The Challenge of Triggering Profound Processes of Understanding in Microlearning Environments

Theoretical Foundations and a Case Study for a "Micro-learning Laboratory"

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Abstract: An epistemologically and cognitively founded pedagogical learning/teaching model tackling these goals is developed. Possible solutions will be suggested by developing a meta-model for learning/teaching processes in a stepwise manner. It turns out that philosophy of science concepts play a crucial role in these processes. Furthermore, the role of micro-learning and technologically supported (mobile) forms of teaching/learning in such a scenario will be investigated.

Keywords: collaborative scientific theory construction, double-loop learning, reflection processes, single-loop learning, virtual communities

1 Introduction and Motivation

1.1 The Primacy of Know-What over Know-How

Most approaches in teaching/learning both in the field of secondary education and of universities focus on the level of skills and competencies. From an epistemological perspective it can be shown, however, 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 or 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 being under investigation first; only then one can start making any decisions or taking action. So, what do we mean by the term to "profoundly and deeply understand" a phenomenon or a reality? In fact, this question is as old as philosophy and metaphysics and has a wide spectrum of possible answers. In general, one can summarize that what our intellect is interested in is the *meaning* and the deeper *sense* of a phenomenon. All of our intellectual efforts aim at achieving a profound answer concerning the understanding of the "what" (and the "why?") of a thing. Above that, we are capable of *reflecting* both on the understanding of the phenomenon itself and the processes having led us to that understanding. Only when we have reached this level of operations we can claim to have come to a kind of profound judgment on a particular aspect of reality[1].

Of course, the aspect of the "how?" or functioning of a reality is an important contribution for the process of understanding it. However, as has been well known since Ancient Philosophy and metaphysics [e.g., Aristoteles, 89], there is a clear (intellectual) *primacy of meaning* of and *understanding* a reality (e.g., "causa formalis") over having some idea about its functioning. One can only fully understand the functioning of a phenomenon, if one has reached some understanding of its meaning, of its "what?", and/or its finality. Remaining on the level of functioning means that one has not penetrated very deep into the phenomenon, because s/he has just arrived at some more or less basic pseudo-understanding of the dynamics and of behavioral patterns of the phenomenon under investigation without having a profound understanding of its meaning. This focus on the process of understanding (in its most profound sense) is a point having been almost forgotten in most educational approaches nowadays. Only, if one takes into consideration issues from epistemology or even ontology and metaphysics, the deficiencies of such a reduction to the functional aspects become evident. Hence, a profound pedagogical approach has to be based also on concepts from cognitive science as well as from epistemology and theory of knowledge [Peschl, 03; Swertz, 04].

Certainly, it is relatively uncomplicated, comfortable, and cost-effective to teach "recipe knowledge", skills, algorithmic knowledge, etc. This especially applies to the field of eLearning and virtual modes of learning and teaching. We have to admit that it is already an intellectual challenge for ourselves to understand a phenomenon in its profound meaning. Hence, it is even more of a challenge to "teach" this process of understanding! Transferring these processes into a virtual environment is an ultimate pedagogical challenge. One reason, why that is so difficult seems to be that "teaching the process of understanding" calls for a completely different approach to teaching/learning: the teacher is not the instrument for knowledge transfer any more; rather, he/she has to act only as a coach or as a *person accompanying* the student in his/her personal process of discovering the meaning and, by that, achieving some understanding of the phenomenon in question [Glasersfeld, 89; Baumgartner, 04]. Above that, the teacher has to be ready for conducting a structured process of *reflection* in which s/he her-/himself could be questioned profoundly. From that perspective it is interesting to discover that new learning technologies offer tools, which

[1] Of course, this does not imply that this knowledge is final—rather, due to the inaccessibility of reality the process of constructing knowledge and understanding is never-ending; compare [Pieper, 03].

exactly fit these requirements (e.g., tools for collaborative knowledge construction, communication, knowledge negotiation, etc.).

When the 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.

