Contextual Learning On-Demand at the Workplace – Strategy, Model, and Practice

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***Abstract*—To be agile in today's business environment, every knowledge-intensive organization faces the challenge of supporting the non-classroom, non-instructional type of learning on-demand, inseparably interwoven with daily job tasks. The next stage of e-learning development at the workplace - Workplace Learning On-demand (WLOD) - is a steady evolution with respect to the increasing demands on just-in-context and just-in-time knowledge and skill update.**

***Index Terms*—Contextualization & collaboration, contextual workplace learning on-demand, metadata tagging, IBM Lotus Notes, knowledge management.**

I. INTRODUCTION

The rise of computer-based learning ("e-learning") is at first, a response from organizations that take advantage of efficient access to information anywhere at anytime. Over the years, the development of e-learning at the workplace has gone through hypes and experiments. The early stage of e-learning was simply putting old wine into the new (e)-bottle, i.e. cataloging books, or publishing text descriptions of a course in an organization's intranet or the World Wide Web of the Internet. Then, varieties of blended- and competency-based e-learning came in. Following the classroom-based instruction approaches, none of those has shed the traces of taking employees as button-pushing, passive, and thus in a way "dumb" learners. When employees are not actively involved in generating their own content and learning process, neither a trainer nor a perfect IT system can cater to their exact learning need and styles at the time and place they need it. In reality, unless it is required or rewarded, people tend to be less motivated and assign less time for learning while simultaneously juggling a full-time job and an equally demanding family life (in case they choose to have one).

The next stage of e-learning in the workplace is to facilitate employees in knowledge creation processes that are embedded in their job context, i.e. at the right time fitting into their availability and schedule supported by the right content delivered to them in appropriate digital assets and tools at the workplace [1] [2]. This is titled as *learning on demand* (LOD) [3]. In this paper, the workplace setting as the virtual and physical embedding part of learning *on-demand* is core focus. Thus, WLOD denotes *workplace learning on demand*.

WLOD reflects three trends in e-learning at the workplace:

1) Strategy shift – the convergence of e-learning and knowledge management that derives from *informal* and *collaborative* processes in knowledge construction at the workplace [4]. Learning at the workplace is not only in a formally structured process or form, but it happens more frequently as "knowledge accidents", by talking to peers next to the water cooler, discussing with experts online or at coffee breaks, or discovering materials from external and internal databases for a presentation [5] [6].

2) Technology Integration – leveraging an existing IT infrastructure for learning integration at the workplace technology layer. The technological enablement of WLOD shall be seamlessly integrated into employees' workplace information and communication environments [7, p. 30-32]. This is not only a cost-efficient solution for organizations, but also for the convenience of the employees/learners who are accustomed to their daily communication and collaboration techniques anyway.

3) Context embedment - a flexible provision of embedded contexts combining both knowledge discovery and construction from design and support perspectives on the one hand and the content side of related or directly involved organizational processes on the other hand. This refers to supporting employees in finding resources and people, and processing learning within their on-going job context. Unlike school education, learning by itself is not the ultimate goal at work, but rather a "by-product of workplace activity" that is set in the organizational context and following work process [8, p. 5]. Masie [4] also emphasizes that context is more important than content at the workplace. At the workplace, not only content needs to be disseminated, but also context shall be conceptualized and managed for sharing and reusing in the on-demand process of knowledge construction.

Against above paradigm in workplace learning, the author will first discuss issues of "learning objects" development because of their premises in supporting modular, sharable and reusable digital resources for just-in-need, just-in-time, and just-the-right-amount learning in the workplace. Then, complementing to learning objects' content-centric approaches, the author denotes a context-driven knowledge management strategy and model for WLOD. This model focuses on learning through contextual embedment of content material for knowledge management, and thus supports learning purposes by means of contextual collaboration in the workplace. Finally, a prototypical implementation of this model and application scenario will be demonstrated.

II. THE LEARNING OBJECT IS DEAD. LONG LIVE THE LEARNING!

A. Challenges of the Learning Objects Approach

In e-learning, the idea of learning objects fits into the trend of accessing free-floating content on the Internet and

organizational intranets. Nevertheless, the archetypes of content-centric and classroom-teaching models still dictate the design and development of LOs.

Wayne Hodgins, an educational visionary, is accredited with coining the term "learning objects" (LOs) in the early 1990s [9][10]. According to Hodgins [11], the basic idea is centered on designing granular, LEGO–like (the toy) objects that can be easily reused in later contexts, as well as shared among different systems independent from their underlying IT-infrastructure.

