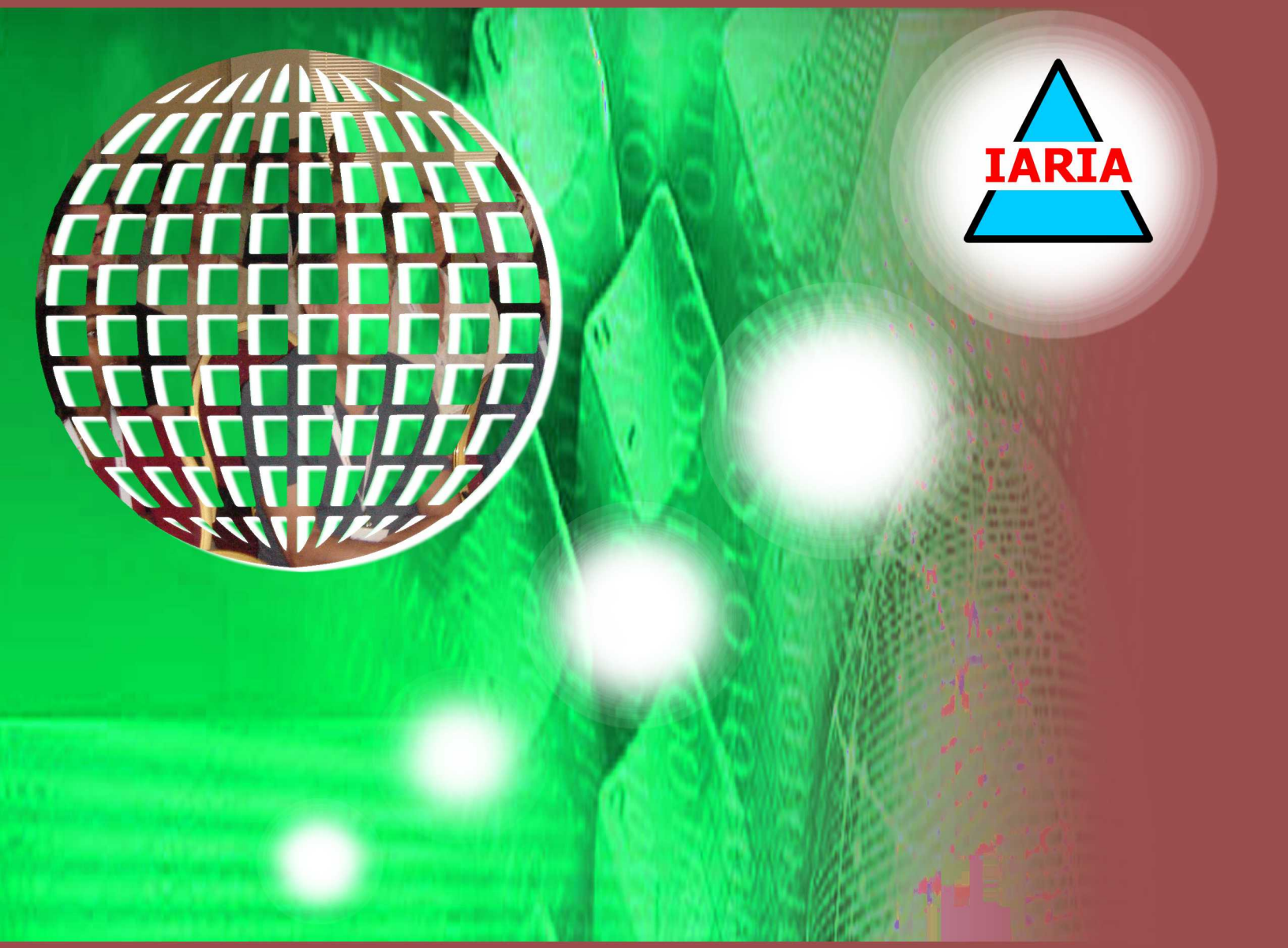
International Journal on Advances in Life Sciences



2011 vol. 3 nr. 3&4

The *International Journal on Advances in Life Sciences* is published by IARIA.
ISSN: 1942-2660
journals site: http://www.iariajournals.org
contact: petre@iaria.org

Sponsored by IARIA
www.iaria.org

International Journal on Advances in Life Sciences
Volume 3, Number 3 & 4, 2011

- Steve Wheeler, University of Plymouth, UK

Advanced Knowledge Representation and Processing

- Freimut Bodendorf, University of Erlangen-Nuernberg Germany
- Borka Jerman-Blazic, Jozef Stefan Institute, Slovenia
- Andrew Kusiak, The University of Iowa, USA
- Selmin Nurcan, University Paris 1 Pantheon Sorbonne, France
- Jeff Riley, Hewlett-Packard Australia, Australia
- Lars Taxen, Linkoping University - Norrkoping, Sweden

International Journal on Advances in Life Sciences
Volume 3, Numbers 3 & 4, 2011

CONTENTS

A Knowledge Development Conception and its Implementation: Ontology Categories, Knowledge Ontology, Rule System and Application Scenarios

Eckhard Ammann
School of Informatics
Reutlingen University, Reutlingen, Germany
Eckhard.Ammann@Reutlingen-University.de

Ismael Navas-Delgado, José F. Aldana-Montes
E.T.S.I. Informática
University of Málaga, 29071 Málaga, Spain
{ismael, jfam}@lcc.uma.es

***Abstract*-- Knowledge development in an enterprise is about approaches, methods, techniques and tools, that will support the advancement of individual and organizational knowledge for the purpose of an improvement of businesses. An approach for knowledge development in a company is described in this paper. This approach is based on a new conception of knowledge, with the introduction of three knowledge dimensions and conversions between knowledge assets. To guide a formalized implementation of this conception in the form of a knowledge ontology, we discuss principal ontology categories of things and adapt them to the domain of knowledge development and management. Thus, we can take advantage of reasoning and rules processing, provided by a reasoner in combination with a rule engine. Important scenarios for knowledge development in a company are identified and it is shown how these scenarios can be supported by processing the developed rules. For example, knowledge requirements for a new or existing employee can be gained once the appropriate requirements for a planned project are known as well as the learning options in the company.**

***Keywords*--** *Conception of knowledge, knowledge development, ontology categories, knowledge ontology, rule system, application scenarios.*

I. INTRODUCTION

This is an extended version of a conference paper [1].

Knowledge development in an enterprise is about approaches, methods, techniques and tools, that will support the advancement of knowledge for the purpose of an improvement of businesses. This notion includes as well individual knowledge as group and organizational knowledge. It can be seen as integral part of knowledge management; see [2], [3] and [4] for a description of several existing approaches for knowledge management. One specific approach for enterprise knowledge development is EKD (Enterprise Knowledge Development), which aims at articulating, modeling and reasoning about knowledge, which supports the process of analyzing, planning, designing, and changing your business; see [5] and [6] for a description of EKD. EKD does not provide a conceptual description of knowledge and knowledge development.

In this paper, we present a new conception of knowledge and knowledge development and describe an implementation of this conception based on a knowledge ontology, reasoning support and a rule system.

For the conception part, there exists one well-known approach by Nonaka/Takeuchi [7], which is built on the distinction between tacit and explicit knowledge and on four knowledge conversions between the knowledge types (SECI-model). However, is explicit knowledge still bound to the human being, or already detached from him? Also, the linear spiral model of knowledge development is limiting.

Concepts for organizational learning, which is closely related to knowledge management, are given by Argyris and Schön [8, 9] and by Senge [10]. The latter refers to system thinking as very important fifth discipline of the learning organization; also, see [11] for system thinking.

Approaches for knowledge transfer are surveyed in [12]. An approach for knowledge access and development in firms is given by Boisot [13]. Here, development scenarios of knowledge in the Information Space are provided.

Our conception of knowledge is represented by a three-dimensional model of knowledge with types, kinds and qualities. General knowledge conversions between the various knowledge variants are introduced as a model for knowledge dynamics in the enterprise. First, a basic set of such conversions is defined. Building on this set, general knowledge conversions can be defined, which reflect knowledge transfers and development and do not suffer from the restrictions of the SECI-model.

In order to formalize this conception of knowledge and knowledge dynamics, we shortly introduce top level categories of ontologies as described in [14] and apply them to the domain of knowledge and knowledge development. Hence, major categories of knowledge management can be identified. A similar approach is given in [15] for the intellectual capital domain.

Following this path, a knowledge ontology with a corresponding rule system is described in this paper, which implements as well the appropriate top level ontology categories as the described conception of knowledge and knowledge conversions. Everything was developed by using the web ontology language OWL [16]. The reasoning support in combination with a rule system allows for a formal treatment of important knowledge development scenarios.

Application scenarios for knowledge development are classified and described in this paper. They can be represented by general knowledge conversions, which are subject to rule processing. A set of corresponding rules for addressing these scenarios and their representations has been developed and is described in this paper. Therefore, possible solutions for those scenarios can be gained.

The structure of the paper is as follows. After an introduction, Section II introduces our conception of knowledge and knowledge dynamics. Section III overviews the top level categories of things and applies this to the domain of knowledge development. Using this, Section IV describes the knowledge ontology and the corresponding rule system. Afterwards, Section V classifies and describes application scenarios for knowledge development, which partly can supported with the formalizations of the previous section. A summary and outlook section will conclude the paper.

II. A CONCEPTION OF KNOWLEDGE AND KNOWLEDGE DYNAMICS

A conception of knowledge and knowledge dynamics in a company is described. More details are given [2].

A. Knowledge Conception

We provide a conception of knowledge with types, kinds and qualities. As our base notion, knowledge is understood as justified true belief (in the propositional kind), with a dimension of purpose and intent, identifying patterns in its validity scope, brought to bear in action, see [3] and [9]. It is a perspective of "knowledge-in-use" [17] because of the importance for its utilization in companies and for knowledge management. In contrast, information is understood as data in relation with a semantic dimension, but without the pragmatic and pattern-oriented dimension, which characterizes knowledge.

1) Type Dimension of Knowledge

The type dimension is the most important for knowledge management in a company. It categorizes knowledge according to its presence and availability. Is it only available for the owning human being, or can it be communicated, applied or transferred to the outside, or is it externally available in the company's organizational memory? It is crucial for the purposes of the company, and hence a main goal of knowledge management activities, to make as much as possible knowledge available, i.e., let it be converted from internal to more external types.

Our conception for the type dimension of knowledge follows a distinction between the internal and external knowledge types, seen from the perspective of the human being. As third and intermediary type, explicit knowledge is seen as an interface for human interaction and for the purpose of knowledge externalization, the latter one ending up in external knowledge. Internal (or implicit) knowledge is bound to the human being. It is all that, what a person has "in its brain" due to experience, history, activities and learning. Explicit knowledge is "made explicit" to the outside world, e.g., through spoken language, but is still bound to the human being. External knowledge finally is detached from the human being and may be kept in appropriate storage media as part of the organizational memory. Figure 1 depicts the different knowledge types.

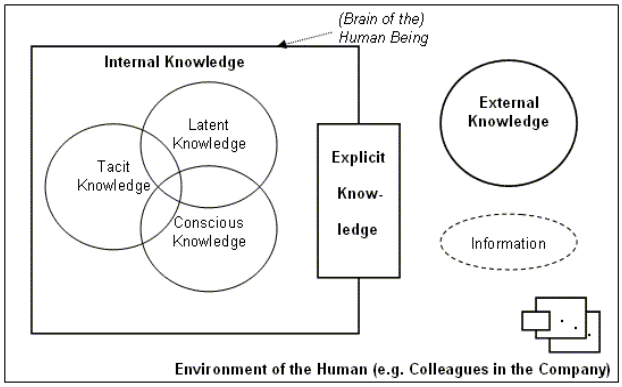


Figure 1. Conception of knowledge types

Internal knowledge can be further divided into tacit, latent and conscious knowledge, where those subtypes do partly overlap with each other; see [18]. Conscious knowledge is conscious and intentional, is cognitively available and may be made explicit easily. Latent knowledge has been typically learning as a by-product and is not available consciously. It may be made explicit, for example in situations, which are similar to the original learning situation, however. Tacit knowledge is built up through experiences and (cultural) socialization situations, is specific in its context and based on intuition and perception.

2) Kind Dimension of Knowledge

In the second dimension of knowledge, four kinds of knowledge are distinguished: propositional, procedural and strategic knowledge, and familiarity. It resembles to a certain degree the type dimension as described in [17]. Propositional knowledge is knowledge about content, facts in a domain, semantic interrelationship and theories. Experience, practical knowledge and the knowledge on "how-to-do" constitute procedural knowledge. Strategic knowledge is meta-cognitive knowledge on optimal strategies for structuring a problem-solving approach. Finally, familiarity is acquaintance with certain situations and environments; it also resembles aspects of situational knowledge, i.e., knowledge about situations, which typically appear in particular domains.

Knowledge kinds go along with knowledge types in the sense, that they occur in most knowledge types. The

TABLE I TYPE/KIND-MATRIX OF KNOWLEDGE

Knowledge Type / Kind	internal			explicit	external
	tacit	latent	conscious		
propositional	X	X	X	X	X
procedural	X	X	X	(X) [1]	(X) [2]
strategic	X	X	X	(X) [3]	—
familiarity	(X) [4]	X	X	X	? [5]

Legend:
1 can be demonstrated, not to be articulated easily
2 partly through intelligent application systems
3 partly, can be demonstrated
4 if at all, unconscious acquaintance
5 if at all, possibly in future intelligent application systems

type/kind-matrix given in Table 1 indicates, which type/kind-pairs normally appear. One interesting content is, that external knowledge does not appear in the strategic and.familiarity kinds, the latter case with the potential of becoming possible with future intelligent application systems.

3) Quality Dimension of Knowledge

The quality dimension introduces five characteristics of knowledge with an appropriate qualifying and is independent of the kind dimension; see [17]. The level characteristics aims at overview vs. deep knowledge, structure distinguishes isolated from structured knowledge. The automation characteristic of knowledge can be step-by-step-doing by a beginner in a domain of work or automated fast acting by an expert.

Modality as the fourth quality of knowledge asks for the representation of it, be it words versus pictures in situational knowledge kinds, or propositions versus pictures in procedural knowledge kinds. Finally, generality differentiates general versus domain-specific knowledge. Knowledge qualities apply to each knowledge asset.