1.2 Knowledge Illiteracy in knowledge society

That is why it seems essential to focus more on the processes of understanding and reflection; especially in our so-called “knowledge-society” it is crucial to be trained in *making an effort* to understand things in their deeper dimensions, their relations, their meaning, etc. The trouble in our “knowledge society” is not so much the question of the digital divide or digital illiteracy, but rather the problem of “*knowledge illiteracy*”. I.e., due to the focus of our educational systems on the know-how, on skills, on fact-learning, on “recipe knowledge”, and on portraying a rather limited view of the world (e.g., presenting only a purely positivistic or economic perspective) it becomes increasingly difficult to intellectually enter into the deeper dimensions of a given phenomenon (e.g., finding out its finality, its deeper meaning, etc.). Restricting education and learning processes to a rather limited class of knowledge types causes a highly restricted perspective and understanding of reality. Knowledge illiteracy seems to be one of the most critical problems which become apparent in our emergent knowledge society.

That is why a model will be developed in the following sections, which lays the theoretical ground for going beyond the classical scope of knowledge types and for reaching a deeper level of understanding. The questions we are going to tackle in the sections to come concern the processes of *understanding*, of developing a *shared understanding*, and *reflection*; more specifically, how these cognitive operations can be taught and developed in an educational setting. This means that we have to take a closer look at the following phases: the process (i) of accessing reality/a phenomenon, (ii) of constructing knowledge about that reality, (iii) of abstracting from particulars of that reality, and by that (iv) achieving a profound understanding of it. Finally, (v) this process itself has to be reflected. (vi) The overall question is, how these processes can be realized in an environment going beyond the standard classroom setting; namely, how internet and mobile technologies as well as microlearning strategies can be applied in order to enhance these cognitive operations.

2 Learning to Understand a Phenomenon and to Construct Knowledge in a Reflected Manner

In the course of the following sections a theoretical foundation and model will be developed for the learning and knowledge construction processes, which are necessary for improving the cognitive operations of understanding, of making abstractions as well as how the resulting knowledge can be shared in a reflected manner.

2.1 First-Order Learning in a Single Loop process

Classical fact-learning ("drill-and-practice"), which is not very efficient with respect to the process of understanding, is a rather simple and linear from of learning. Whereas the focus of linear learning is on mapping more or less static and predetermined chunks of knowledge from one brain to another *single loop learning* or *first order* learning aims at emphasizing the *process of developing knowledge*. Knowledge is not predetermined, but has to be *extracted from reality in an active process of personal/individual and collective construction*.

As is shown in Fig. 1 (internal loop) learning is embedded into a circular process: this epistemological loop is realized as a process of continuous interaction and feedback between the dynamics of the cognitive system's knowledge and cognitive structures and its external and internal environment. The goal is to construct structures of knowledge in such a way that they fit into the environmental dynamics. This is realized in a circular feedback process. Via processes of perception and primary construction knowledge structures are built up in the cognitive system. This knowledge is externalized as behavioural actions and it becomes evident whether the internal model/knowledge has been successful or not. The learner's knowledge has to be changed and adapted according to the level of success/failure and (mis-)match between the expected/desired results and the real environmental dynamics. This epistemological pattern is well known from the classical approach to knowledge construction in the natural sciences. It has been described by Popper (as the process of falsification; [Popper, 62]) or in the area of *constructivist* philosophy of science (e.g., [Peschl, 99, 01]). Abstractly speaking, this procedure can be interpreted as a kind of "epistemological optimization and adaptation process". While linear learning is driven by an external teacher and his/her pre-structured knowledge, single loop learning is an *internally driven* and *self-controlled learning* process having the goal of producing *functionally fitting* knowledge (e.g., [Glasersfeld, 95]) being the result of an *active interaction* with reality.

Limits of Single Loop Learning

From an intellectual perspective, such an approach to learning is not really challenging. Nevertheless this is the major paradigm of theory construction in the "normal" [Kuhn, 70] natural sciences. Looking more closely reveals that—on an epistemological level—this mode of learning has several limitations:

1. It is a rather *conservative* process: instead of exploring new alternatives or taking the risk of new approaches this mode of learning tries to conserve the existing knowledge structures as long as possible; only if there is a crucial mismatch the cognitive system is forced to adapt and change his/her knowledge.

2. *Low*/no chance of *fundamentally new insights*: due to the predetermined space of knowledge ("paradigmatic space") there is very little chance that something completely and fundamentally new is discovered or learnt in this process.

3. *Low* level of *understanding*: due to the goal of generating functionally fitting knowledge the question of “what?” is of almost no.