The vision of LOs-based systems proposes significant promises to enhance the efficiency of learning processes and human performance in workplace learning. For an organization, a learning system based on LOs may reduce the cost and time of reproduction by increasing sharing capabilities, leveraging the independent interoperability character of independent learning objects that may be shared across different divisions in and across organizations.

Given the long list of benefits of LOs, in reality, there are equal numbers of people who have questioned the conceptual soundness of this learning objects approach [12] [13] [14]. The frequently raised challenges of implementing LOs are: the rhetoric in the dispute on defining the label "learning objects"; the lack of tools to implement technical standards and specifications for learning objects (e.g. IEEE Learning Object Metadata Standard [15], SCORM specification [16]); and finding a general granularity or aggregation model for future reusing.

As a prominent advocate of the learning objects approach to design educational materials, Wiley [17] states in his blog that he does not care whether the label *learning object* is alive or dead. His attention is on people's free will to share content via de facto standards. He wonders: "What if all the effort and money spent hyping and building technically interoperable content systems had gone into better understanding the process of localizing educational materials, and developing whatever new tools were necessary to support that process" ([17], para. 11).

Wiley's statement might be taken as an indicator to a closing in the endeavor of developing the state-of-art development of learning objects. First, the debate of how to name the digital learning resource, whether they are called learning objects, nuggets, assets, or simply resources, is not important.

Furthermore, the granularity approach of breaking-up content from its original context is proven to be costly and unrealistic. The issue of "localizing materials" is essentially centered on context information, describing the time, the location, the settings, the application domain, and the people who use, reuse, and repurpose the materials.

Regarding the technological interoperability, in daily workplace setting, employees as the end-users are taking de facto (industry) standards for rendering digital materials evolving from the overall development of information technology, like pdf, ppt, mp3, gif, the http protocol, etc. The IEEE LOM or SCORM standardization approaches might have their place in designing and delivering classical learning, but they are not practical at the on-demand workplace learning setting.

The underlying pattern of the first generation of LO development is based on cognitive learning theories, positioning the learner as a passive entity receiving prepackaged learning via a computer [13]. To facilitate the future trend of learner-centric knowledge construction in on-demand workplace learning, the next generation of modular design and re-use of information and knowledge shall cater to individual learner's contexts as well as enable a learner's contribution in creating learning resources at workplace.

B. Extending LOs to Knowledge Nuggets

One important aspect of e-learning in the workplace is a just-in-time, self-organized, and collaborative effort with peers and experts in and outside the organization. This is to be achieved as an activity integrated with daily job tasks.

To facilitate this kind of on-demand workplace learning need, learning technology must go beyond the traditional classroom setting and merge into the wider realm of organizational knowledge management, combining formal and informal learning processes in a workplace context. Therefore, the author defines the term *knowledge nugget* (K-nugget) further on to replace the term "learning object".

Knowledge nuggets are digital resources - comprising context information and content materials in the form of digital assets - which can be used in facilitating workplace information and knowledge acquisition processes.

The convergence of learning and working positions "knowledge nuggets" as an umbrella term. This embraces not only all digital files, data, and information but also digital artifacts resulting from workplace collaboration, such as comments from peers, logged chat/instant messages, shared or co-edited documents, screen snapshots captured and documented in the context of business processes, recorded electronic conferences, etc. Knowledge nuggets represent a transition from a single-dimensional view of instructional learning/training to multi-dimensional support of formal and informal knowledge management processes in a workplace setting. The knowledge worker takes both roles at the workplace, as a lifelong learner as well as a daily job role, e.g. as manager, consultant, engineer, professor, assistant, etc. The following guidelines dictate the technical architecture of knowledge nuggets:

- Context-driven: In addition to being containers for content, knowledge nuggets are supplied with a rich and multidimensional metadata set enabling the content to be linked in manifold ways in pre-planned as well as unforeseeable business and/or learning contexts.
- Process-driven: knowledge nuggets are technically enabled for process-driven collaboration allowing the necessary associated context changes in a workplace environment.
- End-user-driven: knowledge workers generate, use, modify, and reuse the nuggets to facilitate their job tasks, transactions, and processes including embedded learning phases.
- Integrated solution: knowledge nuggets are embedded in a knowledge management environment and line of business solutions which are an integral part of the workplace platform technology being used in the organization.