4) The Knowledge Cube

Bringing all three dimensions of knowledge together, we gain an overall picture of our knowledge conception. It can be represented by the knowledge cube as shown in Figure 2.

Note, that the dimensions in the knowledge cube behave different. In the type and kind dimensions, the categories are mostly distinctive (with the mentioned exception in the sub-types), while in the quality dimension each of the given five characteristics are always present for each knowledge asset.

B. Knowledge Dynamics

Here we give a conception of knowledge conversions. The transitions between the different knowledge types, kind and qualities are responsible to a high degree for knowledge development in an organization. These general knowledge conversions are the building blocks to model knowledge dynamics, i.e., all of acquisition, conversion, transfer, development and usage of knowledge, in an enterprise.

Most important for knowledge management purposes are conversions between the knowledge types, especially those making individual and internal knowledge of employees usable for a company. The explicitation and externalization conversions described in this section achieve this. Implicitly, socializations between tacit knowledge of different people also contribute to this goal.

1) Basic Knowledge Conversions

Five basic knowledge conversions in the type dimension are distinguished here: socialization, explicitation, externalization, internalization and combination. Basic conversion means, that exactly one source knowledge asset is converted into exactly one destination knowledge asset and exactly one knowledge dimension (i.e., the type dimension in this case) is changed. More complex conversions may be easily gained by building on this set as described in the next sub-section. They will consist of n-to-m-conversions and include information assets in addition.

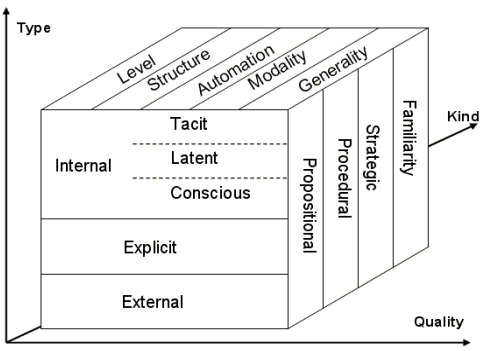


Figure 2. The knowledge cube

Socialization converts tacit knowledge of a person into tacit knowledge of another person. This may succeed by exchange of experience or in a learning-by-doing situation. Explicitation is the internal process of a person, to make internal knowledge of the latent or conscious type explicit, e.g., by articulation and formulation (in the conscious case) or by using metaphors, analogies and models (in the latent case). Externalization converts from explicit knowledge to external knowledge or information and leads to detached knowledge as seen from the perspective of the human being, which can be kept in organizational memory systems. Internalization converts either external or explicit knowledge into internal knowledge of the conscious or latent types. It leads to an integration of experiences and competences in your own mental model. Finally, combination combines existing explicit or external knowledge in new forms.

Basic knowledge conversions in the kind dimension of knowledge do not occur. Those in the quality dimension are mostly knowledge developments aiming at quality improvement. Examples are basic conversions changing the overview, structure and automation quality, respectively.

2) General Knowledge Conversions

Our conception allows the generalization of the basic five knowledge conversions described above. General knowledge conversions are modeled converting several source assets (possibly of different types, kinds and quality) to several destination assets (also possibly different in their knowledge dimensions). In addition, information assets are considered as possible contributing or generated parts of general knowledge conversions.

For example, in a supervised learning-by-doing situation seen as a complex knowledge conversion, a new employee may extend his tacit and conscious knowledge by working on and extending external knowledge in a general conversion, being assisted by the tacit and conscious knowledge of an experienced colleague. As a result of the conversion we have extended internal knowledge of the new employee and extended external knowledge. Figure 3 shows this general knowledge conversion in the proposed BPMN-KEC2 notation, which extends the well-known business process modeling notation BPMN with constructs related to knowledge and knowledge dynamics; see [3] for more details of this notation.

III. ONTOLOGY CATEGORIES

In order to formalize this conception of knowledge and knowledge dynamics, we shortly introduce top level categories of ontologies as described in [14] and apply them to the domain of knowledge and knowledge development. Hence, major categories of knowledge management can be identified. A similar approach is given in [15] for the intellectual capital domain.

" Ontology . . . is the study of existence, of all the kinds of existence – abstract and concrete that make up the world" (Sowa in [14, p.51]). According to Peirce ([19], also in [14]), one fundamental distinction of categories in ontologies is reflected by the idea of so-called triads, which he called Firstness, Secondness, and Thirdness. Here we follow Sowa [14] and call them Independent, Relative, and Mediating, respectively. Independents represent actual entities, which are identified by qualities and can exist independent from any other entities. In logic, they can be represented by a monadic predicate (e.g., person(z)). Relatives denote entities, which exist relative to other entities. In logic, their representation would be in the form of a dyadic predicate (e.g., mother(y,z), where y would be the mother of z here). Mediating (or Thirdness) brings the first and second categories in relation. In our example, a ternary predicate in logic could be motherhood(x, y, z), where the motherhood x brings together the mother y and

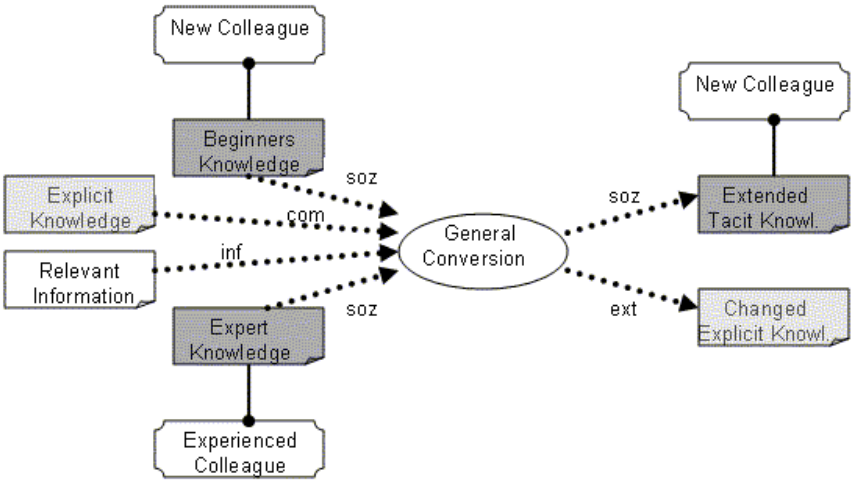


Figure 3. Examples of a general knowledge conversion

	Physical		Abstract	
	Continuant	Occurent	Continuant	Occurent
Independent	Object	Process	Knowledge	Single-Loop Learning
Relative	Relation	Participation	Rules	Double-Loop Learning
Mediating	Organizational Context	Community of Practice	Knowledge Strategy	Deutero Learning

Figure 4. Categories of a knowledge management ontology
(Sources: [19], [15], author's adaptation for knowledge management)

her child person z. It is not possible, to express this mediating entity with a monadic or dyadic predicate or a conjunction of dyadic predicates. In general, mediating entities can be represented in logic by ternary or higher predicates.

The second distinction of ontology categories addresses the physical vs. abstract contrast of entities. This distinctionis independent of an observer's viewpoint. This is different for the third and final distinction of categories, where the contrast between continuant and occurent is stated. Continuants are entities, which are recognizable as one and the same entity at different times. Occurents flow in the sense, that they can only be identified by their location in the space-time region.

Having a triadic and two dual distinctions, we end up in a set of twelve categories of entities. In Figure 4, we list these categories in a matrix representation according to [14]. We changed the categories to reflect important concepts for the domain of knowledge development and management. Those changes are partly already proposed in [15] for the domain of intellectual capital, which is related to knowledge management.

On the physical side, we only want to emphasize the occurent and mediating entry in Figure 4. Here communities of practice in companies can be seen, which relate processes and participation in knowledge themes of interest. On the abstract side, continuants in the knowledge development and management domain are knowledge, rules, and knowledge strategy, taken from independent over relative to mediating. Abstract occurents are organizational learning entities, namely single-looplearning, double-loop learning, and deutero learning, see [8,9] for this organizational learning loops.

IV. THE KNOWLEDGE ONTOLOGY

In this section, we present the Knowledge Ontology, which implements the conception of knowledge and knowledge dynamics, as described in Section II. As one main goal the ontology will enable the discovery of the crucial knowledge conversions for a company. The ontology (as visually shown in Figure 5) is divided in four core concepts: *Knowledge*, *Information*, *Knowledge_Conversion* and *Knowledge_Dimension*. The three different knowledge dimensions are represented as: *Type_Dimension*, *Kind_Dimension* and *Quality-Dimension*. *Knowledge* is defined according to these dimensions. Properties are used to model the relationships between *Knowledge* and *Dimensions*: *hasType*, *hasKind* and *hasQuality*. For example, *Explicit_Knowledge* is defined as every piece of knowledge, which is related to the instance *Explicit_Type* via the *hasType* property. In the same way, *Knowledge* in general must be related to every quality sub-dimension through the *hasQuality* property.

In the case of the type dimension of knowledge, we have defined disjoint axioms in order to make explicit the fact that a piece of knowledge cannot be simultaneously external and internal - except in the case of *Latent*, *Conscious* and *Tacit Knowledge*, which can actually overlap (compare with Figure 1). There are also disjoint axioms for the kind dimension, since a propositional piece of knowledge cannot be *Procedural*, neither *Strategic* nor *Familiarity*.

Two properties have been defined to model the knowledge conversions: *hasSource* and *hasDestination*, with knowledge conversions as ranges, and pieces of knowledge and information as domains.

A General Conversion is modeled through the *Knowledge Conversion* concept, and its only restriction the fact that it must have at least one source asset and one destination asset. *Basic Conversions* are more specific, in the sense that they have only one source and only one destination. Eight basic conversions (five in the type dimension, three in the quality dimension) are defined in the ontology.

The concept *Crucial_Conversion* gathers those conversions that contribute to the goal of making the knowledge available for the company.

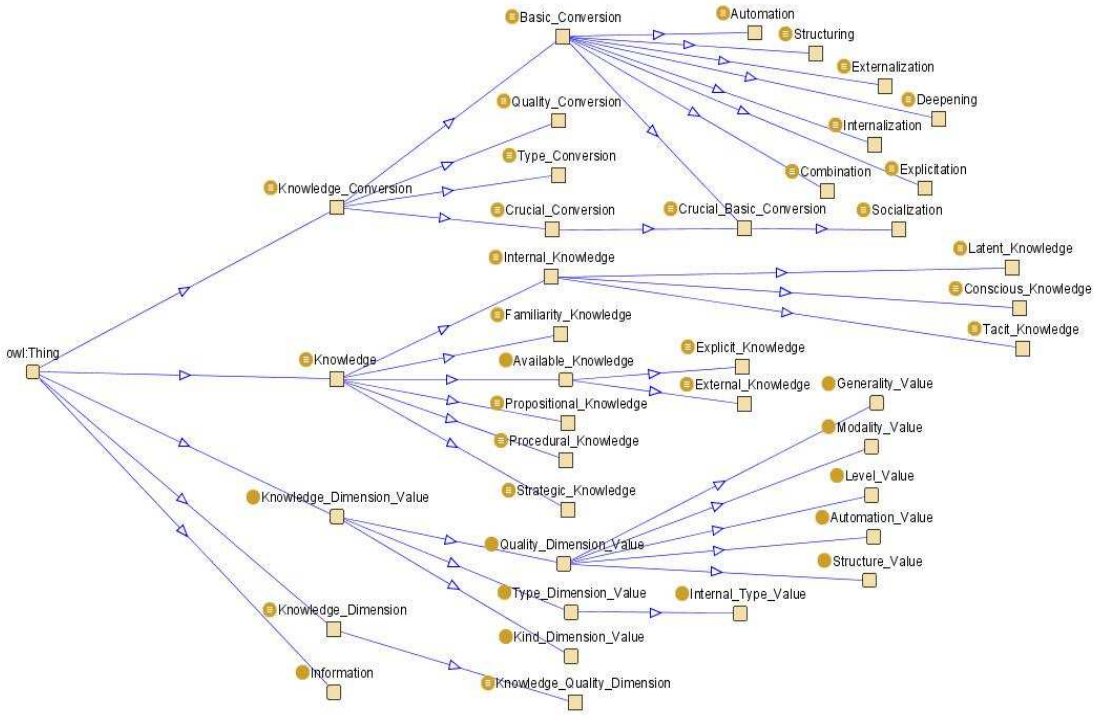


Figure 5. Knowledge ontology hierarchy

A. *Restrictions and Reasoning*

Basic reasoning is based on subsumption mechanisms that deal with the ontology hierarchy. However, ontologies can contain more complex elements to enable advanced reasoning. In this way, the Knowledge Ontology has been extended with OWL restrictions to enable new ways of generating interesting new knowledge.

Here, we will only describe some of the most interesting restrictions. Let us imagine that we have two pieces of knowledge in our company: *knowledge1* and *knowledge2*. Both pieces of knowledge have as type *Explicit* (is related to the instance of *Type_Dimension_Value* called *Explicit* through the property *hasTypeValue*). Additionally we have defined *Explicit_Knowledge* as follows:

Available_Knowledge AND
∃hasTypeValue has Explicit

Thus, a reasoner will identify both pieces of knowledge as *Explicit_Knowledge* (and using subsumption also as *Available_Knowledge*).

We can consider two different conversions *conversion1* and *conversion2*: one that converts *knowledge1* in *knowledge2* and vice versa. Then, we have defined a *Crucial_Conversion* as:

Knowledge_Conversion AND
∃hasDestination some Available_Knowledge

Thus, we can infer that *conversion1* is a *Crucial_Conversion* for the company.

B. *Rules*

Ontology restrictions allow us to infer new characteristics of a given concept or instance. However, in some cases we could require to generate new instances in the ontology depending on certain situations. In this case we have used rules, so the knowledge ontology will be able to infer all the possible conversions given some pieces of knowledge. First, the rule engine will create basic conversions with all the possible source-destination pairs, and then, the same engine will characterize these conversions, inferring the changing dimension for each case.

SWRL [20] rules have been defined and the Jess rule engine [21] has been used. The main rule for our model is the one that creates new conversions for the knowledge assets that we have stored in our ontology:

Knowledge(?k1) ^ Knowledge(?k2) ^
hasDimensionValue(?k1, ?v1) ^
hasDimensionValue(?k2, ?v2) ^
differentFrom(?k1, ?k2) ^ differentFrom(?v1, ?v2) ^
swrlx:makeOWLThing(?c, ?k1, ?k2)
→
Knowledge_Conversion(?c) ^ hasSource(?c, ?k1) ^
hasDestination(?c, ?k2)

Thus, this rule is activated when we have two different pieces of knowledge with different dimensions values. In this case, a new instance is created for providing a new knowledge conversion between both pieces of knowledge.

