

Conceptualizing knowledge transfer as transformation and attunement

Nina Bonderup Dohn¹

¹Department of Design and Communication, University of Southern Denmark, Denmark

Article received 16 October 2020 / Article revised 18 March 2021 / Accepted 7 April / Available online 19 April

Abstract

This article articulates a new theory on the ontology of knowledge transfer. This involves the work of 1) showing that the question “what happens to knowledge in transfer across divergent contexts?” can be made sense of within a situative approach, 2) providing a new conceptualization of situated knowledge, 3) articulating transfer in terms of knowledge transformation and attunement, and 4) putting the issue of learning to transfer knowledge across divergent contexts (back) on the research agenda. The article builds on a view of knowledge as a unity of know-that, know-how, and know-of; which unity forms a practical embodied perspective with which the agent meets the world in interaction. It is argued that knowledge is situatedly realized in attunement to the requirements, possibilities, and restrictions of the concrete situation, as they dynamically unfold. A framework of context levels for analyzing requirements, possibilities, and restrictions (termed “situational characteristics”) is presented. The levels reflect that an activity will always engage with a domain, in a life-setting, taking place within a societal structure, making use of encompassing cultural practices. It is shown how differences in unities of situational characteristics necessitate the transformation of the knowledge perspective in attunement to the situational characteristics of the new context. Towards the end, it is pointed out how this conceptualization of knowledge transfer opens for research into designing and teaching for learning to transfer. Three recent projects are referenced as an illustration of the approach.

Keywords: situative approach; knowledge transfer; knowledge transformation; attunement to situational characteristics; learning design



1. Situating the article: The need for conceptualizing knowledge transfer from within a situative approach

The aim of this article is to show that the question “what happens to knowledge in transfer across divergent contexts?” can be made sense of within a situative approach. This will be done by providing a conceptualization of knowledge transfer as transformation across contexts in attunement to situational characteristics. This conceptualization constitutes a novel theory of the ontology of knowledge transfer. Though the article draws on previous work by me and my colleagues on knowledge and knowledge transformation, it goes a wide step beyond this previous work by articulating what happens ontologically to knowledge in knowledge transfer: Knowledge transforms in a concrete realization of a practical embodied perspective.

My more encompassing aim is for the article to help put the issue of learning to transfer knowledge across divergent contexts (back) on the research agenda. A significant goal for education would seem to be exactly that: to help students learn to navigate different contexts and adapt their knowledge and skills along the way to the situational requirements, possibilities and restrictions at hand. The world of today is characterized by diversity, frequent change, and globalization. It is a defining feature of many people’s lives that they traverse a range of different contexts and participate in a variety of different practices. This is true, both in what Jarvis’ (2007) called a life-wide perspective (across our lives here and now) and what he called a life-long perspective (the temporal stretch of our lives). Accordingly, people often have to use knowledge, learned in one context, in new contexts. Failure to do so in adaptation to the situational characteristics of those contexts can have serious consequences – for the tasks people undertake (dealt with inadequately), for them personally (feelings of incompetence, lack of self-esteem, diminished sense of fulfilment), for the people they engage with (interacted with in insensitive, incompetent or unacceptable ways) and, in general, for the organizational and societal environment within which they are acting. Arguably, the challenge itself is not new, as people have had to traverse contexts in decades and centuries preceding the present one. However, the challenge is magnified, intensified and diversified today: the number of contexts we engage with have multiplied as compared to earlier times; the complexity and heterogeneity of many of the contexts have increased markedly; and the set of social, economic, and environmental sustainability problems we face globally and need to learn to take into consideration across myriads of local situations, are more urgent and decisive today than ever before. Given this, the challenge to transfer knowledge in ways that accommodate adequately (personally, ethically, socially, societally, environmentally, organizationally, economically, etc. speaking) to the situation at hand is of unprecedented significance.

The educational goal of supporting students’ learning to transfer knowledge has, however, been seriously contested in the last decades. Its viability is called into question by research in practice-theory (Dohn, 2017; Dreyfus, 1979; Dreyfus & Dreyfus, 1986; Schatzki, Knorr-Cetina, & von Savigny, 2001; Schön, 1983), situated learning (Greeno, 1997, 2011; Greeno & Gresalfi, 2008; Greeno & TMSMTAPG, 1998; Lave, 1988; Lave & Wenger, 1991), and distributed cognition (Hutchins, 1995; Hutchins & Klausen, 1996; Salomon, 1993). This research combines to show that knowledge is situated, attaining form and content from the context in which it is learnt. Upon accepting the situativity of knowledge, transfer of knowledge between contexts appears problematic (Greeno, 1997; Tuomi-Gröhn & Engeström, 2003); so much so that the notion has been argued to be unsustainable (Carraher & Schliemann, 2002), even incoherent (Lave, 1988; Packer, 2001). Teaching for transfer to happen between, for example, school and work seems impossible, at least from within education (Tuomi-Gröhn & Engeström, 2003).

Of course, not all researchers have accepted the situativity of knowledge. It is not generally accepted by what Lobato terms *mainstream cognitive approaches*: approaches focusing on learners’ information processing in a cognitive architecture comprised of long-term, short-term and sensory memories (Lobato, 2012; Mayer, 2001; Mayer & Massa, 2003; Reed, 1993; Singley & Anderson, 1989). Researchers within these approaches investigate transfer in constrained experiments (e.g., in a laboratory), focusing on how learners in trial ‘transfer situations’ apply content knowledge, abstract



schemas and problem-solving strategies learned in an initial learning situation. They thus ignore the criticism of the situative approaches that a) the experimental context delimits tasks in a very specific way and that b) there is no independent evidence that the knowledge and transfer allegedly displayed by participants represent knowledge and transfer in other life contexts. Some have acknowledged the significance of ‘context’, but treat it as a pre-given, delimited set of circumstances, which pose situational requirements, possibilities and restrictions determinable in advance, and from which learned knowledge can be “decontextualized”. Allegedly, representations, solutions, and so forth can then be “mapped” across such sets of pre-given circumstances (Reed, 2012). Alternatively, ‘context’ is treated as a set of factors which have to be dealt with by the learner in mental representations as part of the process of transfer (Nokes-Malach & Mestre, 2013). These researchers neglect the fundamental situative point that contexts are constituted in the interaction of agents, content, and activity – parts and wholes define each other, much like a rope is made up of threads, none of which run its full length and which for their part are held in place precisely by being part of the rope (Barab & Roth, 2006; McDermott, 1993; Säljö, 2000; Van Oers, 1998b). For this reason, situational requirements, possibilities and restrictions are not fully determined or determinable prior to interaction. In particular, as argued by Van Oers (1998a), the concept of “decontextualization” is highly problematic because it is in effect only a negative qualification, indicating that something doesn’t happen. Arguably, Van Oers overemphasizes the individual’s awareness when he states that “*context* is always strongly related to a personal (explicit or implicit) definition of a situation of action” (p. 136), but the more general point that context is strongly related to human sense-making in interaction holds true. Therefore “decontextualization” would seem to imply “no situation, no action, no meaning at all” (p. 136).

