)formal learning in general, see Zürcher, 2010).

An alternative conception of (in-)formal learning proposed by Livingstone (2001, pp. 2ff) consists of a matrix with four basic types of learning: formal schooling and elder's teachings, non-formal and further education, self-directed and collective learning, informal education/training. This conception is not convincing either, since learning processes cannot be attributed exclusively to one of these domains, a fact that Livingstone (2001, p. 3) frankly concedes.

As these domain models with unspecified boundaries between the domains proved to be unsatisfactory, continuum models were suggested. Simple kinds of continuum models settled for dissolving the boundaries between the domains. Rogers (2004) added 'participatory education' as a further domain to the continuum, and more sophisticated models introduced sub-continua for a number of characteristics of the learning process (Colley et al., 2003, p. 28; Rohs, 2007, p. 34). However, in each case it remained unclear what really happens at a certain point in the continuum.

I have therefore proposed a re-interpretation of the formalization of learning processes, in which the degree of formalization represents the number of options (or the degree of freedom) in choosing each single parameter of the learning process (Zürcher, 2010). This model, which will be elaborated later on, implies that formalization is literally understood as a progressive generalization and standardization of the learning process. The analytic approach of the model differs distinctly from the traditional discursive ones that discuss the teaching and learning conditions in a great variety of contexts, be it the family, the community, volunteer projects or the workplace, and which extract from these contexts different types of learning, like in Livingstone's matrix. The proposed model is compatible with the assumption of Colley et al. (2003, p. 32) that each domain of formal/non-formal/informal learning contains aspects of the other two domains, that most learning situations encompass attributes of (in-)formality and that there is no safe way to establish the differences between formal and informal learning as fundamentally different types of learning (Colley et al., 2003, p. 31). In several points, however, the model goes beyond this insofar as 1) it represents a continuum of formalization degrees where learning situations appear in any case as partially formalized, 2) since the parameters of the teaching-learning process (TLP) usually differ with respect to the extent of their formalization, the continuum is split into sub-continua for each of the parameters, and 3) it introduces a definite time-dependence, as the formalization degrees of the TLP-parameters can change with every activity in the respective learning environment.

In former decades, linear continua have already been utilized for specific learning forms, e.g. from self-directed learning to other-directed learning or from the instructional domain to the autodidactic domain (Candy, 1991). However, their coarse-grained and qualitative character reduced their usability, and for that reason continua for the degree of self-direction only gained limited popularity. In the present model, the control of the learning process appears as one of the many sub-continua endowed with a measure of formalization.

Another point concerns the relation of learning to teaching, with a focus on the widely neglected 'informal teaching'. Due to limitations of space, teaching cannot be discussed here in its full breadth from rigorous instruction to collaborative projects, social movements etc. With respect to the formalization model, teaching is merely considered with regard to a) its measure of formalization, b) its causal relation to learning, and c) its extension to objects. As a consequence, my remarks about teaching may seem somewhat abstract.

Usually the existence of 'informal teaching' is denied with the argument that the rationale of informality requires the non-existence of teaching. As one of the few exceptions, Livingstone (2001, p. 2) introduced 'informal education/informal training' into the discussion of informal learning. In Livingstone's diction, informal education is a kind of private tutoring of a teacher (and informal training of a trainer). Beyond that, for community educators or for tutors in science centres, the notion 'informal educators' is in use.

If informal teaching is to be a viable educational concept, a new perspective on the relationship between learning and teaching is required. The 'Standard Paradigm of Learning' (Beckett & Hager, 2002), which is used here as representative of traditional theories, views learning as the activity of individual minds that acquire transferable, de-contextualized knowledge. Courses are designed to transmit knowledge for later use to solve problems in daily work practice. Learning occurs exclusively in the minds of individuals and it is assumed that the components of the process – subject, object, content, media, etc. – can be neatly separated for model-building and research. Dichotomies like theory/practice, thought/action, teaching/learning or informal/formal lurk in the background, in which an individual existence is ascribed to each counterpart (Dean, Sykes & Turbill, 2012, p. 3). For informal/formal learning, this means that learning takes place either in one or the other state. For teaching/learning this means that teaching is a business of informed individuals like teachers, trainers or parents, and without a teaching person a learner can only teach him-/herself autodidactically, a process in which learning and teaching amalgamate.

In the 20th century, systems theory and quantum theory began to interpret the behaviour of the elements or participants of a system as determined by the state of the whole system. Dewey and Bentley (1949) developed the transactional perspective on learning and 'new ways of learning and knowing as inseparable for action' (Dean et al., 2012, p. 2) were suggested by investigations in work-integrated learning that led to practice-based approaches. The core of these performative, sociomaterial approaches is the mutual enactment of practice and knowing: Learning is enacted or embodied and human entities are inseparably interconnected with non-human entities (Dean et al., 2012, p. 5; Fenwick & Edwards, 2013, p. 50). Non-human entities like objects and artefacts co-constitute the emerging practices. But when 'material things are performative' (Fenwick et al., 2013, p. 53), then one is led to ask: Can non-human entities teach?

The synopsis of the learning continuum, the inseparability of teaching-learning acts and the equivalence of human beings and things in these acts lead to one conclusion: The learning continuum must be complemented by a teaching continuum that extends from informal to formal teaching. But how do these two continua fit together? Do the points of one continuum show a (bijective) one-to-one correspondence with the other continuum? Or is there just a single teaching-learning continuum (TLC) in which the points denote the state of formalization of an inseparable teaching-learning act? Which kind of causality dominates the teaching-learning process (TLP)? What are the consequences for research?

