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Characterizing Knowledge Maturing

A Conceptual Process Model for Integrating E-Learning and Knowledge Management

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Abstract. *Knowledge management and e-learning both attempt to support learning and knowledge transfer in organizations. However, they aim at knowledge of different degrees of maturity. Central hypothesis of this paper is that the approaches can be integrated on the basis of a process that explicitly aims at designing the transitions of knowledge along varying degrees of maturity. The knowledge maturing process is presented as a conceptual model for explaining and analyzing disruptions in the inter-individual flow of knowledge within organizations. These disruptions can be attributed to a fragmented systems landscape and separated organizational units that foster knowledge of different degrees of maturity. The paper presents criteria for a characterization of this process model and discusses its implications for the design of learning support systems.*

1. Introduction

Knowledge management (KM) and e-learning (EL) are both approaches that intend to improve construction, preservation, integration, transfer and (re-) use of knowledge and competencies. In addition to these approaches, programs of personnel development as part of human resource (HR) management support training into the job, on the job, near the job, off the job and out of the job [Scho00]. But despite increased interest in bringing together these disciplines, there are still huge conceptual differences resulting in a separation of research communities, of technical systems and of corporate responsibilities. Whereas e-learning and personnel development have their foundations in (learning) psychology, (media) didactics and (learning) pedagogy and emphasize the importance of structural (by preparing learning material) or personal guidance, knowledge management envisions an organizational memory or organizational knowledge base into

which the individual's knowledge is supposed to be made explicit and which is the basis for (more or less unguided) "knowledge transfer".

From the perspective of information and communication technologies (ICT), numerous systems aim at improving knowledge and learning processes as well as organizational competency development. Examples are HR systems, typically embedded in enterprise systems, document-oriented KM systems, collaboration platforms, content management systems which are easy to use, such as Wikis and Weblogs, as well as learning management systems. Employees thus use a fragmented systems landscape in which each system supports a certain part of knowledge and learning processes. Development of enterprise knowledge infrastructures is a technical solution that aims at integrating these systems [Mai05]. However, there are also conceptual challenges which cannot be solved simply by introducing a technical solution. These are challenges of designing learning and knowledge processes that bring together the separated organizational support infrastructures fostered by organizational units such as HR, EL, KM, innovation and quality management. These are often as separated as the supporting ICT systems. These organizational units again typically target knowledge of different degrees of maturity.

Key hypothesis of this paper is that a so-called knowledge maturing process provides a conceptual framework for the design of the required integrating processes in organizations. This paper presents a systematic characterization of the knowledge maturing process the first version of which was introduced as a semi-formal model in [Schm05] for explaining integration barriers between the different disciplines concerned with learning in organizations. Section 2 gives an overview of the knowledge maturing process on an individual and organizational level. Section 3 presents criteria for characterizing knowledge of different degrees of maturity and discusses the individual phases of the process model. Section 4 discusses a selection of implications from this model before section 5 concludes the paper.

2. Knowledge Maturing Process

The starting point for distilling the model from real-world experiences was the idea of a "knowledge flow", which is seen as a metaphor for interconnected individual learning processes where knowledge is passed on and reconstructed and enriched by the individuals involved. Everyday talk about the "quality" of knowledge in such a knowledge flow speaks of "consolidating", or "putting into the context of a bigger whole", or just that it is "not mature enough". If this is not about one's own knowledge, it is judged from information artefacts produced in the process of passing on.

2.1 Basic Model

In a first step of structuring this process, five phases have been identified after analyzing practical cases, e.g,. projects with industry partners like SAP [SB06] or the KnowCom consortium [BEM05] (see fig. 1):

