The Knowledge-stream Model
A Comprehensive Model for Knowledge Circulation in Communities of Knowledgeable Practitioners

Federico Cabitza, Andrea Cerroni, Angela Locoro and Carla Simone

Università degli Studi di Milano-Bicocca, Viale Sarca 336, 20126 Milano, Italy

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Abstract: In this paper we present an original position on how knowledge is created and shared in organizational domains. We propose a metaphor of diffusion, borrowed from genetics, and a four phase model, which aims to be as simple as the SECI model proposed within the OKCT, but also more comprehensive and sociologically-informed. Our model takes into account the individual, social and cultural dimensions of knowledge (what we denote as co-knowledge) to account for the various ways knowledge is "circulated" among people (i.e., members of any social structure); we also propose ancillary concepts like that of "Knowing Community" and "Knowledge Artifact", as analytical constructs to represent, respectively, the environment hosting such a circulation and the technological driver that either enables or supports it.

1 INTRODUCTION

In this paper we propose a novel model, the Knowledge-Stream Model, to account for the main phenomena that are related to knowledge creation, acquisition, sharing and circulation within social settings, like communities, organizations and even bigger social structures, up to the level of an entire society. To this aim, we will first put our proposal in the light of a knowledge conceptualization that extends the previous ones in the organizational studies and the Knowledge Management scholarly field (KM). We will then present the sensitizing concepts that would help understand our model. And finally, we will outline the model, and challenge its descriptive power against one of the most well known theory and model adopted in KM, the Organizational Knowledge Creation (OKC) Theory of Nonaka and colleagues (Nonaka and Takeuchi, 1995; Nonaka and Von Krogh, 2009; Nonaka, 1994) by a series of small and illustrative examples.

Our proposal has been developed within the research strand that is usually denoted as the "social practice perspective" (Brown and Duguid, 2001; Wenger, 1998), which is grounded on what Schatzki et al. called the "practice turn" in the social sciences (Schatzki et al., 2001). Differently from other viewpoints, among which the cognitive one is probably the most widespread and common in the KM literature (Moradi et al., 2012), the social practice perspective assumes neither that knowledge resides in the minds of individual members of a collective ensemble (like an organization), nor that these members can transform what they know into communicable forms and exchange it in terms of "explicit knowledge". Rather, the social practice viewpoint conceives knowledge as a social practice, i.e., "any coherent, complex, coordinated form of human activity" (Tsoukas, 2003) that is aimed at some purpose, communicative in nature, and "socially built", i.e., agreed upon, representative of a social group, and local to a particular cultural context and milieu.

Since the cognitive perspective puts a strong emphasis on the ways in which "tacit knowledge" is converted into "explicit knowledge" and vice versa, we will argue in opposition to how the OKC theory mentioned above looks at that conversion, that is as an alternation of four processes that is often referred to as SECI model as it includes "socialization", "externalization", "combination", and "internalization". Our model addresses knowledge circulation by considering any idea of "conversion" inapplicable, as (tacit) knowledge resides in social practices, and these are but socially meaningful behaviors and relational interactions. In so doing, we maintain many of the objections raised in regard to

the OKC Theory and the SECI model by a number of scholars (Bereiter, 2002; D'eredita and Barreto, 2006; Essers and Schreinemakers, 1997; Gourlay, 2006; Ribeiro and Collins, 2007; Schmidt, 2012; Tsoukas, 2003), but also contribute in a positive manner as we provide an alternative framework that is more comprehensive, precise and sociologically informed than the SECI model within the research strand mentioned above.

2 AN OUT-OF-THE-(BLACK)BOX VIEW OF KNOWLEDGE

First of all, we need to provide the reader with an operational definition of knowledge that is compatible with our idea of "circulation". To this aim, we rely on our comprehension of the main tenets of the "social practice" view mentioned above (Brown and Duguid, 2001); of the behavioral framework within which "any knowing is a doing" (Maturana and Varela, 1992) and "knowings are behaviors" (cf. Dewey and Bentley, cited in (Gourlay, 2004)); of the "epistemology of practice" held in (Cook and Brown, 1999); and of the Schön's idea of knowledge as "knowing-in-action" (Schön, 1983), which in its turn draws on Polanyi's notion of "tacit" knowing (Polanyi, 1983). That said, the main idea is that no-thing is really circulated (or moved) among the individuals, but that these latter are informed (influenced) by the others in social interactions where knowledge is afforded (Cook and Brown, 1999).