The formalized learning continuum

In the following, the teaching aspect is temporarily disregarded. Existing learning continua still cling to the three domains 'of informal learning – non-formal learning – formal learning', or they implant additional domains like in 'formal education – non-formal education – participatory education – informal learning' (Rogers, 2004). Here, the underlying categories are not properly differentiated. Whereas e.g. participatory learning is a learning form (with participation as its principal characteristic), the informal/formal dichotomy represents the formalization of learning forms and is thus a superordinate category insofar as it affects 'all' forms of learning.

I have already proposed some features of a teaching-learning continuum elsewhere (Zürcher, 2010). In the present paper, this model is refined, the relationship of teaching and learning is analysed in more detail and the notion of 'informal teaching' is discussed. For the sake of a comprehensive picture, I will briefly repeat the basic features of the model.

My point of departure is the assumption that the usual tripartition of the continuum into informal, non-formal and formal learning is too coarse-grained to be useful for research. The definitions of these three domains are descriptive and the transitions between these domains are rather mysterious. The suggested analytic model exhibits some new features (Zürcher, 2010). At first, the meaning of (in-)formality had to be clarified, and this can be done by analysing the semantics and the use of these notions in practice and research. As a result I became convinced that 'formal' – deriving from 'form' – does not indicate that a process or state has been formed, but formalized. But what does 'formalization' entail? It can be interpreted as regulation insofar as, with increasing degrees of formalization, the number of prescriptions and restrictions increase, and at the extreme of complete formalization only one course of action is left. The degree of regulation/formalization can be modelled as a qualitative or quantitative continuum. If quantified, an appropriate measure could be a scale from 0% to 100% or from innumerable options to one option. At the same time, formalization represents the complexity of the respective process or state, with maximum complexity at the informal end and with minimal complexity at the formal end.

Formalization as the constitutive variable of the continuum manifests itself in a variety of ways. As mentioned, the number of possibilities of a learning process for its enactment is its defining characteristic. The manifestations of formalization are, among others, reduction of complexity, linearization, trivialization, standardization, and in special cases abstraction and quantification/mathematization. Complexity is reduced insofar as the transactional learning processes are downsized to interactions or actions whereby the possibilities for their enactment decrease. Nonlinear interactions that are common between individuals are replaced with prescribed behaviour. Knowledge, curricula and assessments are standardized in order to offer the same conditions to all students and to be able to compare their learning outcomes. In the case of the parameter learning content, abstraction eliminates sensual qualities and mathematization introduces a symbolic level that represents the physical world by formulae.

Through this interpretation of formalization, we arrive at a continuum that extends from informal to formal learning: Purely informal learning at the one end indicates the maximum number of possibilities (i.e. zero regulation) within the learning process, the parameters of which (time, content, control, etc.) can be freely selected. Purely formal learning at the other end signifies learning processes with only a single way to proceed. The former may be everyday learning, the latter military drill or traditional classroom learning where all pupils have to fulfil exactly the same requirements demanded by the

teacher. A point in the continuum signifies the degree of formalization of a learning process (LP) at a certain point in time.

*Figure 1*. Formalization continuum of learning processes

Informal LP   **Formal LP**

$$\text{\textit{Formalization}} \rightarrow$$
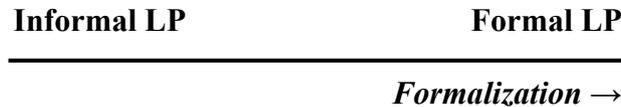
Source: Authors' own design

It is obvious that contextual restrictions and inner conditions of the learners do not allow purely informal or formal learning, so that all actual learning processes find themselves in the inner region of the formalization continuum, with a certain distance from its extreme ends.

A further aspect of the continuum concerns its splitting into the parameters of the learning process so that each parameter varies along its own sub-continuum. For a specific learning process, it is not possible to fix a comprehensive degree of formalization: The duration of the learning phases, content and method, learning control, the social constellation etc. may exhibit different degrees of formalization and they may change with the progress of learning. As a consequence, it is necessary to determine the degree of formalization for each parameter p_1, p_2…, p_n of the learning process as well as its time dependence:

Figure 2. Sub-continua of the learning continuum

Informal LP   **Formal LP**

p_1
p_2
p_3
$\vdots$
p_n

$$\text{\textit{Formalization}} \rightarrow$$
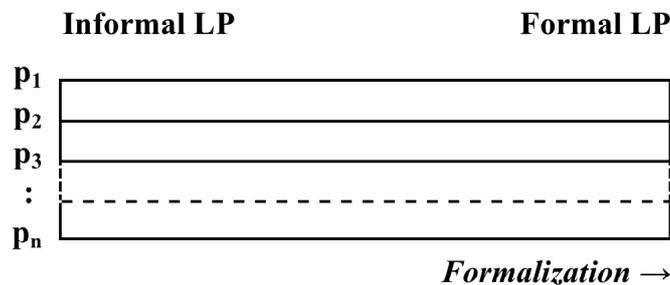
Source: Authors' own design

Foundational constituents of sociomaterial theories

> All things – human and non-human, hybrids and parts, knowledge and systems – emerge
> 'as effects' of connection and activity. (Fenwick et al., 2013, p. 53)

To transform the learning continuum into a teaching-learning continuum, the basic concepts of so-called sociomaterial theories are best suited (Beckett et al., 2002; Fenwick, 2010a; Fenwick, 2010b; Fenwick et al., 2013). For this reason and with a focus on teaching and learning, I will briefly repeat their most important features here.