4. Primacy of *projection*: the more or less consciously chosen premises and assumptions (a *paradigm* I the sense of [Kuhn, 70]) predetermine a space of possible “solutions”, theories, knowledge and the learner only has to explore (in the sense of making explicit) this pre-structured knowledge space. As an implication of the predetermined paradigmatic space projections of these knowledge categories are more important than being receptive to the structure and dynamics of the environment in the process of knowledge acquisition. Thus, there is a high chance that completely unexpected or unwanted aspects of reality will be filtered out in this learning process.

5. Lacking *reflection*: single loop learning does not offer a possibility for reflection. There is no possibility to question the paradigm itself within this mode of learning.

2.2 Second-Order Learning and Learning to Reflect in a Double-Loop Learning Process

In order to overcome some of the limitations of single loop learning an extension is suggested: a second feedback loop is introduced which realizes a kind of *meta-learning strategy*.

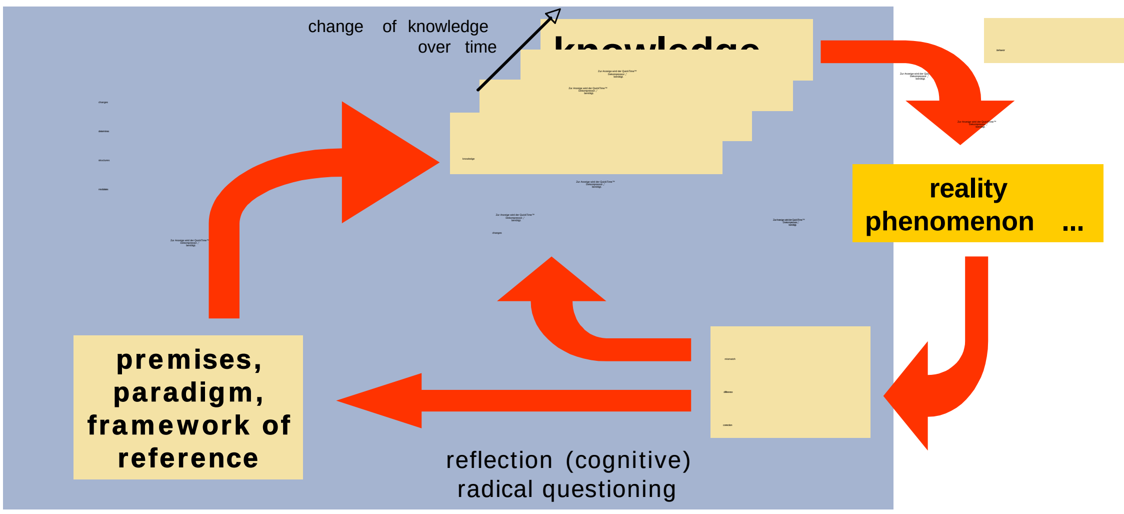

Fig. 1. *Double Loop Learning. The internal loop depicts the process of single-loop learning.*

This second feedback loop takes into consideration that any kind of knowledge is always based on assumptions, premises, or a paradigm [Kuhn, 70]. In general, knowledge always has to be seen as being embedded in and pre-structured by a particular *framework of reference*. Knowledge receives its meaning and structures from this framework of reference. Thus, *understanding* of a phenomenon can only be reached, if this framework is taken into account. As we have seen in single loop learning this framework of reference plays a key role in the process of learning, as it determines the structure of the space of potential knowledge and gives meaning to its basic dimensions—although the role of the framework of reference is never made explicit in the context of single loop learning. In double loop learning a second feedback loop (see figure 1) introduces a completely new dynamics in the whole process of learning: each modification in the set of premises or in the framework of reference causes a radical change in the structure, dimensions, dynamics, etc. of the space of knowledge. By that process entirely new and different knowledge, theories, interpretation patterns, etc. about reality become possible. In the context of science this process can be compared to what Kuhn refers to as scientific revolutions [Kuhn, 70].

The introduction of this second order dynamics reduces the problem of projecting always the same structure of knowledge on the phenomenon under investigation. Although it cannot be avoided in principle, it can be cut back by systematically applying modifications, variations, mutations, combinations, etc. (compare evolutionary operators; [Peschl, 99]) to the premises in the framework of reference. These systematic changes are exactly what is happening in this second feedback loop: the premises are modified and, by that, the whole framework of reference and the structure of the body of knowledge changes. The method being applied in this process is basically the technique of *reflection*. It is a process of *radically questioning* and changing the premises and studying their implications on the body and on the dynamics of knowledge. Double loop learning has its roots in cybernetics, learning theory, in cognitive science, and in the domain of organizational learning [Argyris, 96; Senge, 90].

