Scientific
Research

Semantic Perspectives on Knowledge Management and E-Learning

ABSTRACT

Knowledge Management (KM) and E-Learning (EL) applications interface more and more as their objects of concern consist in 'captured knowledge' resp. 'learning objects', i.e. content. In this paper, we want to discuss the potential synergy from their fusion with respect to two area-specific difficulties: KM's Authoring Problem ("Where are the content authors?") and EL's Control Problem ("Who is in charge?"). In order to understand the underlying assumptions when developing and using such systems, we will point to the relevance of their interaction design (in contrast to interface design) and introduce the notion of "Semantic Interaction Design" requiring a closer look at the evaluation of software products. We will distinguish between the micro-and macro-perspective on KM and EL, particularly on the retrieval question of precision and recall and the motivational optimization problem for software adoption. We suggest that KM's Authoring Problem as well as EL's Control Problem are implications of above semantic perspectives. Moreover, it turns out that KM and EL's resp. strengths and weaknesses are complementary, so that they offer potential resolutions.

1. Introduction

Unfortunately, KM as well as E-Learning weren't as successful as expected (with occasional exceptions). Therefore a joint venture was undertaken to harvest synergy effects as both deal in their own specific way with content on the one hand and the user on the other. In this paper we address the question, which arises with respect to each field's specific problems: can the fusion remedy them?

Knowledge Management (KM) systems as well as E-Learning (EL) systems are built on knowledge[1] blocks that contain reified knowledge, i.e. information about knowledge (often called content or learning object (LO)). As objects these knowledge chunks can e.g. be managed, shared, reused, or aggregated-which are KM tasks. In contrast, as reified knowledge they can be used pedagogically as e.g. REINMANN declares them to be "the

link between learning and teaching" [Reinmann, 2005, p. 117]-these are EL tasks. In particular, software can construct or help to construct learning contexts based on them: knowledge contexts (like ontologies or intersubjective knowledge), didactical contexts (like learning paths), or subjective contexts (like personal learning environments), for examples and ideas we suggest [Kohlhase, 2006c], [Libbrecht and Gross, 2006], or [Maus *et al.*, 2005, p. 53].

At first sight the strength of KM consists in offering the data of their underlying databases to its customers, which we comprise under "effectiveness", whereas EL's strength builds on enabling users to learn what they need to learn, which we subsume with "customization". Merging the two, we theoretically obtain adaptable systems that are effective as well as customizable. Even though this evolving synergy from an intertwinement of KM and EL is quite intuitive, the technological infrastructures are (historically) incompatible: KM developed from the field of Information Technologies and heads for a "*corporate storybook*" [Dunn and Iliff, 2005, p. 3], whereas EL grew out of Human Resources and aims at a "class-in-a-box model" [ibid.]. Moreover, a fusion of two fields typically doesn't involve their strengths alone, their weaknesses have to be addressed as well. So, what are these weaknesses?

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[1]In [Kornwachs, 2005] KORNWACHS critically discusses the use of the terms 'knowledge' versus 'information' and points to their "fundamental difference"[p. 34]. In particular, he points to the "self- referential characteristics"[p. 36] of knowledge that makes its handling via technological systems problematic. Keeping this (as well as [Probst *et al.*, 1997, p. 16], [Liessmann, 2006, 27ff.], and [Brown and Duguid, 2000, p. 125]) in mind, we use the term "knowledge" nevertheless.

The essential bottleneck for Knowledge Management consists in its "**Authoring Problem**": the content for databases is not as voluntarily generated as one might have hoped. It is a follow-up problem of the more general "*Knowledge Acquisition Problem*" in the field of Artificial Intelligence, that appeared in the early eighties with its heat on expert systems. Here, so-called knowledge engineers were to extract knowledge from human experts and feed it into a database, which then represented a knowledge pool from which (with fitting algorithms) just the right expertise at just the right time could be delivered automatically. Essentially it turned out, that people didn't know how (or weren't keen) to formalize knowledge down for machines or they didn't want to share their expertise 'publicly'. With the still-growing acceptance of the World Wide Web, especially its participative aspect, the latter hurdle seems to be lowered considerably. For the former, KM took up the topic of knowledge representation and in the mean time has provided many authoring tools. But the problem remained: who is actually using them? There are still strong difficulties in motivating real people (not just first adopters, e.g. [Moggridge, 2007]) to share and explicate their knowledge.