Thus, we clearly depart from the idea of knowledge as of "justified true belief", which is a common conceptualization dating back to Plato (Fine, 2003). We rather advocate a different stance, where knowledge is a *knowledgeable behavior* (where the quality of being "knowledgeable" refers to the social element and in some way subsumes the quality of being appropriate and effective). Contrasting the idea of knowledge as "belief" entails to consider that, even when knowledge regards ideas, notions and models of the world (that are explicitly expressed in some way), it is but a "convincingly plausible claiming" (that is, trustworthy claims, even self-directed). The content of the claim is "information", which is representable linguistically and has a potential to affect the behaviors of others, also (but not necessarily) for their higher knowledgeability.

Some simple examples will show what we mean with this position: one knows how to drive a car

only when she actually drives a car. Obviously, she can also remember to have proficiently driven a car some day in the past, and likewise be quite sure and confident to be able to drive a car some other day in the future. These two cases should not be mistaken for "knowledge" *stricto sensu*, but rather by metonymy (e.g., intellectual knowledge, declarative knowledge). Moreover, knowing how to drive is social in that this has to be performed compliantly with the "rules of the road" and, therefore (although the two things do not always coincide), the expectations of the other drivers (and car drivers in Rome could have different expectations than drivers in Teheran or Stockholm, as well).

Likewise, one does not really know that America was discovered in 1492: rather she remembers to have heard or read this "fact" somewhere and she trusts that source (or her memory) as reliable (a "source of knowledge"); moreover she can be sufficiently convincing in repeating this notion to someone else, who will possibly trust her. Of course, I can *know* something (i.e., I believe something as true, I hold an idea), but this is knowledge only if I can express it (e.g., by performing a speech act) *so that* someone else can understand my belief and believe it in her turn (in other words, knowledgeability is in the "eye of the beholder"). As recently accepted, this mechanism can regard personal opinions as well as scientific "facts" (Latour, 1987).

That said, we have to address two matters of concern. First, how we reconcile the idea that knowledge is a perceivable behavior with the idea that it can circulate within communities, and that this circulation follows main general patterns (which can be easily modelled). Second, how to avoid the pitfalls of purely behaviorist approaches that neglect the inner, mental part of knowledge, i.e., what is totally hidden to the "others" but yet quite indubitable for any knower (cf. Descartes).

To address these both concerns we turn to the varied body of work on cultural transmission that is often put under the rubric of *memetics* (Heylighen, 1998; Moritz, 1990; Speel, 1996). Being aware of the changing fortunes of this field (Burman, 2012), we rely just on the main concepts that were proposed originally in this research strand, without borrowing any of the most recent and complex models of knowledge transmission within and across communities of people, if not the simple idea that knowledge can spread over even without making anything "explicit" about it.

Indeed, in memetics the main mechanism is imitation and *memes* were first and originally

defined as "units of imitation" (Dawkins, 2006) and as any "idea or behavior that spreads from person to person within a culture" (cf. the Merriam Webster Dictionary) like, e.g., "ways of making pots or of building arches" (Dennett, 1990). On the other hand, imitation is also how "tacit knowledge" is said to be shared among human beings, since when Polanyi has assimilated imitation to learning by doing and learning by example (Polanyi, 1983).

More precisely, we propose to adopt a conceptual analogy with what in the life sciences has been discussed in terms of genotype-phenotype, and assimilate knowledge to a *memotype – phenotype* indissoluble dyad. To clarify this point it is necessary to provide some short definitions. In genetics, a *genome* is considered the entire genetic code characterizing a whole species or individual. A *genotype* is a collection of genes that underlie the expression of a phenotype. A *phenotype* is any actually observed trait or property of an organism, as well as its development or behavior, or related effects on the environment. The extended phenotype includes all the effects that a genotype has on its environment, inside or outside of the body of the individual organism (Dawkins, 1999).

Thus, consistently with the use of this term both in genetics and memetics, a specific trait of a human being that others would recognize as a knowledgeable behavior is but a phenotype. On the other hand, we define a "*memotype*" as *"the capacity of expressing that phenotype in a given environment"*. Thus, neither could exist without the other.