Then, we have six rules to infer the changing dimensions of each of the new discovered conversions: one for the type dimension and five for the quality ones. For example, the rule for the type dimension is as follows:

Knowledge(?k1) ^ Knowledge(?k2) ^
hasTypeValue(?k1, ?v1) ^ hasTypeValue(?k2, ?v2) ^
differentFrom(?v1, ?v2) ^ Knowledge_Conversion(?c1) ^
hasSource(?c, ?k1) ^ hasDestination(?c, ?k2)
→
hasChangingDimension(?c,
Knowledge_Type_Dimension)

Suppose that we have two pieces of knowledge in our company (*knowledge1* and *knowledge2)*, which are related through the *hasTypeValue* property to *Explicit* and *External*, respectively. Both are related to the values *Familiar* and *Step by step*. Using the defined rules, new instances are produced. Thus, the rule engine has inferred two conversions, one for "knowledge1 → knowledge2", and another for "knowledge2 → knowledge1". Then, the reasoner can infer additional facts:

- About the pieces of knowledge:
  - They are both *Familiar_Knowledge*.
  - One of them is *External_Knowledge*, the other is *Explicit_Knowledge*.
  - Both are *Available_Knowledge*.
- About the conversions:
  - They are both *Basic_Conversion*.
  - Both are *Crucial_Conversion* (since they have *Available_Knowledge* as destination).
  - Both are *Type Conversions* (since they change the type dimension).

V. APPLICATION SCENARIOS

Application scenarios for knowledge development in a company can be related with our model of knowledge dynamics. Two categories of scenarios exist. The first one is constructive and builds knowledge development chains (see [2] for a modeling approach). Here we focus on the second scenario category, which consists of analytic scenarios. They can be represented by general knowledge conversions and are subject to rule processing as described in Section IV. In these scenarios we face gaps in knowledge dynamics chains as provided by knowledge conversions. These gaps will be closed by applying appropriate rules to the relevant instances of knowledge assets and conversions, which have been instantiated in our knowledge ontology.

As an example suppose, that the knowledge requirement for a project and the learning options in the company are known. The task would be to identify the minimal knowledge requirements for a new employee, who should work on the project and should be able to fulfill the requirements at least after some learning efforts. This scenario is modeled in Figure 6, where the first part shows the analytic scenario, and the second part is giving the solution after rule application. As notation BPMN-KEC2 is used again.

Part I: Basic analytic scenario

Part II: Solution after rule application

Figure 6. A basic scenario and its solution

Our principle approach to deal with analytic scenarios is shown in Figure 7. The bold arrow in the first line indicates the knowledge development activity, which is needed in order to resolve an application scenario with unknown part. Our approach first represents the application scenario as a general knowledge conversion, applies an appropriate rule of our rule system to it, and finally interprets the completed knowledge conversion as solved application scenario.

For example, the knowledge requirements for a project are known as well as the learning options in the company. From that, one would try to identify minimal knowledge requirements for a new employee, who should work in the project and should be able to fulfill the requirements at least after some learning efforts.

Our representation of this scenario is that we know the result of a knowledge conversion as well as the conversion itself, but we do not know the source knowledge asset. A rule application should deliver the missing knowledge asset.

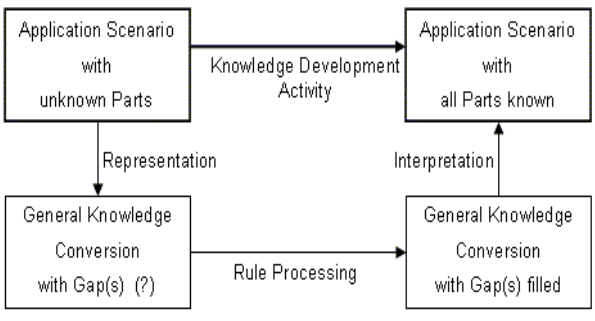


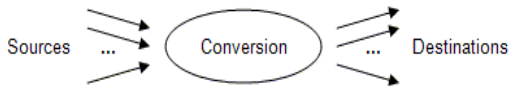
Figure 7. Support of knowledge development scenarios

A. Analytic Application Scenarios and their Representation

Analytic application scenarios for knowledge development are characterized by gaps in the corresponding knowledge dynamics chains. Without restriction of generality, we focus on simple scenarios, which can be represented by a single general knowledge conversion. More complex scenarios should be composed of simple ones.

A representation as a general knowledge conversion leads to a set of eight possible scenarios. In the conversion definition with sources, conversion and destinations we can apply zero or more question marks, i.e., gaps of unknown parts, to the conversion. Out of the eight possible scenarios, we do not further consider two of them. The case with no gap is a constructive scenario really, while the case without any known part is not a realistic one. The other six scenarios are outlined in the following and shown in Figure 8.

Scenarios with known destination parts of the conversion and with gaps on the sources side represent situations, where the target of knowledge development activities is known. A known conversion part in the knowledge conversion in this scenario would indicate existing knowledge development options in the company, while a gap indicates missing development support (Scenarios 1 and 2). Scenario 5 describes known sources and destination parts, but missing development options and support in the company. Scenarios 3 and 4 have a complete sources part of the knowledge conversion and gaps in the destinations part. If existing knowledge development options are available, then the scenario would ask for the potential of evolving knowledge applying these options (Scenario 3). If no such options exist, the question of the scenario would be, which knowledge development activities should be initiated and to which possible result in extended and new knowledge this could lead (Scenario 4). Finally, Scenario 6 assumes existing knowledge development options in the company, but incomplete sources and destinations parts. If only very few out of the sets of sources or destinations are unknown, this scenario can be partly handled with our approach also. Otherwise, especially in the case of completely exclusively unknown sources and destinations, no further treatment is possible.



Scenario	Sources	Conversion	Destinations
1	?	known	known
2	?	?	known
3	known	known	?
4	known	?	?
5	known	?	known
6	?	known	?

Legend:

? for Sources (Destinations):
One or more ot the Sources (Destinations) are unknown
? for Conversion:
Conversion is unknown

Figure 8. Application scenarios and representations

B. Rules Application to Representations of Scenarios

As described in Section IV, a rule system has been developed, which is applied to instances of knowledge and conversions introduced in the knowledge ontology.

Only rules for basic knowledge conversions in the type dimension with only one gap exist until now. We therefore are restricted currently to the corresponding 1-to-1 cases of scenarios 1, 3 and 5 as described before in Figure 8. A rule for Scenario 5 case has already been given in Section IV. For each of Scenarios 1 and 3, there exist five such 1-to-1 cases, because the known conversion part must be one of the five basic knowledge conversions in the type dimension. Here we analyze the cases and provide appropriate rules. Note that in some scenarios there is unambiguous implication result of the corresponding rules.

1) Scenario: Source → Socialization → ?
The following rule produces a new destination *Tacit_Knowledge:*

Knowledge(?k1) ^ Socialization(?s) ^
hasSource(?s, ?k1) ^
swrlx:makeOWLThing(?k2, ?k1)
→
Tacit_Knowledge(?k2) ^ hasDestination(?s, ?k2)

2) ? → Socialization → Destination
A new source Tacit_Knowledge is produced:

Knowledge(?k2) ^
Socialization(?s) ^
hasDestination(?s, ?k2) ^
swrlx:makeOWLThing(?k1, ?k2)
→
Tacit_Knowledge(?k1) ^
hasSource(?s, ?k1)

3) Source → Explicitation → ?
A new destination Explicit_Knowledge is produced:

Knowledge(?k1) ^
Explicitation(?e) ^
hasSource(?e, ?k1) ^
swrlx:makeOWLThing(?k2, ?k1)
→
Explicit_Knowledge(?k2) ^
hasDestination(?e, ?k2)

4) ? → Explicitation → Destination
In this case, we produce latent or conscious knowledge as the source. However, it is not possible to decide on one of them so this rule has been generalized to produce a new destination internal knowledge.

5) Source → Externalization → ?
This kind of conversion produces information or external knowledge. So, this case will depend on the user perspective and decision, so it cannot be solved at rule level.

6) ? → Externalization → Destination
A new source explicit knowledge is produced:
Knowledge(?k2) ^
Externalization(?e) ^
hasDestination(?e, ?k2) ^
swrlx:makeOWLThing(?k1, ?k2)
→
Explicit_Knowledge(?k1) ^
hasSource(?e, ?k1)

7) Source → Internalization → ?
We produce a new source internal knowledge:
Knowledge(?k1) ^
Internalisation(?i) ^
hasSource(?i, ?k1) ^
swrlx:makeOWLThing(?k2, ?k1)
→
Internal_Knowledge(?k2) ^
hasDestination(?i, ?k2)

8) ? → Internalization → Destination
This kind of conversion can work over information or external knowledge. So, this case will depend on the user perspective and decision, so it cannot be solved at rule level.

9) Source → Combination → ?
This kind of conversion can produce Information or External Knowledge. So, this case will depend on the user perspective and decision, so it cannot be solved at rule level.

10) Scenario: ? → Combination → Destination
The following rule produces a new source *Available_Knowledge*, it cannot decide on a specific type of *Explicit_Knowledge* or *External_Knowledge*:
Knowledge(?k2) ^ Combination(?c) ^
hasDestination(?c, ?k2) ^
swrlx:makeOWLThing(?k1, ?k2)
→
Available_Knowledge(?k1) ^
hasSource(?c, ?k1)

C. Setting the Approach into Perspective

In this section, application scenarios have been discussed so far, with focus on analytic scenarios. In this sub-section, the findings are set into perspective.

As can be seen in Figure 7, there is a distinction between the application scenario level and the formal representational level with general knowledge conversions.

In a real knowledge development situation in a company, as first activity the corresponding application scenario must be identified and described. The following steps of representation as general knowledge conversions with gaps, rule processing, and the interpretation of the results as application scenario with all parts known are shown in Figure 7. As a final activity these outcomes have to be implemented in the company.

According to this discussion, we can in principle identify a hierarchy consisting of knowledge development instances, descriptions of them, and a model for formally handling them:

- Knowledge development situation/need in the company.
- Identification and description of it as application scenario with unknown parts.
- Modeling of this scenario with general knowledge conversions with gaps, which allows for rule processing in order to fill the gaps.

What is needed in the future is, firstly, to build up experience in concrete knowledge development situations in companies and to apply the steps to them as described above. This would verify our approach and indicate its value for knowledge development. Secondly, the body of rules on the modeling level must be extended beyond basic knowledge conversions and augmented with heuristics, where rules application could not possibly show up a unique result. Heuristics should provide good or acceptable solutions, where exact solutions are not possible.

VI. SUMMARY AND OUTLOOK

A conception of knowledge development in an enterprise has been given. It is based on a concept of knowledge and knowledge dynamics.

In order to formalize this conception of knowledge and knowledge dynamics, top level categories of ontologies have been given and applied to the domain of knowledge and knowledge development. Hence, major categories of knowledge management could be identified.

In order to implement this conception, a knowledge ontology has been built and described in this paper, together with reasoning support and in combination with a rule engine. This has opened the path, to solve open questions in application scenarios for knowledge development.

With the help of representations, these scenarios can be mapped to general knowledge conversions, which are subject to rule processing in relation to the knowledge ontology. A final interpretation steps leads back to the solved scenario. In effect, the knowledge development activity has been undertaken with this procedure. A clear

distinction between the application scenario level and the formalized model level is shown by this approach, with representation and interpretation as bridging "operators".

Until now only simple application scenarios and their representations are covered by the set of developed rules. In more complex scenarios, possible solutions are no longer unique. With the help of heuristics, which have to be developed, good or acceptable solutions may be identified. Those heuristics should be developed having results of several fields of study in mind, e.g., learning psychology and organizational learning.

What is needed in the future is, to build up experience in concrete knowledge development situations in companies and to apply the steps to them as described above. This would verify our approach and indicate its value for knowledge development.

ACKNOWLEDGEMENT

Supported in parts by TIN2008-04844 (Spanish Ministry of Education and Science).

REFERENCES

[1] Ammann, E., Ruiz-Montiel, M., Navas-Delgado, I., and Aldana-Montes, J.F.: "A Knowledge Development Conception and its Implementation: Knowledge Ontology, Rule System and Application Scenarios", Proc. of the 2nd Int. Conf. on Advanced Cognitive Technologies and Applications (COGNITIVE 2010), Lisbon, Portugal, 21-25 November, 2010, pp. 60-65.

[2] Ammann, E.: "A Meta-Model for Knowledge Management", Proc. of the 5th Int. Conf. on Intellectual Capital and Knowledge Management (ICICKM), New York 2008, pp 37-44.

[3] Ammann, E.: "The Knowledge Cube and Knowledge Conversions", Proc. of the World Congress of Engineering, International Conference on Data Mining and Knowledge Engineering (ICDMKE), London, UK 2009, pp.319-324.

[4] Lehner, F.: Wissensmanagement (in German), 3rd ed., Hanser, München 2010.

[5] Bubenko, J.A., Jr., Brash, D., and Stirna, J.: EKD User Guide, Dept. of Computer and System Science, KTH and Stockholm University, Elektrum 212, S-16440, Sweden.

[6] EKD – Enterprise Knowledge Development, ekd.dsv.su.se/home.html. Last access: January 5, 2012.

[7] Nonaka, I. and Takeuchi, H.: The Knowledge-Creating Company – How Japanese Companies Foster Creativity and Innovation for Competitive Advantage, Oxford University Press, London 1995.

[8] Argyris, C. and Schön, D.A.: Organizational Learning: a Theory of Action Perspective, Addison-Wesley, Reading, Massachusetts 1978.

[9] Argyris, C. and Schön, D.A.: Organizational Learning II – Theory, Method, and Practice, Addison-Wesley, Reading, Massachusetts 1996.

[10] Senge, P.: The Fifth Discipline, Currency Doubleday, New York 1994.

[11] Sterman, J.D.: Business Dynamics – Systems Thinking and Modeling for a Complex World, McGraw Hill, Boston, USA 2000.

[12] Ling, L.H.: "From Shannon-Weaver to Boisot: A Review on the Research of Knowledge Transfer", in: Proc. of Wireless Communications, Networking and Mobile Computing (WiCom 2007), 2007, pp. 5439-5442.