III. CONTEXTUAL MODEL FOR WORKPLACE LEARNING ON-DEMAND (CM-WLOD)

A. *Foundation of CM-WLOD*

In an attempt to present basic architectural elements of CM-WLOD in an intuitive way, a visual representation used in medical research on signal transduction is borrowed. Signal transduction research is focusing on responses of *cells* to physiological (e.g. stress) and environmental (e.g. toxins) stimuli, external settings and/or contextual factors, which have significant implication on human health and disease (e.g. diabetes, asthma, heart diseases and cancer) (Laboratory of Signal Transduction, U.S. National Institutes of Health, LST[1]). For instance, the bad air quality and stress factors have negative influence on the development of diseases.

Fig. 1 presents these contextual factors. All the factors shown embody different parameters which are related to the respective external expertise area they are attributed to. To visually make clear that the contextual factors in turn represent distinct external features, different icons/symbols are taken around the cell. When it comes to detail each of these icons/symbols might represent a set of contextual parameter values being attributed to the specific contextual factor. The combined set of all these contextual factors defines a contextual profile which is shown in an interaction pattern to the cell in the center of the graph. The contextual parameters are on the boundary of the graph to denote their connection to entities and knowledge domains existing outside.

The arrows on Fig. 1 give a sketchy hint to some of the underlying dynamics of mutually influencing factors.

This medical model easily and rather isomorphically relates to the knowledge nugget approach identified by the author. However, the following explanation of the CM-WLOD approach in this paper is not a literal translation from medical signal transduction research to the contextual granulation procedure of knowledge nuggets. Rather some parts explaining the most relevant building blocks of evolution processes and related phenomena in the natural sciences are borrowed.

The common focus between signal transduction research and knowledge nuggets is the usage of a set of contextual factors characterizing a specific context of the content attached to the knowledge nugget. The knowledge nugget is modeled in analogy. It is defined by context information expressed by contextual parameters on the one hand and the content kernel with digital material on the other hand, the latter being the "cell" in medical research. The contextual parameters have to be modeled to characterize a usage purpose of the attached content at the workplace according to a specific application domain. The contextual parameters are not derived "internally" as drawn solely from information about the content. Rather they define a relation between the content and external (to the content) factors derived from actual organizational and business processes of an application domain where the content happens to be embedded during one process state of its life cycle.

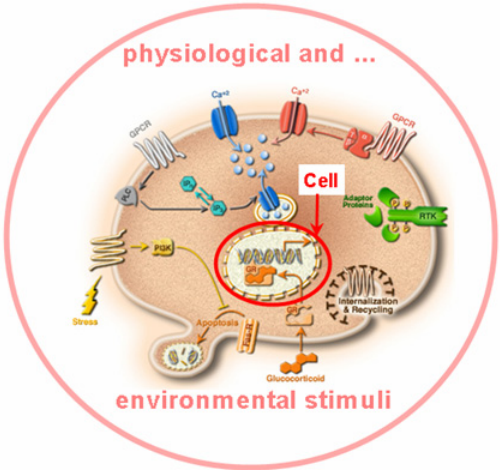

Figure 1. Adapted from the cell image of the signal transduction research from LST (U.S. National Institutes of Health, 2006[1])

The external contextual influences are interacting within the changing process structures of a living organization of which the workplace is a part. But, in this paper the focus primarily will not be on analysis of the interaction dynamics between single contextual factors and their impact on the content part of the knowledge nugget (as suggested by the arrows in the medical model above). Rather the dynamics of organizational processes as described in appropriate contextual factors will be reflected in different sets of contextual factors which can be assigned one after another to the content part of the knowledge nugget over the life span of the content.

A principal visualization of the knowledge nugget architecture as used in CM-WLOD is outlined in Fig.2. In this visual transformation from medical research, all the content material contained in the content field is linked to (nine in the example) contextual parameters, which altogether form one context information set for the K-nugget. Especially, the graph visually emphasizes the concept of allowing different and independent contextual parameters with their own taxonomy to be part of a context parameter set. This is illustrated in the graph by using a variety of pictograms derived from medical research.

The content field of Fig. 2 is designed to serve as container for a collection of digital assets of any given digital format of data, information and knowledge used at the workplace. The term "knowledge" is used here following the conceptual notion of knowledge management pointing out the transition between tacit and explicit knowledge in organizations from Nonaka and Takeuchi ([18], p. 57-59). The CM-WLOD approach is centered on the codification of tacit knowledge to explicit knowledge by a process of contextualization and internalization via interactions among knowledge workers enabled by a set of tools.

To be noticed, central to the CM-WLOD approach are the contextual elements and process stimuli around information and knowledge. It is not the author's intention to focus on content generation. In general, in this paper, content is taken as a given set of assets in any digital format.