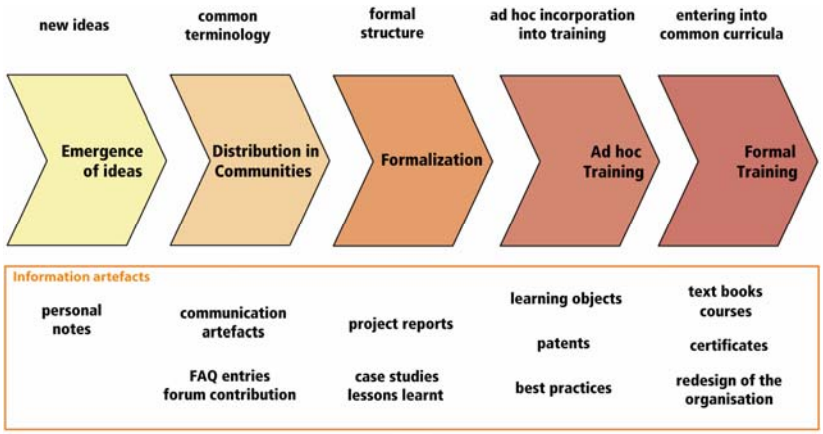

Figure 1: The Knowledge Maturing Process

1. **Emergence of Ideas.** New ideas are developed by individuals in highly informal discussions. The vocabulary used for communication is vague and usually restricted to the originator.
2. **Distribution in Communities.** This phase accomplishes an important maturing step, i.e. the development of common terminology shared among community members, e.g., in discussion forum entries or Blog postings.
3. **Formalization.** Artefacts created in the preceding two phases are inherently unstructured. In this phase, purpose-driven structured documents are created, e.g., project reports or design documents.
4. **Ad-Hoc-Training.** Documents produced in the preceding phase are not well suited as learning materials because no didactical considerations were taken into account. Now the topic is prepared in a pedagogically sound way, enabling broader dissemination.
5. **Formal Training.** The ultimate maturity phase puts together individual learning objects to cover a broader subject area. As a consequence, this subject area becomes teachable to novices.

2.2 Integrating the Organizational Perspective

Learning in organizations requires extending the individual perspective as described in section 2.1 by an organizational perspective. Metaphors of organizational knowledge and learning need to be considered in the design of a knowledge maturing process. However, it is important not to simply equate the individual and organizational levels [Wil01]. The model of organizational information processing provides a starting point for an organizational perspective on the knowledge and learning process ([Mai04], 133-138) a portion of which has also been investigated in an empirical study of the 500 largest organizations and 50 largest banks and insurance companies in Germany ([Mai04], 454-462). The model aims at integrating concepts and theories of diverse research fields surrounding EL and KM and helps to explain and design those organizational processes that underlie the knowledge maturing process described in section 2.1.

The fields of organizational psychology and sociology suggest that the group as a collective of people is the single most important entity processing information in organizations ([HSD82], [Weg86]). Transactive memory systems (TMS, [Weg86]) explain the impact of inter-subjective knowledge, its linking and embedding on information processing in a group. Levitan's [Lev82] life cycle of information production extended by [RK96] extends the organizational learning cycle to start with the perception of information in an organization's environment and to end with the dissemination of new information resources. The SECI-model [NT95] shows which knowledge conversion tasks are focused in each of the quadrants. Nonaka's spiral model ([Non94], 20) reflects the circular movement of knowledge in the organizational learning cycle. The concepts used in Argyris/Schön's theory [AS78] are assigned to the two fields institutionalized knowledge (espoused theories) and knowledge-in-use (theories-in-use).

Organizational knowledge processing (see fig. 2) starts with the establishment of data in the organization, called knowledge acquisition (1), or from within the organization, called knowledge identification (2). Via individual learning (3) knowledge sources become part of the organizational learning cycle. Individual knowledge is analyzed, verified and its value is determined by the individual. Knowledge is shared (4) and inter-subjective knowledge is created. In order to be fully accessible and independent of individuals, knowledge has to be institutionalized (5). Institutionalized knowledge (espoused theories) represents proclaimed, officially accredited or agreed ways of reacting to certain situations as opposed to knowledge (theories) in use (6) which denotes rules and hypotheses that are actually applied ([AS78], 11). Knowledge in use may or may not be compatible with

institutionalized knowledge. The results of actions finally give feedback (7). New individual knowledge is created. The knowledge created, shared, institutionalized and applied within the organizational learning cycle can be refined and repackaged (8) and thus used to create knowledge products and services. These products and services can be communicated, sold and disseminated to the environment (9) or they can be communicated internally and knowledge services can be offered to employees (10).