2.2.1 From Individual to Collective Double Loop Learning

The mode of double loop learning unfolds its full effectiveness, if it is performed in the milieu of a group or a team (under the assumption that the members of the group are ready and motivated to listen and learn from each other). Findings from organizational learning (e.g., [Argyris, 96; Senge, 90]) show that *collective reflection* is one of the most powerful instruments in the process of achieving both an individual and a mutually shared understanding of a phenomenon or of a problem. Apart from the double feedback loops of the double loop learning procedure, an additional feedback loop is introduced between individual and collective learning- and knowledge-processes. This additional feedback loop enables an even more radical process of questioning premises, as the space of possible perspectives and frameworks of reference is not limited to an individual, but to the diversity of the participants knowledge backgrounds. Apart from the readiness of the group's participants to listen to each other and to share knowledge an atmosphere of mutual *trust* is a conditio sine qua non for the success of such a collective reflective setting.

3 A Concrete Double-Loop Learning Setting

3.1 Individual and Collaborative Knowledge Construction in a Virtual Environment

How can such a deep understanding be achieved in a virtual learning environment? In this part of the paper a *concrete learning scenario* is presented in which the double-loop learning strategy is implemented as a (blended) *micro-learning environment* (see [Peschl, 05] for more details): students have to first individually and, later on, collectively develop a theory/model by making virtual experiments with a virtual organism (being realized as a non-trivial machine) in an interactive internet application. This process happens in *several micro-learning steps* and *loops* integrating the following processes:

- *Conducting virtual experiments*: learning how to design an experiment, how to observe, and how to collect data in an experiment
- *Individual theory/model construction*: learning how to generate knowledge by applying inductive methods
- Verifying/falsifying hypotheses
- *Presenting and defending* these hypotheses/models to the peer-group in the virtual domain (via discussion boards, chats, etc.)
- *Negotiating* these results and trying to find a collective understanding/model of the virtual organism
- Finding a final form/*visualization for presenting* the resulting model in a pedagogically adequate manner
- *Reflecting* the whole process of theory construction itself (both in the virtual domain and in the classroom)

Each of these steps can be (partly) completed in a time span of 3—15 minutes. Due to its interactive design (concerning both the virtual experiment dimension and the social dimension of knowledge construction) these learning processes can be carried out in an iterative manner going through several loops and repetitions of micro-learning steps in a double-loop learning style. Experience and feedback from the students has shown that a *continuous learning process accompanies* the learner over a period of 10–40 days.

The goal is not to learn something by heart (like in foreign language training or drill-and-practice learning environments), but to keep the learner in a *continuous active process* of thinking and *pondering over a single non-trivial problem over a longer period of time*. By that, she dives into the “deeper levels” of the problems concerning both the particular questions of the virtual organism and the process of theory/knowledge-construction (= meta-level). These thinking/learning-processes are supported by an additional stream of interventions: the dimension of virtual collaboration, negotiation and social interaction. These processes are minute steps of micro-learning which are implemented in continuous integrating feedback-loops. That guaranties continuous processes of reflection on an individual and collective level.

3.2 Implications for Processes of Collaborative Knowledge Construction and Knowledge Sharing

Making double-loop learning the foundation of a microlearning strategy has turned out to be a highly efficient learning strategy in the context of learning how to achieve a profound and deep understanding of a phenomenon, a reality, or a problem, and how to share this knowledge between the participants of this collective knowledge construction process; this is due to the fact that the learner is forced to *step back* and *take an external perspective* on the original (single loop learning-) task of simply trying to adapt to the environmental dynamics and construct mechanisms generating the observed regularities. Above these construction processes, he/she has to reflect (a) *what* it is he/she is investigating and (b) on which foundations and framework of reference this process of theory construction is based. Here is exactly the point where philosophical and philosophy of science concepts turn out to be highly relevant in the process of *knowledge construction*, *understanding* as well as *knowledge sharing*. The key for successful knowledge construction and sharing seems to be the factor of systematic individual and collective processes of *reflection* being realized in the external feedback-loop of the double-loop learning model (see Fig. 1).