A 'system' is created by isolating specific entities under certain aspects from the whole, whereby a 'boundary' between the system and its environment or 'context' originates. Boundaries emerge as well when a system is divided into subsystems. In the case of a transactional teaching-learning process (TLP): When, for the sake of simplifying a TLP, learning is separated from teaching, a boundary is introduced to

exclude other parts of the activity, to reduce the relational network and to stabilize the partial system that is under view. The perpetual transitions are fixed to identify the dominating parameters of the process. As a consequence learning (or teaching) is detached from the whole transaction, which involves the risk of misinterpreting causes and effects, the influence of materials and situational parameters.

Learning embedded in different social practices and in a multitude of contexts (classroom, workplace, home…) must be considered in a similar way: If a single context, e.g. formal learning at school, is isolated, boundaries are introduced to all other learning contexts. As a consequence, the learning outcomes have to be transferred across a boundary into other contexts, e.g. from training to the workplace. 'Boundary objects' with the property of functioning as elements of many different contexts allow for border-crossing between these contexts (Tsui & Law, 2007, p. 1290). Teaching and learning and especially informal teaching and informal learning appear as a result of boundary-making: For practical reasons, a part of the inseparable TLP is isolated to reduce complexity and to study specific features from the singular perspective of teaching '*or*' learning.

An important change in perspective, put forward in particular by actor-network theory (ANT) and its most prominent exponent Latour (2005), is the substitution of domains or containers by 'relational networks'. Relational framings, like in theories of learning that emphasise activity, favour 'concepts of Union and networks rather than those of context' (Edwards, 2009, p. 3). For ANT, knowledge is generated through relational strategies, through networks and performed through inanimate as well as animate beings in precarious arrangements (Fenwick et al., 2013, pp. 56-57). This implicates that we need to abandon separate domains like subject/object, teaching/learning or formal learning/informal learning.

As the notion 'sociomaterial' suggests, 'material' plays an essential role in the theory. The material includes natural objects and artefacts, tools and technologies, texts and schemes etc. A sociomaterial approach represents 'a post-humanism that refutes the anthropomorphic centrality of human beings and human knowledge in defining the world and its relations' (Fenwick et al., 2013, p. 58). Learning is assumed to be a materializing assemblage and not a cognitive achievement or way of interacting. Teaching 'is not simply about the relationships between humans but is about the networks of humans and things through which teaching and learning are translated and enacted as such' (Fenwick et al., 2013, p. 54).

The relations of the entities in a TLP are informed by 'affordances' of the involved human beings, materials, tools and technology. Affordances, i.e. the range of (perceived) opportunities that the environment (humans, objects…) offers for possible interactions and performances (Greeno, 1994), can be cognitive, affective, social or educational. Sociocultural affordances that are important for learning are 'the social structures and patterns of participation within the community of practice that create opportunities to learn' (Willis, Davis & Chaplin, 2013, p. 36). Educational affordances of subjects depend, among others, on prior knowledge, learning ability, phantasy, motivation and volition. Affordances are a kind of potential glue, a part of which is utilized by the participants in a TLP, which actually ties them together.

'Transactions' take place between individuals and their environment with the result of (learning) experiences. Transactions denote the whole TLP, in which no single elements can be isolated: 'Transaction is Fact such that no one of its constituents can be adequately specified as fact apart from the specification of other constituents of the full subject matter' (Dewey et al., 1949, p. 137). If two of the constituents, e.g. two subjects or a subject and an object, are isolated, we arrive at an 'interaction': 'Inter-action

suggests that entities are separate and predetermined prior to their encounter' (Fenwick et al., 2013, p. 59). An 'action' finally is the result of a further reduction in perspective that views the activities of a single entity. It is obvious that an investigation which confines its analysis to the activities of a teacher or a learner is unable to describe the emergent reality of a TLP.

Characteristics of sociomaterial theories

In the first instance, Cultural Historical Activity Theory (CHAT), actor-network theory (ANT), and complexity theory (CT) are considered to be performative, sociomaterial theories. Although they exhibit different genealogies and purposes, they conform to the assumption that learning cannot be reduced to psychological processes within the heads of human beings. For a complete description of learning, its social and material conditions are indispensable.

Practice- and performance-based approaches take into account not only the situatedness of learning, its tacit dimension and its dynamic character, but also the effects of materials and artefacts, the mutual interaction of human and non-human entities, and the inseparability of cognitive, affective, social and material relations in every kind of practice. These complex states are assemblages in perpetual transition and are a much better fit with everyday learning and workplace conditions, whereas the Standard Paradigm of Learning is incommensurable with informal learning (Dean et al., 2012, p. 1). It privileges individual cognitive processes and assumes knowledge to be de-contextualised and transferable.

I will now proceed to summarize those aspects of performative ontologies that support the argument for a unified teaching-learning continuum, in which informal teaching appears as a kind of missing link:

- *Relationality*: The essential characteristic of performative ontologies in general and of transactions in particular is the relational network between the involved entities. The isolation of single relations generates a distorted picture.
- *Inseparability*: All entities of a transaction – like a TLP – are related in a way that none exists without the others.
- *Causality*: The entities of a transaction emerge jointly, transactions develop via emergent causality. 'The phenomena of learning may be viewed as "emergent" phenomena in interconnected networks' (Jörg, 2009, p. 16). In case a boundary is introduced to isolate teaching and learning, these two entities can be said to be connected in reciprocal causality.[1] (One could assume that the control of the TLP is unidirectional, that it is at the side of the teacher in case of a lecture and at the side of the learner in case of self-directed learning. This view neglects the fact that in all possible cases of a teaching-learning act, both sides are indispensable actors of the process.)
- *Indeterminacy*: Emergent causality implies an indeterminate development of states. Knower, known and knowledge do not pre-exist, future possibilities develop at every encounter (Fenwick, 2010a, p. 115). Situations and actions are indeterminate, educational processes cannot be predicted. (However, experience allows for anticipating the development of educational processes with a certain probability.)
- *Materiality*: 'We employ no basic differentiation of subject vs. object any more than of soul *vs.* body, of mind *vs.* matter, or of self *vs.* not-self' (Dewey et al.,