[1] http://dir.niehs.nih.gov/dirlst/imagemap/cell.jpg

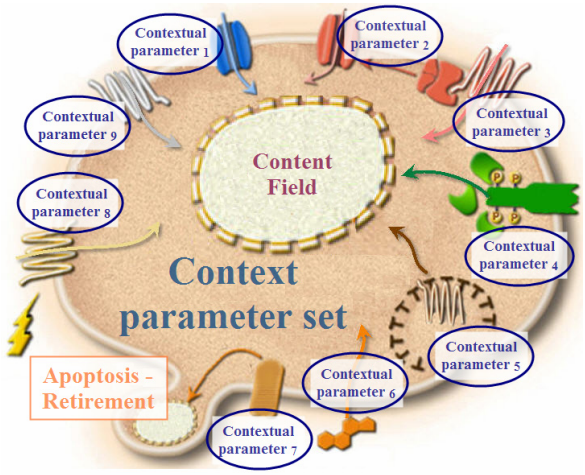

Figure 2. K-nugget - visualization of contextual model (adapted from medical research, LST, 2006)

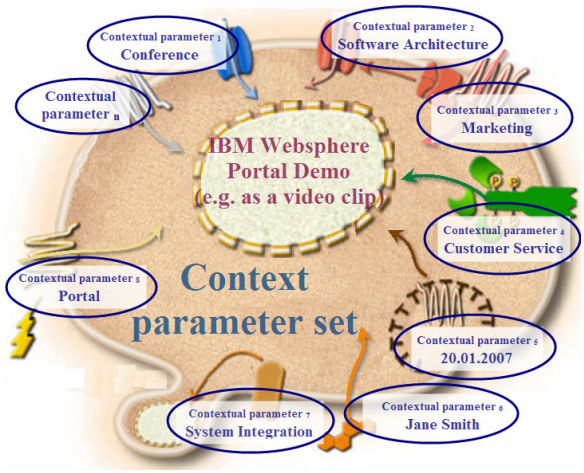

Figure 3. Example for narrow interpretation of context: single context information set

B. A Narrow Interpretation of Context: Single Context Information Set

The term "context" seems intuitively to be understood as describing the environment of an object in a specific setting. However, it is difficult to define. In this research for the purpose of modeling processes of information and knowledge within an organization, the author explores two types of context interpretation. The first is a narrow one derived from content or in many cases related to the first apparent usage of a knowledge nugget in a specific application domain. The second is a broader understanding of context associated to later reusing, repurposing, and referencing events of a knowledge nugget.

A suitable approach to articulate the usage of context at this point appears to be to take a real world example. In the following, meaning and mechanics of a single set of contextual parameters are explained. As exemplary content material a demonstration (as presented in Fig. 3) of a piece of current technology is taken, a video clip showing various aspects of IBM's "Websphere Portal" system (= IBM Corp.'s approach to corporate Web technology). The video clip was prepared by a team of IBM experts. Its digitized assets had been embedded in the content field of a knowledge nugget. Context information was derived from the viewpoint of context available at this first usage of the K-nugget in its life-cycle. This context information includes as contextual parameter$_1$ "Conference", as contextual parameter$_2$ "Software Architecture", etc. The knowledge nugget had been stored in a knowledge management system accordingly, including content material "IBM Websphere Portal Demo" as video clip (plus describing textual material) in the content field and a (first) context information set. The descriptors for the respective contextual parameters of this context information set speak for themselves: The video was produced as a "Portal Demo" for a "Conference" for the purpose of "Marketing" for "Customer Service". It was shown on "20.01.2007", presented by "Jane Smith" as "Portal" application for a "System Integration" solution.

Fig. 3 shows, as an example, the simplest case that all contextual parameters take exactly one value. In general this will not be the case. Thus, the contextual parameter$_6$, apparently denoting the presenter, alternatively might take more values than just "Jane Smith", e.g. if "Pei Wang-Nastansky" would be a presenter on 20.01.2007 as well. Similarly, contextual parameter$_8$ might take more values like "Portlet" and "Page" in addition to "Portal". To summarize: A context information set consists of a specific collection of contextual parameters where each parameter can take as many values as necessary (or reasonable) to describe the content material with respect to a specific use in an application domain.

C. A Broader Interpretation of Context: Multiple Context Information Sets

In reality, in the workplace, a sequence of re-usages and repurposing of the knowledge nugget, Fig. 3 can be executed in the course of various subsequent in the organization, such as in sales events, marketing events, other conferences, or workshops. For these subsequent activities more context information has to be added.