Instead of focusing on “decontextualization”, knowledge is better approached as a “functional stance on the interaction” in response to the “affordance networks” of the environment (Barab & Roth, 2006, p. 3). Affordance is here understood as relational to the actual embodied capabilities of the agent (Dohn, 2009). However, as the concepts of “affordance” and “affordance networks” centre on the possibilities of the situation (positive or negative), they do not fully cover the restrictions and requirements of the situation. Furthermore, the concept of “affordances” is fraught with diverging understandings in the literature. For these reasons, I here choose a different terminology and speak of the requirements, possibilities and restrictions of a situation and refer to these collectively as “situational characteristics”.¹

Somewhat ironically, perhaps, researchers who do accept the situativity of knowledge have generally refrained from investigating how people’s situated knowledge in one context might potentially relate in positive ways to their situated knowledge in other, very different contexts. That is, it is under-investigated how people’s knowledge transforms across major shifts in context. Instead, such researchers have contented themselves with documenting the lack of transfer between such contexts (Lave, 1988; Nielsen & Kvale, 2003; Wedege, 1999), or have studied in a much broader way how “boundary crossing” leads to shifts in social relations, participatory roles, identities, accountabilities, and values (Akkerman & Bakker, 2011; Engeström, 2001; Thrysoe, 2011; Tuomi-Gröhn & Engeström, 2003; Wenger, 1998). Studies which do focus on transfer and transformation of knowledge confine themselves to the microlevel of situative interaction. Here, researchers perform detailed analyses of, for example, the ways in which mathematical formulas are interpreted and reused across different tasks (Lobato, 2012; Wagner, 2010). Or they look at how teachers can frame situations, roles, and content to

¹ As introduced originally by Gibson, “The *affordances* of the environment are what it *offers* the animal, what it *provides* or *furnishes*, either for good or ill.” (Gibson, 1986, p. 127, italics in original). In other words, affordances are possibilities for action and interaction with others (including possibilities with negative outcomes). Constraints of the situation delimit a person’s possibilities but not all constraints need be directly entailed or clear from the situation’s affordances. For this reason, in the reception of Gibson’s view, the concept of “constraints” has often been added in the description of situational characteristics (Greeno, 1994; Norman, 1988/2002, 1999). However, this combination of “affordances and constraints” still does not capture all situational characteristics, because it does not cover the sense in which a situation may require one to do something, for example, save a drowning child. For this reason, I add “requirements” to “possibilities and restrictions” in the delineation of situational characteristics.



foster students' knowledge transfer between different curricular lessons, for example, between assignments and instances of group work (Engle, 2006; Engle, Lam, Meyer, & Nix, 2012). Interesting and informative *vis-a-vis* the development of student understanding as they are, such microlevel studies take place within the same overall institutional context of formal education. It is thus an open question to which extent they can inform the questions of how people transfer and transform their knowledge across overall institutional contexts, and, in particular, whether it is possible educationally to support students in learning to do so.

2. Conceptualizing knowledge

Taking a step back, an important first point to clarify in conceptualizing knowledge is whether it is first and foremost a phenomenon ascribed to persons (and perhaps animals) or to a set of propositions/abstract ideas. Do humans have/incorporate/display/enact knowledge – or do books (as representations of the abstract ideas)? Popper famously formulated this question as the question of whether knowledge resides in World 2, that is, the human world (where World 1 is the physical world) or World 3, that is, the world of ideas (Popper, 1972). Popper sided with the latter, arguing that though humans produce the abstract ideas, their production brings the ideas into independent existence as knowledge objects. Only in a derivative sense can we, according to Popper, ascribe knowledge to persons, namely when they understand the abstract ideas – or, as one might alternatively put it, depending on one's theoretical preferences: when they develop a conception of, master, interpret, make their own, and so forth the abstract ideas. Further, Popper's view can be developed to allow this derivative sense to be used about not only individuals, but also groups, for example, about a scientific community's "state-of-knowledge" (see e.g., Bereiter, 2002). On this developed Popperian view, the World 2 understanding of the World 3 abstract ideas may be distributed between the scientific community's members, rather than any single member understanding all the abstract ideas.

There are many problems with this view, not least the obvious one that understood this way, knowledge is – quite literally – not useful, not even for its own sake; it cannot grow, inspire, or challenge; it cannot help us out of ignorance; it cannot bring about any of the processes or circumstances which knowledge is usually held accountable for: Abstract ideas residing in a realm of their own cannot do anything or lead anywhere; humans (and perhaps animals) who understand or master knowledge can. In any consideration of why knowledge is important, including considerations concerning pursuing it for its own sake, human understanding is central, not the abstract ideas per se. The point is both ontological and epistemological: Ontologically, the point is that the kind of existence which knowledge, in the sense of World 3-abstract-objects, could have, would be deficient as compared to its realization-through-human-(and-animal)-understanding in so-called Worlds 2 and 1. Epistemologically, the point is that abstract ideas always need interpretation (i.e., human or animal understanding) to be applicable.

Because of problems such as these, I do not agree with this view. On the contrary, on my view, knowledge in its primary sense is a phenomenon ascribed to humans, and only derivatively to books or abstract ideas represented in books (derivatively, because books and ideas may be said to embody that which persons' knowledge is about). Incidentally, on my view, it is in a similar derive sense that one speaks of knowledge as embodied in material and virtual artefacts. But even if one takes a Popperian approach and views talk of a person's or group's knowledge as derivative to a primary World-3 sense, the question argued above to be of prime importance remains, that is, how persons and groups make use of knowledge learned in one context in new ones. Whether this use of the term 'knowledge' is construed as constituting its primary or derivative sense, the question concerns what people do in interaction with each other and the situations they come in. Since World 3 abstract ideas can't do anything, the ontological elevation of abstract ideas does nothing to answer this question.



An apparent middle ground between ascribing knowledge to humans and to abstract ideas is taken by Radford (Radford, 2013). Radford interestingly provides a Hegelian articulation of knowledge as abstract potentiality which comes into concrete existence – acquires reality in a singular manifestation – through particularization in a specific activity. In this way, the activity, as a particular, mediates between the singular and the general. Radford's view accommodates – indeed hinges on – the point just made: that abstract objects are ontologically deficient ("pure possibility" as he says, p. 18) and require actualization in a concrete singular to come into existence. However, this comes at the expense of the somewhat enigmatic notion of knowledge as "pure possibility", existing "in itself" (p. 25), developing culturally through "successive determination" (p. 15) – reminiscent of Hegel's idea of the Spirit as an overarching Subject (in the Continental sense of the word), concretizing through cultural development. My own view aligns with Radford's in stressing realization in concrete actualization as the full ontological mode of existence, but the potentiality that is being realized is not that of a general, abstract Subject, but of the individual's *practical embodied perspective*, as I shall explain in the next subsection.

2.1. Conceptualizing knowledge as situatedly realized

Within situative approaches, it is common to discard the term 'knowledge' in favour of 'knowing'. This is done to stress a process view over an objectifying one, that is, to specify that 'to know' is to *do* something rather than to *possess* something (Barab & Roth, 2006; Greeno & TMSMTAPG, 1998; Sfard, 1998; Wenger, 1998). I choose to speak of 'knowledge', however, to not seemingly decide on the fate of transfer by choice of words alone: 'Knowing' easily misleads to a narrow view of knowing-as-doing as singular, discrete actions. Such actions can hardly be envisaged as transferable. But if knowing were *only* discrete actions, it would be a tremendous coincidence that people can sometimes consistently and repeatedly perform the same actions, whether in new or well-known contexts. Conversely, using the term 'knowledge' does not preclude an analysis depicting knowledge as realized first and foremost in action. Quite the opposite, such analyses have been put forward by a number of practice philosophers, some of whom have inspired the situative approaches (Dohn, 2017; Dreyfus, 1979; Dreyfus & Dreyfus, 1986; Molander, 1992; Schatzki et al., 2001; Wittgenstein, 1958, 1969/1979). Across differences between these philosophers, their analyses concur in ascribing full ontological existence to knowledge only as actualized in action. That is, they concur in providing analyses that do not reify knowledge, even though they retain the seemingly object-indicating noun².

