Knowledge-Oriented Educational Processes
From Knowledge Transfer to Collective Knowledge
Creation and Innovation

Abstract: Over the last years a general understanding has been established that knowledge is one of the main resources, not only in economics and science, but also in our everyday life. The whole movement of knowledge management (e.g., Nonaka et al. 1995; Holsapple 2003, 2003a, and many others) is just one expression of this new understanding. Nevertheless, the notion, focus, and importance of knowledge is acknowledged only very slowly in the area of (university) teaching. The goal of this paper is to develop an understanding of teaching and learning processes which are “knowledge-based/driven”; i.e., the process of teaching and learning will be re-interpreted in the light of individual and collective knowledge (co-)construction and knowledge creation. It will turn out that both concepts form knowledge management, organizational learning as well as from constructivism play a central role in this approach.

Taking Seriously Knowledge and Cognition in Educational Processes

A vast number of studies, evaluations, reviews, etc. (e.g., PISA) has brought into light that our students seem to have deficiencies in a number of skills, such as reading, mathematics, problem solving, etc. Apart from such rather superficial statistical results, both personal and reported experiences reveal that these intellectual and cognitive problems are almost omnipresent not only in the knowledge intensive industrial context, but also in our universities. One has to ask what are the reasons and causes behind such deficiencies.

Shifting our Attention Towards Cognitive Processes and a Knowledge Perspective

From an epistemological and cognitive science perspective one has to shift the focus of attention from particular skills or competencies to the underlying cognitive operations which are responsible for knowledge processes on diverse levels (see 0). One can identify a lack of intellectual capacities in at least the following domains: (i) the domain of observing, (ii) of making abstractions and induction/classification, (iii) the capacity of profound understanding, (iv) of developing creative knowledge and solutions, and (v) the ability of reflecting. These capacities can not be seen as separated from each other, as they are mutually dependent on each other: in order to understand a phenomenon profoundly it is necessary to perform a precise and careful observation of the phenomenon and to make an abstraction on these observations; in order to arrive at an abstraction it is necessary to have some understanding. Philosophically and cognitively speaking both understanding and abstraction are core cognitive capacities which are located in the higher cognitive areas/mind (“intelligence”) (e.g., Wilson et al. 1999; Aristoteles 1995; Clark 2001; Haegel 1999). Reflection is a meta-competence necessary for shifting the framework of reference and for questioning one’s own knowledge, premises, etc. Hence, in order to increase the performance on the (superficial) level of skills and competencies it will be necessary to find ways of strengthening the intellectual capacities having been mentioned above on a more basic level.

However, most approaches of teaching/learning aim at the domain of skills and competencies (even at the university level). From an epistemological perspective it can be shown that these approaches do not really aim at what is the peak of human cognitive
capacities: generally speaking, skills concern rather superficial knowledge on the level of functionalities, algorithms, “know-how”, techniques, “systems”, “recipes”, guidelines, methods, etc. Yet, human mind is designed to penetrate much deeper into reality, into the phenomenon of our interest. Our intellect is not satisfied with being able to grasp the functional aspects of a phenomenon (e.g., the dynamics of a particular system) or to control certain aspects of reality. Rather, both our cognition and most complex tasks in almost every field (of science, economics, technology, etc.) call for a profound understanding of the object under investigation first; only then one can start making any decisions or taking action (in a responsible manner).

Generating Qualitative Knowledge?

From a knowledge perspective, what are the main deficits that can be observed? Apart from classical complaints about the decay of the level of education and of competencies in almost every domain it seems that we have to focus on problems and their causes on a more general and, at the same time, more profound level of knowledge and cognition. Several classes of intellectual problems/deficiencies and their causes can be identified both in the field of (university) education and of more economic settings:

- A lack of capacities to generate qualitatively new knowledge and approaches.
- As one implication, the approach and attitude of problem solving is given a higher priority than creating and constructing new knowledge or developing a new vision.
- A lack of capacities in discovering, constructing, as well as understanding complex and global relationships between a large number of seemingly unrelated events or phenomena.
- A lack of creative solutions to complex problems and questions. This is due to our conservative way of solving problems and answering questions by applying well established and successful “recipes” rather than (taking the risk of) inventing new solutions and trying innovative approaches;
- Tangible realities are found to be more “real” than what is behind these realities;

Performing a qualitative induction over these deficiencies it turns out that the majority of them has a common cause lying at their root: a lack in the capacity to deeply understand and intellectually penetrate in the meaning of a phenomenon or reality. From a learning perspective this means that we have to take a closer look at the processes leading to this understanding, namely the processes of knowledge construction and knowledge creation.