[13] Boisot, M.H.: Knowledge Assets, Oxford University Press, 1999.

[14] Sowa, J.F.: Knowledge Representation – Logical, Philosophical, and Computational Foundations, Brooks/Cole Thomson Learning, Pacific Grove, 2000.

[15] Vlismas, O. and Venieris, G.: "Towards an Ontology for the Intellectual Capital Domain", in: Journal of Intellectual Capital, Vol.12, No. 1, 2011, pp. 75-110.

[16] OWL Web Ontology Language Reference, http://www.w3.org/standards/history/owl-ref. Last access: January 5, 2012.

[17] De Jong, T. and Fergusson-Hessler, M.G.M.: "Types and Qualities of Knowledge", Educational Psychologist, 31(2), 1996, pp. 105-113.

[18] Hasler Rumois, U. : Studienbuch Wissensmanagement (in German), UTB orell fuessli, Zürich 2007.

[19] Peirce, Ch.S.: Writing of Charles S. Peirce, vols.1-5, Indiana University Press, Bloomington, 1982-1993.

[20] SWRL: A Semantic Web Rule Language Combining OWL and RuleML, http://www.w3.org/Submission/SWRL/ . Last access: January 3, 2012.

[21] Jess Rule Engine, http://www.jessrules.com. Last access: January 4, 2012.

Effectively Using an Online Multidisciplinary Tool to Update Healthcare Mentors: A Comparative Evaluative Study

Stephen White, Karen Ousey
The University of Huddersfield
Huddersfield, UK
stephen.white@hud.ac.uk , karen.ousey@hud.ac.uk

***Abstract*—This paper presents data comparing two evaluation studies following the implementation of a multiprofessional online mentor update tool designed to meet the learning needs of mentors in clinical healthcare practice. The data presented highlights that there was a positive response from clinicians using the tool during the first evaluation of 643 respondents and that this has remained positive following an increase in use to 1439. The huge resources needed to sustain traditional delivery of the updates, plus the inability of mentors to attend these events, were amongst the main drivers for the development of this tool. Results of the evaluation have identified that the flexibility of the online tool promotes engagement for both mentors and their line managers, and in doing so provides academic staff to alternatively utilize the time saved delivering it. The multiprofessional originality and uniqueness of the package has also promoted users to consider the mentor role from an inter-disciplinary perspective. With the Nursing and Midwifery Council praising the package as an example of innovative good practice, it is intended to promote its use in other regions that provide healthcare education.**

Keywords - Online; Mentor; Mentor update; Multidisciplinary; Interdisciplinary; Multiprofessional; Nursing

I. BACKGROUND

In healthcare education, the term mentor is used to describe the member of staff responsible for supporting students, for facilitating their learning and experiences within the clinical area, and making assessment decisions on their clinical abilities and knowledge. Mentors need to be adequately prepared, understanding the expectations and responsibilities of the role and the needs of their mentees. This paper explores and discusses further collection and analysis of evaluation data following implementation of an online multiprofessional update package for mentors of nursing, midwifery and other healthcare professionals. The package was originally conceived at the University of Huddersfield for use by just three professional groups [1], and has since been designed for use by fourteen professions in total: nurses; midwives; operating department practitioners (ODPs); occupational therapists; physiotherapists; dieticians; podiatrists; audiologists; clinical physiologists; diagnostic radiographers; radiotherapists; social workers; speech and language therapists and paramedics across the nine Higher Education Institutions (HEIs) in the Yorkshire and the Humber Strategic Health Authority [2].

An initial evaluation of the update tool was carried out [3], and this paper takes this process further. The data collection and analysis tools that were used for the prior evaluation are used again, but with a greater number of respondents (n=1439), to determine if the original outcomes are consistent. Finally, a summary of the findings and future plans are presented.

II. WHY IS THIS STUDY IMPORTANT?

The importance of healthcare professionals learning together to provide quality care has been discussed in the literature [4,5]. With increased time pressures on all healthcare professionals internationally, the need to provide education that is flexible to meet the personal and professional priorities of staff is essential. Additionally the use of an on line tool allows for mandatory information to be shared to large groups of individuals in a time efficient manner. Although this paper presents an online multidisciplinary tool focused on meeting the education needs of healthcare mentors, the underpinning developmental principles of the tool can be transferred to a range of learning activities, where it is important that information is transferred to large groups of staff immediately to maintain their knowledge and skills base. The interactivity of the tool provides the user with opportunities for professional development and to learn collaboratively, share ideas, discuss practice and

reflect on their own practice. Additionally tutors can facilitate conversations, offer advice and guidance ensuring that principles of quality are maintained, which is supported by Sims, who maintained that an online learning environment must be interactive and engage the learner in active communication [6].

III. THE NEED FOR AN ALTERNATIVE MENTOR UPDATE PACKAGE

The purpose of the update is not only to provide information, but also to offer a forum for mentors to discuss issues and to ask questions. For nurses and midwives there is a requirement by the Nursing and Midwifery Council (NMC), to update annually in order to be on a 'live' mentor register [7]. For ODPs an update is required within a two-year period as part of their Continuing Professional Development (CPD) cycle [8]. For the other disciplines involved in this project there are currently no specific periodic requirements for an update.

The updates, when delivered 'traditionally' through face-to-face sessions, were found to be resource-intensive, and variable in duration, quality and content, dependent on who delivered them. Added to this was a growing trend of falling attendance due to increased pressures from the clinical workplace. Therefore the time was right to consider an alternative delivery method. As a result, a web-based update tool for healthcare mentors was produced and evaluated. Background information on the development activity, underpinning processes, and initial evaluation, are described in detail in previous publications [1-3].

IV. DATA COLLECTION

Data collection is a continuous process. A questionnaire of both quantitative and qualitative questions is presented to the mentors at the end of the update, asking for responses that evaluate the update activity they have just undertaken; this provides the opportunity for regular analysis to take place [3]. A Likert scale [11] is used to extract data: strongly agree – agree – neutral –disagree – strongly disagree, with space available to add in comments, if required.

V. DATA ANALYSIS

One thousand, four hundred and thirty nine mentors completed the online update over a twelve-month period, more than double the number included in the previous evaluation [3]; Table I shows the demographic of the disciplines. Nurses and midwives, as expected, are still the majority of the professions that are updating; this will be a regular pattern for reasons previously indicated in this paper.

VI. DEVELOPING KNOWLEDGE

The update provided all of the relevant information relating to the mentorship role, as reported by 86% of mentors, with 88% indicating that it helped provide them with the knowledge of where to access further information. In relation to specific sections, positive responses were received from 90% of the users on the generic content (19% Strongly Agree, 71% Agree), 87% on the content in the Sets (scenarios) (18% Strongly Agree, 69% Agree), and 90% on the profession-specific content (20% Strongly Agree, 70% Agree). In consideration as to whether the update had been relevant to their role as a mentor, 92% were in agreement (21% Strongly Agree, 71% Agree).

Table II displays the differences between the original evaluation of 652 respondents compared to the follow up evaluation of 1439 respondents. Interestingly respondents from both groups have continued to agree that the content is relevant to their role thus highlighting that the format and content is meeting the needs of the mentors.

One mentor commented, '*Good update - interaction good as makes you consider all areas. Good to reflect on past experiences whilst having update and relevant learning criteria*', however, a small number of mentors commented that they would have preferred a face-to-face update and

TABLE I. NUMBER OF MENTORS IN EACH DISCIPLINE THAT HAVE COMPLETED THE UPDATE PACKAGE (N= 1439)

Audiology	3	Operating Department Practitioner	46
Clinical Physiology	4	Paramedic	0
Diagnostic Radiography	3	Physiotherapy	18
Dietetics	0	Podiatry	0
Midwifery	82	Radiotherapy	0
Nursing	1272	Social Work	2
Occupational Therapy	9	Speech and Language Therapy	0

TABLE II. COMPARISON OF MENTORS RESPONSES REGARDING RELEVANCE OF THE CONTENT

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
Overall relevance	21%	19%	71%	72%	7%	8%	1%	1%	0%	1%
Professional content	20%	20%	70%	69%	8%	10%	1%	1%	0%	0%
Sets	18%	16%	69%	69%	11%	13%	1%	1%	0%	0%
Generic content	19%	17%	71%	70%	9%	12%	1%	1%	0%	0%

Key: Unshaded = 652 responses Shaded = 1439 responses

would prefer the information to be paper based; it is worthwhile noting that there were consistent negative responses from this number of mentors for every question, clearly indicating a dislike for anything computer-based. However the majority reported that they preferred the online version as '*it made me think*' and '*more interactive than sitting listening to a tutor*'; a sentiment echoed by another mentor '*i had to engage a lot more than i do in the attended updates where i don't always concentrate*'.

One aim in developing the package was to move away from the disparate uni-professional nature of traditional updates, and to engender a multiprofessional perspective to the activity. This appears to have been achieved; when asked if the update had improved their understanding of how the mentor role can function in a multiprofessional way, 77% of the mentors felt that it had (20% Strongly Agree, 57% Agree), with only 4% disagreeing (3% Disagree, 1% Strongly Disagree).

VII. DURATION

One of the main drivers for developing the online update, was to overcome the problem of clinical staff struggling to find time to attend scheduled update activities. However, this same lack of time has been reported in the past as a specific obstacle to nurses undertaking computer-based education in the clinical area [12,13], as has lack of access to computers, and deficiencies in users' IT skills [14-16]. During the first evaluation we identified that the highest majority of mentors took under four hours to complete the package. During the second evaluation we wanted to ascertain whether this was still the case, as we did not want staff to be taking over four hours to complete the update knowing that many of the mentors were undertaking this in their own time.

When asked 'How long, not including breaks, did the update take you to complete?' the mentors' responses indicated that 50% took less than 2 hours to complete it, and 79% completed it in under 3 hours (Table III); this indicates the duration of the online update is equitable to the traditional update for most users. In contrast, 8% of mentors responded that the update had taken longer than 4 hours; however, it is not an unreasonable assumption that this was due to them accessing multiple areas of content, because students from more than one discipline were placed within their clinical area. This would have traditionally required them to attend multiple update events, each lasting several hours, and as such there appears to be time saved through doing it this way.

When asked '*Were you given time during your working day to complete this update?*' it was interesting to note that 64% of mentors had been given time, which appears to contradict the supposition that mentors had not been able to attend the face-to-face update sessions due to work pressures. It is not unreasonable to surmise, based on some of the qualitative comments, that in direct response to a new system being introduced, line managers had unusually made time available; one mentor stated that this was the '*first time ever that I have been given time…*' Another mentor identified that *'I have just started a new job so had the time made available during working hours as part of induction programme'*. However, not all mentors were afforded time to undertake the package, but due to the nature of the delivery were able to complete it in personal time; one mentor said, *'Because of the shortage of staff on our unit time was not available to allow me to complete this in works time'*. Indeed one mentor; '*found quiet time within night shift to complete'* which would not have been possible to achieve had they been

TABLE III. TIME TAKEN TO COMPLETE THE UPDATE

Less than 1 hour	6%	5%
1 to 2 hours	44%	43%
2 to 3 hours	29%	28%
3 to 4 hours	13%	15%
4+ hours	8%	8%

Key: Unshaded = 652 responses Shaded = 1439 responses

expected to undertake the traditional face-to-face session. These comments would support the assertion that finding time is a problem [12,13], but also identify that it can be overcome during certain shift patterns. There were no comments from mentors to indicate that lack of resources or poor personal ability hindered their progress with the update; this contradicts previous findings [14-16].

Respondents did state that they would have found it beneficial to be informed of the approximate time it takes to complete the update, prior to starting it, so that they could plan their time accordingly. They also commented that they would have liked to see a 'timeline' on each page so they knew how much they had completed. These issues are being addressed, with the evaluation data on duration, discussed above, being used to provide guidance on the average length of time it may take to complete the package. A progress indicator is also being introduced; however this is proving more difficult than anticipated due to the 'looping' options available to the mentors as they progress through the package.

VIII. USABILITY

The online package was reported as easy to navigate by 76% of the mentors (21% Strongly Agree; 55% Agree), with a further 15% providing a Neutral response. These figures are comparable, if not slightly improved, over the previous evaluation, as indicated in Table IV. Whilst recognizing that this is a positive outcome for a new tool with an untested design, and despite one mentor commenting that '*I am not the best IT person but find it so easy to use*', the data suggests there is still some room for improvement.

Ease of use featured regularly in the qualitative comments, with mentors indicating that the tool was '*easy to navigate', 'easy to understand and follow', 'user-friendly'* and *'straightforward to use'*. Arguably one parameter from which usability could be determined is how enjoyable the mentors found the experience. 40% of the mentors indicated positively with regard to enjoyment of the activity (7% Strongly Agree; 33% Agree), with 41% staying Neutral in their response; this means that 19% did not enjoy the experience (14% Disagree; 5% Strongly Disagree). It is not possible from this data alone to determine if these mentors' lack of enjoyment is a direct result of this particular package or the new delivery method, nor indeed whether it is the actual experience of updating that they do not find enjoyable. However, when asked if they would, by choice, undertake other activities online following this experience, 83% of the mentors said '*Yes'*. Also, when invited to rate this package in comparison to other updates they have experienced (1 being the lowest and 10 being the highest), 75% valued it 6 or above, with 13% providing a neutral response, Table V.

From the outcome of these two questions it can be surmised that overall the package and its 'new' delivery method were generally well received, suggesting the lack of enjoyment experienced by some may not be specifically related to the tool, but some other, as yet undetermined, factor.

Determining how enjoyable the mentors found

TABLE IV. COMPARISON OF MENTORS' RESPONSES REGARDING EASE OF NAVIGATION

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
652 respondents	18%	55%	17%	8%	2%
1439 respondents	21%	55%	15%	7%	2%

TABLE V. COMPARISON OF MENTORS' RESPONSES REGARDING HOW THEY RATE THE ONLINE PACKAGE, WITH 1 BEING THE LOWEST AND 10 BEING THE HIGHEST

	652 respondents	1439 respondents
1	1%	1%
2	2%	2%
3	4%	3%
4	6%	4%
5	17%	13%
6	9%	12%
7	15%	19%
8	29%	28%
9	14%	11%
10	4%	5%

the package is also important in relation to levels of personal motivation, high levels of which have been identified as essential for success by students on online courses [17].