Conducting double loop learning not only on an individual level but also in a group/team-environment of cooperative knowledge construction has amplified the effect of the learning and knowledge sharing process. Due to collective processes of reflection completely new and unexpected spaces of understanding and solutions have opened up both on an individual and on a collective level. Mutually revealing one’s knowledge and premises to each other induces a completely new dynamics and opens new aspects and sometimes dimensions in thinking and cooperative knowledge construction and understanding. It was due to the continuous microlearning based learning strategy slicing the learning tasks into small peaces and being supported by methods of virtual knowledge sharing, knowledge construction, and discussion that these processes have been highly successful and satisfying for almost every participant (as well as the teacher).

Apart from this microlearning course-design, one of the main conditions for such an emergent process is an atmosphere of openness and trust in the group of participants. It is the responsibility of the teacher or moderator to establish such an atmosphere, which facilitates these processes of developing shared understanding, shared meaning, and perhaps shared vision.

What are the goals and some of the basic implications having been reached by embedding the mode of double loop learning into a microlearning strategy (in the context of knowledge construction and knowledge sharing)?

1. Blind spots, ideologies, unconscious and perhaps unwanted assumptions, prejudices, or biases are uncovered and become evident in such a process of radical questioning and reflecting.

2. Due to changes in the realm of premises the range of possible knowledge spaces and knowledge dynamics explodes exponentially.

3. Reflection is used as a "weapon" against single minded and mono-disciplinary approaches and learning processes.

4. Double loop learning does not only encourage inter-/transdisciplinarity, but makes a multi-disciplinary approach a necessity.

5. The *profound understanding* of a phenomenon is supported in this process. By systematically taking different positions and by reflecting these positions the "what?" and "why?" of a reality is revealed in a radical manner. The learner is forced to go beyond pure functional descriptions and penetrate into deeper layers of reality.

6. *Focusing on and Sharpening the Cognitive Capacity of Perception and Observation*. Due to a rigorous process of questioning and reflecting the capacity of one's perception is constantly trained as well. One is forced to take new perspectives on the same phenomenon; by that multi-perspective approach blind spots are uncovered, but what counts even more, new dimensions and new categories are discovered. Not only categories concerning the particular phenomenon under investigation, but new categories of how to observe, perceive, and interpret reality in general! This is extremely important for almost every process of knowledge management/sharing, as a multiple perspectives and their reflected consolidation are the foundation for every process of shared meaning and understanding.

7. *Meta-learning*. Double loop learning forces the reflection of the learning process itself and, by that, allows a critical perspective on the learner's own processes, assumptions, and habits of knowledge construction and knowledge acquisition.

4 Conclusions and Perspectives for (Mobile) Microlearning

What are some of the implications from the concepts having been presented above? What are the insights for a technology based learning setting, more specifically for a mobile learning scenario as well as for the application of a microlearning strategy?

4.1 The Concept of Enabling in Face-to-Face and (Mobile) Virtual Learning Settings

One of the implications of double loop learning concerns the role of the teacher; it has radically changed in such a setting of learning/teaching: His/her primary task is to provide a "pedagogically augmented environment"; furthermore he/she is responsible for creating an atmosphere of collective reflection (e.g., via drawing attention to the importance of openness and trust). Beyond the role of a coach [Baumgartner et al., 04] the teacher has to act as a facilitator or "*enabler*" for the (individual and collective) processes of double loop learning rather than transmitting knowledge.

4.1.1 Integrating Mobile Technology and Microlearning

Apart from the teacher's role as facilitator *mobile technology* and microlearning as well has to be recognized as a *catalyst enabling* processes of individual and collective understanding. Normally, mobile technology is seen as a means for communication only. The (intellectual) value of these technologies can be increased by magnitudes, if they are extended and explicitly applied in the context of a (collective) double-loop learning setting. As has been shown above these settings are based on *highly interactive* processes in a twofold manner: (i) interaction between environmental structures/dynamics and the learner/user and (ii) interaction between learners/users. Both interaction types can be supported by mobile technologies:

Interaction type (i) concerns mostly processes of single-loop learning: whereas classical e-learning technology offers rather static and predetermined chunks of knowledge (perhaps providing variations in knowledge types or paths through that space of knowledge [e.g., Swertz, 04]) both microlearning strategies and mobile technology can be used to enhance learning processes by providing "augmented reality" features being adaptive and sensitive to concrete real-world situations (e.g., by utilizing location based or RFID services in combination with personal and public knowledge bases). Of course, the process of understanding has to be carried out by the learner him-/herself; however, it is supported by mobile technology providing the "raw material" (i.e., basic information/data and knowledge) for a particular (micro-)learning situation in a mobile context. Personal data, personal knowledge profiles/bases, personal interests and learning preferences, etc. can be combined with location based (public)/RFID data and the user's/learner's particular questions. The challenge is (a) to integrate these huge amounts of knowledge and data, (b) compute them into a result, and (c) transform these results into a visual and multi-modal representation that supports the learner's process of understanding (on the fly).

Type-(ii) interaction mostly is present in the context of double-loop learning. Beyond classical one-to-one, one-to-many, or many-to-many communication mobile technologies have to be developed towards supporting, structuring, molding, and shaping these communicative settings in the sense of double-loop learning processes having been developed above. I.e., the task is to provide a structured *virtual space enabling* efficient and successful processes of reflection in a microlearning design.

These processes go beyond classical knowledge sharing—the objective is to create a kind of (virtual) "knowledge market" as a place where meaning and understanding of knowledge/reality is *negotiated* in the sense of double-loop learning: i.e., a space where it is possible to share, to make explicit, and to make accessible/visible every participant's premises, background assumptions, paradigm, or (implicit) framework of reference. Normally, this is not a process which can be accomplished within a relatively short period of time—rather, this is a procedure typically taking many little steps (of negotiation, presentation, discussion, etc.) which can be split up in a microlearning style process.

The goal is to use such a space of shared reflection for arriving at building a community of shared meaning and understanding and, by that, perhaps at developing a joint vision of a group (e.g. [Scharmer 01]). In other words, these processes could improve both the individual and the collective understanding. On the one hand mobile technology is challenged to provide the means for supporting these processes of shared reflection. Here are some examples:

- An instrument for supporting the process of making visible and making comparable diverse "knowledge perspectives" (e.g., via shared knowledge maps, topic maps, etc.);
- An instrument for structuring and shaping this communication and interaction process;
- An instrument for supporting this *socio-epistemological process* of negotiating and consolidating the meaning and understanding, etc.

On the other hand, microlearning strategies and designs will have to be developed in order to bring these learning processes to a successful end. Mobile technologies offer the advantage that double-loop learning is not restricted any more to a particular physical space, but can be carried out in a distributed manner without interfering too much with the constraints of collaboration. It has to be clear, however, that mobile technology cannot completely replace face-to-face communication—this applies especially to the rather sensitive area of the reflective processes of double-loop learning. Progress in virtualization of learning processes increases the demand for high-quality face-to-face communication/dialogue [cf. Scharmer et al. 02]. Nevertheless, mobile technologies in combination with microlearning strategies play he role of an *enabler* for supporting the virtual and, as an implication, the face-to-face quality of knowledge construction.

4.2 (Mobile) Microlearning Laboratories

As an implication of the points having been made above as well as of the concepts of double-loop learning one could think of developing "Microlearning Laboratories" which could act as virtual spaces explicitly dedicated to learning processes in microlearning style. Such a Microlearning Laboratory acts as an interface between reality, cognition, learning processes, and the creation of new knowledge. The strengths of the "*microlearning laboratory*" approach clearly lie in the following points:

1. The integration of different modalities of learning, knowledge construction, and interaction;
2. The *integration* of *various forms of knowledge*: the approach having been exemplified above follows a radical knowledge-oriented strategy. This implies that all aspects of reality/knowledge are taken into consideration and integrated in an overall perspective the full range of know-how (in the process of theory/model construction), know-what (process of questioning what this organism is about, what are its goals, etc.), meta-knowledge (reflection on the process of theory construction);

3. Slicing the learning tasks into micro-tasks which can be accomplished in a manageable period of time and

4. at the same time trigger a *continuous cognitive activity* being focused on a single complex problem (vs. learning of more or less disconnected facts) by providing a continuous stream of interventions;

5. Breaking through the superficial levels of knowledge (e.g., the functional aspects of a phenomenon) and accessing “deeper” dimensions (such as the meaning or the finality of a phenomenon).

6. Supporting the processes of understanding (on the level of the particular problem as well as on a general level), reflection (meta-level), and knowledge construction in an effective and sustainable manner.