Many of these practice philosophers take an ecological approach (Gibson, 1986), stressing the basic reciprocity of individual and environment. Often with reference to Merleau-Ponty's concept of body-schema (Merleau-Ponty, 1962), this reciprocity is explained as a pre-reflective correspondence between what we can do in the world (skills incorporated in our body-schema) and the meaning it takes on for us (its affordances for us) (Dohn, 2009, 2017; Gallagher, 2005; Sanders, 1993). Based on this work, I have elsewhere explicated knowledge as a unity of propositional knowledge (know-that), practical knowledge (know-how), and experiential knowledge (know-of) and argued that this unity forms a *practical embodied perspective* with which the agent meets the world in interaction (Dohn, 2017). This *knowledge perspective* (as I also term it) lets the world present itself as meaningful to the person in accordance with the holistic set of interests, needs and capabilities of that person. Importantly, not all constituents of this holistic set need be consciously recognized, which is part of what is meant by stating that the perspective is practical and embodied. It is practical and embodied in the further sense that meaningfulness will present itself with immediacy, before reflection, as a practical 'feel for' the situation and what needs to be done in it. Finally, it is practical and embodied also in the sense that the perspective has its full ontological realization in use, taking on concrete form and content from the

² Incidentally, researchers who prefer to speak of 'knowing' would seem to invite the question "Yes, you have explained what people do when they know; now could you please explain what knowledge is", inadvertently leading to a reinstatement of a reifying view of knowledge, precisely because they do not give the object-indicating noun a non-reified interpretation.



specific situation in response to the requirements, possibilities and restrictions posed by the situation. This is where my view aligns with Radford's: in stressing actualization as the full ontological mode of existence. The difference is that the potentiality that is being actualized is not an abstract general possibility, but the individual's embodied perspective: As bodily beings, we are always in a specific situation in the material world, and in this sense the perspective is always concretely realized – there is no way we as bodily beings cannot have a specific viewpoint on the world, both literally and metaphorically speaking. However, as we move around our environment, the perspective changes (literally and metaphorically), meaning that the perspective is also always the potentiality for being realized as a different viewpoint. In this way, the potentiality is not an abstract form, but rather the possibility for continuous attunement to the situation at hand.

This rather abstract articulation of the perspectival character of knowledge begs an illustration with a few examples. My first example is Polanyi's description of the way X-ray pictures look to expert radiologists and to novice students, respectively (Polanyi, 1962, p. 101). From the radiologists' knowledge perspective, the X-ray picture presents itself directly as showing "a rich panorama of significant details", including physiological variations, scars, and acute signs of illness. The students, for their part, at first do not even see the lungs, but only the ribs. The second example is the similar one supplied by Kuhn which concerns the way a bubble chamber photograph looks to the physicist in comparison with what students see: The physicist will see a record of familiar sub-nuclear events whereas students will only see a set of broken lines (Kuhn, 1970, p. 111). Now, in phrasing these examples in terms of seeing, the practical nature of the perspective is left somewhat implicit. However, 'seeing' may well have actionable significance: From the radiologists' knowledge perspective, X-ray pictures are part of their diagnostic practice and a given picture can bear the significance of calling for specific actions as ways of treating the illness; for example, additional tests, medication, or operation. For the physicist, the significance of bubble chamber photographs resonates with a web of experimental procedures and results inscribed within scientific practice. A third example brings the actionable significance of the knowledge perspective more to the fore: Lave and de la Rocha have studied how shoppers and Weight Watchers, respectively, do best-buy calculations in the supermarket and mete out prescribed portions in the kitchen (de la Rocha, 1985; Lave, 1988). Their studies show how the participants' knowledge perspective of the everyday situation they are in let actions with tangible objects, difference strategies, direct comparison of size, and so forth stand out as the relevant mathematical procedures to undertake. In showing this, both studies further demonstrate how the situation provides form and content to the determination of the shoppers and Weight Watchers knowledge of mathematical procedures.

A common strategy at this point is to distinguish between "generalizable" structures and "surface" (or "accidental" or "particular") features of a situation. This strategy is most prevalent in cognitivist approaches to transfer (Gick & Holyoak, 1983; Judd, 1908; Reed, 1993). However, even within the situative approach, some researchers have made use of the analogous ecological distinction between "invariant" and "variant" elements of a situation (Barab & Roth, 2006). Barab and Roth thus claim that facts, concepts, and principles are "invariant structures" which have "cross-contextual value" (p. 3) because they can be used "as tools in other situations at other times" (p. 4). They further claim that "learners [can] interrogate the problem [the task they have been posed] in terms of the invariant and variant aspects" (and that transfer is facilitated by such interrogation) (p. 10).

The problem with this approach is that it treats 'invariant' and 'variant' aspects as independent of each other (and similarly with generalizable structures vs. surface features). This, in turn, leads to a view of knowledge of the aspects as decomposable into independent elements (that can then be recombined in new situations). Using Lave's shopper case to illustrate the problem; on the criticized view, arithmetic procedures to calculate unit prices would be invariant aspects; variant ones would be for example, family dietary preferences, layout of the supermarket, and available groceries. However, as I shall argue in greater detail below, the concrete situation decides the role of calculations, how they should be performed, when unit prices are relevant, and even what counts as a unit. In this sense, the invariant aspects are concretely realized and only come into actual being through the variant aspects.



This seriously questions the adequacy of the term ‘invariant’ as applied to concrete situations, and, moreover, highlights that invariant and variant aspects are not independent of one another in their realization. This, it should be noted, is an ontological point concerning the actualization of aspects of a situation. It does not preclude taking a realistic stance to for instance physical mechanisms or to human psychological or sociological traits. One may follow Bhaskar (1975) in arguing that such mechanisms and traits are real, understood as potentiality (in a related, but different, sense from the Hegelian Spirit), and have to be actualized in concrete situations (Bhaskar speaks of ‘events’). This actualization is precisely the realization I argue for, where the role which mechanisms and traits get to play in any specific situation is one as concretely realized in unity with other aspects. Therefore, the way the mechanisms and traits come into actual being differ due to each situation’s different contextual unity of situational aspects.

The corresponding epistemological point is that knowledge is not to be understood as a combination of independent elements. Instead, in line with the proposed reciprocity of individual and environment (cf. above), knowledge is situatedly realized as an attunement to and enactment of the concrete unity of the allegedly variant and invariant aspects. This attunement may, but need not, be in part available for conscious reflection, but will, in any case, involve a pre-reflective practical embodied accommodation to the situation, which dynamically upholds the correspondence between body and world (between what we can do in the world and the meaning it has for us, cf. above). This dynamic accommodation may be compared to – indeed is exemplified by – partaking in a dance or a choir or band where skilful participants continuously and unreflectively accommodate to the movements of the others in the specific physical environment. The dynamic accommodation is the actualization of the practical, embodied perspective on the situation which, correspondingly, lets the situation stand out with the meaning it has as a concretely realized unity of situational requirements, possibilities, and restrictions for action. Some aspects may be recognizable from other contexts, but they are not related to as invariant, but as situationally concrete, as transformed by the current situation’s contextual unity. Furthermore, what aspects will be recognizable from other contexts will depend on the present situation, including persons’ interaction in it, and need not be predictable in advance.

3. A framework of context levels of situational characteristics

In this section, I shall present a framework for analysing situational requirements, possibilities, and restrictions (henceforth *situational characteristics*), previously developed in Dohn (2017), Hachmann and Dohn (2018), and Dohn and Hansen, S.B. (2020). The framework is based, on the one hand, on the recognition that such situational characteristics analytically pertain to different levels of specificity as regards the activity in question: An *activity* engages with a *domain*, in a *life-setting*, taking place within a *societal structure*, making use of encompassing *cultural practices*. On the other hand, the framework takes into account that situational characteristics at these different levels interact. Amongst others, the framework has been used to criticize the operationalization of the OECD’s Programme for International Student Assessment (PISA) (Dohn, 2007). It has also been used to highlight the incoherent competence demands placed on students when Web 2.0 practices are introduced as learning activities within education (Dohn, 2009). The framework is inspired by Wedege’s distinction between “situation context” and “problem context” (Wedege, 1999) and by Engle’s distinction between “social context of learning” and “content” (Engle et al., 2012).