1949, p. 136). The material includes objects, bodies, tools, texts, etc. that constitute together with humans the transactional TLP. The material world is treated as embedded in the immaterial and the human (Fenwick, 2013, p. 50). Things like materials, spaces, concepts, rules, discourses etc. emerge in the practice of action through the encounter of human and non-human entities.

- *Symmetry*: Between matter and living beings, a partial symmetry exists insofar as both can teach but only living beings can learn. A second symmetry can be seen between teaching and learning because of their inseparability: Without teaching there is no learning and vice versa.[2]

- *Singularity*: Whereas the Standard Paradigm of Learning privileges the average learner, for relational ontologies each learner's transactions are unique as the learner's knowledge and experiences evolve.

- *Time dependence*: In transactional inquiries, time is a key dimension. Time is 'a full duration, rather than as composed of an addition or other kind of combination of separate, instantaneous, or short-span events' (Dewey & Bentley, 1949, p. 114). Time is a continuous albeit not a uniform flow, since 'habits have different levels of inertia, and this is a major factor of change and learning' (Lorino, 2013, p. 9).

- *Knowledge*: 'Knowledge is viewed as a set of emergent patterns of action, always in the making, and learning as one specific aspect of the process of acting and meaning-making' (Lorino, 2013, p. 1). Knowledge emerges by adaptive self-organization and is enacted in networks.

- *Unit of analysis*: For research, the unit of analysis is the whole system and its development. The interactions among human and non-human entities constitute the focus of analysis.

These characteristics are contrasted with those of the Standard Paradigm of Learning in the following table:

Table 1. Characteristics of teaching-learning processes as seen by two different paradigms.

TLP characteristics	Standard Paradigm of Learning	Sociomaterial approaches
relationality	action; interaction	interaction; transaction
separability	teaching and learning separated	inseparable teaching-learning acts
	humans and non-humans separated	humans and non-humans entangled
	internal and external conditions separated	inseparable internal and external conditions
causality	linear	emergent
determinacy	planable and predictable teaching and learning	unplanable and unpredictable teaching-learning
centrality/multiplicity	key variables; central perspective; few identifiable influences	no key variables; multiple perspectives; multiple influences
symmetry	asymmetry between teaching and learning	symmetrical teaching-learning
	asymmetry between humans and materials	partial symmetry between humans and materials
singularity	average learner	individual learner
time dependence	linear	dynamic state, perpetual transitions; dependence on inertia of the systems
knowledge	representation; growing body of knowledge in subject's minds	emergence; adaptive self-organization; enacting knowledge in networks
unit of analysis	components of the system; separate entities	whole system; inter-/transactions among human and non-human entities of the system

Source: Authors' own design

The relationship of teaching and learning

Sociomaterial theories enable us to look at the relationship of teaching and learning in a new way. This relationship, the core of didactics, remains an issue of permanent debate. The present paper focuses primarily on an abstract model and leaves psychological or methodological questions aside.

Teaching and learning, or teaching-learning?

Does a teacher teach if nobody in the classroom learns anything? Certainly not. He/she generates information for possible listeners, but if they do not integrate this information into their cognitive/affective structure, their knowledge will not extend and if they do not change their behaviour or their attitudes they do not learn. Without listeners paying attention, the teacher produces signs and gestures, but does not teach. A further question arises when someone learns something with the help of tools in everyday life or at work: Who is teaching? Is the person teaching him-/herself or do the objects teach?

Sociomaterial, performative ontologies or the transactional view of teaching and learning that Dewey and Bentley (1949) elaborated far ahead of their time contest that teaching and learning cannot be conceptualized as separate processes. Learning is not just an effect of the act of teaching (T → L) and it is not just an interaction where teaching and learning, being separated, depend on each other (T ↔ L). Teaching-learning is a single and intertwined activity where both, teaching and learning, emerge exclusively together within their respective context (TL).

Who, then, teaches, and who learns? If the TLP is inseparable, then it is reasonable to state that objects (O) can teach subjects (S), although not vice versa. Therefore TLP are possible between subjects on the one hand ($S_1 ↔ S_2$) and between object and subject on the other hand (S ← O), whereby in the second case the symmetry is broken. This assumption of entangled teaching-learning implies some far-reaching consequences for teaching and for the learning continuum.

The teaching-learning continuum (TLC)

Whether a model is useful depends on its explorative power: Can it explain a greater wealth of phenomena than former models, does it enable us to investigate more aspects in detail, can these aspects be determined with higher accuracy? Second, a model is a question of efficiency and elegance, e.g. by minimizing the preconditions and by eliminating possible contradictions. So, the TLC may be supposed to be useful when it 'best covers the ground' (Dewey et al., 1949, p. 141).