Why do we propose this sensitizing analogy as first step towards the proposal of new model for knowledge circulation in human communities (including organizations and the broader society)? The memotype-phenotype dyad allows us to go beyond the typical distinction by which knowledge is both "the actuality of skillful action" and its "potentiality" (Stehr and others, 1992). The dyad subsumes both these aspects. Moreover, we go beyond the idea of single memes as "units" that could be transferred (which we would consider a reductionist and simplistic view at best): we do not mean memotypes in the literal meaning of 'complex ensemble of memes that interact with each other and the environment to produce articulated phenotypes' but more simply as "*what allows for a specific knowledgeable trait to be expressed by someone and recognized by someone else*".

In this view, knowledge circulation is framed as the *mutual influence among phenotypes*, including the exchange of language utterances, the sharing or common use of material resources, like written inscriptions (i.e., a surrogate of spoken language) and objects. However, to say that someone would share the memotype with another one, or even that a memotype has been transferred, would probably miss the point: the memotype-phenotype is given as indissoluble and therefore to speak of "transmission" (as often done in memetics) would hide the simple (and more important to our aims) fact that one person has influenced the latter, with her behaviors, including communication and her products, broadly speaking. Traditional views of (tacit) knowledge, which do not consider its outer effects, miss the point of what happens in imitation and physical association, and thus they need to theorize an explicit counterpart of knowledge to give account for knowledge diffusion. On the contrary, the memotype-genotype viewpoint focuses on influence: thus in the very same way a genotype responsible for blue eyes would not produce any perceivable phenotype for potential mates that cannot detect colors, and hence would not directly spread through sexual selection in a blue-blind community of partners, so knowledge circulation is more a matter of mutual alignment (within a stream, so to say), than of "transfer" of knowledge units.

An example will help clarify this point: for instance, if I want to share a way of, say, hunting with a bow and arrows, I can say "Watch me and do as I do. Watch closely!" (Judges 7:17); I can describe the whole procedure in words like in a manual (how to draw the arc, aim at the prey, to shoot the arrow, etc.). Or I can hand the person an arc and arrow directly: as these latter are built so that usage is somehow afforded, and the shape of the arrow has been progressively tweaked and refined for more and precise aiming (and so forth) I could be confident that trials and errors could lead to some clear results in a matter of time, irrespective of my constant intervention as an expert, as long as I stand for the pupil as a master or influential teacher (this approach is also magnificently described in (Herrigel, 1999)).

In short, framing knowledge as a memotype-phenotype dyad allows to see knowledge both i) at the granularity level (i.e., single ideas, more articulated arguments, whole theories: all encompassed in the idea of memotype); and ii) at the conceptual level (i.e., mind, behaviors, objects: all encompassed in the concept of phenotype) that one feels more comfortable with.

The inscribed and material resources that we trace back to the concept of extended phenotype are often denoted, respectively, as "explicit or symbolic

knowledge" and "embodied or objectified knowledge" (cf. Marx). Our point is that this is useful and effective only in a metaphorical way, and in virtue of the non-totally unproblematic metonymies that are applied every time knowledge is said to be embedded in a technology (e.g., (Argote and Darr, 2000), in documents, organizational routines, practices and norms (Davenport and Prusak, 1998), social structures (Stehr, 2005), and in the "physical structure of the workplace" (Argote and Ingram, 2000). Here we rather claim that neither language nor material objects do *carry* or, notably, *represent* "memotypes". However, these are all resources that, even if not necessarily produced to this aim, can facilitate the influence of individuals on other individuals, so that these latter can develop "something" that would eventually allow them to express the same skills, competencies and behaviors: a related knowledge along the continuous development of human capabilities in a cross-human, overindividual, cultural dimension (the *genus*). To this respect, landscapes produced by societies over the centuries, sometimes for artistic reasons and more often for practical needs, ranging from low-tech agricultural countrysides to ambitious urban skylines integrating computational services and hyperconnected "Webs of Things" can be seen as the stratified product of Co-knowledge over time, which both inspire and affect knowing, innovation and learning much alike texts and common objects are said to do (Cerroni, 2006).