Knowledge Sharing as Foundation for Educational Processes

Almost every teaching/learning situation has to be seen as a situation of knowledge sharing in one sense or the other. The goal of this process of knowledge sharing is to individually and collectively construct and create new knowledge as well as to develop a deeper understanding of the phenomenon under investigation.

Collaborative Knowledge Construction and Knowledge Creation

Figure 1 shows the elements and the processes which are involved in this knowledge-sharing cycle. Knowledge sharing always takes place between the poles of (i) individual knowledge (including all the cognitive processes leading to this knowledge), (ii) actually shared knowledge (in the particular group working in a concrete moment together), and (iii) organizational knowledge (comprising of artifacts, etc.). In the domain of university teaching organizational knowledge is realized as scientific knowledge in most
cases. Contrary to shared/collective knowledge scientific/organizational knowledge remains “alive” after the process of knowledge sharing and negotiation between the members of the group has come to an end. This is realized via artifacts holding the potentiality to be interpreted as meaningful chunks of (explicit externalized) knowledge.

Figure 1: Elements and processes involved in the process of collaborative knowledge sharing and knowledge construction/creation (compare also Huysman and de Wit 2003).

The whole process is organized as a knowledge-sharing cycle aiming at the construction of knowledge. As Huysman et al. (2003) point out this process is similar to Nonaka and Takeuchi’s (1995) knowledge creation cycle of socialization, externalization, combination, and internalization. It has also similarities to Berger and Luckmann’s (1966) social constructivist concepts and phases which can be discerned during the institutionalization of knowledge.

From the knowledge-sharing cycle of Figure 1 three types of knowledge sharing can be derived (see also Huysman and de Wit 2003; Scharmer 2000, 2001). They are crucial for any educational process:

(i) **Knowledge retrieval/downloading**: knowledge retrieval basically is “downloading” already existing knowledge in the form of artifacts (e.g., from books, e-learning lectures, etc.). It is a process of knowledge retrieval from external explicit knowledge (artifacts) to individual knowledge. Most of our teaching processes are located in that domain.

(ii) **Knowledge exchange**: knowledge exchange takes place in the negotiation and externalization processes between the individual cognitive systems leading to a space of shared/collective knowledge. Individual knowledge is shared in a learning process being realized in a communication setting.

(iii) **Knowledge creation**: the ultimate goal of knowledge sharing-processes (i) and (ii) is to generate and to create new knowledge. The construction of new knowledge is based on the combination of different sources of individual, collective, and organizational knowledge.
The whole cycle is organized as a feedback process where the result of one cycle is the basis for the next round of knowledge creation. As will become evident in the sections to come these types of knowledge sharing determine the way of how teaching and learning processes are organized.

Technologies for Knowledge Construction and Knowledge Sharing

Each of these types of knowledge-sharing can be associated with knowledge-sharing and educational technologies (in a broad sense). These technologies are giving educational processes a special flavor and favor certain types of learning/teaching strategies and knowledge processes. Sharples (2005) introduces a differentiation relating strategies of knowledge sharing and learning/teaching with certain media (see Table 1).

<table>
<thead>
<tr>
<th>Strategy of knowledge sharing and learning/teaching</th>
<th>Medium &amp; context</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Learning as knowledge transfer</td>
<td>Print, textbook</td>
</tr>
<tr>
<td>Learning as downloading and repeating of (well established) mental models</td>
<td>Download style (e)learning (“first generation eLearning”)</td>
</tr>
<tr>
<td>B Learning as (individual and collective) knowledge construction, modeling</td>
<td>eLearning + collaborative aspect (virtual cooperation, communication, etc.)</td>
</tr>
<tr>
<td>C Learning as dialogue/conversation in context</td>
<td>Being embedded in a (concrete, physical, etc.) context + Creating/changing context + Embodiment in reality + in social context + in technological context + Immediate/direct experience with reality and changing reality Mobile learning (technologies) „Socrates like learning“, „peripatetic learning“ Concept of “Ba”</td>
</tr>
</tbody>
</table>

Table 1: the relationship between strategies of knowledge sharing (teaching/learning) and the medium being applied in that process (see also Sharples 2005).

In the era of mass print literacy (Table 1; A) the textbook (and its related form in the domain of eLearning) was the medium of instruction. This implies an understanding of learning as knowledge transfer and downloading of mental models. Whereas in the knowledge transfer perspective the goal of the learner is to repeat these models, knowledge, etc., “advanced” learning strategies aim at individual and collective knowledge construction and modeling (see (B)). Learning is a process of “coming to know”; learners in cooperation with peers and teachers construct knowledge and models which can be interpreted as transiently stable interpretations of their world (e.g., Foerster 1972; Glasersfeld 1984, 1989, 1995; Sharples 2005). Most eLearning technologies, which are presently in use, support these processes by providing platforms for presenting knowledge, for enabling communication and virtual collaboration and cooperation.