The learning paradigm of Constructivism lies at the heart of (most) E-Learning systems' weaknesses: there are many things to learn in E-Learning applications, but how are they learned by real people?[2] Constructivism as learning theory states that the learning process is steered by the learner herself by adaptation and accommodation processes [Piaget, 1996]. That is, how does EL software present the content to its user steering her to a prefixed

learning goal at the same time as encouraging self-steered learning processes with the same goal in mind? We speak of EL's "**Control Problem**". The implementation of the constructivistic approach in E-Learning systems is rather antagonistic, as it focuses on a learner's guidance via didactical steering methods and underlying (already constructed) ontologies for learning objects, sometimes enhanced by simple user modeling techniques that principally are not adequate for a user's individual adaptation frame.

2. Semantic Interaction Design

Principally, we start out with the assumption that software is actively appropriated by the user (e.g. [Sesink, 2004; Schelhowe, 2007; Lunenfeld, 1999]). That means that data conveyed via a computer can be considered as mere semiotic signs, they only become meaningful when being interpreted by human beings. This activity allows to fit software into real life by interpreting their meaning and thereby relevance for the 'here-and-now'. Therefore, we are interested in the **micro-perspectives of users**, i.e. perspectives that evolve within concrete situations that are evaluated individually by each user. This view from within allows to understand the rationality of taking action when using a software product.

Although "having the user in mind" seems very natural, it really isn't. What feels natural about it, is that generally every software designer has the good of the end user in mind as otherwise there is no (acceptable) reason for developing such programs. What is not natural, is that software designers are not trained in understanding other people's life context (even though some are trained with respect to analyzing work contexts). Thus, the micro-perspectives view goes beyond mere 'user-centred design' which most software products claim for themselves nowadays.

In order to understand the (semantic) relationship between user and software, we contrast the micro-perspectives discussed above with the macro-perspective, i.e. a global view from without. We argue that software is typically designed from the macro-perspective, whereas the "use of software"-action is decided from the micro-perspective of each potential user-explaining unforeseen roadblocks for using software. By investigating the differences between macro-and micro-perspectives in more detail we will be enabled to understand the conditions behind specific situations. From a macro-perspective the benefits of using an application might seem to be very convincing, from a micro-perspective, there is often

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[2]We believe that Constructivism has been taken up so broadly as learning paradigm because of its more modern "Menschenbild", i.e. idea of man, (for an overview, see [Reinmann, 2005, 146ff] or http://beat.doebe.li/bibliothek/f00048.html, last seen at 2007/08/24).

Up to the middle of the 20th century Behaviorism [Skinner, 1999; Pavlov, 2007; Bandura, 1976] with its knowledge transfer model was the leading paradigm. Here, the idea of man is coined by its stimulus-response model which induces rather over-directed, inautonomous human beings.

It was replaced by Cognitivism [Tolman, 1932] with its knowledge tutoring model. Here, in a nutshell, human brains are thought of as computers without acknowledging essential aspects of learning like motivation and emotion.

In the 1980s this technocratic, engineering approach started to be superseded by the more empowering Constructivism [Piaget, 1996; Maturana and Varela, 1992] and the according knowledge coaching model. Here, people are considered as creators of their own reality, which indeed fits much better to the current understanding of men, e.g. think of the "N-Gen" [Tapscott, 1997] or "Digital Natives" [Prensky, 2001]. Seymour Papert introduced a variant called Constructionism [Papert and Harel, 1991], which stresses the embodied aspects of learning.

also motivation against taking action: The personal costs might be just too high. The essence of an occuring problem frequently lies in its assumptions-knowing these explicitly provides helpful keys for the problem's resolution.

These perspectives are especially interesting if we don't apply them to the interface design, but to the underlying interaction design as this represents the setting for the relationship between user and data: "*Designing interaction rather than interfaces means that our goal is to control the quality of the interaction between user and computer: user interfaces are the means, not the end*" [Beaudouin-Lafon, 2004, p. 4]. We depicted the situation between user and data in Figure 1. The (red) full arrow represents not only the input action, but also the user's expectations and attitude towards the system in the interaction. Likewise the (blue) dotted arrow marks not only software's (re)action but also the approach towards the user inscribed in the interaction design. This way, for instance a concept like "autonomy" can be represented even though it is not reified in the interface. For ease of terminology use[3], we divide the interaction process into an 'action' part where the user is in focus, depicted with the full (red) arrow, and a 'reaction' part, in which the stress is on the data/software, depicted by the dotted (blue) arrow. Note that interaction design rather connects user and software, whereas interface design tentatively separates them as the involved subjects and objects are not considered holistically.