3 CONCEPTS IN THE STREAM

The Knowledge-Stream model moves on three analytical levels (Cerroni, 2006,Cerroni, 2007): the (socialized) individual; the social structure (both at micro scale, i.e., any community, and at the macro scale, i.e., the whole society itself); and the human genus (*Gattung* in Marx). Processes belonging to these three dimensions show a different essential nature, but all of them partake in the circulation "in the sea" of the (Co)Knowledge (see next), of which any single expression of knowledge, as we know it, can be seen as a sort of "local hardening" or "ripple". In the words of Stehr: "knowing is, then, grosso modo participation in the cultural resources of society." (Stehr, 2005)

At the *individual* level we typically find daily life processes with a biographical time-scale dynamics (roughly speaking, socially relevant cognitions and actions and what else is supposed to have, after Aristotle, both an ontological and methodological primacy in a scientific inquiry). At the (strictly speaking) *social* level, we find roles configurations within the reference community, what we call the "knowing community" (Cabitza et al., 2014), and interactions among communities (i.e. negotiations and both symbolical and economical exchanges). At the *genus* level, we place what we call Co-Knowledge. This is the knowledge-related part of the "complex whole" of known techniques, practices, implicatures, beliefs, "arts, customs [...] and any other capabilities and habits acquired by man as a member of [a] society" that is usually denoted as "Culture" since Tylor (Tylor, 1871), comprising (indeed, resulting from) multiple "epistemic cultures" (Knorr-Cetina, 1999); this can also be seen as a sort of "*memoma*" in accordance with the memetics perspective outlined above. Obviously the "Co" prefix is proposed to stress the fact that knowledge is intrinsically social, *co-produced in* and *constituted of* relational and meaningful interactions among individuals in a given social and cultural context, so as to retake the "*ko*" root ("together") that characterizes the Latin term "cognoscentia" and all its derivates.

The overall phenotype of this social and overindividual "memome" encompasses all possible knowledge productions: that is, both symbolic representations related to (i.e., both triggering and resulting from) the processes of knowing, what we refer to as "knowledge artifact" (Cabitza and Locoro, 2014); and these latter processes too, like idea expression and exchange, content and structure negotiation, meaning reconciliation, collective deliberation, new product and process co-design, knowledge representation at various degrees of (under)specification, problem framing and solving, mutual learning, novice training and any possible interpretation of the representations mentioned above (cf. semeiosis) (Gourlay, 2004).

4 THE PHASES OF THE KNOWLEDGE STREAM

We can model *knowledge circulation* as four logical phases between close levels (see Figure 1).

In this metaphorical flow, *Production* regards the creation of a knowledge-claim (e.g., any assertion, discourse, content intentionally produced to contribute to a knowledge body, as well as any expression of practical knowledge) in some representation language by individuals and its proposal to the reference-community; within the

global society we speak of production because this phase regards the expression or "bringing forth" (cf. pro-ducere) of some knowledgeable behavior by some individual agency, that is a single person, or a tight team of people acting in close accord: in other terms it is both creating and making this creation publicly visible within a social ensemble. How "creation" actually occurs is beyond the model's scope, as it probably pertains more to cognitive and group psychology, and to how ingenuity and intuition work in creative settings. In the case of product design, for instance, the new knowledge should not be reduced to the technical sketches that represent the "new" thing (the product of knowledge). Rather, it is the process of creating such a new thing, which encompasses procuring the materials, shaping them into single components, and assembling these components together, and even testing the final outcome for overall quality (that is performance expectations are embedded in the process also in terms of what should certify its quality, as well of the output of the process). According to the innovations that are implemented, new knowledge can also encompass the procurement of the needed pieces, the packaging (and to some extent also marketing the product effectively, and delivering it efficiently).

Thus, with reference to the widely discussed case study presented in (Nonaka and Takeuchi, 1995) new knowledge regards "how" to "build" a "better" bread machine, not "how" to knead bread so to make it "good". The product designer Tanaka could have found inspiration in spending time with some master baker, and found a way to emulate the right kneading with "special mechanic ribs", and maybe have even become a good baker himself in the process but one kind of tacit know-how (i.e., making the bread) has not been converted into design sketches and hardware. Rather, one "knowledge" has influenced another "knowledge" (e.g., designing machines), in that a product innovation always entails a process innovation, that is the very process of building the product. This process then is *enabled and supported* by colocated associations, lots of conversations (Ljungberg, 1997; Suchman, 2011), as well as documents and material resources, like sketches, 3D models, material scale models, resource management plans (even workforce schedules), to which this new knowledge can never be totally reduced.