IX. ACCESSIBILTY

The inability of mentors to attend traditional updates had been cited as one of the main drivers for the initiative to develop this tool and therefore accessibility of the package was an important factor in determining how successful the project had been for mentors. Indeed one of the main drivers for the development of accessibility of the learning tool was the importance of providing quality education and updates for staff who work in rural locations. These staff often found it difficult to leave their place for of work to attend traditional face-to-face updates due to the time taken to travel to locations. Therefore to be able to provide a means of education that ensured they received mandatory information to continue to undertake the mentor role in an effective manner was vital to both the mentor themselves and for the organisation. Through providing online education, the organisation could be assured that staff were provided with a vehicle to access up to date information regarding the mentor role and any professional, local or national guidance/policies/procedures that had been developed in support of the role.

Flexibility and convenience were repeatedly mentioned when mentors were asked what they liked most about the update during both evaluations, particularly being able to undertake it in a place of their choice, usually at home, rather than having to attend a session in a specific location; *'it was convenient for me to do at home because I have childcare issues to think about'; 'I could do it at work and not attend a study day'; 'if I have to attend a day course it is 140 miles round trip'; 'I could sit in my lounge and drink tea!'* This supports the supposition that healthcare professionals in general prefer to undertake computer-based professional education at home [18].

Being able to undertake the update at a time of their own choosing, was also perceived to be beneficial by mentors, '*I could complete it in my own time when convenient for me*'; '*able to do online read at your leisure*'; '*it could be done when it was convenient to me and my workplace*'; '*it was on line so didn't need to go to a lecture and could do it when i wanted*'; '*the ability to complete update without attending a teaching session, made it easier to fit in work commitments*'.

In addition, the ability to work at their own rate, as and when practical for each mentor, was identified as advantageous, '*was able to complete at a convenient time and pace*'; '*able to complete it at my own speed*'; '*I was able to work at my own pace*', as was the functionality that permits mentors to carry out the update intermittently, returning as and when time permits, '*because the ward has been so busy i have been able to do this in my own time and be able to go back to it from time to time*'; '*could log out and complete the course in sections rather than having to complete it in one go*'; '*liked the ability to log in and out and not complete the update in one sitting*'.

It was important for us during the second evaluation that respondents remained positive about the update package and that they were continuing to use it. We were concerned that there may have been less enthusiasm about the on line version as time progressed. However this flexibility was appreciated so much, that several mentors already exhibited anxiety at the thought of not using it; *'I wish the updates could always be like this'; 'I would rather do this every year than have to go to a normal update in three years time like they say I have to'; 'Why do we have to do a face to face update every 3 years when this is good enough?'*

X. SUMMARY

'*Yes, it exceeded what I thought I needed but in reflection may be it was just what the doctor ordered'*.

As indicated by this quote from one of the mentors, the online mentor package has evaluated positively during the evaluation period. Users of the package have found it easy to navigate, whilst also identifying that it has met the learning and information needs required to undertake their mentor role effectively.

The inability of staff to attend updating activities [1,9] appears to have been remedied in

many ways through the online version, with significant numbers undertaking the update in a short period of time. This would appear to not only be due to its flexible access allowing staff to fit it into their schedules [19,20], but also as a result of a visible shift in the line managers' willingness to give time during the working day. It may be that the stimulus of a new approach was the cause of this, but whatever the reason, it contradicts suggestions that staff lack motivation and incentive to attend [21], if provided with the opportunity.

Somewhat surprisingly, staff also stated that they generally enjoyed the experience, and whilst it is unknown whether this also applied to the traditional approach, there is clear evidence that this tool was appreciated, in the main, above previous update experiences. This supports findings that online approaches to learning can provide stimulus and interest for students [22], promoting meaningful learning [23].

The multiprofessional originality and uniqueness of the package has also promoted the professional groups to learn about the mentor role from a perspective beyond their own discipline, and importantly it has provided them with a 'one stop shop' to enhance their knowledge base in mentoring students from more than one profession and one HEI, at one session.

There still appears to be confusion amongst some of the nursing mentors regarding the requirements of the Nursing and Midwifery Council, and whether or not a face-to-face update is still required once in every three-years. This appears to be a misinterpretation of the updated NMC Standards [4], where the information pertaining to 'Continuing Professional Development for Mentors', states that the provision for updating should give mentors the '*opportunity to discuss issues related to mentoring, assessment of competence and fitness for safe and effective practice.*' This in itself would not explain the confusion, but may do so when coupled with reference in the Standard to a triennial review, where each mentor is reviewed every three years, to ensure they continue to meet the requirements to be a mentor. Regardless of why this misinterpretation may have occurred, the situation will need clarification for the future to ensure the mentors understand what is required. There are several ways for mentors to discuss elements of the role, even when updating online. For this reason, the update package has systems built-in that facilitate both updating as a group, and communicating via a synchronous text-based communication (Chat room); mentors can also discuss issues arising from the update with colleagues back in the workplace. This activity of sharing may enforce learning, and also promote teams of mentors in consistently working together.

It is anticipated that freeing academic staff from the 'burden' of delivering the updates will now enable them to concentrate this time more effectively in providing further support for the mentors within the actual placement environments; thus meeting their identified needs [9, 24].

A limitation of this evaluation is that the majority of the participants are from one discipline, nursing, which may make it difficult to generalize the results. However, this can also be construed as a positive, because for this professional group, annual updating will have been 'the norm' throughout their career; as such they are the group most suited to evaluate this new tool against their previous, traditional, experiences.

However, it is interesting to note the experiences of medical staff mentors' experiences of undertaking mentor learning programmes [25]. It was identified that very few publications exploring mentorship programmes focused on the effect of these programmes for the mentor, but rather discussed the benefits to the mentee. Results highlighted that respondents discussed the increased use of reflection of their own work and values, as well as a development in their approach to relations, patients, colleagues and ethical dilemmas, as a result of undertaking a mentorship course [25]. In our evaluation of the online mentor update tool respondents highlighted that undertaking the tool had heightened their awareness of working as a multidisciplinary team member, as can be seen in Figure 1.

The whole ethos of the mentor role is to improve the experience of the learner, Stenfors-Hayes et. al. suggested that the findings of their study may provide a link between teaching and clinical practice and be a way to support and enhance the teacher role in the field of medicine [25].

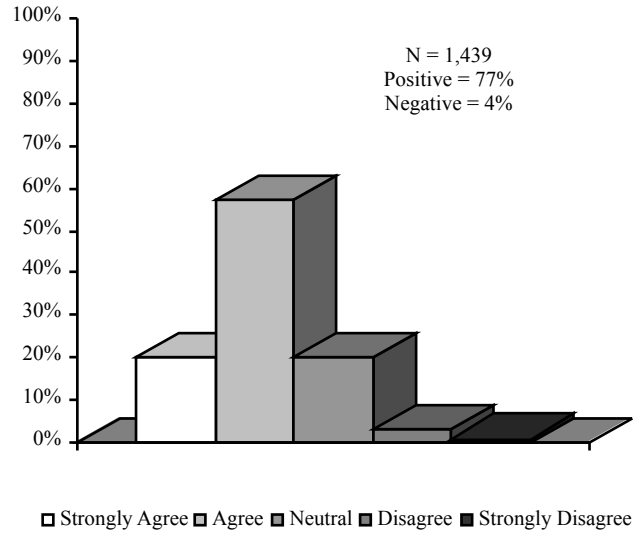


Figure 1. "I have an improved understanding of how the mentor role can function in a multiprofessional way"

Indeed in our study respondents claimed that their understanding of the learning needs of students had been enhanced, as exemplified in Figure 2.

XI. CONCLUSION AND FUTURE WORK

The development and implementation of the package has proved successful in meeting the mandatory training needs of mentors in practice. Additionally it has identified the importance of clinical practitioners learning together and has promoted interdisciplinary learning. The NMC have praised the package as being '*an example of innovative good practice*', and as such it is intended to promote use of it in other regions that provide healthcare education. It is also anticipated that the structure underpinning the tool may be utilized for other subject areas.

Future work includes continual evaluation of the package to ensure the information maintains its relevance and currency; it is anticipated that this will be achieved through delegation of administrative rights to each discipline or institution, allowing self-management of the content.

Further development of the chat tool [2] is also being considered, to introduce video functionality, in order to enhance the interactions between the mentors. However, initial investigations into this suggest there may be problems accessing video via some institution's networks, due to current security settings.

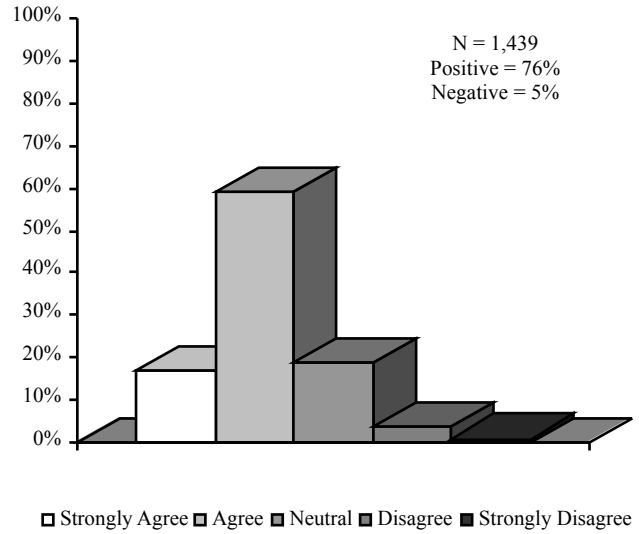


Figure 2. "Through this activity my understanding of how to improve the learners' experience has been enhanced"

REFERENCES

[1] Ousey, K.J. and White, S.A. "Developing a multi-professional e-learning mentor update package", Proceedings of the International Conference on Mobile, Hybrid, and On-line Learning, elml, pp. 103-107, 2009.

[2] Ousey, K. and White, S. "A case study exploring a multi-disciplinary collaborative initiative to use e-learning to meet the professional learning needs of health care practitioners," in: *Interprofessional E-Learning and Collaborative Work: Practices and Technologies*, A. Bromage, L. Clouder, J. Thistlethwaite and F. Gordon, Eds. IGI-Global: Pennsylvania, pp. 286-300, 2010.

[3] White, S. and Ousey, K. "Evaluating Effectiveness of a Multiprofessional Online Mentor Update Tool" Proceedings of the Third International Conference on Mobile, Hybrid, and On-line Learning, elmL, pp. 6-11, 2011.

[4] Pollard, K., Sellman, D., and Senior, B. "The need for interprofessional working", in: *Interprofessional working in health and social care: Professional perspectives*, G. Barrett, D. Sellman, and J. Thomas, Eds. Palgrave Macmillan: Basingstoke, pp. 7–17, 2005.

[5] Nembhard, I.M., and Edmondson, A.C. "Making it safe: The effects of leader inclusiveness and professional status on psychological safety and improvement efforts in health care teams", Journal of Organizational Behavior, 27(7), pp. 941–66, 2006.

[6] Sims, R. "Promises of interactivity: Aligning learner perceptions and expectations with strategies for flexible and online learning", Distance Education, 24(1), pp. 85-103, 2003.

[7] N.M.C. "Standards to support learning and assessment in practice", Nursing and Midwifery Council, London, 2008.

[8] C.O.D.P. "Standards, recommendations and guidance for mentors and practice placements: Supporting pre-registration education in Operating Department Practice provision", College of Operating Department Practitioners, London, 2009.

[9] Pulsford, D., Boit, K. and Owen, S. "Are mentors ready to make a difference? A survey of mentors' attitudes towards nurse education", Nurse Education Today, 22(6), pp. 439-446, 2002.

[10] Myall, M., Levett-Jones, T. and Lathlean, J. "Mentorship in contemporary practice: the experiences of nursing students and practice mentors", Journal of Clinical Nursing, 17(14), pp. 1834-1842, 2008.

[11] Trochim, W.M. "Likert scaling". Available from: http://www.socialresearchmethods.net/kb/scallik.htm. Accessed: 03 December 2011

[12] Atack, L. "Becoming a web-based learner: registered nurses' experiences", Journal of Advanced Nursing 44(3), pp. 288–297, 2003.

[13] Cooper, R., Rittenbruch, M., Viller, S. "Clinical Practice Performance Portfolio Evaluation", The University of Queensland, 2006.

[14] Lawson, M., Nestel, D., Jolly, B. "An E-Portfolio in Health Professional Education", (No. 38), Blackwell Publishing Limited, 2004.

[15] Wright, A., Bingham, H. "E-Learning Scoping Exercise for NHS South Central: Results and Recommendations. Part One: Trusts and PCTs", 2008.

[16] Huntington, A., Gilmour, J., Schluter, P., Tuckett, A., Bogossian, F., Turner, C. "The Internet as a research site: establishment of a web-based longitudinal study of the nursing and midwifery workforce in three countries", Journal of Advanced Nursing, 65(6), pp.1309–1317, 2009.

[17] Farrell, M. "Learning differently: e-learning in nurse education", Nursing Management - UK 13(6), pp.14–17, 2006.

[18] Dames, D. and Handscomb, A. "A pilot study to assess the case for e-learning in the NHS", Nursing Times Research 7(6), pp.428–443, 2002.

[19] O'Malley, J. and McGraw, H. "Students perceptions of distance learning, online learning and the traditional classroom", Online Journal of Distance Learning Administration, 2(4), 1999.

[20] Sit, J.W.H., Chung, J.W.Y., Chow, M.C.M. and Wong, T.K.S. "Experiences of online learning: students' perspective", Nurse Education Today, 25, pp. 140–147, 2005.

[21] Joshua-Amadi, M. "Recruitment and retention: a study in motivation", Nursing Management, 9, pp. 7–21, 2002.

[22] Rosenlund, C.H. and Damark-Bembenek, B. "Assessing the effectiveness of an online program", Nurse Educator, 24(1), pp. 5–6, 1999.

[23] Jonassen, D.H. "Transforming learning with technology: Beyond modernism and postmodernism or whoever controls the technology creates the reality", Educational Technology, 40(2), pp. 21–25, 2000.

[24] Hutchings, A., Williamson, G.R. and Humphreys, A. "Supporting learners in clinical practice: capacity issues", Journal of Clinical Nursing, 14, pp. 945–955, 2005.

[25] Stenfors-Hayes, T., Kalén, S., Hult, H., Dahigren, L.O., Hindbeck, H., and Ponzer, S. "Being a mentor for undergraduate medical students enhances personal and professional development", Medical Teacher, 32, pp. 148–153, 2010.