Two caveats before proceeding: First, the examples of situational characteristics provided below have been chosen because they are easily recognized. Their recognizability may, however, mislead to the impression that they are pre-given and static, that is, exist as concrete invariants across contexts. This is not the case; in every specific situation, their significance and meaning (including a potential negation of them) will be concretely realized in the interaction of the agent(s) in practice. I illustrate this



point with examples below. Second, at all levels, some situational characteristics may be implicit, acknowledged in action, rather than explicitly articulated.

The framework levels are:

1. *The domain level.* This level is concerned with the domain or *content area*; for example, genre theory; linear algebra; nuclear physics; and musical harmonization. Examples of situational characteristics at this level could be: fairy tales can include magical happenings, documentary essays cannot; subtracting a negative number equals adding the numerically identical positive number ($-(-a) = a$); calculations involving nuclear phenomena should be performed utilizing quantum mechanics rather than Newtonian mechanics.

2. *The activity level.* This level is concerned with the *activity itself*; for example, reading a book; individually or collaboratively solving a problem; attending a lecture; writing an entry in Wikipedia; and having a discussion with peers. Situational characteristics at this level could include: all participants in group work should be allowed to speak; students sit relatively quietly whilst attending lectures; entry writing for Wikipedia involves building upon and refining others' contributions and accepting non-copyrighted "use-and-reuse" of one's own. A typical word problem in school tasks will delineate a fictional setting in which the problem is supposed to take place – the "problem context" in Wedege's terms (cf. above). Contextual requirements of this fictional setting will be specified as part of the problem description, for example, the amount of money available for shopping, or two persons' opposing views on a subject such as graffiti. It is an activity level situational characteristic that one should take such fictional/problem-story contextual requirements into account in solving the problem.

3. *The life-setting level.* This level is concerned with the *life-setting which frames the activity*; for example, shopping for groceries; participating in a class within an educational program; and having leisure time to spend as one pleases. Situational characteristics at this level could concern, for example, making do with the actual resources available in the situation; taking food preferences of family members and storage limitations at home into account; acknowledging the teacher as the authority in the classroom; making a self-directed choice as to what one spends leisure time on. This is the level of Wedege's "situation context" and of Engle's "social context of learning".

4. *The societal structure level.* This level is concerned with *societal organizational structures and institutions* which *allow or enable the life-setting to exist and the activity to take place within it*. Examples of societal structures are the organization of learning within a school system or within traditional family-centred apprenticeships with room and board provided, of religious practice through church mediation, and of the distribution of commodities in society through the free market. Situational characteristics at this level concern for example, general curriculum demands and national standards; (implicit or explicit) expectations concerning parents' engagement (or not) in their children's schooling; formal qualification requirements for certain professional jobs; expectations concerning citizens' involvement (or not) in religious practice.

5. *The cultural practices level.* This level is concerned with the *cultural tools and ways of behaving which are prevalent in a culture across specific practices and societal structures*. Examples of cultural practices are dominant communication forms (oral communication in some cultures; reading and writing in others; internet-based communication in many cultures today); the use of money as a medium of exchange; and the production of tools with certain materials (stone in the Stone Age, iron in the Iron Age, plastic in modern times). Examples of situational characteristics at this level are: contemporary expectations of increased digitalization across societal institutions; preference for oral, written or digitalized communication in different cultures.

By 'domain' I simply understand 'what the activity is about'. 'Activity', similarly, is 'what participants are engaged in doing'. The scope of both will vary: In the context of a university-level mathematics course, linear systems will be a domain, whereas algebra will be a domain in primary school. Likewise, in the context of collaborative problem solving, 'group discussion' will be part of the activity, whereas in other situations it may be the activity itself. As regards 'societal structures', this



term refers primarily to the state/national level at which state- or nationwide institutions are constituted. However, given the pluralistic nature of today's societies, two points should be noted about this. Firstly, within states and nations, communities and subgroups may have their own societal structures negotiated within or challenging the bounds of the state/national ones. So the scope of this level varies, too. Secondly, for individuals, the societal structures at the state/national level need not be appropriated as their own; individuals can be estranged and marginalized by societal structures and experience them as unfair, elite or majority rule. That this can be the case of course only underscores the significance of situational characteristics at this level. Similar points apply to the cultural practices level.

As indicated, situational characteristics interact. The ones at higher (i.e., less activity-specific) levels frame and delimit the ones at lower levels, determining their specific concretization, and in some cases vice versa. In Dohn (2007), I thus show through analysis of the assessment guide to specific PISA test items' how the situational characteristics of the test situation (level 3: the life-setting level) delimit what is accepted as adequate answers to a question of letter style (level 1: domain level). I also show how the situational characteristics of a couple of non-test situations (level 3) would lead to different evaluations of the provided answers.

A further example is provided in Yackel and Cobb's (1996) study of the establishment over time of socio-mathematical norms in a second-grade classroom. One of the norms which developed was that students are only justified in contributing a solution to the class discussion when the solution is mathematically different from previously proposed solutions. This norm integrates situational characteristics at

- domain level: what counts as mathematically different
- activity level: discussion norms
- life-setting level: students raise their hands to contribute; teacher regulates the discussion and has the authority to evaluate answers

The example illustrates that situational characteristics are not pre-given but develop in the interaction of agents with content and each other in the unfolding of socio-historical place and time.

In general, situational characteristics interact to form a concrete unity, and it is in response to this concrete unity that knowledge has its full ontological realization, taking on specific form and content in attunement to it. I illustrate this further in the next section, demonstrating also how different contexts lead to different knowledge realizations.

4. Attunement of the practical embodied perspective to the unity of situational characteristics

Knowledge is learnt in concrete situations with specific unities of situational characteristics. Thus, the students in Yackel and Cobb's study learn mathematical concepts, principles and arguments (level 1) intertwined with learning

- to participate in the specific teacher-questions-students-answer-interaction-format (level 2 discussion norms as framed at level 3 by the classroom)
- the respective social positions of teacher authority and student compliance (level 3)
- to negotiate these social positions (level 3).

Because the situational characteristics at different levels interact, decontextualization of knowledge pertaining to the domain level is not possible. Any apparent decontextualization will actually just be another concrete realization of knowledge in response to the new situation's unity of situational characteristics. With inspiration from Lave's (1988) study, this can be illustrated by comparing real



supermarket buys (level 3) with the ones of school word problems (level 2, taking place within the level 3 life-setting of school).³

When shopping for ingredients for an apple pie in the supermarket, situational characteristics at level 3 such as the recipe, storage capacity in the car and at home, family members' preferences for specific apple brands, for apples and for apple pie over other types of fruit and dessert (pp. 120-121, 162, 166), frame the situational characteristics of the actual choosing of groceries (level 2) and of the use of math for doing so (level 1). Attuning to these characteristics involves the shopper's knowledge at all levels concretizing together into a specific realization of the knowledge perspective in the situation. As a result, at level 1, difference strategies⁴ (pp. 119-120) or direct comparison of sizes (p. 154) become appropriate uses of math for deciding which apples to buy. The use of math may also be adjusted, for example, what counts as a unit and how units should be added. For instance, when 2 apples are added to 3 apples to make the 4 large ones required by the recipe. Alternatively, the brands or prices available may lead the shopper at level 2 to decide to shop elsewhere or make another dessert (p. 166).