Preconditions for a unified TLC are: Teaching and learning are processes that can be formalized; the parameters of the TLP exhibit different – and time-dependent – degrees of formalization; teaching-learning is an inseparable transactional process; humans and non-humans are equivalent (and therefore also things can teach). Given these premises, the TLC can be modelled in the following way, with p_1, p_2..., p_n as the parameters (e.g. time, space, content, control, intentionality) that define the TLP ('deleted for anonymity'):

Figure 3. Sub-continua of the teaching-learning continuum with a snapshot of a possible TLP

Informal TLP   **Formal TLP**
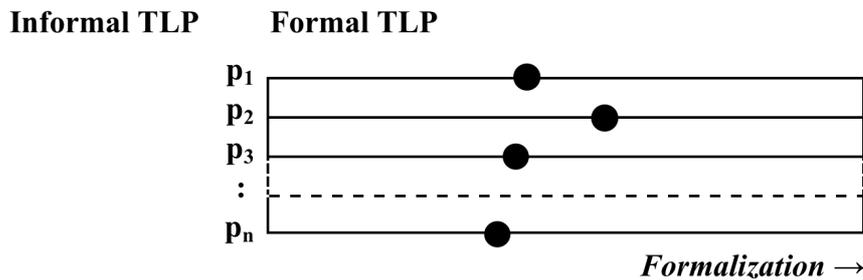
Formalization →

Source: Authors' own design

The model for the formalization of TLP is thus a time-dependent pattern of the state of formalization of its parameters. There may be predominant or stable configurations in this pattern, which coincide with real TLP. In the model, each parameter p is formalized on its own terms. A simple measure is the percentage to which a parameter is formalized. At a deeper level, it is the number of possibilities for a TLP to enact itself. Is it possible to define a single degree of formalization for the complete TLP, e.g. a mean square of the formalization degrees of all parameters? This will not be the case, because the parameters of the TLP differ in importance and they are not calibrated to the same scale.

Informal teaching – the missing link

> Stones are mute teachers; they silence the observer, and the most valuable lesson we learn from them we cannot communicate. (Goethe, 1830, p. 266)

For the TLC, we have assumed that objects can teach as well, a fact that is crucial for the area of low degrees of formalization. But whereas the designation 'informal learning' for learning in this area is well accepted, 'informal teaching' remains widely unnoticed. Some examples:

(1) Parents want to teach their children some basics of cooking. They gather them in the kitchen, inform the children about tools and materials, demonstrate some methods, and finally they prepare dinner together. Is this kind of coaching informal teaching?

(2) Friends debate personal and political affairs in a café and afterwards they go dancing at a disco. Who were their teachers who improved their knowledge and dancing skills?

(3) A farmer wanting to bring in his harvest looks at the cloudy sky and then he decides, in combination with what he has heard on the radio weather forecast, to wait until the next day. Has he been taught informally by the sky and the radio information?

(4) A surgeon consults an x-ray picture with the result of certainty what measures to take. Obviously the picture imparted her valuable insights.

This small extract from innumerable situations refers to the fact that in any possible learning case, somebody or something with a teaching function is involved. Hitherto,

according to conventional interpretations, informal teaching was performed exclusively by human beings in everyday or work situations. The TLC extends the teaching aspect to things and differentiates the parameters of the TLP. For the mentioned examples, this means that in order to get a picture of the scope of (in-)formality in each single case, the degree of formalization of every parameter has to be determined.

Can teaching and learning be analysed on their own, although sociomaterial theories maintain the inseparability of teaching and learning? For practical reasons, informal teaching and informal learning may be treated as isolated concepts, provided that their inseparability and their close ties to the environment are kept in mind. (Similar procedures are common in descriptions of isolated factors in ecology or regarding single forces in physics.)

Discussion

The main aspects of the model presented in this paper are the TLP in the light of sociomaterial theories (A.), the technical features of the model (B.) and its educational consequences (C.).

A. It is clear that in comparison to a TLC, the consideration of the functionalities of a learning continuum or a teaching continuum alone would be much simpler. The relationship of teaching and learning, being a source of much confusion, would not have to be taken into account. In effect, up till now even the learning continuum has hardly been investigated. For a complete picture, however, the TLC is indispensable.

The most remarkable characteristic of the TLC is its material dependence, expressed in the symmetry between matter and living beings in teaching activities. When, for example, I stroll through the woods and learn that the tree branch angle and the maximum leaf area depend on each other, one could maintain that it is only a question of semantics to say 'The trees taught me…' or 'I have taught myself…' or 'I have learned…'. In the view of the model, these three perspectives fuse to a single teaching-learning act with the realization of the fact as a result.

Symmetry has been assumed to exist between teaching and learning, which should be synchronous and inseparable. On the other hand, the aims of a teacher and those of learners are not a priori symmetric, they frequently differ. This seeming contradiction disappears when the two counterparts are seen as two different aspects: Symmetry between teaching and learning concerns the process as such, it is a precondition for a TLP to take place. On the other hand, the aims and the control of the TLP can shift along the continuum, from learner to group to teacher to government agencies.

Complexity has been assumed to be a general interpretation of the formalization continuum: The higher the degree of formalization, the lower the complexity of the teaching-learning states. Complexity is, however, a difficult measure, since there is a number of different approaches and meanings. We confine ourselves to the view that complexity is a relational measure: The higher the number of the relations of the given elements/actors, the higher the complexity of the system. In effect, informal TLP entail a multitude of individual relations, whereas formal TLP exhibit only a few general relations. The informal domain can be seen as a complex adaptive system with its self-organizing nature, whereas the formal domain resembles an ordered system where the agent behaviour is limited to the rules of the system.