A Holistic Stress Intervention Online System

- Designing for Self-help through Multiple Help

Åsa Smedberg
The Department of Computer and Systems Sciences
Stockholm University
Kista, Sweden
asasmed@dsv.su.se

Hélène Sandmark
School of Health, Care and Social Welfare
Division of Public Health Sciences
Mälardalen University
Västerås, Sweden
helene.sandmark@mdh.se

***Abstract*—E-health has undergone many changes during the years. One is the development of web-based self-help services for patients and citizens with health concerns. This article presents design ideas of a web-based stress intervention system that takes the development of self-help services further. The aim of the system is to help people with mild to intermediate levels of stress change patterns of behavior and take control of their stressful life situations. The system includes not only self-help through individual work with stress-related issues, but it also complements the individual efforts with help from peers and medical professionals. The system then becomes a platform for combining multiple help online. The system design ideas have resulted from research studies and practical experiences of stress management and web-based self-help systems. The article also presents a map of the system structure and a couple of scenarios to illustrate in what ways the system usage can be characterized by multiple help online and a holistic approach to stress intervention. The article ends with reflections on how to evaluate this type of intervention system.**

Keywords-stress intervention; web-based; intervention online; self-help; multiple help; holistic; complementary support; communication.

I. INTRODUCTION

E-health systems have evolved in many different health areas. Both patients with physical and mental conditions and citizens with health concerns, such as unhealthy lifestyles, use the Internet to search for information and seek help from medical professionals and peers. One area is self-help for people who experience unhealthy levels of stress and high stress responses. This article discusses the topic from a holistic perspective. Based on recent work [1], it demonstrates the design of a web-based system for stress intervention that integrates different complementary functions and actors.

Studies have shown that many people in working life are on sick leaves due to high levels of stress [2] [3]. In Sweden, stress related dysfunctions have become the second most common reason behind sickness absence [4]-[6]. By changing unhealthy lifestyles, people can reduce the risk of getting severe illnesses. Preventive healthcare and early interventions are therefore recognized as important in order to help groups of people from becoming patients of the healthcare system and from being forced to sick leaves and long-term sickness absence.

Stress research has since a long time been oriented toward studies involving the physiological response (= the body's reaction) to stress and the cognitive processes that influence the perception of stress. However, the social perspective of the stress response has established that people with similar life conditions are not necessarily affected in the same way, which indicates that stress is caused, at least in part, by a person's mind or way of thinking. To change a certain way of thinking and to tackle an unhealthy behavior includes promotive and preventive interventions and an ongoing support [7] [8]. This is where the Internet and web-based systems can play an important role through available information of different kinds and continuous communication with others. Intervention systems need flexibility and to allow people to find their own ways through the system.

The use of self-management intervention systems on the Internet today is characterized by information management, interactivity and communication. However, the use of the different online health services for information and communication with experts and peers has not yet reached the level of integration and holistic thinking. The article addresses this gap. It introduces the design of a new type of web-based stress intervention system that considers integration, flexibility and individual differences. It includes different ways to approach stress, both from a stressor perspective (triggers) and a response perspective (stress reactions). However, the main focus is on the individual intervention. It also includes different sources of help, from research findings to real life stories, communication with peers and practical tools and counseling.

The article sections are organized as follows. To start with, background knowledge and understanding of stress, stress interventions and Internet self-help services will be presented. Thereafter, we will introduce our design of a new web-based stress intervention system based on a holistic approach using multiple help online. Examples of ways to use the system are illustrated through two scenarios. At the end, reflections on how to evaluate this type of intervention system will be presented.

II. Related Research and Knowledge

A. Stress

The concept of stress is somewhat complicated as it is defined both as a stimulus, a life event, or a set of circumstances, as well as the physiologic and mental reactions. For the stimulus part, the exposure, the term *stressor* is often used, and the reactions are the *stress response.*

Hans Selye developed the concept of stress in a three-stage model of the body's response to stress [9]. He called this the General Adaptation Syndrome (GAS). The first phase is an *alarm reaction*, the second stage is *resistance or adaptation*, and the final stage is *exhaustion*. During the alarm stage the body responds to a stressor, which could be physical or mental. First the heart begins to beat fast and the release of adrenaline makes the individual alert and prepared to take precautions. Another response might include reactions in the stomach, a rise in the blood pressure, frequent breathing, dilation of the eyes, and a dry mouth. To help to meet the sudden danger (the stressor), the blood flows away from the organs that are not needed to confront the danger, to organs and tissues which are involved, for example, the heart, the eyes, and the muscles.

In the resistance stage of the stress reaction, the body is still ready to meet the stressful situation. If this part of the GAS is prolonged, the immune system might be heavily affected, and attenuated. In the final stage, the exhaustion stage, the body readjusts, and hormones are released to help bring the body back to normal, to a state of balance called *homeostasis*. Until this balance is reached, the release of hormones continues, ultimately suppressing the immune system.

According to the bio-psychosocial model of stress, it is stated that biological, psychological and social factors are linked in the progress of promoting health or causing disease [10]. In this model, the mind and the body are well connected and interdependent, which means that biological, psychological, and social issues operate together to affect the health status. The model is somewhat more comprehensive and could be considered a development of Selye's original model [9]. The stress response is elicited by a many different psychosocial stimuli which can threat the homeostasis, which is the ability to maintain internal equilibrium by adjusting its physiological processes. Stress is experienced negatively when this imbalance occurs between the individual's perceived demands and the ability to respond to these demands. In today´s life the psychosocial stressors are the most common. To let a thought or an event be appraised as a stressor, there is a perceived mismatch between the demands and the individual's resources to cope with it [11].

B. Work Stress

Stress among employees is a public health issue in modern working life. In the western world, there has been an increase in stress-related disorders and sleeping problems since the 1990-ties. It has been shown in scientific studies that the number of hours of overtime worked has increased. Work-related stress and overtime work has demonstrated associations with altered physiological arousal, increased risk for stress related ill-health, lack of sleep, fatigue and impaired performance.

Also, intense lifestyles with job and also domestic demands let people experience high levels of long term stress exposures. Persistent ill-health, sometimes leading to long-term sickness and absence from work, can be a consequence of too high stress exposure during a long period of time.

Overcommitment at work could entail increased risk to experience work issues as stressful [12] [13]. Exposure to stressful job conditions such as very high workload, infrequent rest breaks, long work hours, shift work, and demanding interpersonal relationships, can certainly have a direct influence on workers' health.

C. Stress Intervention

A healthy job situation is when the pressures on employees are appropriate in relation to their abilities and resources. It is also about control over one´s work, and enough support. As health is not merely the absence of disease, but a positive state of physical, mental and social well-being [14], a healthy working environment is where there is not only an absence of harmful conditions but also health-promoting circumstances. The concept of the health promoting workplace can ensure a flexible and dynamic balance between the co-workers' expectations and the organizational targets and also the employees' skills and health improvements.

In stress intervention, empowerment is a central concept. The strategies can be concluded as the processes leading to increased stress management and better health in different populations and groups of people. Empowerment helps people to increase control and manage their lives according to their needs and preferences. The key question is how to build on and reinforce authentic participation ensuring autonomy, feelings of value and sense of mastery in decision-making. Learning and problem solving abilities are important assets for any organization or work site wishing to reach its full potential, and empowerment within the individual stimulates job satisfaction. The educational approach to stress management is concerned to enable people to make informed choices, set limits, and increase coping ability. The preventive and promotive approach are aimed to achieve behavior changes: Internal locus of control is a key factor in efforts to create empowered environments and empowered individuals able to meet stressors at work and in private life [15] [16].

D. Evidence for Behavior Change Methods

The management of health-related problems is a question of behavioral change, whether it is via the Internet or face-to-face appointments. Individuals usually have to engage in changing their lifestyles for example, to be more physically active or use self-management to improve their health problems.

There are many behavior modification methods [17] [18]. In a meta-analysis of changing health behaviors via the Internet, it was concluded that included studies reported a large number of behavior change methods [19]. The mostly

used behavior modification methods were to provide information of the consequences of a behavior in general terms, self-monitoring of behavior, and identification of barriers and facilitators for behavior. Methods that yielded the largest treatment effect sizes were stress management and training of communication skills. Observational learning, relapse prevention and problem-solving plan, goal setting, action planning and feedback all had significant positive effects [19]. It has been concluded that treatment including self-monitoring of the behavior with techniques including intention formulation, goal-setting, feedback on the performance, and review of goals, was at least partially more effective than behavior modification treatment without these techniques. This was concluded in a meta-regression analysis of behavioral change studies to increase healthy eating and physical activity [20].

E. Self-Help and Different Actors Online

There are different types of self-help services on the Internet today for people with lifestyle issues such as stressful lives. One is the Ask-the-Expert service that lets users post questions directly to the system to be answered by an expert, and the users can also choose to browse the system for stored questions and answers [21]. This function in the e-health area is believed to offer value to people who need to gain new health knowledge and guidance [22]. The users can get health recommendations and advice from medical experts [23], health service that is also recognized to offer a new type of continuous relationships with medical experts [24].

Another self-help service on the Internet is the community forum systems for peers. These community forums on health issues have become popular lately and are used regularly by patients and citizens with different physical and mental conditions [25]. These systems let people share experiences and offer each other advice on how to cope with different health concerns [26] [27]. Research shows that patients online tend to be well informed today, and that they act both as producers and consumers of health information [28]. This blur between being a producer and a consumer of health information and services is also named ‘prosumption’ and the user a ‘prosumer’ (e.g., [29] [30]). The online self-help groups have also shown to enhance decision-making skills for people who are in distress, and to foster well-being, a sense of control and self-confidence to manage situations [31].

When web-based community conversations for peers have been compared to published questions and answers in the Ask-the-Expert service on lifestyle problems, the two types of help services were shown to offer the users complementary contents and knowledge [32] [33]. Advice and information given in the two types of systems were seen to be of different characteristics, allowing people with lifestyle problems to get diverse and complementary views of their problems. While answers from health experts were characterized by detailed descriptions of health subjects, the peer conversations emphasized personal experiences and more practically oriented advice. By linking the different answers – the ones from health experts and the ones from peers in community conversations – the users are assumed to benefit more [32]. This leads us to believe that a combination of different types of health services and actors in the stress management area would help people with mild to intermediate levels of stress problems change patterns of behavior and take control of their stressful lives. To integrate knowledge and experiences of medical professionals and peers is believed to make an advantage.

Many people who suffer from stress related disorders prefer to get interventions through the Internet, and studies have also shown positive effects on health outcomes. There is evidence that Internet-based treatment with CBT (cognitive behavioral therapy) for depression and panic disorders in psychiatric care can be efficient. The Internet treatment is effective in reducing symptoms of depression and panic disorders [34]. It also makes psychological treatment more accessible.

A systematic review was done of 12 studies in which cognitive behavioral therapy for different health problems was administered via the Internet [35]. The quality of the studies was variable as well as the content of treatment program. Advice for self-care with or without telephone or e-mail support was used. Most treatments included education and training on specific health problem, restructuring of thoughts, relaxation techniques, and training of social skills. The studies showed a limited to large effect compared with the control group that often consisted of patients on a waiting list [35].

However, there are probably high rates of drop-outs [36] [37]. There is also little known about the participants’ use of the web-based stress intervention programs, what the communication patterns are like, and what support the participants take advantage of. How to make use of technological possibilities and human resources in this field needs to be further explored.

III. DESIGNING A HOLISTIC STRESS INTERVENTION SYSTEM

A. Multiple Help Online – Five Types of Help

The system for stress intervention online that we propose is designed as to form a whole of different help services and actors who contribute together. The system consists of five types of help: Ask-the-Expert, Counseling room, Community forum, Exercise programs and Stories told & research results. Below, the basic characteristics of each of these five are described.

1) Ask-the-Expert

Ask-the-Expert is where the user can ask medical professionals for help and advice on different stress related concerns. This type of help can be used both for direct questions and also for browsing for previously popped questions and their answers (FAQs). This part of the system is based on textual communication between one user and a medical expert. The user gets a personal answer to his or her question through e-mail. When making both question and answer (FAQ) public, the question is made anonymous, and any personal information is reduced. The process of making

them public is handled by the health expert, who also ensures that necessary editorial changes are made.

2) Counseling Room

The counseling room is a chat area in which users and medical professionals can meet in smaller group sessions. The counseling room is based on synchronous communication among the participants. Different predefined topics related to stress management can be addressed during these sessions. Cognitive behavioral therapy for stress management addresses topics such as excessive job involvement, low self-esteem, lack of recuperation, work-family imbalance, job mobility and competence matching.

If the user clicks on one of the scheduled counseling sessions, information about the counseling session is shown, such as time of session, theme of the session, health moderator, and if there is room left for more participants. The user can choose to sign up for the session, if the group limit is not exceeded. At the time of session, the user joins the session chat.

3) Community Forum

Communication between peers is also important for keeping up with ongoing stress interventions. Community forum lets the users have conversations together on current topics in their daily lives, related to sleep, work situation or balance between work and family, for example. The forum is based on asynchronous communication, and communication can therefore take place whenever the users have the need for it. The community normally needs a moderator, but the role of the moderator differs from the one in the counseling room. The community conversations will not be steered by the moderator in the same way; instead the main role of the moderator will be to monitor the conversations and interfere only if negative online behavior occurs or if advice is given that is believed to cause harm to the user.

The web communication with peers can help people get new insights and encouragement to develop and maintain new habits. It supports the idea of ongoing social support as an important means for dealing with new habits.

4) Exercise Programs

The fourth help service of the system is the exercise programs. Depending on the stress issue, there are different available exercises that the users can do on their own. Reflection exercises on work or study situation, relaxation techniques and abdominal breathing exercises to ease physical tensions are examples. The exercises are presented in textual, audio and video format, depending on the purpose of the exercise.

Below is an example of video demonstration of a relaxation exercise (see Fig. 1). The video demonstration illustrates how one can perform the exercise while sitting on one's office chair at work. The exercise in the example takes only a few minutes.

Figure 1. Example of a video-demonstrated exercise

5) Stories Told & Research Results

The last function of the system is about giving the users access to stress-related research results and real-life stories told by others who are, or have been, in similar situations. This part of the system is mainly based on storage and retrieval of textual information, but can also be illustrated in the form of audio recordings. By letting the users access other people's real-life stories together with the comments and advice from medical professionals, the users can learn to see their own situations clearer. It also aims at helping to reduce stigmatization.