The context information set of Fig. 3 makes up only one incident referring to one specific application domain where the "Websphere Portal Demo" has been used. When aiming at modeling reusability in more application domains, one way could be to add more values to existing contextual parameters and/or include, if necessary, more contextual parameters with their respective value(s) into the existing context information set. But this would turn out misleading context information. Here an example: Betty Hess is about to use the "Websphere Portal Demo" at an upcoming sales event in March. If she would be included in the contextual parameter denoting the presenter (in addition to Jane Smith and Pei Wang-Nastansky) this contextual parameter would have three values. But then, wrongly, she would be related to the date "20.01.2007" of the first event "Conference" as well. Thus, to model multiple usages of shared content material, independent contextual parameter sets are necessary which respectively possess their own individual contextual signature relating to a specific purpose of usage as displayed in Fig. 4.

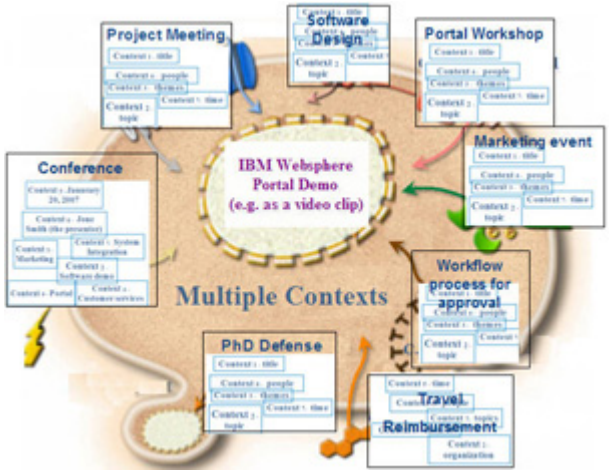

Figure 4. Example for broader interpretation of context: multiple context information sets

This approach will be called "multiple context information sets" for knowledge nuggets. With this approach a more general model allowing broader and extended usages of content material in workplace learning on-demand environments is introduced.

Fig. 4 gives an example for multiple context information sets. Exactly eight context information sets are assigned to the "IBM Websphere Portal Demo" video clip. One of these context information sets including all its contextual parameters is the one assigned by first usage, as exemplified above ("Conference", Fig. 3). Context information sets "Conference", "Sales event", "Portal Workshop" and "Marketing event" relate the video clip to separate events; they all include their respective contextual parameters with a distinct contextual signature. "Software Design" and "Market value" define the use for training and learning purposes. "Workflow process for approval" currently links the knowledge nugget to an approval process; when this approval process is terminated this context information set will be purged (or archived, if it seems appropriate). Similarly, the knowledge nugget is temporarily linked to a "Travel Reimbursement" context in the organization.

The next section will articulate more in detail the basic model of context information sets and the mechanism for assigning them to content as used in the CM-WLOD approach and leading to a prototypical implementation.

IV. IMPLEMENTATION OF THE CM-WLOD

The CM-WLOD approach is towards an ontology-based data model to classify, organize, manage and communicate contexts for workplace applications in a collaborative manner. Within this model, the main focus is on context, the complexity of which is one of the greatest challenges at the workplace. The on-demand factor is assumed via the availability and readiness of business information and communication systems that apply CM-WLOD. The content management side of knowledge in this model is taken as a given fact. The focal point of modeling context in CM-WLOD is based on seven contextual parameters which reflect a pragmatic approach to organizational data modeling. For optimizing sharing, an approach of context signatures for reusing and repurposing content is derived, by assigning different sets of context information to content material collections.

TABLE I.
SYSTEM LAYERS OF CM-WLO

Layer	Layer Services	Applied System
4	**Workplace application layer for KM & contextual learning** Use of layer 3: customize, set general contextual parameter contexts, define organizational infrastructure (elements, processes), create CM-WLOD specific templates, create profiles & dashboard views/portlets, provide infrastructure for embedded objects, etc.	**CM-WLOD system**
3	Enterprise content and knowledge management layer	K-pool system
2	Collaboration services layer	IBM Lotus Notes system
1	Corporate workplace services layer	Operating system (MS Windows, Linux, Apple Macintosh)

Technically, denoted in Table 1, CM-WLOD is implemented in a layered approach on top of IBM Lotus Notes and "Knowledge Pool" (GCC K-pool), a knowledge management system (more detail: http://gcc.upb.de/K-Pool/CM-WLOD-PWN).