Another subtle point concerning complexity can be derived from social systems, for which Hetherington (2013, p. 81) stated that 'any action that reduces complexity in social systems means weaving interactions together in 'different' ways that have the

potential to result in emergent phenomena'. This means that the reduction of complexity with increasing formalization is tempered with a counteracting increase of complexity because of new possibilities that result from regulative measures. Applied to the TLC, this would result in a lesser decrease of complexity with increasing formalization, e.g. because of new and ordered social constellations of learners, or, concerning content, because of abstractions like formulae that did not exist in the informal domain. On the other hand, this is not necessarily the case, since all the more regulated states in the formal area can be thought to be implicitly present in the informal states, too.

B. The essential issue of the continuum model is an appropriate measure for the degree of formalization. In the model presented here, the most general measure is the number of possibilities a TLP commands at a certain point in time. But what is a 'probability'? One possible answer is to see probability as a complement to actuality: A possibility is an actuality that has not (yet) taken place. Next, a possibility may be discontinuous (possible/not possible) or continuous (from weak to strong possibility, depending on probability). Third, a situation or an object affords all (learning) possibilities but in a TLP only those accessible to the learner are relevant. And fourth, only a small number of possibilities are actually realized. For the continuum, we adopt as a measure the number of accessible possibilities, which may vary in probability.

Another question concerns the formalizability of the parameters of a TLP: Are they 'all' formalizable? Furniture, class time or a curriculum can be standardized but parameters like motivation or volition can obviously only be partially influenced. Material and organizational properties are open to formalization, mental and affective properties remain – at least to some extent – under control of the individuals.

C. The term 'continuum' induces the image of a seamless transition from informal to formal learning situations in the real world. In this case, knowledge and behaviour acquired in everyday socialization processes could be extended and generalized in school without any problem. In fact, these two worlds differ qualitatively, as Scribner and Cole (1973, p. 556) asserted – the values, attitudes and content are not the same and they influence the organization of the learning systems. Informal education rests upon person-oriented values, formal education upon universalistic values and standards of performance. In between, individualistic values meet general ones, a prototypical situation in adult education groups. It is common practice in education to bridge these domains either by including everyday experiences in school or adult education or vice versa by presenting formalized concepts of the world that are of little importance to the individual's experience. From the perspective of the formalization model, larger distances between TLP of low and high formalization degrees should be bridged very cautiously in order to be sustainable.

The degree of formalization as a measure of the TLC is an intuitively accessible measure, but in practice its identification for each parameter of the TLP is not really simple. This may not be a problem for the parameter 'space' when two out of five possible learning places are used. Difficulties arise with parameters like the aim of learning, the control of the TLP or motivation, where it is nearly impossible to draw on a fixed number of possibilities, because they are relational entities and depend on prior knowledge, learning ability, context etc. Because of this fact, we must conclude that the degree of formalization is an individual characteristic, even when all students in a classroom or all learners in a training session are presented with the same lecture.

It may seem that the abstract model of the formalization continuum (Fig. 2) is quite distant from pedagogical reality or everyday life. In fact, each point in a continuum line denotes a special situation and condition for a learner and thus represents his or her area of freedom for learning. For instance it is obvious that a restriction of learning to its

formalized domain deprives young people of their free development. Other formalization movements like the Bologna System at the tertiary level or the introduction of educational standards at the secondary level seriously reduce spaces of free individual development. The formalization pattern of the model yields an immediate picture of the amount of control in TLP, as well as who is in command, thus visualizing the power relations in the TLP. The formalization continuum leads to the question of which degrees of formalization are best for an individual or a group under the present conditions – and who is entitled to decide this question? Here, value judgements come into play.

Implications for research

> For use in research adequate report of the full event is necessary, and for this again adequate behavioral description must be secured. (Dewey et al., 1949, p. 133/footnote)

How reasonable is it to isolate individual characteristics of a TLP and to investigate their interdependence under the condition that a TLP is an inseparable transactional process? Causes and effects in teaching-learning situations are difficult to isolate and to study independently, since any change of an agency in the system influences other states and forces acting in the system. E.g. the conversion of a traditional classroom into a space that meets the requirements of modern pedagogy – functional zones, individual furniture, etc. – influences other variables (materials and tasks, the social constellation, the atmosphere...) of the TLP. The isolation of monocausal effects results in conclusions of restricted value. This applies all the more to the informal domain, as here the TLP are less ordered and more complex than in the formalized area.

Towards the informal end of the TLC, the number of possible realizations and interdependencies of the characteristics of a TLP becomes overwhelmingly high. In this area, sociomaterial theories and especially Complexity Theory are the method of choice. These approaches apply, of course, to all TLP, but for the present paper the less formalized and comparatively little investigated domain that represents notably early childhood, everyday learning and work-integrated learning is of greater interest. Two points are considered here: A. In which aspects do sociomaterial approaches influence research settings for the low formalized domain? B. In which way can the formalization model support this research and what are the open questions concerning the model?

A. A relational, performative approach emphasises knowledge as practice and proceeds from the mutual enactment of practice and knowing (Dean et al., 2012, p. 4). It starts with 'a sensibility and a language for speaking about the orders that are tried to construct out of the messy conditions and circumstances that constitute the educational world' (Fenwick et al., 2013, p. 60). TLP are embedded in material interaction and are not exclusively a playground for the concepts and feelings of the participants. Investigations concerning the informal domain have to consider not only the invisible educational activities in material contexts, but also the aspects of everyday and work life that seem, at first sight, not to be important for learning (Dean et al., 2012, p. 8). In addition, sociomaterial research takes the whole network of relations into account, explores the entangled human/non-human interactions, matters and meanings and pays attention to the process of making and disappearing boundaries that include or exclude human beings and objects. This aspect of inclusion/exclusion applies to the researchers, too, insofar as they are responsible for their own participation not only in research, but also in the on-going processes in their field of studies.