In contrast, the realization of the knowledge perspective in a school context will let a word problem concerned with the buying of apples for an apple pie stand out as exactly that. This restricts the types of calculation permissible at level 1. Difference strategies, direct comparison of size, and the adjustments of units are improper uses of math, unless the word problem specifically asks for it. Deciding for another dessert at level 2 is not an option, because the activity is that of solving a math problem, not that of getting dessert.

Lave suggests "the possibility of an indeterminate number of arithmetics" (Lave, 1988, p. 63f) corresponding to diverse situations of arithmetic practice. This suggestion begs the question of why we across all these situations should characterize what is going on as "an arithmetic" rather than something else. The framework I propose supplies an answer: The domain is the same – for example, elementary algebra – across the situations. Yet its situational characteristics are concretized by the activity and life-setting situational characteristics. This provides situation-specific form and content to what works as correct domain procedures in the concrete situation. In the shopping example, the different situational characteristics act to make difference strategies, direct comparison, and unit adjustments workable algebraic procedures in the supermarket, but not in school. Transfer of knowledge from either context to the other – to the extent that it takes place at all⁵ – does not happen as a decontextualization of the algebraic procedures used in the one situation, followed by 'recontextualization' in the new situation. Rather, the concretized practical embodied perspective of the one situation – with its inherent potentiality of being concretized differently – transform in accommodation to the unity of situational characteristics in the other one, resulting specifically in changes in what works as algebraic procedures.

Again, the analogy and example of dance is illustrative: Dancing is realized in concrete physical and social situations, as an immediate bodily attunement to the unity of situational characteristics. Dancing transforms between situations, not as a decontextualization of moves – practising dance moves is a concrete realization of moves in accordance with a unity of situational characteristics as well – but as a dynamic accommodation of movement upholding the pre-reflective correspondence between body and world. The dynamic accommodation is the continuous, concrete realization of the embodied

³ To allow all points to be made with just one example, I have constructed the following dessert example from Lave's observations of several supermarket buys of different groceries. Page numbers refer to documentation of the point in question in Lave (1988) (involving other groceries than ones for dessert).

⁴ Difference strategies compare differences in price and amount without calculating unit price. An example is "One bag of apples is €3, two bags are €4, so I get a bag extra for just €1."

⁵ Lave's research shows that transfer of math knowledge from school to everyday situations is not as direct, widespread and obvious to persons themselves as math educators might wish for. Still, a person may transfer knowledge without acknowledging the transfer process; that is, make use of knowledge learned in another context without awareness that it stems from this other context. It may simply be part of the practical embodied perspective with which the person meets the world. Lave's shoppers for instance make use of numbers and basic algebraic procedures of adding and subtracting. These will not in general have been learned in the supermarket, though they need not have been learned in school, either.



perspective on the situation, which as part of the process lets the material and human phenomena present stand out with a significance specific to this situation (e.g., obstacle, an axis to revolve around, a possibility for ‘echoing’ moves, etc.), calling for further moves of the dancer.

We do not, of course, always succeed in attuning correctly to the unity of situational characteristics. The practical embodied perspective may concretize in ways which over- or under-acknowledge the situational characteristics at one or more of the levels. Children who write “I do not like apples” as the answer to apple pie word problems in school have under-acknowledged how the situational characteristics at level 3 frame activity and domain. An example of over-acknowledgement of situational characteristics at both levels 3 and 1 is provided in Säljö and Wyndhamn (1993). Here, students, aged 15 and 16, had to determine the necessary stamp values for different letters. One group did this by calculating first the proportional price-per-weight and then linearly increasing stamp prices. They thus over-acknowledged the level 3 situational characteristics of the school context in interaction with level 1 situational characteristics of elementary algebra. This overruled their out-of-school post office knowledge of weight ranges for stamp price calculation, though this knowledge was supposed to have been applied in the problem-solving at level 2. Arguably, children learning to read who stop to spell their way through every street sign over-acknowledge the situational characteristics of the reading activity at level 2. They thereby neglect the situational characteristics at both level 3 (requiring them to move on) and level 1 (what the signs say).

These latter examples of inadequate attuning to the unity of situational characteristics highlight the need for transformation of the knowledge perspective across different situations. Without such transformation, new situations will be met inadequately with the concretized knowledge perspective of other situations. This will result in apparently ‘obstinate’, inflexible, context-insensitive behaviour. One example is found in Engeström (2001). Here, health professionals working within different contexts had to deal with patient issues cutting across the contexts. Their initial approaches were inadequate, precisely because they were rooted in their respective work contexts, rather than transformed to meet the cross-cutting unity of situational characteristics.

To reiterate: Situational characteristics are not pre-given or static but develop in the interaction of agents in practice. Further, precisely *how* persons transform their knowledge across contexts is rarely predictable in any detail. Still, both situational characteristics and persons’ transformation of knowledge will often be analysable after the fact. This is exemplified at the microlevel within the context of school in Lobato’s and Wagner’s research (cf. above). Hachmann and Dohn (2020) illustrate it for the larger shift, involved in a practicum experience, between the contexts of school and professional practice. A similar analysis is allowed for in Engeström’s description of the health professionals’ subsequent negotiation of new ways of addressing the patient issues in question.

Moreover, it is possible to reflect in advance on what might potentially count as adequate transformations of knowledge between specified contexts. Though the actual situational characteristics of these contexts may turn out to differ, such reflections can heighten awareness of the *need* to attune as well as to types of considerations that may be appropriate in attuning. Reflections can be done from within educational contexts. For instance, teachers can point to transformed uses of curricular content in learners’ current out-of-school practices (life-wide perspective) as well as in practices in which they might engage in the future (life-long perspective). Such pointers will frame the use of curricular content, potentially with the much more far-reaching significance intended by Engle et al. for the concept of framing, but not actually realized in their empirical research on microlevel framing between curricular lessons (Engle, 2006; Engle et al., 2012). If successful, it may help learners both in effecting actual specific transfer between contexts and in developing dispositions for flexible attunement which may facilitate transfer for them more generally.

For the sake of clarity of presentation, I have restricted my examples to contexts which differ at the life-setting level (level 3), but which are found within the same society. This means that the state-/national situational characteristics at levels 4 and 5 are much the same, though they may have differing significance at level 3 for the different life-settings, and may be negotiated, lived with and challenged



very differently by specific communities and individuals within the life-settings. However, teachers could point to transformations across contexts which differ at these levels, too. This may be relevant for international students enrolling in a schooling system diverging markedly from the one in their home country (level 4) (cf. Carroll & Ryan, 2005; Kandiko & Weyers, 2013). Variances for such students may also concern cultural practices (level 5), for example, the degree of digitalization and the value accorded to it.

5. Putting the issue of learning to transfer knowledge (back) on the research agenda

The context level framework allows asking from within a situative approach what happens to knowledge in transfer across divergent contexts. It makes possible the analysis of how the situativity plays out in different situations as the attunement to diverging unities of interacting situational characteristics. That is, the framework on the one hand allows acknowledging that knowledge is realized situatedly in a unique way for each situation. On the other hand, it permits maintaining that the format of the situativity is the same across instances, namely attunement to a unique unity of situational characteristics developing interactionally. This justifies research questions such as: How do people learn to attune to developing unities of situational characteristics? How do they transform their concretized knowledge perspective from one context to fit the unity of situational characteristics in new ones? Moreover, the framework makes it possible from within educational contexts to analyse how curricular domain knowledge is realized differently in different activities inside and outside of school. This raises the question of how students can be facilitated educationally in transforming their curricular knowledge perspective across such contexts. And it invites further research questions concerning the development and testing of learning designs aimed at this facilitation.