Institutionalization regards the identification, selection, validation, structuring organization and "design for diffusion" of the knowledge produced and shared in that community, and that this latter one, often represented by the seniors, the gurus, the recognized experts (Wenger, 1998a), the managers somehow *acknowledges and announces*, by *ratifying* and making it further public, making it the potential Co-Knowledge mentioned above (a sort of Capitalized Knowledge that is collectively available in some form). From the memetic viewpoint, institutionalization refers to the phase of a meme circulation where this process gains an inflation of reproduction power, like a top-down or peer-driven legitimation in "fertilizing" the other members of the community, and a call to these latter to make themselves more sensitive and receptive, if possible, to the related phenotype (including the symbolic and material representations mobilized). Moreover, as it also regards the appropriation of knowledge by someone else than the original contributor(s), this phase has also a transformative power, as it can entail a reconciliation of meanings, a systematization, and an integration into existing nomenclatures, habits, procedures and "standards". This phase makes our proposal deeply different from the SECI model: while in the OKTC communities are seen as mere places where multiple individuals meet and interact, our model, conversely, acknowledges the transforming role of the overarching social structure(s) in which the new contributions are proposed (and new phenotypes emerge).

Diffusion refers to the "rippling percolation" of the Co-Knowledge by multiple and heterogeneous means like textual accounts, knowledge-affording objects, symbolic signs, and through essentially communicative processes, which also cross to the boundaries between other communities than the original one, up to – at least in principle – the whole (knowledge) society (Stehr, 1994)(Burke, 2012). Accordingly, diffusion regards the process in which people become more and more sensitive to innovation and pay some effort in actively perceiving or relaxing barriers to be influenced by the related extended phenotype, which, it is important to emphasize it, encompasses both behaviors, actions and their direct outputs. Then, diffusion is *never* a "top-down" or "transmission" or "dissemination" process, but a still cooperative – although not intended to be so –, properly *communicative* and creative process of co-production of a shared knowledge, not necessarily an "expert" one, ideally entailing the whole social environment.

Finally, *Socialization* deals with what the SECI model denotes as internalization and introjection (Nonaka and van Krogh, 2009), as well as with
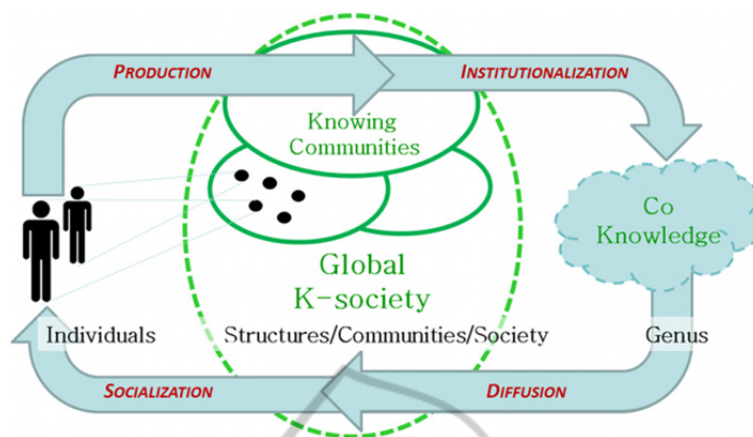
Figure 1: The knowledge stream model.

education and regulation (i.e., sociologically *normative*) processes, through which knowledge productions acquire a *reference* value, which is both publicly sanctioned (by, e.g., rule of law, technical regulation, accountable behavior), privately interiorized (the Self, professional ethos, her/his own responsibility) and transformed in that kind of "structured and structuring disposition" that individuals can learn only through their participation in social practices (Bourdieu and Wacquant, 1992). This is the process in which the phenotype can be replicated (adopted) by someone other than whom generated the original dyad memotype-phenotype: the behavior or the skill is said to have been internalized in that another member is recognized by the community as able to produce the intended (and institutionalized) behavior. Notably, where Nonaka speaks of internalization, we prefer speaking of socialization: in fact, Nonaka pointed out that internalization is "closely related [to] the traditional notion of learning". In doing so, however, he seems to neglect that education is a "bringing up out" *(educare)* the "raw" individual into the overarching patterns of behaviors and beliefs that are deemed appropriate for a specific social group (and society in the large): so what it is "closely related to learning" is not pouring into someone's mind some knowledge, but rather to acculturate her (i.e., assimilate her into a culture) and socialize her, i.e., to make her social, or "fit for life in companionship with others" (cf. the Random House Dictionary, 2014). In other words, for the individuals, socialization regards being "socialized *to"* some knowledge and to be educated to use it creatively so as (also) to move forward; while for the society in the large, socialization regards the incorporation of knowledge into its culture.