Going one step further, (Table 1; C) learning is extended “back to the roots”: this mode of learning and knowledge sharing/construction takes into account that each learner is not only embedded in an intellectual framework and in a virtual and artifactual environment, but also
in his/her physical and social context. Furthermore, this approach respects the fact that he/she is not only a more or less passive recipient of knowledge constructing his/her mental models, but that the learner is also actively interacting with his/her environment (compare also approaches to situated cognition; e.g., Suchman 1987; Clark 1999, 2001, etc.). I.e., the learner is capable of actively changing environmental dynamics and structures (e.g., by conducting experiments, by creating artifacts, etc.). In that sense, learning becomes a kind of “conversation/dialogue in context”—dialogue and conversation on multiple levels: with other learners, with external reality, with external knowledge, etc. In such a context mobile learning technologies become highly interesting and effective tools supporting this kind of situated learning processes. Furthermore, dialogue is understood in this context in the specific meaning of D.Bohm’s and others concept of dialogue (cf. Bohm 1996; Schein 1993).

The Concept of “ba”: a Space for Knowledge Sharing and Knowledge Creation

If learning and knowledge-sharing processes are understood in such a way, we have reached quite a sophisticated level of knowledge work: namely the domain of knowledge creation. It can be compared to a concept well known in knowledge management, which is referred to as “ba”; Nonaka et al. (2003) describe it as follows:

Ba is a continuously created generative mechanism that explains the potentialities and tendencies that either hinder or stimulate knowledge creative activities... The knowledge-creating process is necessarily context-specific in terms of time, space, and relationship with others. Knowledge cannot be created in vacuum, and needs a place where information is given meaning through interpretation to become knowledge... We define ba as a shared context in motion, in which knowledge is shared, created, and utilized... Ba is a phenomenological time and space where knowledge, as ‘a stream of meaning’ emerges. New knowledge is created out of existing knowledge through the change of meanings and contexts... Ba is an existential place where participants share their contexts and create new meanings through interactions. Participants of ba bring in their own contexts, and through interactions with others and the environment, the contexts of ba, participants, and the environment change. Ba is a way of organizing that is based on the meaning it creates, rather than a form of organization such as hierarchy or network. (p 6f)

In that sense, the concept of “ba” goes far beyond purely technological or educational issues—it concerns the general question of knowledge construction and knowledge creation; more specifically, the conditions enabling and facilitating these processes. If we start to understand university teaching and educational processes in general in such a way the character of both the knowledge taught and the learning strategies and pedagogical means will change dramatically. In the sections to come it will be developed, what these changes look like in more concrete detail.

Finally, it has to be said that these three modes of learning and knowledge sharing do not exclude each other. Rather, mode C (“learning as conversation in context”)—to some extent—is based on knowledge downloading and construction processes.

Modes of knowing and Knowledge

We have come to the point where knowledge and knowledge construction are considered to be the heart of educational and knowledge sharing processes. In order to understand and improve learning/teaching processes according to the concepts having been developed above, we have to take a closer look at the modes of knowing and knowledge that are involved in these processes first. Table 2 gives an overview over these modes. This table identifies three domains describing (i) the level of knowledge (in the sense of which realm of reality this level refers to), (ii) the cognitive activities which are necessary to construct and explore this realm,
and (iii) the characterization of the knowledge which is the result of these construction processes.

<table>
<thead>
<tr>
<th>Level</th>
<th>Process/Activity</th>
<th>Resulting knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Behavioral level</td>
<td>- Observing&lt;br&gt;- Detecting &amp; registering&lt;br&gt;- Describing</td>
</tr>
<tr>
<td>2</td>
<td>Level of (emerging) patterns of behaviors and relationships</td>
<td>- Searching for, constructing, and “discovering” regularities and patterns&lt;br&gt;- Projecting patterns&lt;br&gt;- Quantitative induction&lt;br&gt;- Constructing patterns&lt;br&gt;- Single-loop learning</td>
</tr>
<tr>
<td>3</td>
<td>Level of causes and the “source”</td>
<td>- Searching for, constructing, and discovering causes, meaning, finality, etc.&lt;br&gt;- activity of “radical questioning”&lt;br&gt;- Discovering/constructing the intangible dimensions of reality&lt;br&gt;- Discovering &amp; constructing the “deeper source”, the “substance”</td>
</tr>
<tr>
<td>4</td>
<td>Level of potentiality, change, and design</td>
<td>- Exploring, discovering, and developing the potentials of a reality&lt;br&gt;- Making use of and bringing “deep knowledge” and the mechanisms to the domain of application&lt;br&gt;- “Facere” and design&lt;br&gt;- Changing reality according to knowledge</td>
</tr>
<tr>
<td>5</td>
<td>Level of reflection (of the causes, source, patterns, processes of knowledge construction, etc.)</td>
<td>- Reflecting&lt;br&gt;- Reframing&lt;br&gt;- Radical Questioning (your mental models, premises, etc.)&lt;br&gt;- Reflecting the learning and construction process itself&lt;br&gt;- Reflecting the design-process itself&lt;br&gt;- Double-loop learning</td>
</tr>
</tbody>
</table>