B. Stress Intervention Areas

The holistic design is also based on a set of interrelated stress intervention areas. There are different areas that need to be addressed in order to ease the stress levels of the users. The system's multiple help is therefore structured in accordance with four main stress intervention areas: sleep, work/studies, balance in life and physical wellbeing. A mockup design of this structure is seen on next page (see Fig. 2). The stress intervention areas are introduced in the following sub sections.

1) Sleep

It has been concluded that stress is strongly linked to disturbed sleep, insomnia and impaired awakening. The inability to relax and to let work issues act as stressors is probably an important link in the relation between stress and sleep. The quality of sleep has thus shown to be of great importance for the onset of stress-related dysfunctions as well as the recovery. It is therefore an impending risk that a person with high levels of stress ends up in a negative loop of increased sleeping disturbances and high level of stress. Assessments of sleeping quality and insomnia and exposure to stress as well as the effects of interventions need to be further investigated.

2) Work/Studies

An overcommitment at work could entail increased risk to experience work issues as stressful [12] [13]. Exposure to stressful job conditions such as heavy workload, infrequent rest breaks, long work hours, shift work, and interpersonal relationships, can certainly have a direct influence on workers' health. Overcommitted co-workers often suffer from inappropriate perceptions of demands and fail in their coping

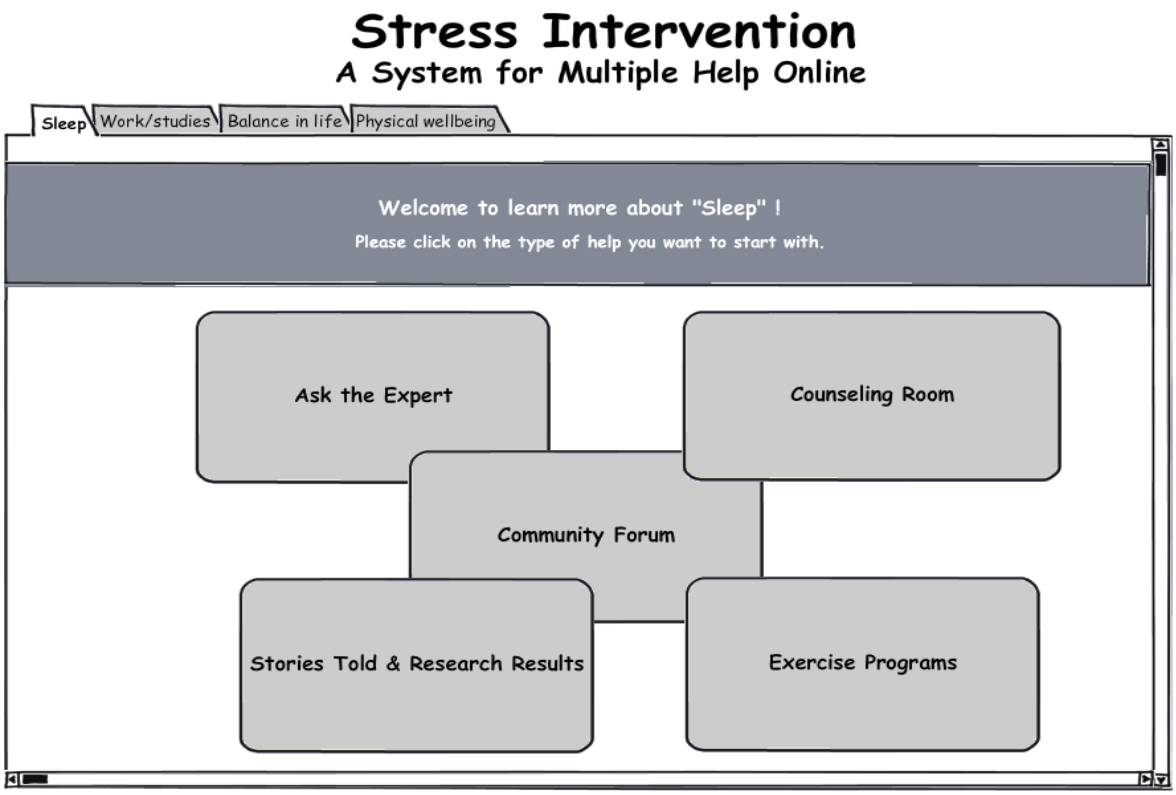


Figure 2. Mockup design of the stress intervention system showing the multiple help functions and stress intervention areas.

ability. Also, perfectionists have been described as people who are highly responsive to stress, and they tend to generate extensive stress for themselves [38]. Concern over mistakes and automatic thoughts of perfectionism are examples of things that can increase the level of stress.

Both work and studies nowadays include a great amount of flexibility and ability to stay connected independently of time and space. In general, this is a positive development since it allows for distance work and studies. But at the same time it increases the risk of having more people ending up in active work and study lives without boundaries. To be able to negotiate about expectations regarding availability, and to set limits, are important for a healthy work and study life [39].

3) Balance in Life

Stressors related to occupational work such as a frustrating work situation or a work-family imbalance are often major causes of strain, and mental ill-health, as well as psychosomatic conditions [5] [40]. Especially job strain with exposure to stressful job conditions could certainly be a health hazard to those who have additional strain from family life. Perceptual distortion can prevent people from accurately assess cost–gain relations and to set limits [12].

4) Physical Wellbeing

Responses to stress are often manifested in body tension. Regarding individual interventions in the area of dysfunction due to negative stress exposure, progressive muscle relaxation was originally designed by Jacobson to guide people through successive tensing and relaxation of the body muscle groups from toe to head to achieve overall body relaxation [41]. This process is easy to learn and teach, safe, non-threatening and non-competitive. Since then it has been concluded that the effectiveness of the interventions varied according to the health-outcome measure used. Cognitive-behavioral skills were more effective for psychological outcomes, whereas muscle relaxation techniques were more effective for physiological outcomes. Using a combination of techniques; muscle relaxation and cognitive-behavioral skills seemed to be more effective across outcome measures than using a single technique. Deep, diaphragmatic breathing is known to counteract the fight or flight response symptoms that are often associated with anxiety and negative reactions on stress exposure. Also meditation can be used to counteract stressful situations, as it is a technique to develop concentration and awareness to produce a calming effect. Here, diaphragmatic breathing is central to any meditation practice. It has been found that there could be a lowering of blood pressure during deep breathing, which is interesting to consider in stress management [41]-[44].

C. A Holistic Design with Multiple Help Integration

The stress intervention system proposed in this article applies the concept of multiple help online for different stress intervention areas. From this, it follows that peer conversations, questions to as well as answers from medical experts, counseling sessions, research results, life stories and exercises are available in each of the stress intervention areas. The system also focuses on keeping it together, allowing the

different parts to be linked together. This idea is rooted in systems thinking.

In systems thinking, not only the separate objects of the system but also the relations between the objects play an important role for the system [45]. Even though we cannot determine the output from a certain input in complex systems, there are certainly connections that make the subsystems affect the performance of each other. The holistic properties of a system are based on the subsystems working together as to form a whole [45] [46]. A way to categorize relations is to look at the way they affect the involved subsystems. Symbiotic relationships are necessary for either one or both of the connected subsystems to function. Synergistic relationships are not functionally crucial, but they increase the levels of performance for the involved subsystems. Without the connection between the subsystems, the sum of their individual performances would not reach the same level as if they work together in combined actions, i.e., the whole is larger than the sum of the separated parts. There are also redundant relations, a sort of relations used to improve reliability of a system.

The web-based stress intervention system proposed in this article takes a stand point in holistic and systems thinking. The different stress intervention areas aim at letting the user choose his or her way into the system based on what is believed to be the most urgent stress-related concern. At the same time, it is important to offer easy ways to navigate between the different intervention areas. The technical system can assist in this through links and navigation menus, but also the medical professionals engaged in the online system, as well as the peers, can support this by referring to other intervention areas. In a conversation on sleep, for example, there could be references to related conversations on work issues within the work/studies intervention area.

The same idea is applied to the five types of help in the multiple help concept. The different help services are linked together so that the users can navigate easy between them, but also the medical professionals can encourage the users to take advantage of other help services for complementary support and knowledge. In the Ask-the-Expert answers, there can be references to relevant peer conversations that the user could join, for example. This is implemented manually to start with, by having the medical expert suggesting peer conversations in his or her answer. In a future setting, it is also possible to implement automatic matching techniques in order to generate links to similar stress-related topics in different parts of the system.

All the links that are created between stress intervention areas and types of help contribute to the idea of holistic and systems thinking.

D. System Structure and Navigation

The system is structured in a way as to make navigation easy. When entering the system, the four stress intervention areas are seen. For each one of these areas, the five help services are displayed and accessible. The user can then choose to focus on one stress intervention area and activate the different help services to learn about the specific area from different perspectives and from different online actors. An illustration of the structure of the system can be seen in the figure below (see Fig. 3).

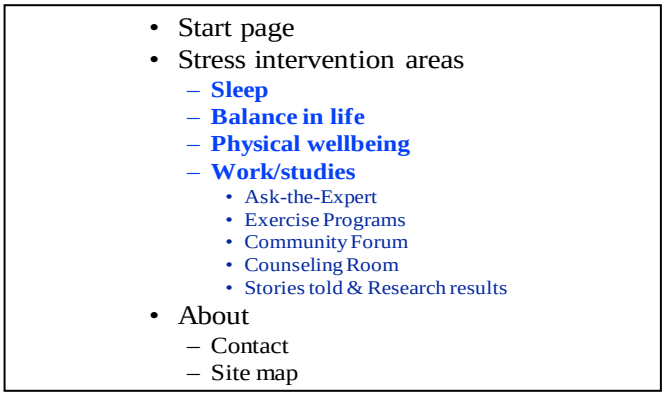


Figure 3. Map of the stress intervention system when the intervention area Work/studies has been expanded.

The system structure aims to let the users navigate easily between the different help services. It also supports navigation between the stress intervention areas. When activating a help service, such as the Ask-the-Expert in the area of work/studies, FAQs can be searched for and new questions to the medical professionals posted. What is also possible for the user to do is to navigate from here to FAQs in other stress intervention areas. Figure 4 illustrates this.

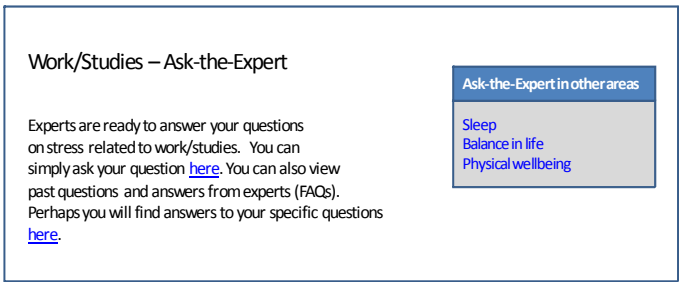


Figure 4. Example of design for navigation: Connecting Ask-the-Expert services.

IV. SCENARIOS

Below, there are two short examples of scenarios aiming to illustrate in what ways the web-based stress intervention system can be used to let the different stress areas, information sources, tools and actors work together.

A. Scenario 1: Chain of Complementary Support

Eve, 52 years, is a middle manager in a company. She is ambitious and has always felt that people around her have high demands on her. Today, her employees and family take almost all her time, which has led to a stressful life situation with too little sleep and unhealthy food and exercise habits.

Eve enters the stress intervention system by visiting the stress intervention area for balance in life and its community

forum for peers. She finds a conversation that is ongoing, on a theme close to her own situation. She reads the conversation for a while, and then adds a posting telling the others that she finds it difficult to make room for herself and her needs. The conversation continues with the problem of saying no and to delegate responsibilities. One peer recommends Eve and the others to sign up for an online counseling session on how to set limits. Eve signs up, and later she joins the counseling session together with a handful of peers, moderated by a medical professional. During the session, the medical professional refers to an exercise on how to practice limit settings present in the help service for exercise programs. When Eve has practiced some of the exercises on setting limits, she wants to spend some time doing physical training exercises. Therefore, she visits the exercise programs in the stress intervention area for physical wellbeing. She also starts to participate in the online conversations on physical wellbeing, to get advice from peers regarding where to buy price worthy shoes and other equipment for training activities.

The combination of different help services as described in the scenario can contribute to a better understanding of the current situation, and what to do, than if only one of the help services was used. Since the different types of services offer different knowledge and advice, they complement each other. In the scenario described, the expert contributes with medical insights and knowledge of what exercises that could be beneficiary to perform and the peers contribute with their own experiences and practical advice regarding sports equipment, for example.

The described scenario path through the system can also be seen in the figure below (see Fig. 5).

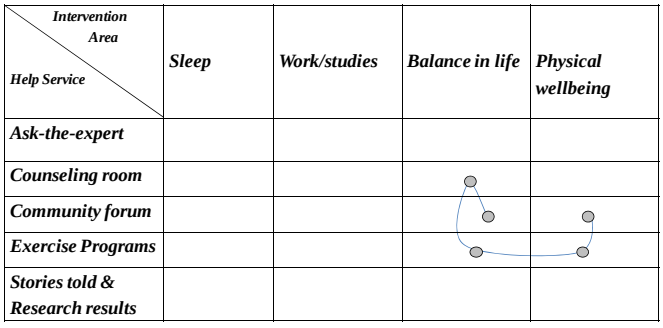


Figure 5. Example of scenario path (scenario1)

B. Scenario 2: Complementary Stress Intervention Areas

Johan is a 37-year old man who works with systems analysis at a big IT-company. He works very long hours in front of his computer. His back has started to hurt, and his body is stiff and his eyes dry. Recently, his sleep has been affected as well. He finds it difficult to fall asleep and he often wakes up at night.

The first thing Johan does when entering the stress intervention system is to open the intervention area for issues about sleep. He starts to search for similar issues among the FAQs in the Ask-the-Expert service to find out about what he can do to ease his sleeping problems. Eventually, he posts a question. The medical expert who answers the question from Johan presents some practical advice on how to relax before going to bed. The expert recommends Johan to have a look at the video instructions for relaxation available in the system's exercise programs service. But, since Johan has several concerns, the expert also recommends exercises that Johan can do at work, both to increase the variety of physical work activities when using the computer and to reduce strain on the eyes. These exercises are found in the stress intervention area for work/studies. The medical expert also recommends Johan to visit the stress intervention area for issues related to balance in life, to read about research results and to join conversations with peers on how to make room for other activities besides work.