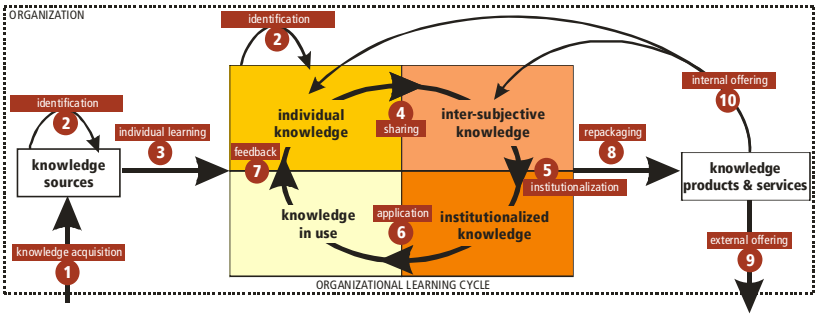

Figure 2: Model of organizational information processing ([Mai04],134)

According to the authors' consulting experiences with organizations, employees typically can choose from numerous media and locations to preserve as well as channels to transfer knowledge of varying degrees of maturity. The choice is often difficult, leading to inadequate supply of information and knowledge in organizations and thus can be improved.

When comparing the two models in section 2.1 and 2.2, all processes in the basic model of knowledge maturing are also part of the model of information processing. The emergence of ideas corresponds to the process of individual learning, distribution in communities corresponds to sharing, formalization is reflected in institutionalization, ad-hoc training in feedback and formal training in the refining and repackaging processes. The basic model in section 2.1 sets the focus on a pragmatic chain of knowledge development tasks that can be designed so that formal, mature knowledge products are the outcome of the respective knowledge maturing process.

3 Phases of Knowledge Maturing

This section presents concrete criteria which can be used to classify knowledge according to its level of maturity. The class then suggests the appropriate form of learning and technical support systems. The following criteria have been identified as useful:

- **Hardness.** In analogy to mineralogy, this criterion describes the (alleged) validity and reliability of information or knowledge. According to [Wat05], a possible scale ranges from unidentified sources for rumours up to stock exchange data (see fig. 3)

1	Unidentified source rumors, gossip, and hearsay	**6**	Budgets, formal plans
2	Identified non-expert source opinions, feelings, ideas	**7**	News reports, non-financial data, industry statistics, survey data
3	Identified expert source predictions, speculations, forecasts, estimates	**8**	Unaudited financial statements, government statistics
4	Unsworn testimony explanations, justifications, assessments, interpretations	**9**	Audited financial statements, government statistics
5	Sworn testimony explanations, justifications, assessments, interpretations	**10**	Stock exchange and commodity market data

Figure 3: Hardness scale according to [Wat05]

- **Interconnectedness/contextualization.** "Learning is network creation" [Sie05]. With the deepened understanding, connections to other topics become visible. This must not be confused with contextualization of knowledge which decreases in the knowledge maturing process and refers to the degree of *implicit* linkage to the creation context, so that it cannot be used outside the original context. Contextualization and interconnectedness are inverse properties.
- **Commitment/legitimation.** Knowledge can be structured according to the amount of support it gets. Support can be in the form of commitment by members of groups, teams, communities or other organizational units. Another form of support can be authorization to use knowledge by supervisors, executives or committees as well as legalisation and standardization, forms of legitimation (see Fig. 4).

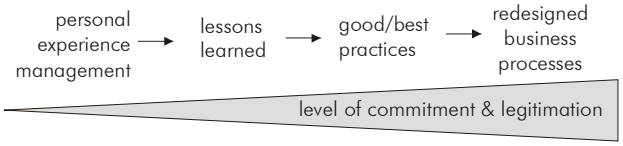

Figure 4: Commitment & Legitimation

- **Teachability.** As knowledge maturing is basically interconnection of individual learning processes where knowledge is taught and learnt, an important criterion is its teachability. Whereas immature knowledge is hard to teach (even to experts), formal training allows by definition for wide-range dissemination.