Thus, in regard to the bread machine case study,

we can reinterpret it in the following terms: Institutionalization regards the "bringing the new bread machine into production", with the commitment of the management, including the mobilization of the needed resources, the creation of commitment in several organizational roles, and their alignment towards the objective to deploy the new (innovated) bread machine. Diffusion regards how the changes in the production process are disseminated to the roles involved, including the marketing force and salespeople, and how it changes in value through this active "dissemination": the complex memotype herein involved encompasses also a new confidence (no matter whether ill-grounded or not) that the bread made with the new machine is better and similar to the "good real bread of the baker". Socialization is the process in which the people involved get proficient in the new production&marketing line and come to trust it is an actual and valuable innovation.

The same phases can be recognized also outside the company that produces the new bread machine. In this case the "new thing" is not the bread machine, which is said to be "materializing the skill of kneading [of the master baker] into specific mechanics" (Nonaka and Takeuchi, 1995, p. 101); but rather it is the related process of "making the bread at home", that includes a bread-making machine, of course. To this respect, we then see a company bringing forth a new method (and related practice) that obviously employs a new product of theirs (what they want to sell to increase their market share and revenues). This method must be "institutionalized" within the community of potential consumers (e.g., by a customer association, or some guru, like a famous chef with some visibility on TV, or knowledgeable representatives, like a journalist of some cuisine magazine, and the like) that is,

accepted as a legitimate and adoptable behavior (to this aim, advertisement and social semiotic techniques are also to be factored in). Diffusion refers to the process in which people come to buy the new machine and kitchen books with recipes on how to make the homemade bread with the new machine (cf. the case of the Vorwerk Bimby-Thermomix), start to use it with daily creativity, and spread the word about its quality. Socialization is the process in which "making the bread at home with, say, the Thermomix" is considered mainstream and socially desirable, changing community habits and (to some extent) values.

This example allowed us to show that the overall circulation process described by the model is scale invariant. In particular the last three phases of the "stream" can occur at various scales: i.e., within single communities of peers, experts or practitioners; between different communities (cf. cross-fertilization); and in progressively vaster communities, up to the level of the Global Knowledge Society (see Figure 1).

5 CONCLUSIONS

In this position paper we have presented a novel model of knowledge circulation in social settings, including organizations. Our model extends but also opposes the SECI model by Nonaka and colleagues (Nonaka and van Krogh, 2009) in a number of points: most notably that there is no continuum between tacit and explicit knowledge, no need to theorize the existence of a "cognitive tacit knowledge" (i.e., mental models of the world), of "explicit" knowledge, and indeed the idea itself of conversion at all. Accordingly, we maintain that "explicit knowledge" is not really "knowledge" (i.e., an object autonomous in its own), but rather a sort of scaffolding for its expression (Orlikowski, 2006), within a social process *in fieri* that must be maintained alive to keep it valuable; we have also proposed the metaphorical dyad "memotype – phenotype" to account for the "what" that could be exhibited and learnt within a social arrangement by people through observation, imitation and communication.

That said, new lines of investigation could regard to get a better understanding of how local knowledge (i.e., dyads memotype – phenotype) is appropriated at collective level and continually transformed in the process of circulating it, that is of letting it flow into what we called Co-Knowledge. In so doing, we intend to go beyond the OKC theory in

that our model acknowledges that knowledge can be created ex novo (differently from the OKTC where emphasis is either on externalization or internalization), it accounts for the ways in which "concepts are systematized into a knowledge system" without the need to theorize any combination of explicit knowledge (Nonaka and Takeuchi, 1995) [p. 67] and, most notably, it takes the social dimension of communities seriously, recognizing an "agency" in communities that transforms knowledge and makes it circulate actively. Thus, in our model no-thing is converted, nor moved or transferred, but it is rather acknowledged that some behaviors emerge, evolve and spread over a community of people in virtue of some processes. In the "Knowledge Stream Model" we parcel these processes out in terms of institutionalization, diffusion and socialization. These phases can entail different articulations of activities according to the nature and size of the social structure in which they occur, but we claim their function is scale- and domain-invariant. This opens up a research strand focusing on the role and functionalities of Knowledge Artifacts in enabling and supporting those phases, that is focusing on functionalities that support, e.g., group brainstorming and argumentation, meaning reconciliation, collective deliberation, appropriation, learning and training, rather than Knowledge representation and logic inference.

Future work will also encompass the application of the model to concrete case studies, like the project we describe in (Cabitza et al., 2014) where to show its descriptive, rhetorical, inferential and applicative power (Halverson et al., 2008).

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