This scenario had its focus on the complementary stress intervention areas. It showed how the three areas, "sleep" "work/studies" and "balance in life", worked together to help Johan gain new insights into how to handle his upcoming health problems.

This scenario path of complementary stress intervention areas can also be seen in the figure below (see Fig. 6).

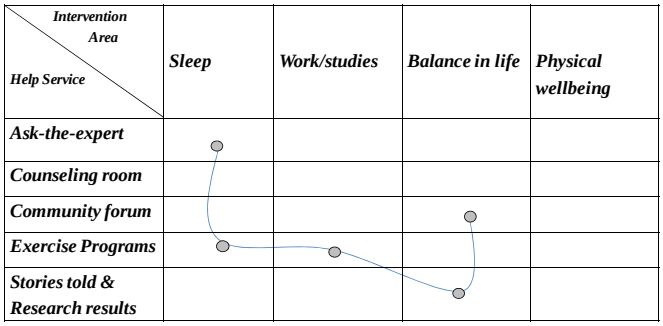


Figure 6. Example of scenario path (scenario2)

V. Evaluation of the Stress Intervention System

The web-based stress intervention system proposed in this article is flexible and uses present human resources for the stress interventions; both the users with stress symptoms and the medical expertise contribute with their knowledge and experiences. In what ways they contribute depends to a large extent on their communication about stress-related issues. We have also discussed the individual approach to the system by illustrating how the users with stress-related symptoms are encouraged to move between the different system parts based on their individual needs.

From these characteristics of the web-based system follows that the contents of the system is dynamic, and so are also the online interventions. To evaluate this kind of system demands for a new way of thinking.

Evaluation has to be based on established evaluation questionnaires for self-evaluation of participants' health status (e.g., [47] [48]), but, it needs also to target the actual usage of

the system and the individual opinions and experiences of using the system. The actual usage of the system can be evaluated through observations and analyses of logged online activities, such as the social activities in terms of number of answers to posted questions and answers expressing empathy [27]. Different analyses of patterns of posted questions and answers will give valuable information about online activities. Furthermore, we need to learn what kind of questions the users with stress symptoms ask, the way they respond to each other by giving advice and different opinions, the contents of their advice, etc. [32] [33] [49]. In addition, the evaluation questionnaire about the participants' health status needs to be complemented by a questionnaire about their experiences of the system.

VI. Conclusion and Future Work

This article has outlined some basic foundation of a new and holistic web-based system for stress intervention. The novelty of the system lies in the holistic approach considering both different aspects of stress and stress intervention and also different supportive roles and functions. Not only have attention been drawn to self-help through information access and exercises, but also to the necessity of having support and guidance from peers and medical professionals to ease the individual struggle for sustainable new habits and improved health. To make the system holistic, web links between the different intervention areas and also between the different kinds of help are considered. Additionally, the medical professionals and other actors in the system can amplify the holistic view of the system by making references to different system parts. This will let the user navigate more easily between the different parts of the system and to use different kinds of help in combination.

Next step is to have the system design fully implemented and tested. It is to be evaluated by a test group of white-collar workers with stress symptoms. Research studies will be conducted on their system usage, such as their online communication behaviors, their experiences of the system and their health status at different times during and after the intervention.

References

[1] Å. Smedberg and H. Sandmark, "Stress intervention online - designing for self-help through multiple help", Proceedings of the Third International Conference on eHealth, Telemedicine, and Social Medicine (eTELEMED 2011), 2011, pp. 120-125 , ISBN: 978-1-61208-119-9.

[2] M. Henderson, N. Glozier, and E. K. Holland, "Long term sickness absence is caused by common conditions and needs managing", BMJ. 2005; 330:802–3.

[3] P. M. Dekkers-Sánchez, J. L. Hoving, J. K. Sluiter, and M. H. Frings-Dresen, "Factors associated with long-term sick leave in sick-listed employees: a systematic review", Occup Environ Med. 2008, 65, pp. 153–157.

[4] K. Holmgren, S. Dahlin-Ivanoff, C. Björkelund, and G. Hensing. "The prevalence of work-related stress, and its association with self-perceived health and sick-leave, in a population of employed Swedish women", BMC Public Health. 2009; 2;9:73.

[5] H. Sandmark, "Work and family: associations with long term sick-listing in Swedish women", BMC Public Health 2007, 7:287.

[6] Försäkringskassan [The Swedish Social Insurance Agency]. Social insurance statistics. Available at (accessed 10 October 2010): http://statistik.forsakringskassan.se/portal/page?_pageid=93,1&_dad=portal&_schema=PORTAL.

[7] K. Baughman, E. Logue., K. Sutton, C. Capers, D. Jarjoura, and W. Smucker, "Biopsychosocial characteristics of overweight and obese primary care patients: do psychosocial and behavior factors mediate sociodemographic effects?", Preventive Medicine, No. 37, 2003, pp. 129-137, Academic Press.

[8] G. J. Norman, "A review of ehealth interventions for physical activity and dietary behavior change", Am J Prev Med., 33(4), 2007, pp. 336-345.

[9] H. Selye, "History and present status of the stress concept", In A. Monat and R.S. Lazarus, eds. Stress and Coping, 2nd ed. New York: Columbia University, 1985.

[10] G. Engel, "The need for a new medical model: a challenge for biomedicine", Science 1977; 196, pp.129–136.

[11] J. Siegrist, "Psychosocial factors and stress", In Encyclopedia of stress, Edited by Fink G. London, Academic Press, 2000.

[12] D. Preckel, R. von Känel, B. M. Kudielka, and J. E. Fischer, "Over commitment to work is associated with vital exhaustion", Int Arch Occup Environ Health 2005, 78, pp.117–122.

[13] J. Siegrist and M. Marmot, "Health inequalities and the psychosocial environment—two scientific challenges", Soc Sci Med, 58, 2004. pp. 1463–1473.

[14] WHO, Ottawa charter for health promotion, 1986, Copenhagen: WHO Europe.

[15] K. Tones and J. Green, Health promotion : planning and strategies, Sage Publications, 2003.

[16] I. Rootman, M. Goodstadt, L. Potvin, and J. Springett, "A framework for health promotion evaluation", In Rootman, I. (ed.), Evaluation in Health Promotion: Principles and Perspectives. WHO, Regional Office for Europe, Copenhagen, 2001(92):7-38.

[17] C. Abraham C and S. Michie S, "A taxonomy of behavior change techniques used in interventions", Health Psychology. 2007;27: 379-87.

[18] S. Michie and A. Prestwich, "Are interventions theory-based? Development of a theory coding scheme", Health Psychology. 2010;29(1):1-8.

[19] P. Kraft, R. Botelho, T. Webb, J. Joseph , L. Yardley and S. Michie, "Using the Internet to promote health behavior change: A systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy", Journal of Medical Internet Research. 2010;12(1):e4.

[20] S. Michie, C. Abraham, C. Whittington, J. McAteer and S. Gupta, "Effective techniques in healthy eating and physical activity interventions: a meta-regression", Health Psychology. 2009;28(6):690-701.

[21] J. Budzik and K. Hammond, "Q&A: A system for the capture, organization and reuse of expertise", Proceedings of the sixty-second annual meeting of the American Society for Information Science, Information Today, Inc., Medford N, 1999.

[22] S. Marine, P. J. Embi, M. McCuistion, D. Haag, and J. R. Guard, "NetWellness 1995-2005: ten years of experience and growth as a non-profit consumer health information and Ask-an-Expert service", AMIA 2005 Symposium proceedings, 2005.

[23] R. Bromme, R. Jucks, and T. Wagner, "How to refer to 'diabetes'? language in online health advice", Applied Cognitive Psychology, 19(5), 2005, pp. 569-586.

[24] J. Marco, R. Barba, J. E. Losa, C.M. De la Serna, M. Sainz, I. F. Lantigua, and J. L. de la Serna, "Advice from a medical expert through the Internet on queries about AIDS and hepatitis: analysis of a pilot experiment", PLoS Medicine, Public Library of Science, 3 (7), 2006, pp. 1041-1047.

[25] S. Fox and D. Fallows, "Internet health resources", Pew Internet & American Life Project, July 16, 2003.

[26] D. Maloney-Krichmar and J. Preece, "A multilevel analysis of sociability, usability and community dynamics in an online health

community", ACM Transactions on Computer-Human Interaction, 12(2), 2005, pp. 201-232.

[27] J. Preece, Online communities – designing usability, supporting sociability, Wiley & Sons, 2000.

[28] U. Josefsson, "Coping online – patients' use of the Internet". Doctoral thesis, Report 37, Dep. of Applied Information Technology, IT-University of Göteborg, Sweden, ISBN 978-91-628-7080-5, 2007.

[29] E. Riessman, "Restructuring help: a human services paradigm for the 1990's", American Journal of Community Psychology, 18, 1990. pp. 221-230.

[30] M. S. Salzer, "Consumer empowerment in mental health organizations: Concept, benefits and impediments", Administration and Policy in Mental Health, Vol. 24, No. 5, 1997. pp. 425-434.

[31] A. Barak, M. Boniel-Nissim and J. Suler, "Fostering empowerment in online support groups". Computers in Human Behavior. 24(5), 2008. pp. 1867-1883. DOI= http://dx.doi.org/10.1016/j.chb.2008.02.004.

[32] Å. Smedberg, "To design holistic health service systems on the Internet", Proceedings of World Academy of Science, Engineering and Technology, November 2007, pp. 311-317.

[33] Å. Smedberg, "How to combine the online community with Ask the Expert system in a health care site", Proceedings of the first International Conference on the Digital Society, IEEE Computer Society Press, 2007.

[34] J. Bergström, "Internet-based treatment for depression and panic disorder". From Development to Deployment, Thesis. Karolinska Institutet, 2010.

[35] P. Cuijpers and A. vanStraten, "Internet-administered cognitive behavior therapy for health problems: a systematic review". Journal of Behavioral Medicine. 2008;31:169-77.

[36] K. Cavanagh and D. Shapiro, "Computer treatment for common mental health problems", J Clin Psychol, 2004, 60, pp. 239–251.

[37] T. L. Bessell, S. McDonald, C. A. Silagy, J. N. Anderson, J. E. Hiller, and L. N. Sansom, "Do Internet interventions for consumers cause more harm than good? A systematic review". Health Expect, 2002, 5, pp. 28–37.

[38] A. A-C. Chantal, J. Irvine, P. Ritvo, R. A. Cribbie, G. L. Flett, and P. L. Hewitt, "Perfectionism and psychological distress: a modeling approach to understanding their therapeutic relationship", J Rat-Emo Cognitive-Behav Ther, 2008, 26, pp. 151–167.

[39] R. A. Karasek and T. Theorell, "Healthy work: stress, productivity, and the reconstruction of working life", New York: Basic Books; 1990.

[40] H. Sandmark, "Job mismatching, unequal opportunities and long-term sickness absence in female white collar workers in Sweden", Scand J Public Health 2009, 37, pp. 43-49.

[41] E. Jacobson, Progressive relaxation (2nd ed.), University of Chicago, Chicago, 1938.

[42] L. R. Murphy, "Stress management in work settings: a critical review of the health effects", American Journal of Health Promotion, 1996, 11, pp. 112–135.

[43] M. C Jones and D. W. Johnston, "Reducing distress in first level and student nurses: a review of the applied stress management literature", Journal of Adv Nursing, 2000, 32, pp. 66–74.

[44] B. Seaward, Managing stress, Boston: Jones and Bartlett, 2002.

[45] P. P. Schoderbek, C. G. Schoderbek and A. G. Kefalas, Management systems – Conceptual considerations, 1990, Richard D. Irwin, Inc.

[46] C. W. Churchman, The systems approach, 1968, Delacorte Press.

[47] Karolinska fatigue questionnaire [Karolinska utmattingsformulär]. http://www.stressmottagningen.nu/wp-content/uploads/dokument/utmattningsform.pdf

[48] T. Åkerstedt, A. Knutsson, P. Westerholm, T. Theorell, L. Alfredsson and G. Kecklund, "Sleep disturbances, work stress and work hours—a cross-sectional study". J Psychosom Res., 2002, 53:741–48.

[49] Å. Smedberg, "Learning conversations for people with established bad habits: A study of four health-communities", International Journal of Healthcare Technology and Management, 9(2), 2008, pp. 143-154.

www.iariajournals.org

International Journal On Advances in Intelligent Systems
ICAS, ACHI, ICCGI, UBICOMM, ADVCOMP, CENTRIC, GEOProcessing, SEMAPRO, BIOSYSCOM, BIOINFO, BIOTECHNO, FUTURE COMPUTING, SERVICE COMPUTATION, COGNITIVE, ADAPTIVE, CONTENT, PATTERNS, CLOUD COMPUTING, COMPUTATION TOOLS
issn: 1942-2679

International Journal On Advances in Internet Technology
ICDS, ICIW, CTRQ, UBICOMM, ICSNC, AFIN, INTERNET, AP2PS, EMERGING
issn: 1942-2652

International Journal On Advances in Life Sciences
eTELEMED, eKNOW, eL&mL, BIODIV, BIOENVIRONMENT, BIOGREEN, BIOSYSCOM, BIOINFO, BIOTECHNO
issn: 1942-2660

International Journal On Advances in Networks and Services
ICN, ICNS, ICIW, ICWMC, SENSORCOMM, MESH, CENTRIC, MMEDIA, SERVICE COMPUTATION
issn: 1942-2644

International Journal On Advances in Security
ICQNM, SECURWARE, MESH, DEPEND, INTERNET, CYBERLAWS
issn: 1942-2636

International Journal On Advances in Software
ICSEA, ICCGI, ADVCOMP, GEOProcessing, DBKDA, INTENSIVE, VALID, SIMUL, FUTURE COMPUTING, SERVICE COMPUTATION, COGNITIVE, ADAPTIVE, CONTENT, PATTERNS, CLOUD COMPUTING, COMPUTATION TOOLS
issn: 1942-2628

International Journal On Advances in Systems and Measurements
ICQNM, ICONS, ICIMP, SENSORCOMM, CENICS, VALID, SIMUL
issn: 1942-261x

International Journal On Advances in Telecommunications
AICT, ICDT, ICWMC, ICSNC, CTRQ, SPACOMM, MMEDIA
issn: 1942-2601