Living Documents as a Collaboration and Knowledge Maturing Platform

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ABSTRACT

Work-based learning often suffers from lack of opportunities and space for learning activities as part of everyday work processes. One possibility is the active involvement into collective sense-making processes, e.g., how to translate new or updated clinical guidelines into changes of processes and treatment at a concrete practice. This active involvement requires sharing of opinions, ideas, and other "immature" pieces of information/knowledge. However, a major obstacle lies in individuals' reluctance to share and use immature knowledge if they experience uncertainty about the maturity. Living Documents tries to address this issue. It is a web-based system that allows for collaboration and knowledge development based on the metaphor of a living document. Such living documents combines stable and more mature parts with emergent comments and opinions, which are made first class citizens. Document, sub-documents, and comments can be associated with knowledge maturing indicators. In this respect, the approach to support learning has been based on the knowledge maturing model. The system promotes knowledge maturing by providing a contextual space for conversations that can be linked to more mature knowledge.

Categories and Subject Descriptors

General Terms
Design

Keywords
Knowledge maturing, collaborative editing, collaboration

1. INTRODUCTION

Knowledge development in organizations and networks of organizations is an essential, but inherently complex process. Under the label knowledge maturing, this has been described [3] as a sequence of phases of maturing each of which has different characteristics, ranging from emerging ideas to standardization. One of the problems associated with knowledge development is that "standards" or "guidelines" are disseminated as norms or best practices, but do not get adopted and translated into everyday routines. This is not just a passive process, but requires active participation and contribution of those who have to implement these guidelines.

We have analyzed this problem in the healthcare domain with practices of General Practitioners where clinical guidelines are condensed results of years of results and meta analyses of studies. One example are the NICE guidelines in the UK, which are created on a national level, but need to be contextualized at a local level. This is done with the help of devising a local implementation plan. However making sure that the implementation plans are acknowledged and implemented in practice in a timely manner is a problem for practices. The key factors affecting this process can be summarized in the following list:

- Staff members do not acknowledge updates in a timely manner.
- They are hesitant about their own interpretations of the guidelines.
- District challenges such as a medical practice operating in a relatively poor area makes implementing the guidelines even more difficult since clinicians are faced with more limitations such as not being able to prescribe a specific drug due to its relatively high price.
- Clinicians need targeted information on what has changed in comparison to previous versions, otherwise the process consumes too much time and becomes exhausting since the clinician will need to figure out on his own the recent changes made.
- Moreover local implementation plans need to be updated by the experiences clinicians gained when they applied the guidelines in practice so that other staff members can benefit from these experiences as well.

Therefore we have developed a platform that fits into the busy schedules of clinicians. They need a space to discuss their interpretations, opinions and worries about the guidelines and a central hub for getting updates about the changes in guidelines offers a viable solution to tackle the above problems, which are affecting the complexity and speed required to implement the guidelines into the everyday practices of clinicians.

2. ANALYSIS

The development has been embedded into a design-based research approach as described in [1]. We have conducted a series of co-design workshops. One thing that has become clear through this process is that technologies need to be adapted to the context, must be designed with simplicity as a primary design goal, and they must integrate into rigid and busy schedules.

Furthermore, we have used the knowledge maturing model [2] as an analysis model for extracting the underlying conceptual problem. The knowledge maturing model describes collective