This last point is reminiscent of action research, and in fact this approach exhibits substantial similarities with Complexity Theory. Among others, action research accepts the inherent unpredictability, the emergent nature of change, the role of agent interaction and of self-organization in open systems (Phelps & Hase, 2002; Phelps & Graham, 2010). Complexity Theory in turn offers a solution to old problems of traditional theories, e.g. the mixture of quantitative and qualitative methods, the contextuality of case studies and their generalization or the multiple correlations of elements that lead to unpredictable emergences. Complexity Theory allows us to conflate the binary concept qualitative/quantitative and to conceptualize context in case studies in relation to the boundaries of the case in a meaningful way (Haggis, 2008).

From a general point of view, the complex processes of teaching-learning interactions suggest a multiple-method approach that has become known as 'bricolage' (Kincheloe, 2001, 2005). Bricolage not only includes divergent methods of inquiry but also diverse theoretical and philosophical understandings of the elements encountered in the research process. Distinguishing 'method' and 'methodology', Alhadeff-Jones (2013) designed a theoretical framework for researchers based on three moments: the definition of the research process and its sub-systems, a matrix to model the research process, and the development of a research method. This last moment requires adopting a strategic position, and, since a complete description of all methodological dimensions is impossible, the method cannot be predefined in advance but has to be developed and adapted according to the contingencies in the course of the inquiry process.

Returning to the low formalized domain, a few investigations based on complexity thinking are already available. Dean et al. (2012) studied informal learning in work-integrated learning, based on a relational, performative approach. With the help of ethnographic vignettes the learning processes of three business interns, working for sixteen days in a local organisation, were tracked. The methods included participant observation, open interviews, photographs and artefacts (assessments, workplace artefacts, researcher's notes and reflections). This enabled the research team to uncover usually overlooked aspects of informal learning.
Hetherington (2013) discusses case study approaches and especially the problem of the necessary complexity reduction in the context of introducing a new curriculum for 11-12 year old pupils. She began with the usual methods – interviews, observations and questionnaires – and used a research journal. To capture the time-dependence of the case, Hetherington explored the students' work in lessons, made interviews with focus groups of students and observed the professional development of the teachers in relation to the new curriculum over two years. Her own role moved close to an action research perspective, as she regarded herself as being situated within the case itself, thus reducing and producing complexity at the same time.

Summing up, for researchers who are aware of the enormous complexity of TLP sociomaterial approaches can seem very attractive. A warning from Fenwick and Edwards (2013, p. 57) should, however, be kept in mind: 'There is a danger in becoming overly fascinated with conceptions that trace complexity and assemblings, without asking how such analysis is any more productive in understanding and responding to educational concerns'.

B. As described earlier, the formalization model is conceptualized on the basis of sociomaterial theories. How can it support investigations in the area of low formalized TLP? Traditional research of informal learning processes relies on interviews and questionnaires that offer information about the content and duration people believe they learn informally. These data yield no information about unintentional and unconscious learning processes and they depend heavily on the definition of informal learning (with

the result that the value of comparative studies and statistical analyses is rather limited). Case studies on learning processes in the community or at work are frequently realized as biographical research with qualitative methods or based on grounded theory.

The TLC serves first of all to understand the deeper meaning of formalization in TLP and second as an instrument at hand that can be used for investigations into formalized processes. The formalization pattern indicates the scope of individual freedom and at the same time the scope of external control in TLP. Beyond that, the model serves as a kind of periodic system: It indicates the empty spaces in the continuum that are not covered e.g. in the TLP of an educational institution. This information can be valuable for planning well-balanced educational scenarios.

Since the presented TLC (Fig. 2) is the first of its kind, numerous questions remain to be solved, e.g.: Which parameters $p_1, \ldots, p_n$ should be chosen to adequately represent a TLP? Are all parameters equally important? In which way are they related? What is a convenient formalization measure for the parameters? Is it possible to identify a complete formalization pattern for a specific TLP? How does this pattern change with time? Do typical educational situations show a recurring formalization pattern?

Conclusion

Performative, practice-based approaches are indispensable in order to investigate the low formalized section of the TLC. The material aspect of sociomaterial theories enables us to argue for the (partial) symmetry of the teaching-learning relationship, for the equivalence of human/non-human action in TLP and to understand informal learning and in particular informal teaching in a new way.

Apart from emergent causality and irreversible time dependence, the central feature of TLP appears to be connectivity of the involved actors, elements and processes. These transactional TLP with their entangled teaching-learning states and context dependence present considerable challenges for research, especially when quantitative investigations with empirical methods are on the agenda. The suggested model offers a transparent image of the formalization state of TLP, but a lot of questions regarding its details remain to be solved.

Notes

[1] Another appropriate candidate for causality could be the recently discussed 'superpositional causality', in which a single event can at the same time be cause and effect of another event (Oreshkov, Costa & Brukner, 2012).
[2] This is not to be confounded with the flow of information, which is usually asymmetrical (Nomiku, Pitsch & Rohlfing, 2013, p. VII).

Acknowledgements

References

Alhadeff-Jones, M. (2013). Complexity, Methodology and Method: Crafting a Critical Process of Research. *Complicity – An International Journal of Complexity and Education, 10*(1/2), 19-44.

Beckett, D., & Hager, P. J. (2002). *Life, Work and Learning: Practice in Postmodernity.* London: Routledge.