The viability of addressing such research questions from within a situative approach can be illustrated with a couple of recent projects investigating different ‘learning designs for transfer’. In one such learning design, student teachers in a first language course were asked in groups to teach modules in a local primary school (Hachmann, 2020). The modules were on subjects which were part of the student teachers’ own curriculum, for example, dramatic structure. The design idea thus was to require the student teachers to transfer curricular knowledge between the teacher training program and the primary school classroom. The curricular knowledge to be transferred was at the domain level, since the curricula of the primary school class and the teacher training program overlapped thematically, though of course at different levels of academic sophistication. When the student teachers employed specific participation formats from their own course (for example, class-based analysis of a text) in the primary school class, curricular knowledge at the activity level was also involved. Knowledge transformation between the two contexts was evident in the adaption of academic terminology, use of visualizations and choice of examples (level 1). Similarly, it showed up in the way the class-based analysis was structured (level 2) to take into account classroom culture and the need for classroom management in the primary school class (level 3). Research questions here concerned how to design for student teachers’ knowledge transformation between the two contexts of the teacher training program and the primary school; characterization of the resulting knowledge transformation; and the identification of factors that facilitated or hindered it. A particular focus was on how the student teachers were supported in transforming knowledge between the divergent contexts by acts of explicit framing (performed by the educator at the teaching training program) (Engle, 2006; Engle et al., 2012) of the relevance for the primary school class of concepts (level 1) and activity forms (level 2). The research questions were investigated through a design-based research methodology (Amiel & Reeves, 2008), utilizing ethnographic observations, video recordings of group work, interviews, and analyses of student-teacher assignments. The project resulted in design principles for ‘learning to transfer’ curricular knowledge, applicable beyond this very specific form of in-course school-practice coupling.



A second project (Hansen, J.J. & Dohn, 2018, 2020) investigated a learning design of ‘simulated social practices’. This design combined role-play within a university classroom context with projects anchored in student engagements in out-of-school workplace practices. The learning design thus coupled between contexts in which the students participated: on the one hand, a university course in which they all participated, and on the other hand, several workplace contexts in which they participated individually. The aim was to facilitate students in learning to transfer knowledge back and forth between these contexts. More specifically, students had a series of tasks (portfolio and in-class role-play) centred around developing and testing a product intended for (though in most cases not presented to) a specific workplace. The aim was to support the students in transforming their curricular knowledge perspective into workplace knowledge as well as, reciprocally, in drawing on their workplace knowledge perspective to elucidate classroom discussions. Within the life-setting of the course (level 3), the workplaces had the role of cases-treated-within-education. Therefore, the situational characteristics of the workplace life-setting were subsumed and transformed into situational characteristics at the activity level (level 2) within the course life-setting (level 3). The projects, portfolio and in-class role-play tasks likewise were activities at level 2. In consequence, as compared to what would have been expected in the workplaces, there were increased expectations of academic reflections about the projects and correspondingly less focus on workplace issues such as profit or growth. This was reflected in the students’ assignments where all students made use of curricular domain knowledge (as is to be expected within the context of a course), but only some of the students managed to integrate their workplace knowledge perspective in their case analysis and product design. The status of the project as activity-within-a-course was also evident in the way role-play in class progressed: roles had to be articulated at the outset; they were taken up in a playful ‘as-if’ manner; particularly distinctive in-role comments by the students prompted laughter (because in-role comments were out-of-character at level 3); and out-of-role comments addressing the course framing of the activity were recurrent. Research questions in this project concerned how students transform and integrate their curricular and workplace knowledge in response to the differing unities of situational characteristics in workplace and course contexts. They also concerned the transformations involved *within* the course context between the different portfolio and role-play tasks. The research questions were investigated with a design-based research approach, utilizing ethnographic observation, analysis of student assignments, and qualitative questionnaires.

A third project focused on facilitating children’s transition from a) day-care to b) a 4-months-transition-module to c) school, through engaging them in the production of digital artefacts (e.g., photo books) and dialogue about these artefacts (Odgaard, 2018, 2019). The basic design idea was that the digital artefacts could be negotiated as boundary objects (Wenger, 1998) which connected the contexts of day-care, transition module, and school and facilitated the children’s engagement with their new contexts. The project investigated how children may be facilitated in transforming their experience from daycare to school. Transfer was supported through initiating production and dialogue (level 2), focused on topics (level 1) central to the children’s experiences – or presumed by the day-care practitioners to be so. The study illustrated, on the one hand, that activities with the digital artefacts can indeed support children in transforming their experience through highlighting similarities and differences between the contexts. On the other hand, however, it also showed that practitioners and children alike sometimes engage in the production and dialogue of the digital artefacts as somewhat forced activities. The problem is that the societal structure-level (level 4) poses the requirement of ‘establishing continuity for children’ on the life-settings of day-care, transition module, and school (level 3). This then again frames the transition activities (level 2) as obligatory.

These examples illustrate the usefulness of the framework for research into learning to transfer, both as concerns the development of design principles and as regards the subsequent analysis of transformation processes involved in transfer across contexts.



6. In conclusion

The aim of this article is to articulate a theory on the ontology of knowledge transfer which makes it possible to conceptualize knowledge transfer across contexts within a situative approach. I have presented an analytical framework of context levels, at which interacting situational characteristics are constituted and dynamically negotiated. I have argued that knowledge takes on concrete form and meaning from the specific situation in response to its unity of situational characteristics. Therefore, the transfer of knowledge between contexts requires knowledge to be transformed in attunement to the unity of situational characteristics of the new context. My wider goal in presenting this argument has been to put research into learning to transfer across divergent life contexts (back) on the research agenda: Given the framework of context levels, it is possible to some extent to analyse situational characteristics of new situations in advance, though their dynamic nature must be emphasized. It is also possible to point out non-exclusive ways in which transformation can be undertaken to attune to these situational characteristics. In this way, it is possible from within education to support students in achieving transfer and potentially also in developing dispositions for flexibly attuning to different unities of situational characteristics.

By way of conclusion, I wish to emphasize two things: Firstly, the usefulness of the framework of context levels for researching learning to transfer does not hinge on the specific view of knowledge presented here. Other situative conceptualizations could make similar use of the framework. Thus, given Barab and Roth's (2006) understanding, one could analyse how different situations require flexibly transformed enlisting of a person's "effectivity sets". Likewise, the framework will provide points of focus for analysing the "encompassing process" which Wenger claims that participation is, and with it "knowing" (Wenger, 1998, p. 4)⁶. This, in turn, will enable consideration of how knowing (as participation) may transform across contexts in response to the changed unities of situational characteristics of different "practices of social communities".

Secondly, the framework will be useful, not only for research into learning to transfer, but also for designing and teaching for it. Thus, a detailed analysis of interacting situational characteristics will help teachers articulate to students how their curricular knowledge perspective must be transformed to be utilized in workplace contexts. Tasks which involve such transformation may be developed, as in the first two projects above, facilitating students in actually achieving transfer, not only in becoming aware of its challenges. Within a somewhat different area, the framework may help teachers and students alike become aware of differences in situational characteristics between the contexts of school and of students' out-of-school informal digital practices (Greenhow, Robelia, & Hughes, 2009; Knobel & Kalman, 2016; Lankshear & Knobel, 2011). Hereby, students may be facilitated in utilizing their familiarity with literacy practices on social media in ways which align with school expectations. Teachers may also be supported in designing tasks which help students accomplish the necessary transformation by explicitly highlighting differences in situational characteristics between the contexts of informal practices and of school. Potentially, it might even stimulate educational designers to question situational characteristics of the educational system not aligned with those of informal practices, such as the individualist focus of assessment practices. Similarly, as indicated, analysis of variances in situational characteristics between school systems in different countries (level 4: societal structure-level) may facilitate international students in transforming their curricular knowledge perspectives in attunement to the unity of situational characteristics of their country of study. Correspondingly, it may support their teachers in realizing systematic differences in their students' concretized knowledge perspectives as compared to their home students, and consequently in posing tasks which help them perform the transformation.