Table 2: Levels of knowledge, modes of knowing, and the (cognitive) activities necessary for developing these modes.
From Observations to Causes

Level 1 concerns the “superficial” properties of reality: our primary observation, perception, and cognitive processes bring about a rather superficial and singular (in the sense of referring to a single concrete object or phenomenon) kind of knowledge in a first step. This knowledge is realized as a list of observations, description of behaviors or behavioral dynamics, a list of data, facts, etc. It is not about more general and universal properties of the observed phenomenon, but describes this phenomenon on its behavioral level. Taking this descriptive knowledge as a point of departure and progress in the processes of construction, we are reaching the level of (emerging) patterns, trends, and relationships: they are not “directly perceivable” with our senses. In order to arrive at that level more complex and active construction processes are necessary. Normally, this is the domain of the (natural) sciences, where first relationships are constructed between facts and descriptions, and behavioral patterns begin to emerge. I.e., these patterns are the result of more or less complex inductive and constructive processes (in most cases being realized as statistical procedures). Most so-called (scientific) explanations are situated on that level: they offer cognitive, mental, or even physical mechanisms explicating the relationship between hidden (theoretical) structures and observed phenomena. These mechanisms are assumed to be “responsible” for generating the observed phenomena (compare, for instance, Maturana’s concept of scientific methodology; Maturana 1980, 1991)—by offering such a mechanism one can also offer an explanation for the constructed patterns and regularities by providing this pattern-generating mechanism. Hence the resulting knowledge mainly is concerned with the “how” and the dynamics of the observed phenomena. In many cases it has the form of “recipe-knowledge”. The cognitive activities leading to this kind of knowledge has strong structural similarities with the processes of theory/hypothesis construction well known from the natural sciences (e.g., Peschl 2001). From a learning perspective, these construction processes can be considered as epistemological optimization aiming at finding the best possible level of functional fitness (in the constructivist sense; e.g., Glasersfeld 1984, 1995); they are realized in a single-loop learning cycle (e.g., Argyris et al. 1996; Senge 1990).

On level 3 we are going one step further: on that level more qualitative issues are at stake. While level 2 was mainly concerned with rather quantitative and measurable matters construction processes on that level aim at the realm of a phenomenon going beyond its material, measurable, and tangible properties, such as its meaning, finality, etc. Philosophically speaking, this level concerns the exploration and the construction of causes (for instance, in an Aristotelian sense [1989]). It can be reached by applying intellectual tools, such as radically questioning, exploring the meaning, or trying to reach “deep understanding” of a phenomenon. The resulting knowledge, in a way, is the source for a deeper understanding of a phenomenon—i.e., the construction of a kind of “deep knowing/knowledge” (e.g., Jaworski et al. 2000; Scharmer 2000, 2001; Senge et al. 2004), knowing reality “from within”. From a constructivist perspective this may sound quite metaphysically, and, in fact, is very close to metaphysics in the original sense (Aristotle 1989, Philippe 1991). However, it is not a contradiction to a constructivist approach. Rather, it makes a statement about how classical natural science inspired (and limited) construction processes can be overcome and be led into a more qualitative understanding of a phenomenon, e.g., by exploring its finality.