The author has decided to prototype CM-WLOD on top of a technology platform accepted and proven in the corporate world. Central parts of Table 1 are a layer providing document management, communication and collaboration services (IBM Lotus Notes), and as a layer dedicated to knowledge management (K-pool system, developed at the University of Paderborn). The goal is to prove the applicability of the model and to present showcase applications. For this, it is shown how the CM-WLOD data model and structure are adopted to the customization options presented by K-pool and Lotus Notes. In the adoption, and for isomorphic modeling CM-WLOD on top of K-pool, the author had to suggest two functional extensions for K-pool. One is to allow more than one context signature for a given set of content materials. The other is to allow for a deliberate set of values of contextual parameters to define a selection profile for content, assembled according to the profiled context.

The data model of the prototypical implementation of CM-WLOD is isomorphic to the cellular and bottom up approach, because in the implementation K-nuggets are mapped onto documents. Therefore, each K-nugget document contains a content field and metadata fields for context information. Most likely a considerable amount of this context information might be similar in different K-nuggets.

According to the architecture outlined in Table 1, a K-nugget is modeled as a "document" following the semi-structured data model of a Lotus Notes based application. "Semi-structured" means, that parts of a document have to follow rigid formatting requirements, other parts don't. It is exactly this structure which has been introduced for

modeling K-nuggets. Thus, the context stub containing metadata defining contextual parameters is precisely pre-formatted, according to CM-WLOD's approach. The content part on the other hand serves as a container for content material which can be deliberately formatted according to the needs and preferences of content creators, content contributors, or content editors. A "good" K-nugget consists of a context stub containing a reasonable set of contextual parameters as displayed in Fig. 5 with seven different parameter sets, which are well structured by formal format enforcement of the CM-WLOD system. A second element is a content part containing the content material, well structured by the content creators using a format fitting the respective needs of the material, e.g. underlying application domain, knowledge area, or processes involved in working through the material.

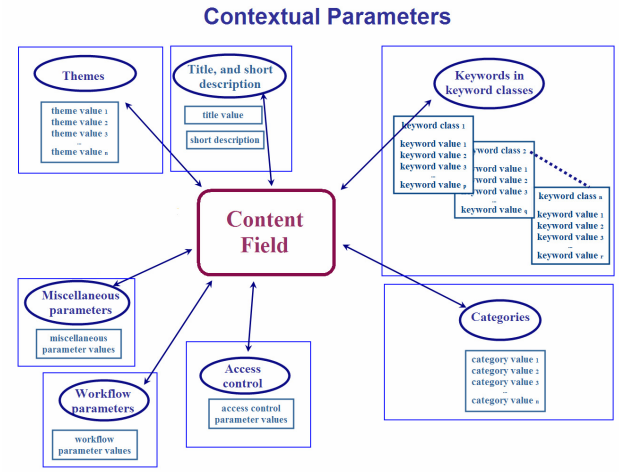

Figure 5. Data Model for contextual parameters for a K-nugget in CM-WLOD

There are two possible approaches to work with a K-nugget: in an intranet environment via the rich-text editor being a central part of the Notes client, or, in extranet or Internet environment via web-browser which is supported by the HTML task of the Lotus Domino backend server. It is recommended that for easy working, secured infrastructures, good desktop integration or higher quality demands on content structure and layout K-nuggets be worked upon in the Notes client environment. Meanwhile, a web-browser is suitable as an environment e.g. for spontaneous access to K-nuggets, attachment contributions not demanding subtle rich-text editing, adjustment of contextual parameters or open communication activities. Other important issues in choosing the right workplace approach for working with K-nuggets is that the Notes client does not depend on network connectivity, so much of the "learning" and contextualizing work in CM-WLOD can be done in offline mode. Furthermore, the Notes client generally delivers more easy to use and versatile tools and functionalities in contextualizing K-nuggets than the web-browser front-end in the K-pool platform.

Fig. 6 is a real-life project scenario where the author has applied CM-WLOD's core concepts. This way it seems, that the rather abstract and possibly vague notion of "context" can be better filled with practical meaning and convey more substance for concrete reflections and associations for the reader.

The referred project is a knowledge transfer endeavor. It involves preparing, organizing and carrying out a one week workshop at the "Chinese German Graduate College" at Tongji University in Shanghai. CDHK (German: Chinesisch-Deutsches Hochschulkolleg) has been initiated and co-founded by the German Academic Exchange Service (DAAD). The "METRO Group Innovation Center" at CDHK is one of GCC's international partners. The workshop topic is "Information Management", with focus on workplace and knowledge management systems. The author has been part of the team, her roles during the several project phases comprising manager and coordinator functions as well as being part of the project staff on an operational level. The workshop is carried out once a year. Therefore, the project constitutes one instance of a repeating event.