To understand KM and EL systems we will look into their interaction design with a focus on the way users attribute meaning to the inherent actions and reactions. We will speak of the **Semantic Interaction Design** of a system. Note that this must take the user's situatedness into account as a critical component, as interaction relies on the human's capability of interpreting data so that they not only become meaningful but even carry agency (by their in terpreted underlying semantics). Semantic interaction gets enabled on the conceptual level: how do user and software deal with each other. In anthropomorphic terminology, we can speak of "computer and user as partners" [Kohlhase, 2006a] or interaction as an ongoing "conversation" [Crawford, 2003, p. 5].

The interaction framework can be evaluated from either

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[3]Interaction is a rather complex term, in which we do not want to get entangled here. For a full account of interaction we refer to e.g. [Schelhowe, 2006], for 'Interaction Design' to [L̈owgren and Stolterman, 2004].
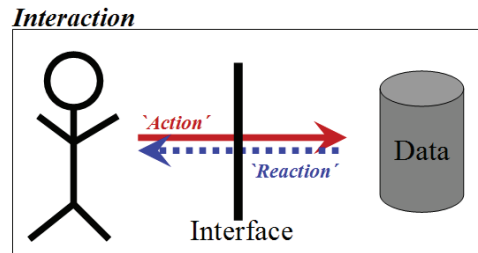
Figure 1. Designing interaction is more than designing Interfaces.

microormacro-perspective, so that observed strengths and weaknesses sometimes turn out to be contrary.

An explicit goal of Semantic Interaction Design is the alignment of micro-and macro-perspectives, where the Semantic Interaction Design *process* is characerized by the following properties:

• The micro-perspective shows a benefit of the system when approached by a user (i.e. a positive full (red) arrow, so that the user is motivated to take the action of using it).
• The macro-perspective is in favor of the delivering part of the interaction (i.e. a positive dotted (blue) arrow, so that the design lives up to the expectations of the user).

We will now discuss these semantic perspectives concerning EL's Control Problem as well as KM's Authoring problem in regard to a combination of Knowledge Management and E-Learning.

3. Semantic Perspectives in KM versus EL

In this paper, having both these fundamental problems in mind, we want to elaborate on authoring of and dealing with knowledge blocks in KM and EL using the macro-and micro-standpoints as analytical method. That is, we need to address the question how combining KM and EL effects or may effect the creation and use of formalized content.

3.1. Use of Content

PATRICK DUNN and MARK ILIFF comprise the underlying strains of both fields as follows:

"The big idea of knowledge management is to use technology to make the knowledge contained within the business available to all employees, when they need it. The big idea of e-learning is to use technology to put
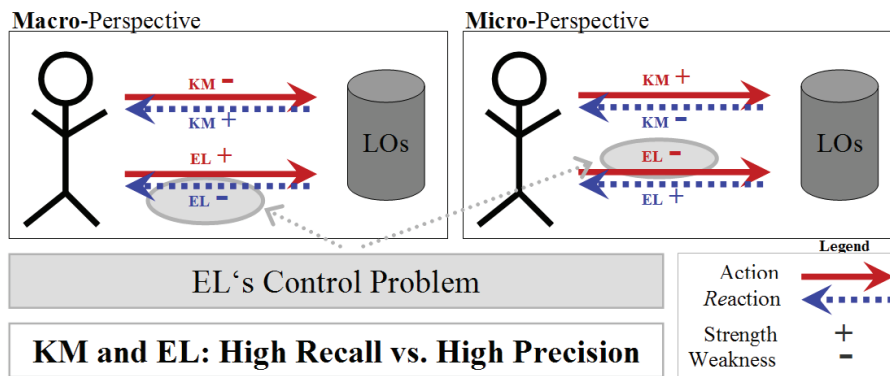
Figure 2. Distinct perspectives on KM and EL wrt. use of content.

training and coaching at the disposal of employees in such a way that they can learn what they need, when they need it." [Dunn and Iliff, 2005, p. 5].

This description of KM and EL is obviously given from a macro-perspective and not from a single user's standpoint. From this macro-perspective, KM techniques mainly try to capture the available knowledge to be able to make effective use of it (but distribute it rather as an afterthought). On the other hand, EL technology aims at delivering the content just-in-time, i.e. at the exact moment when it is needed, thereby assuming an abundance of content.