Creating Realities, Innovation, and Reflection

It is that level of deep knowing which also reveals another dimension of a phenomenon or reality: its potential(-ity) with regard to change. I.e., each reality is in a certain state at every point in time and that state can change over time. Hence, there exists a space of potential change(s) at every moment; a space of possible changes which can happen to that reality. As
a simple example, think of a stone which is given a new form by an artist: a process of “transformation” into a sculpture according to the artist’s plan or knowledge. This sculpture is one possible instantiation in the space of potentiality of that stone. Only if one has a profound knowledge (level 3) about an object, a phenomenon, etc., it is possible to explore, construct, and develop the full potential of that reality. I.e., on level 4 we are changing the perspective from the mode of “contemplation” to the mode of “facere”/doing. The interesting point is that this level of knowledge does not only explore the space of potentiality, but also realizes (some of) these possibilities. I.e., by applying knowledge from the levels 1-3 new realities are constructed, are physically instantiated, existing realities are changed, etc. In a way it is a “materialized constructivism” where artifacts, design, technology, etc. are in the same way a product of this level 4 knowledge-process as creating cultural, scientific, social, etc. realities. This mode of knowledge is the key for most processes of knowledge creation, of innovation, and of finding and instantiating a vision. It is not well established in educational processes in many cases.

Finally, level 5 knowledge brings in a completely new quality in the process of knowledge construction: the dimension of reflection. This step has the potential to fundamentally question the knowledge having been constructed so far by reflecting on the knowledge, its premises, as well as on the construction- and learning processes having led to that knowledge. The cognitive activities, methods, and “epistemological technologies” being applied in that process include processes of deep reflection and questioning, systematic reframing, questioning the premises, ideologies, the construction processes, uncovering mental models and hidden assumptions, etc. This level of knowing introduces a completely new dynamics into the whole process of knowledge construction and knowledge creation, because it is situated on a meta-level and it can bring up completely unexpected results and new perspectives which have not been considered so far. This mode of knowing and knowledge acquisition is realized in the double-loop learning strategy (e.g., Argyris et al. 1996; Senge 1990)—it is especially powerful when it is performed in a collective setting.

Modes of Knowing and Educational Processes

It is clear that these levels of knowledge (from Table 2 above) do not exclude each other—rather, they depend on each other and there is strong interaction between them. Knowledge-oriented educational processes do not mean that one only abstractly knows these modes of knowledge, but that these modes explicitly find their way into the design of the particular course. Normally, educational processes at university level do not go beyond level 2 (especially in the natural and technical sciences) and level 3 of Table 2.

From what has been discussed above, it is essential to focus more on the processes of understanding and reflection; especially in our so-called “knowledge-society”, which is rather a society whose intellectual pride is based on the ability to surf in a sea of unreflected and unrelated chunks of information, it is crucial to be trained in making an effort to understand things in their deeper dimensions, their relations, their meaning, etc. When a student has not only become familiar with these basic intellectual operations of deep understanding and reflection, but also has achieved some sovereignty in this domain, it will be very easy for him/her to quickly learn particular practical skills or competencies.

How can we achieve a high level of these intellectual capacities of understanding and reflection?

1. Taking a radically knowledge oriented perspective: i.e., the teaching/learning process has to take as its point of departure the whole spectrum of different forms of knowledge (see 0; Peschl 2003). Only if one is aware of this spectrum it will be possible to go
beyond single minded learning scenarios and relatively naïve learning outcomes and teaching goals. The focus is on reaching an integration of the theoretical understanding of a phenomenon, of knowledge concerning its functioning, as well as of knowledge and skills how to deal with it practically. Recent approaches in knowledge didactics take these aspects into consideration (e.g., Swertz 2004). Above that, the whole didactical process has to be based on an alternative understanding of knowledge: namely, knowledge is understood as a process rather than static thing.

2. Taking a closer look at the structure of reality and at the construction processes being responsible for our knowledge: reality or, more precisely, a specific phenomenon in reality is not just a homogeneous unity; ontologically speaking there are various levels and domains, which can be differentiated (see 0). These domains give rise to different types of knowledge having been mentioned above. If one is aware of these levels of reality it is possible to penetrate much deeper into the phenomenon of interest and, by that, achieve a more profound understanding which is not limited to a specific aspect. This implies that it is necessary to bring the operation, capabilities, and techniques of knowledge construction, observation, and reflection more into the focus of teaching processes (e.g., Peschl 2005; Senge et al. 2004; Scharmer 2001, etc. Argyris et al. 1996).

3. Reframe and redefine the role of teachers as well as students—both are responsible for co-constructing and co-creating knowledge.

4. Educational processes are no longer “knowledge transfer processes”, but socio-epistemological processes of negotiating meaning and creating knowledge in a social as well as technological environment.

If students are supposed to reach a profound understanding and a high level of sovereignty and autonomy in a certain domain (of reality/knowledge), it is necessary to consider all of these levels of knowing and to concretely implement them in a particular course or curriculum. Reducing knowledge to only one or two of these levels perhaps leads to highly specialized and efficient “optimizers” and well adapted “recipe applicators”, but surely will not bring forth persons with a highly open attitude, with exceptional potential for innovation and for developing radically new perspectives, and with a high level of reflection.

References