Fig. 6 shows the "CDHK workshop logbook 2007" document, structured as a K-nugget, denoting the event at the METRO Group Innovation Center of CDHK, Shanghai, China from March 20 – 24, 2006. Fig. 6 presents the overall structure of a K-nugget which is rendered within three inter-connected spaces from 1 to 3.

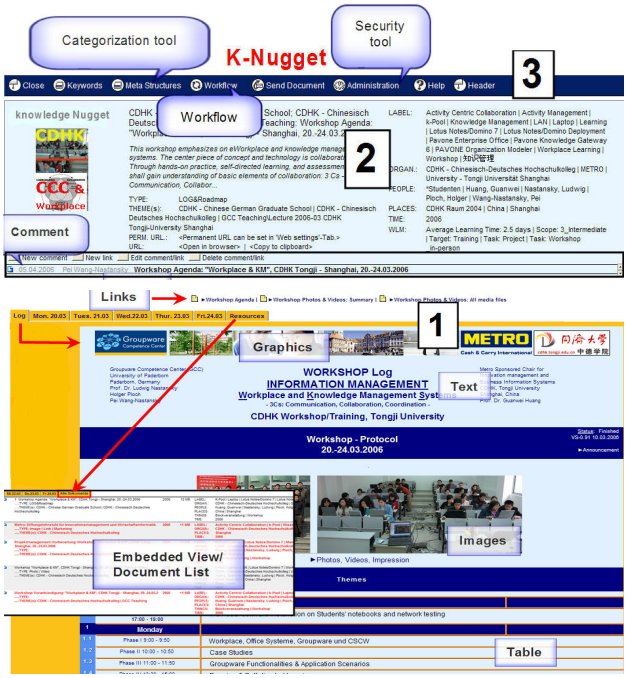

Figure 6. A contextualized K-nugget rendered as Lotus Notes document

From the bottom up, area 1 denotes the content part of the K-nugget which can be generally used for one content piece or a set of content materials in any digital format as outlined above. Here, a set of content materials is included. The content part is a Notes rich-text field which in this example contains – formally speaking - text, tabular structures, images, graphics, and embedded objects interwoven with links. Speaking from the application domain side, this CDHK K-nugget is realized as a structured logbook in a tabular format which contains a set of content materials allowing a top-down access to the workshop for all participants. Parts of the content are links to other knowledge nuggets containing further related workshop materials, e.g. media K-nuggets of the workshop with photo collections and videos. The overall tabular structure of the workshop logbook is organized by

dates, as shown by the row of "tabs" with date entries on top in area 1.

The context information relating to the application domain is defined in the context-stub of the K-nugget. This is represented in area 2 of Fig. 6, denoting the actual set of contextual parameters referring to the CDHK workshop of 2006. According to CM-WLOD's definition, the context stub comprises seven contextual factors, namely, "Themes", "Title, and short description", "Keywords" in keyword-classes, "Categories", "Access control parameters", "Workflow parameters", and "Miscellaneous other parameters". In Fig. 6, the values of some contextual parameters are visible, and some are not. Examples are:

- Themes parameter, contains a list of three values: "CDHK - Chinese German Graduate School", "CDHK – Chinesisch Deutsches Hochschulkolleg", "GCC Teaching …"
- Title and short description parameter: "Workshop Agenda: Workplace & KM …" and "This workshop emphasizes on e-workplace and knowledge management systems …");
- Keywords in keyword-classes parameter: Visible are the keyword-classes LABEL, ORGAN., PEOPLE, PLACES, TIME and WLM. These in turn contain the values, e.g. "K-pool", "Laptop", … in keyword-class "LABEL"; "CDHK Raum 2004", "China", "Shanghai" in keyword-class "Places"; etc.
- Miscellaneous other parameters: e.g. the thumbnail image, URL from document ID and permanent URL, area for "Comments".

In addition to area 2, area 3 provides a tooling environment (workflow, metadata tagging, administration, etc.) to contextually structure and process K-nuggets. For instance, in Fig. 7, via a set of intelligent tools will be accessed where end-users may dynamically tag K-nuggets based on a taxonomy (simply: category list) for their individual and personal categorization. Additionally, workflow contextual parameters can be assigned to the K-nuggets for ad-hoc workflow process as shown in Fig. 8.