In Figure 2 the relationship between the different systems and the underlying learning objects is tentatively demonstrated. In particular, from the macro-view KM offers lots of content to a user, i.e. from this standpoint we can mark it (the blue (dotted) arrow) as KM's strength. But how it can be made use of is of lesser concern to KM, i.e. from the macro-perspective KM's weakness consists in stopping short of the goal. In contrast, here E-Learning systems want to win the user with the learning opportunities offered and take much less care in the learning process itself. That is, the full (red) arrow in Figure 2 can be labelled with EL's strength, whereas the dotted (blue) arrow has to be referred to as its weakness.

It is rather striking, that the richness of the LO database is on the one side considered as means (EL) and on the other as ends (KM). Therefore, we can interpret the interaction (depicted as arrows) as a question of retrieval quality, where high precision is taken care of by EL and high recall by KM. In other words, we argue that from the macro-perspective.

- KM wants to achieve high recall rates (so that 'all' knowledge is made use of), but that
- EL strives for high precision rates (so that the 'right'

knowledge is made use of).

Now let us look at those big ideas from the micro-perspective. Again we turn to PATRICK DUNN and MARK ILIFF first:

The current implementation of knowledge management is, in essence, databases. [...] Current e-learning [...] is useful for basic-level training, compliance and information delivery. [Dunn and Iliff, 2005, p. 5]

The abundance of available content in KM systems attracts users, even though not too many services are offered. Working examples are content management systems like "WebCT" (Blackboard) or social software like "Wikipedia". The success of such systems shows that KM systems have veritable strengths on the input aspect of their interaction design, which counteracts its weakness on the reaction aspect (offering services).

The strength of an EL system is it's ability to provide user-tailored presentations of learning objects in a given learning situation, in other words in the reaction aspect of the interaction design. But the price for this is that the user may feel alienated that she is represented in the software-if at all-via a rather simplistic, static user model (e.g. in the ACTIVEMATH system [Melis *et al*., 2001]). That is, even though she might think of the respective EL system as an enabling technology that broadens her action-radius or heightens her competence level eventually, it doesn't take care of the here-and-now of her concrete context. Note the stark contrast to the macro-perspective—the perspective of the institution offering the E-Learning education here.

As a surprising consequence the requirements for retrieval from the micro-view are complementary to the ones from the macro-view. In particular, from the micro-perspective,

- KM wants to achieve high precision rates (so that a user gets what she needs at that point in time), whereas
- EL strives for high recall rates (so that a user can find the 'best' learning object suiting her personal needs).

Note that customization presumes potential high recall, whereas effectiveness is based on high precision. In particular (cf. Figure 2), EL's Control Problem can be interpreted as a call for high precision from the macro-perspective and a call for high recall from the micro-perspective when retrieving content.

3.1.1. Semantic KM Addresses EL's Control Problem

The main thrust in EL has been developing techniques or models to answer the high precision requirement. But, we argue, that the micro-perspective has to take precedence as it is decisive for taking the action of using the respective system (see [Kohlhase, 2005]). The Control Problem between user and system is a natural consequence of favoring the micro-perspective (high recall) over the macro-perspective (high precision) in EL. Maybe we 'just' have to vary the assumptions: EL interaction design has to take the user's demand for high recall into account. This can be delivered by semantic KM technology, i.e. a combination of KM-and semantic technology, building on explicitly represented knowledge objects (rather than EL text with implicit knowledge). In particular, if KM databases can offer more intelligent content, then all this content can be offered to the EL user enabling her not to choose from much too abundant content resources, but make informed decisions about her self-steered learning path. The constructivistic approach in KM Systems consists in managing microcontent, that can be aggregated, i.e. constructed, in various ways after its production. This way, we can make use of KM's strength to overcome EL's Control Problem.

3.2. Creation of Content

There is a common understanding in the Knowledge Management discipline that not all fabricated content can be supplied by outsiders, in the contrary that most has to be created within the context of evolvement, i.e. by collaboration. We list just a few of the arguments in the following. For one, as financial resources are evidently limited. For two (especially in organizations), since know-

ledge is far too dynamic and progresses fast. For three, because knowledge has a strong context component (see e.g. [Lave and Wenger, 1991; Brown and Duguid, 2000; 1991]). We can also spot a general tendency in the field of E-Learning to incorporate more and more collaborative features into their systems. Here, the reasoning is based on the social component of learning (based on e.g. [Vygotsky, 1978; Dewey, 1933; Lave and Wenger, 1991]). Together with the general trend from private data to public data on the Web, showcased by the considerable success of Social Software like DEL.ICIO.US, FLICKR, or SECONDLIFE in terms of user rates and described intriguingly in [Weinberger, 2002] and [Dourish, 2003], we restrict our analysis to collaborative creation of content.