Colley, H., Hodkinson, P., & Malcolm, J. (2003). *Informality and formality in learning: a report for the Learning and Skills Research Centre.* London: Learning and Skills Research Centre.

Candy, P. C. (1991). *Self-Direction for Lifelong Learning. A Comprehensive Guide to Theory and Practice.* San Francisco: Jossey-Bass Publishers.

Commission of the European Union (2001). *Making a European Area of Lifelong Learning a Reality.* Brussels, 21. 11.

Dean, B., Sykes, C., & Turbill, J. (2012). *'So, what did you do?' A performative, practice-based approach to examining informal learning in WIL* (pp. 1-13). Paper presented at the 9th International Conference on Cooperative and Work-Integrated Education of the World Association for Cooperative Education, Bahcesehir University, Istanbul.

Dewey, J. (1899/1966). *Lectures in the Philosophy of Education.* New York: Random House.

Dewey, J., & Bentley, A. F. (1949). *Knowing and the Known.* Boston: Beacon Press.

Edwards, R. (2009). Introduction: Life as a learning context? In R. Edwards, G. Biesta, & M. Thorpe (Eds.), *Rethinking Contexts for Learning and Teaching. Communities, Activities and Networks* (pp. 1-13). New York: Routledge.

Fenwick, T. (2010a). Re-thinking the "thing": Sociomaterial approaches to understanding and researching learning in work. *Journal of Workplace Learning, 22*(1/2), 104-116.

Fenwick, T. (2010b). Workplace 'learning' and adult education. Messy objects, blurry maps and making difference. *European Journal for Research on the Education and Learning of Adults, 1*(1/2), 79-95.

Fenwick, T., & Edwards, R. (2013). Performative ontologies. Sociomaterial approaches to researching adult education and lifelong learning. *European Journal for Research on the Education and Learning of Adults, 4*(1), 49-63.

Goethe, Johann Wolfgang von. (1830). *Wilhelm Meisters Wanderjahre oder die Entsagenden.* Goethe's Werke, Dreyundzwanzigster Band, Aus Makariens Archiv. Stuttgart und Tübingen: J. G. Cotta'sche Buchhandlung

Greeno, J. G. (1994). Gibson's Affordances. *Psychological Review, 101*(2), 236-342.

Haggis, T. (2008). Knowledge must be contextual: exploring some possible implications of complexity and dynamic systems theories for educational research. *Educational Philosophy and Theory, 40*(1), 159-176.

Hetherington, L. (2013). Complexity Thinking and Methodology: the Potential of 'Complex Case Study' for Educational Research. *Complicity: an International Journal of Complexity Theory and Education, 10*(1/2), 71-85.

Jörg, T. (2009). Thinking in Complexity about Learning and Education: A Programmatic View. *Complicity: An International Journal of Complexity and Education, 6*(1), 1-22.

Kincheloe, J. L. (2001). Describing the Bricolage: Conceptualizing a New Rigor in Qualitative Research. *Qualitative Inquiry, 7*(6), 679-692.

Kincheloe, J. L. (2005). On to the Next Level: Continuing the Conceptualization of the Bricolage. *Qualitative Inquiry, 11*(3), 323-350.

Latour, B. (2005). *Re-assembling the Social - An Introduction to Actor Network Theory.* London: Oxford University Press.

Livingstone, D. W. (2001). *Adult's Informal Learning: Definitions, Findings, Gaps and Future Research.* NALL Working Paper No. 21.Toronto: Ontario Institute for Studies in Education, University of Toronto.

Lorino, P. (2013). *Transaction and Transformation: A Pragmatist Perspective on Learning as Transforming Action and Transacting Forms.* Paper presented at the International Conference on Organizational Learning, Knowledge and Capabilities, The George Washington University, 25 – 27 April.

Nomiku, I., Pitsch, K., & Rohlfing, K. J. (2013). Asymmetry and adaptation in social interaction (Editorial). *Interaction Studies, Special Issue, 14*(2), VII-XII. DOI 10.1075/is.14.2.001nom.

Oreshkov, O., Costa, F., & Brukner, C. (2012). Quantum correlations with no causal order. *Nature Communications 3*, Article Number 1092. DOI: 10.1038/ncomms2076.

Phelps, R., & Hase, S. (2002). Complexity and action research: exploring the theoretical and methodological connection. *Educational Action Research, 10*(3), 507-524.

Phelps, R., & Graham, A. (2010). Exploring the complementarities between complexity and action research: the story of Technology Together. Cambridge *Journal of Education, 40*(2), 183-197.

Rogers, A. (2004). 'Looking again at non-formal and informal education – towards a new paradigm'. *The encyclopaedia of informal education*. London: YMCA George Williams College.

Rohs, M. (2007). *Zur Theorie formellen und informellen Lernens in der IT-Weiterbildung*. Dissertation, University of the Federal Armed Forces Hamburg, Hamburg.

Scribner, S., & Cole, M. (1973). Cognitive consequences of formal and informal education. *Science, 182*(4112), 553-559.

Tsui, A. B. M., & Law, D. Y. K. (2007). Learning as boundary-crossing in school–university partnership. *Teaching and Teacher Education, 23*(8) 1289–1301.

Willis, J., Davis, K., & Chaplin, S. (2013). Sociocultural affordances of online peer engagement. *Journal of Learning Design, 6*(1), 34-45.

Zürcher, Reinhard. (2010). Teaching-learning processes between informality and formalization. *The encyclopaedia of informal education*. London: YMCA George Williams College.