Figure 7. "Categories" contextual parameter for personalization of contexts

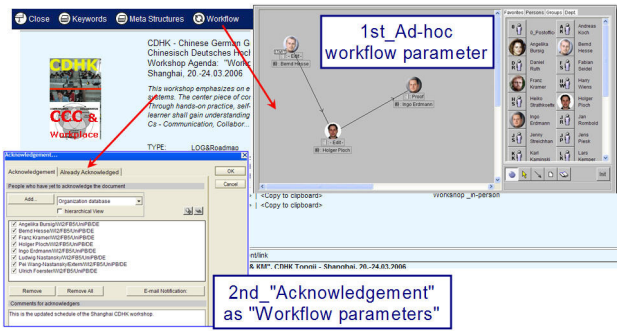

Figure 8. Assigning different "Workflow parameters" to the context information set.

In summary, the CM-WLOD[2] approach essentially aims at denoting a decentralized, learner-generated learning/working process which is driven by contextual collaboration with digital resources, peers, and experts in an organizational workplace setting. Especially, CM-WLOD deals with the ever changing patterns of re-use and re-purposing of information and their underlying re-contextualization in an effective way in the workplace.

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APPENDIX

Applied Definition of Terms Used in CM-WLOD

1. Domain /application domain: A domain or application domain is considered to be a topic, focal point, a practice area, or a specific field of expertise and knowledge in the real world. A domain might be determined by e.g.: individual activities of employees, recurring (business) processes or projects in the organization, learning or training endeavors. A domain might be defined by an individual (employee in a line of business, subject matter expert, trainer, manager, business partner, etc.) or group of users (departments, projects, customer organization, suppliers, etc.). The specific application environment of a K-nugget in the real world is defined as the K-nugget's "application domain" in this research work.
2. Content /content material: Given data, information, and knowledge assets being rendered in digital format (i.e. text, graphics, image, video, animation, demo and test cases, etc.).
3. Contextual factors/contextual parameters /tag class: Data types and values describing the relation of content to an application domain. Generally, contextual factors can be attributed taxonomies. The assignment of contextual parameters is accomplished via metadata modeling and related tools, based e.g. on tagging, contextual wrapping, adding context links to objects, template design, or individual and specific context objects.
4. Context information set /context stub: The aggregation and packaging of contextual factors into a specific collection. Within the framework of the CM-WLOD approach tag classes are packaged in parameter containers, denoted as context stubs. A specific context stub is defining one context information set. In addition, specific contextual factors might be closely interwoven with content material, e.g. links or dynamically embedded objects.
5. K-nugget /knowledge nugget: A digital resource which includes 1) content material and 2) context information sets. In CM-WLOD a K-nugget is modeled as a document. A K-nugget consists of exactly one set of content material contained in a content field, and one or more context information sets contained in respective content stubs associated to the content field. The purpose of a K-nugget is to be used in facilitating workplace information and knowledge acquisition processes on-demand.
6. Context information: Comprehensive aggregation states or collection forms of contextual factors as modeled in context information sets. In CM-WLOD context information about a K-nugget is revealed to the outside by its associated context information set(s) and/or by automated content analysis (e.g. full text search, semantic analysis). Context information can be rendered in a variety of formats to the user in the workplace environment, using e.g. textual, tabular, list or graphical representations. Basically, the rendering shows the values of context parameters presented in a way appropriate to the purpose of usage of the related K-nuggets in an actual business process situation at the workplace.
7. Multiple contexts / Multiple context information sets: In CM-WLOD context is modeled in a way that independently more than one context information set can be assigned to one set of content material. This important feature will be referenced to as "multiple contexts". Thus, different context information sets might be indexed as: $context_1$, $context_2$…$context_n$ denoting this feature.
8. Contextual signature /Contextual profile: A Contextual signature is a comprehensive representation of a specific context information set. Contextual signatures are different if they vary in at least one value of a contextual parameter. An arbitrary subset of a K-nugget's actual contextual parameters is called a Contextual profile. These Contextual profiles might be search upon.
9. Tagging: A mechanism to assign context information by allocating values to contextual parameters, e.g. by assigning keywords, by adding links, or by connecting pre-fabricated templates to the current set of context information. In this research, due to the workplace orientation, tagging in most cases exists of adding whole new context stubs to already existing K-nuggets or adding/changing/deleting values of contextual parameters in context information sets during the course of business processes. Tagging can be done by humans or software agents.

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