⁶ "Knowing is a matter of participating in the pursuit of [valued] enterprises" where "Participation ... refers... to a[n] ... encompassing process of being active participants in the *practices* of social communities and constructing *identities* in relation to these communities" (Wenger, 1988, p. 4, emphasis in original).



For all these suggested practical uses of the framework, complementing research questions may of course be asked, in collaboration with practitioners through participatory or design-based methods, or in case studies of existing learning designs.

Keypoints

- A new ontology of knowledge transfer is articulated.
- The question “what happens to knowledge in transfer across major context shifts” is shown to make sense also from within a situative approach.
- Situated knowledge is conceptualized as attunement to a unity of situational characteristics, analysable with a five-level context framework.
- Transfer is conceptualized as knowledge transformation in attunement to the new situation’s differing unity of situational characteristics.
- The article puts the issue of *learning* to transfer knowledge across divergent contexts (back) on the research agenda.

Acknowledgments

I thank two anonymous reviewers for their insightful comments which helped me strengthen my arguments. Research for the article has been supported by the Independent Research Fund Denmark, Grant No. DFF – 4180-00062.

References

- Akkerman, S. F., & Bakker, A. (2011). Boundary crossing and boundary objects. *Review of educational research*, 81(2), 132-169. doi:10.3102/0034654311404435
- Amiel, T., & Reeves, T. C. (2008). Design-based research and educational technology: Rethinking technology and the research agenda. *Educational Technology & Society*, 11(4), 29-40.
- Barab, S. A., & Roth, W.-M. (2006). Curriculum-based ecosystems: Supporting knowing from an ecological perspective. *Educational Researcher*, 35(5), 3-13. doi:10.3102/0013189X035005003
- Bereiter, C. (2002). *Education and mind in the knowledge age*. Mahwah: L. Erlbaum Associates.
- Bhaskar, R. (1975). *A realist theory of science*. New York: Routledge.
- Carraher, D., & Schliemann, A. (2002). The transfer dilemma. *Journal of the Learning Sciences*, 11(1), 1-24. doi:10.1207/S15327809JLS1101_1
- Carroll, J., & Ryan, J. (2005). *Teaching international students: improving learning for all*. Abingdon: Routledge.
- de la Rocha, O. (1985). The reorganization of arithmetic practice in the kitchen. *Anthropology & Education Quarterly*, 16(3), 193-198.
- Dohn, N. B. (2007). Knowledge and skills for PISA—Assessing the assessment. *Journal of Philosophy of Education*, 41(1), 1-16. doi:10.1111/j.1467-9752.2007.00542.x
- Dohn, N. B. (2009). Affordances revisited: Articulating a Merleau-Pontian view. *International Journal of Computer-Supported Collaborative Learning*, 4(2), 151-170. doi:10.1007/s11412-009-9062-z
- Dohn, N. B. (2009). Web 2.0-Mediated Competence – Implicit educational demands on learners. *Electronic Journal of E-learning* 7(1), 111-118.



- Dohn, N. B. (2017). *Epistemological concerns - querying the learning field from a philosophical point of view*. (Professorial Thesis (dr.phil.)). University of Southern Denmark, Retrieved from <http://dohn.sdu.dk/>
- Dohn, N. B., & Hachmann, R. (2020). Knowledge transformation across changes in situational demands between education and professional practice. In N. B. Dohn, S. B. Hansen, & J. J. Hansen (Eds.), *Designing for situated knowledge transformation* (pp. 249-266). Abingdon: Routledge.
- Dohn, N. B., & Hansen, S. B. (2020). Context framework for analyzing situated knowledge transformation. In N. B. Dohn, S. B. Hansen, & J. J. Hansen (Eds.), *Designing for situated knowledge transformation* (pp. 59-74). Abingdon: Routledge.
- Dreyfus, H. L. (1979). *What computers still can't do*. New York: Harper & Row.
- Dreyfus, H. L., & Dreyfus, S. E. (1986). *Mind over machine. The power of human intuition and expertise in the era of the computer*. New York: Free Press.
- Engeström, Y. (2001). Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of education and work*, 14(1), 133-156. doi:10.1080/13639080020028747
- Engle, R. A. (2006). Framing interactions to foster generative learning: A situative explanation of transfer in a community of learners classroom. *Journal of the Learning Sciences*, 15(4), 451-498. doi:10.1207/s15327809jls1504_2
- Engle, R. A., Lam, D. P., Meyer, X. S., & Nix, S. E. (2012). How does expansive framing promote transfer? Several proposed explanations and a research agenda for investigating them. *Educational Psychologist*, 47(3), 215-231. doi:10.1080/00461520.2012.695678
- Gallagher, S. (2005). *How the body shapes the mind*. Oxford: Clarendon Press.
- Gibson, J. J. (1986). *The ecological approach to visual perception*. Hillsdale: Lawrence Erlbaum Associates.
- Gick, M. L., & Holyoak, K. J. (1983). Schema induction and analogical transfer. *Cognitive Psychology*, 15(1), 1-38. doi:10.1016/0010-0285(83)90002-6
- Greenhow, C., Robelia, B., & Hughes, J. E. (2009). Learning, teaching, and scholarship in a digital age: Web 2.0 and classroom research: What path should we take now? *Educational Researcher*, 38(4), 246-259. doi:10.3102/0013189X09336671
- Greeno, J. G. (1994). Gibson's affordances. *Psychological Review*, 101(2), 336-342. doi:10.1037//0033-295X.101.2.336
- Greeno, J. G. (1997). On claims that answer the wrong questions. *Educational Researcher*, 26(1), 5-17. doi:10.3102/0013189X026001005
- Greeno, J. G. (2011). A situative perspective on cognition and learning in interaction. In T. Koschmann (Ed.), *Theories of learning and studies of instructional practice* (Vol. 1, pp. 41-71). New York: Springer.
- Greeno, J. G., & Gresalfi, M. S. (2008). Opportunities to learn in practice and identity. In P. A. Moss, D. C. Pullin, J. P. Gee, E. H. Haertel, & L. J. Young (Eds.), *Assessment, equity, and opportunity to learn* (pp. 170-199). New York: Cambridge University Press.
- Greeno, J. G., & TMSMTAPG (1998). The situativity of knowing, learning, and research. *American Psychologist*, 53(1), 5-26. doi:10.1037/0003-066X.53.1.5
- Hachmann, R., & Dohn, N. B. (2018). Participatory skills for learning in a networked world. In N. B. Dohn (Ed.), *Designing for learning in a networked world* (pp. 102-119). Abingdon: Routledge.
- Hachmann, R. (2020). *Didaktisk design for transformationer af faglig viden: En undersøgelse af lærerstuderendes videnstransformationer på tværs af professionsuddannelse og -praksis*. (PhD Dissertation). University of Southern Denmark, Kolding.
- Hansen, J. J., & Dohn, N. B. (2018). Design principles for learning in simulated social practices. In N. B. Dohn (Ed.), *Designing for learning in a networked world* (pp. 214-231). Abingdon: Routledge.
- Hansen, J. J., & Dohn, N. B. (2020). Designing for mediational transition and learning through simulation: a task analysis of knowledge transformation. In N. B. Dohn, S. B. Hansen, & J. J. Hansen (Eds.), *Designing for situated knowledge transformation* (pp. 267-283). Abingdon: Routledge.
- Hutchins, E. (1995). *Cognition in the wild*. Cambridge, Massachusetts: MIT Press.