7. Above supporting processes of understanding the microlearning laboratory approach can be applied as a highly effective tool in the processes of applying knowledge in the context of design, art (inspiration), building technology, etc.

As a near future perspective mobile collaboration/communication plays a central role in this “*microlearning laboratory*” approach: It acts as a permanent “companion” for individual and collective processes of knowledge construction and shared understanding in a kind of ubiquitous learning and shaping process.

4.3 Outlook— “Ubiquitous Individual Cultivation”

As a final step of our learning model one could imagine the introduction of a third learning loop, “*triple-loop learning*”; this loop concerns the most fundamental level of the person(-ality): his/her values, being, etc. and their role in understanding, learning, and the person as a whole. On that level microlearning in combination with mobile learning plays a central role: it acts as a continuous “companion” for *individual cultivation* in a kind of ubiquitous and permanent learning and shaping process of the person. Whether this is a desirable application of microlearning technology remains to be answered.

5 References

[Argyris, 96] Argyris, C. and D.A. Schön (1996). Organizational learning II. Theory, method, and practice. Redwood City, CA: Addison-Wesley.

[Aristoteles, 89] Aristoteles (1989). Metaphysik (third ed.). Hamburg: Felix Meiner Verlag.

[Baumgartner, 04] Baumgartner, P. and M. Kalz (2004). Content Management Systeme aus bildungstechnologischer Sicht. In P. Baumgartner et al. (Eds.), Content Management Systeme für e-Education. Auswahl, Potenziale und Einsatzmöglichkeiten Innsbruck, Wien: Studien Verlag.

[Glasersfeld, 89] Glasersfeld, E.v. (1989). Cognition, construction of knowledge, and teaching. Synthese 80(1), 121–141.

[Glasersfeld, 95] Glasersfeld, E.v. (1995). Radical constructivism: a way of knowing and learning. London: Falmer Press.

[Kuhn, 70] Kuhn, T.S. (1970). The structure of scientific revolutions (second ed.). Chicago: The University of Chicago Press.

[Peschl, 99] Peschl, M.F. (1999). The development of scientific theories and their embodiment in the representational activities of cognitive systems. Neural representation spaces, theory spaces and paradigmatic shifts. In P.v. Loocke (Ed.), The Nature of Concepts, pp. 184–214. London: Routledge & K. Paul.

[Peschl, 01] Peschl, M.F. (2001). Constructivism, cognition, and science. An Investigation of its links and possible shortcomings. Foundations of Science 6(1), 125–161.

[Peschl, 03] Peschl, M.F. (2003). Structures and diversity in everyday knowledge. From reality to cognition and back. In J. Gadner, R. Buber, and L. Richards (Eds.), Organising Knowledge. Methods and case studies, pp. 3–27. Hampshire: Palgrave Macmillan.

[Peschl, 05] Peschl, M.F. (2005). Acquiring basic cognitive and intellectual skills for informatics. Facilitating understanding and abstraction in a virtual cooperative learning environment. In P. Micheuz, P. Antonitsch, and R. Mittermeir (Eds.), Innovative concepts for teaching informatics, pp. 86–101. Wien: Ueberreuter.

[Pieper, 03] Pieper, J. (2003). Was heißt Philosophieren? (new ed. ed.). Einsiedeln, Freiburg: Johannes Verlag.

[Popper, 62] Popper, K.R. (1962). Conjectures and refutations; the growth of scientific knowledge. New York: Basic Books.

[Scharmer, 01] Scharmer, C.O. (2001). Self-transcending knowledge. Sensing and organizing around emerging opportunities. Journal of Knowledge Management 5(2), 137–150.

[Scharmer, 02] Scharmer, C.O. and K. Käufer (2002). Universities as the birthplace for the entrepreneuring human being. Reflections. The SoL Journal on Knowledge, Learning, and Change (forthcoming)(http://www.ottoscharmer.com (Feb. 2, 2005)).

[Senge, 90] Senge, P.M. (1990). The fifth discipline. The art and practice of the learning organization. New York: Doubleday.

[Swertz, 04] Swertz, C. (2004). Didaktisches Design. Ein Leitfaden für den Aufbau hypermedialer Lernsysteme mit der Web-Didaktik. Bielefeld: Wilhelm Bertelsmann Verlag.