In [Kohlhase and Kohlhase, 2004] we showed that the benefits of formalizing content for KM lie principally with its "readers", while the sacrifices remain with its "authors"-creating what we call the "Authoring Dilemma"[4] as we based our argument on the well-known "Prisoner's Dilemma" [Axelrod, 1984], which is often used for analyzing short term decision-making processes in cooperation scenarios, where the actors do not have any specific expectations about future interactions or collaborations. Moreover, in [Kohlhase, 2006b] the Authoring Dilemma was traced back to differing perspectives on the problem: the micro-perspective and the macro-perspective, where the first one is disabling content collaboration.

In particular, the problem was formulated in terms of a value 'landscape' where the action of creating can be optimized towards distinct optima. That is, here we can think about the according creation tasks in terms of optimizing action from the macro-perspective as follows:

- KM wants to achieve the global optimum (so that all available content is captured), but that
- EL strives for the local optimum (so that a user can progress on her chosen way).

In contrast, E-Learning software simply assumes the existence of qualitatively high learning resources and focuses on setting it up in the right context. That is, EL technology offers itself to the user notwithstanding the quality of learning objects. Again rather surprisingly, the resulting action optimizations from the micro-view are complementary to the ones from the macro-view. In particular, from the micro-perspective,

- KM wants to achieve the local optimum (so that a user gets done what needs to get done), whereas.

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[4]In the field of Mathematical Knowledge Management (MKM) this is also referred to as "MKM's chicken-and-egg problem".
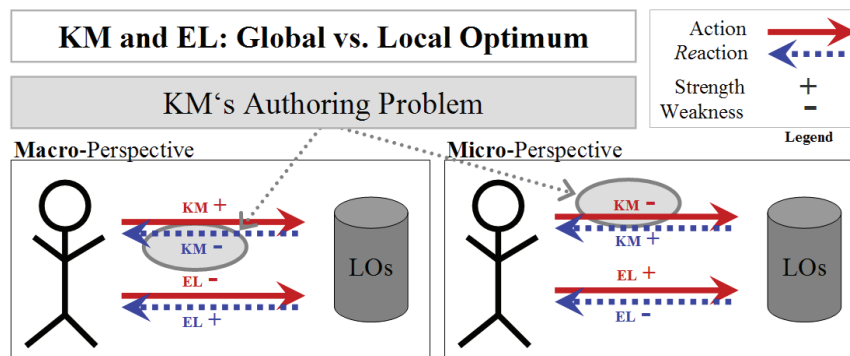
Figure 3 . Distinct perspectives on KM and EL wrt. creation of content

- EL strives for the global optimum (comprised in a "Lifelong Learning" goal or aiming at lifting each individual's educational level).

Note that customization tends to go for the local optimum, whereas effectiveness is aimed at the global optimum.

3.2.1. Semantic EL Addressing KM's Authoring Problem

Figure 3 visualizes the strengths and weaknesses of KM and EL with respect to the creation of content. We have argued elsewhere that the macro-perspective on KM technologies stresses its potential, but the actual offerings are rather simple and consist in authoring tools. From the micro-perspective however, the lack of supportive services prevents users from using the available authoring tools. Therefore, the Authoring Problem is a *consequence* of neglecting the micro-perspective and the failure of supplying Added-Value Services [Kohlhase and M¨uller, 2007] based on the content. Even though the fashionable paradigm of the "user as producer and consumer" is appealing from a macro-perspective-from a micro-per- spective, the hurdle to become a producer is a serious one and has to be acknowledged in software-design.

How can this be done? We suggest to use a combination of El and semantic technology, which we call semantic EL technologies. In particular, if EL data consisted of more intelligent content, then this could be tailored to the KM author enabling her to appreciate direct, intelligent services for her here-and-now situation. EL systems use the provided metadata of microcontent to construct a use context for the user. This approach makes use of EL's strength to alleviate KM's Authoring Problem.

4. Conclusions

In order to understand the benefits of a fusion of Knowledge Management and E-Learning technologies, we have focused on KM's Authoring Problem and EL's Control Problem. For this, we have looked at the strengths and weaknesses of their semantic interaction designs with respect to using and creating content within them. Here, we noted that both problems are characterized by weak user approaches from the micro-perspective and weak software deliveries from the macro-perspective. At the same time, KM and EL turned out to be rather complementary with respect to these actions under the distinct views. Therefore, we expect that merging the technologies will alleviate the respective problems. Moreover, we suggest that KM as well as EL technologies that are enriched by semantic technologies will enhance the potential resolution process.

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