- Hutchins, E., & Klausen, T. (1996). Distributed cognition in an airline cockpit. In Y. Engeström & D. Middleton (Eds.), *Cognition and communication at work* (pp. 15-34). New York: Cambridge University Press.
- Jarvis, P. (2007). *Globalization, lifelong learning and the learning society: Sociological perspectives*. London: Routledge.
- Judd, C. (1908). The relation of special training to general intelligence. *Educational Review*, 36, 28-42.
- Kandiko, C. B., & Weyers, M. (Eds.). (2013). *The global student experience: An international and comparative analysis* (1 ed.). Abingdon: Routledge.
- Knobel, M., & Kalman, J. (Eds.). (2016). *New literacies and teacher learning: professional development and the digital turn* (Vol. 74). New York: Peter Lang.
- Kuhn, T. S. (1970). *The structure of scientific revolutions* (2 ed.). Chicago: The University of Chicago Press.
- Lankshear, C., & Knobel, M. (2011). *New literacies: Everyday practices and social learning*. Maidenhead, Great Britain: Open University Press.
- Lave, J. (1988). *Cognition in practice - Mind, mathematics and culture in everyday life*. Cambridge: Cambridge University Press.
- Lave, J., & Wenger, E. (1991). *Situated learning - Legitimate peripheral participation*. New York: Cambridge University Press.
- Lobato, J. (2012). The actor-oriented transfer perspective and its contributions to educational research and practice. *Educational Psychologist*, 47(3), 232-247. doi:10.1080/00461520.2012.693353
- Mayer, R. E. (2001). *Multimedia learning*. Cambridge: Cambridge University Press.
- Mayer, R. E., & Massa, L. J. (2003). Three facets of visual and verbal learners: Cognitive ability, cognitive style, and learning preference. *Journal of Educational Psychology*, 95(4), 833-846. doi:10.1037/0022-0663.95.4.833
- McDermott, R. (1993). The acquisition of a child by a learning disability. In J. Lave & S. Chaiklin (Eds.), *Understanding practice: Perspectives on activity and context* (pp. 269-305). New York: Cambridge University Press.
- Merleau-Ponty, M. (1962). *Phenomenology of perception*. London: Routledge and Kegan, Paul.
- Molander, B. (1992). Tacit knowledge and silenced knowledge: fundamental problems and controversies. In B. Göranzon & M. Florin (Eds.), *Skill and education: Reflection and experience* (pp. 9-31). London: Springer Verlag.
- Nielsen, K., & Kvale, S. (Eds.). (2003). *Praktikkens læringslandskab : at lære gennem arbejde*. København: Akademisk Forlag.
- Nokes-Malach, T. J., & Mestre, J. P. (2013). Toward a model of transfer as sense-making. *Educational Psychologist*, 48(3), 184-207. doi:10.1080/00461520.2013.807556
- Norman, D. A. (1988/2002). *The design of everyday things*. New York: Basic books.
- Norman, D. A. (1999). Affordance, conventions, and design. *Interactions*, 6(3), 38-43. doi:10.1145/301153.301168
- Odgaard, A. B. (2018). *Networked learning in children's transition from day-care to school: Connections between contexts*. Paper presented at the 11th International Conference on Networked Learning, Zagreb, Croatia.
- Odgaard, A. B. (2019). *Teknologimedierede aktiviteter i børns overgang fra dagtilbud til skole - et sociokulturelt informeret og design-baseret studie*. (PhD Dissertation). University of Southern Denmark, Kolding.
- Packer, M. J. (2001). The problem of transfer, and the sociocultural critique of schooling. *The Journal of the Learning Sciences*, 10(4), 493-514. doi:10.1207/S15327809JLS1004new_4
- Polanyi, M. (1962). *Personal knowledge: Towards a post-critical philosophy* (Vol. 1158). Chicago: University of Chicago Press.
- Popper, K. R. (1972). *Objective knowledge: An evolutionary approach*. Clarendon Press.
- Reed, S. K. (1993). A schema-based theory of transfer. In D. K. Detterman & R. J. Sternberg (Eds.), *Transfer on trial: Intelligence, cognition, and instruction* (pp. 39-67). Norwood, New Jersey: Ablex.



- Reed, S. K. (2012). Learning by mapping across situations. *Journal of the Learning Sciences*, 21(3), 353-398. doi:10.1080/10508406.2011.607007
- Salomon, G. (Ed.) (1993). *Distributed cognitions: Psychological and educational considerations*. New York: Cambridge University Press.
- Sanders, J. T. (1993). Merleau-Ponty, Gibson, and the materiality of meaning. *Man and World*, 26(3), 287-302. doi:10.1007/BF01273397
- Schatzki, T. R., Knorr-Cetina, K., & von Savigny, E. (2001). *The practice turn in contemporary theory*. London: Routledge.
- Schön, D. A. (1983). *The reflective practitioner: How professionals think in action* (Vol. 5126). New York: Basic books.
- Sfard, A. (1998). On two metaphors for learning and the dangers of choosing just one. *Educational Researcher*, 27(2), 4-13. doi:10.2307/1176193
- Singley, M. K., & Anderson, J. R. f. (1989). *The transfer of cognitive skill*. Cambridge, Massachussets: Harvard University Press.
- Säljö, R. (2000). *Lärande i praktiken: ett sociokulturellt perspektiv*. Stockholm: Prisma.
- Säljö, R., & Wyndhamm, J. (1993). Solving everyday problems in the formal setting: An empirical study of the school as context for thought. In S. Chaiklin & J. Lave (Eds.), *Understanding practice: Perspectives on activity and context* (pp. 327-342). New York: Cambridge University Press.
- Thrysøe, L. (2011). *At blive og at være sygeplejerske: En undersøgelse af oplevelsen ved at være næsten færdiguddannet og nyuddannet sygeplejerske og interaktionens betydning for deltagelse i praksisfællesskabet*. Ph.D. dissertation. Odense: Research Unit of Nursing, University of Southern Denmark.
- Tuomi-Gröhn, T., & Engeström, Y. (Eds.). (2003). *Between school and work: New perspectives on transfer and boundary-crossing*. Oxford: Elsevier Science Ltd.
- Van Oers, B. (1998a). The fallacy of decontextualization. *Mind, Culture and Activity*, 5(2), 135-142. doi:10.1207/s15327884mca0502_7
- Van Oers, B. (1998b). From context to contextualizing. *Learning and Instruction*, 8(6), 473-488. doi:10.1016/s0959-4752(98)00031-0
- Wagner, J. F. (2010). A transfer-in-pieces consideration of the perception of structure in the transfer of learning. *Journal of the Learning Sciences*, 19(4), 443-479. doi:10.1080/10508406.2010.505138
- Wedge, T. (1999). To know or not to know – mathematics, that is a question of context. *Educational Studies in Mathematics*, 39(1-3), 205-227.
- Wenger, E. (1998). *Communities of practice*. New York: Cambridge University Press.
- Wittgenstein, L. (1958). *Philosophical investigations* (G. E. t. Anscombe Ed.). Oxford: Blackwell.
- Wittgenstein, L. (1969/1979). *On certainty* (R. Rhees & G. H. von Wright Eds.). Oxford: Blackwell.
- Yackel, E., & Cobb, P. (1996). Sociomathematical norms, argumentation, and autonomy in mathematics. *Journal for research in mathematics education*, 27(4), 458-477. doi:10.2307/749877