Table 1 gives an overview of the phases of the knowledge maturing process with an example list of typical types of knowledge, values according to the criteria discussed in this section as well as implications for technical implementation which are discussed in the following.

	Type of knowledge	*Hard ness*	*Medium/Inter-connectedness*	*Commitment/ Legitimation*	*Form of learning*	*Technical implementation*
Emergence of Ideas	Rumours	1	Human, highly contextualized	n/a	informal & direct communication	communication technology (phone, IM, mail)
	Personal experiences	2	Human, personal notes highly contextualized	Commitment of individuals, confirmation by colleagues	direct communication, exchange of personal artefacts, emergence of communities	computer-mediated communication, collaboration technology, Weblogs
Distribution in Communities	Ideas and proposals	2	Forum entry, suggestion form explicit connections to application context	Commitment of inidividuals, legitimation by colleagues	organizational process for improvement capturing ideas, community format.	Community work-space, forum, suggestion system
	Questions & answers	3	FAQ explicit connections to problem context	legitimation by experts	self-steered, on-demand inform. seeking, beginning formalization	FAQ database and Wikis
Formalization	Project results	3	project/milestone report with structure, explicit connections	legitimation by project manager	on-demand information seeking	project & document management system
	Lessons learnt	4	LL-document project context made explicit	legitimation by project team	case-based, self-steered learning	LL-database Wikis, Weblogs
Ad-Hoc Training	Learning objects	3	well-defined digital resource, formal metadata	legitimation by experts	ad-hoc training	learning object repository
	Good/best practices	5	best practice document explicit creation context	commitment of an organiza-tional unit	case-based, self-steered learning, ad-hoc training	best practice database
	Patents	7	patent application, explicit connections to potential usage context	legitimation by patent office	specialized information seeking	patent databases
Formal Training	Reorganized busin. proc.	6	process models and descriptions	commitment of process owner	standardized training, courses	process warehouse
	Courses	6	interconnected learning objects, notion of curriculum	legitimation by course vendor	standardized training	WBT-authoring, LMS

Table 1: Types of knowledge in different maturing phases

4. Implications

This section shows for two examples (a) how the conceptual model helps to *understand* disruptions in the knowledge maturing process and (b) how organizational and ICT learning support helps to *overcome* these disruptions.

4.1 Formalization vs. Ad-Hoc-Training

The classical barrier between KM and EL can be located between the formalization (KM) and ad-hoc training phase (EL). On a technical level, formalization is usually supported by document management systems, whereas the ad-hoc training phase is supported by learning (content) management systems (LMS). On the organizational level, ad-hoc training is under the responsibility of HR development or training departments, learning in the formalization phase (usually not called "learning") is managed by the operating departments themselves. The differences between these two phases can be directly derived from our criteria legitimation (project teams & manager vs. training experts) and the paradigms of learning (information seeking vs. ad-hoc-training).

One example of how to foster knowledge maturing at this "point of rupture" on an organizational level is the Ramp-Up Knowledge Transfer program of SAP in which developer documentation is transformed into ad-hoc training material before rolling out new products on a large scale. In a moderated process, development and training experts collaborate on the maturing task.

4.2 Distribution in Communities vs. Formalization

A less prominent barrier in the knowledge maturing process can be identified between the second and the third phase. In KM, this is usually investigated as the problem of externalizing knowledge. Barriers between these phases can be traced back to human and social issues: the detachment from the originator of an idea. In communities, the originator of an idea is usually still active and mostly identifies with community goals so that the distribution is seen as contributing to reputation and social esteem, rather than losing something. But with formalization, knowledge is supposed to spread far beyond community boundaries so that the community loses control. Again, this can be illustrated using the criteria from the previous section: the maturing step requires transformation from commitment by individuals to legitimation by a formal organizational unit, and the transition from community-driven systems to enterprise-level systems.

A promising approach to overcoming this type of disruption lies in an increased visibility of the individual. Weblogs and Wikis (especially in combination) are good instruments. *Weblogs* are communicative instruments of individuals to spread their ideas and opinions and for informal formation of communities among the Blog readers. Trackbacks can link different steps in the maturation of an idea. *Wikis* have evolved into useful instruments for discussing and working collaboratively on the presentation of a topic while still retaining visibility of individual contributions.

Additional conventions within Wiki systems allow for adding legitimation and indicating maturity so that these systems can provide an interesting alternative to classic CMS, proving transition opportunities from the community phase up to the ad-hoc training phase.

5. Conclusions

The knowledge maturing process is a model for structuring real-world phenomena of dealing with knowledge in companies and for systematically elaborating technical solutions. This model is not an attempt to explain how learning takes place, but rather to point out that learning takes place differently based on the maturity of knowledge to be constructed. The maturity level yields an indication for the appropriate medium, form of learning and learning support technology. This allows for a systematic design of the ICT infrastructure of companies, incorporating processes, roles, and tools with a special *awareness* of disruptions in the maturing process. Future research will concentrate on the elaboration and validation of a methodological framework for maturity-aware learning support.

References

[AS78] Argyris, C., Schön, D.: Organizational Learning: A Theory of Action Perspective, Reading (MA) 1978.

[BEM05] Bayer, F.; Enparantza, R.; Maier, R.; Obermair, F.; Schmiedinger B.: Know-CoM: Decentralized Knowledge Management Systems for Cooperating Die and Mould Making SMEs, in: Jennex, M. E. (ed.), Case Studies in Knowledge Management, Hershey (PA, USA) 2005, 186-209.

[HSD82] Hartwick, J., Sheppard, B. H., Davis, J. H.: Group Remembering: Research and Implications, in: Guzzo, R. A. (ed.): Improving Group Decision Making in Organizations. Approaches from Theory and Research, New York et al. 1982, 41-72.

[Lev82] Levitan, K. B.: Information Resources as „Goods" in the Life Cycle of Information Production, in: Journal of the American Society for Information Science, Vol. 33, January 1982, 44-54.

[Mai04] Maier, R.: Knowledge Management Systems. Information and Communication Technologies. 2. ed., Berlin 2004.

[MHP05] Maier, R., Hädrich, T., Peinl, R.: Enterprise Knowledge Infrastructures. Berlin 2005.

[Non94] Nonaka, I.: A Dynamic Theory of Organizational Knowledge Creation, in: Organization Science, Vol. 5, No. 1, 1994, 14-37.

[NT95] Nonaka, I., Takeuchi, H.: The Knowledge Creating Company, New York, 1995.

[RK96] Rehäuser, J., Krcmar, H.: Wissensmanagement im Unternehmen, in: Schreyögg, G., Conrad, P.: (eds.): Managementforschung, Vol. 6: Wissensmanagement. Berlin, New York 1996, 1-40.

[Schm05] Schmidt, A.: Knowledge Maturing and the Continuity of Context as a Unifying Concept for Integrating Knowledge Management and E-Learning. In: Proceedings I-KNOW '05, Graz, 2005.

[SB06] Schmidt, A., Braun, S.: Context-Aware Workplace Learning Support: Concepts, Experiences, and Remaining Challenges. In: Proceedings of ECTEL '06, LNCS vol. vol. 4227, pp. 518-524

[Scho00] Scholz, C. (2000): Personalmanagement. Informationsorientierte und verhaltenstheoretische Grundlagen. Munich 2000.

[Sie05] Siemens, G.: Connectivism: Learning as Network Creation, elearnspace, 2005, http://www.elearnspace.org/Articles/networks.htm.

[Wat05] Watson, R. T.: Data Management. Databases and Organizations. 5th ed., New York 2005.

[Weg86] Wegner, D. M.: Transactive Memory: A Contemporary Analysis of the Group Mind, in: Mullen, B., Goethals, G. R. (eds.): Theories of Group Behaviour, New York et al. 1986, 185-208.

[Wil01] Willke, H.: Systemisches Wissensmanagement, 2nd ed. Stuttgart 2001.