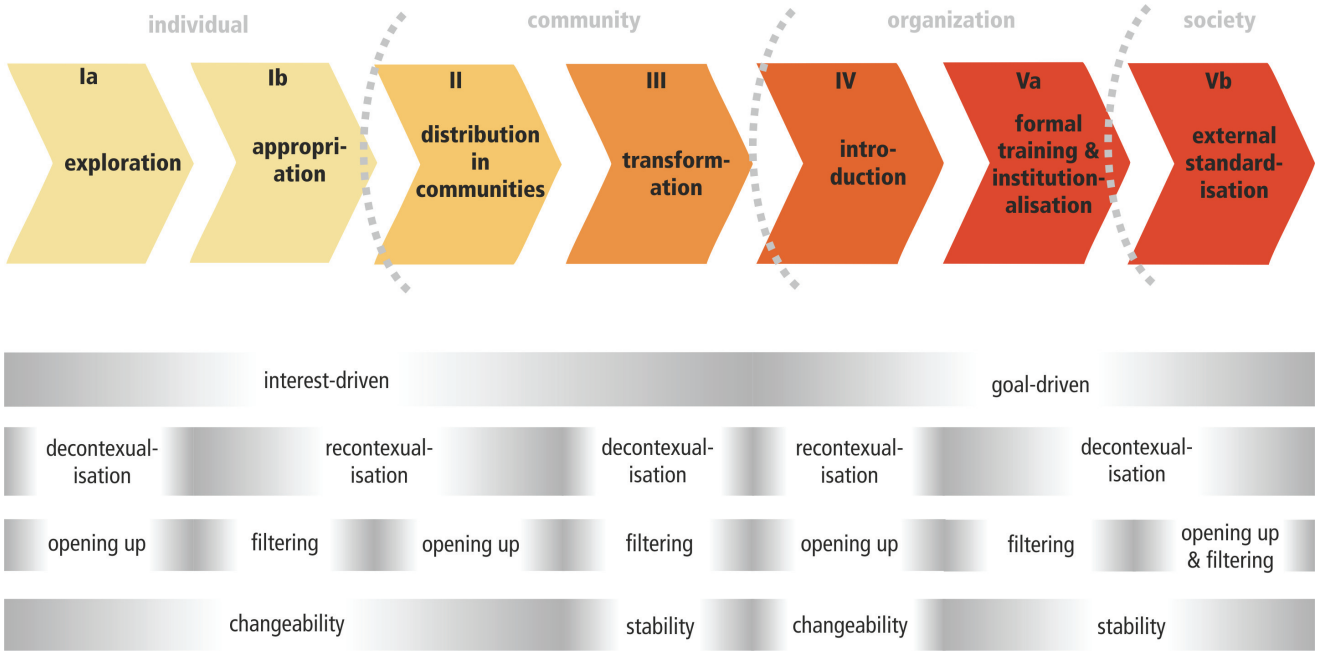

Figure 1: Knowledge maturing phases and characteristics [2]

knowledge development along several phases each of which has different characteristics

The initial phases (**I. Emergence)** are characterized by the **exploration** (Ia) of new spaces. Knowledge is deeply subjective, and the individual decides through appropriation (Ib) where or not to pursue further development of the usually abundant items in phase Ia.

In the next phase (**II. distribution in communities),** where knowledge gets discussed and negotiated between different individuals of a social group. This includes the development of a shared vocabulary and associated understanding, and usually many individual contributions get amalgamated. To reach beyond the social group, **transformation (III)** is required where the focus is on creating artefacts by restructuring and agreeing on. Transformation means that knowledge is restructured and decontextualized to ease the transfer to collectives other than the originating community.

For further outreach, the **introduction phase (IV)** provides an initial step in which either knowledge is prepared in a way that it is easier to understand for others as part of workshops or trainings (instructional strand) or put to practice in a pilot (such as process knowledge). Both is experimental and is a learning phase where experiences are incorporated that prepare for a wider roll-out in the **institutionalization phase (Va)** where the knowledge gets a stable place, either as part of formal training plans, or as company-wide implementations (processes, products or similar). The goal is here to gain efficiency.

Finally, moving beyond the limited scope of companies, phase **Vb (External standardization)** moves towards standardisation or certification where comparability, and compliance play a primary role.

Along these phases, key patterns can be observed, such as the alternation between the focus on changeability (Ia-II, IV) vs. stability (III, V), or the openness to impulses from outside (Ia, II, IV, Vb) vs. the filtering in phases Ib, III, Va.

Based on this model, we could identify that while they are ways of disseminating "mature" knowledge (e.g., guidelines) through respective trainings or similar, but they the possibility to share more immature knowledge, such as opinions. Opinions are an important element of knowledge development, but require conversations, which are an essential part of many social media solutions. However, particularly in healthcare, but also in other professional contexts users are sensitive to (i) sharing their (immature) opinions, and (ii) to reusing information which maturity level it represents. Social processes to negotiate this knowledge is hampered by barriers that are related to changeability (opinions), stability (internal rules in practices, or national guidelines). This is related to the formation of their mindlines [3] – an important concept for workplace learning in healthcare.

3. STATE OF THE ART

In the following sections, we analyze existing solutions for collaborative editing and publishing, most notably Google Docs, Wikis, and blogs.

3.1 GOOGLE DOCS

One of the most popular collaborative editing solutions, is Google Docs, which offers an online word processor (and spreadsheet solution). Discussions within Google Docs documents can be made by creating comments on the right side of the document, after a discussion is finished or no longer relevant to always be in sight of the users discussions can be set as resolved. Resolved discussions no longer appear in the document and they are deleted forever. It has the underlying assumption that consensus is reached and that possibly diverging opinions are not worth keeping.

This approach is designed for commenting and reviewing contents of a specific document since comments are often short in length

and straight to the point. However, many discussions require more space and are much richer and lengthier in their content when compared to comments.

Another limitation of Google Docs appears when trying to handle a huge number of users commenting and replying to comments since users will lose track with an increased number of comments.

3.2 BLOGS

A different way of collaboration can be found through blogs where there is a clear distinction between content and comments. Blogs offer commenting below the entire document, but it many cases it is important to comment on specific parts by selecting parts of the document. This restricts the usefulness of discussions as the anchors are not obvious.

3.3 WIKIS

Another very popular collaborative editing solution are wikis. Wikis offer the ability to link to related material within the content for discussions about a document and that has two main downsides:

The original document is changed to include the link or tag for each sub-discussion and this is not appropriate when working with official documents like the national clinical guidelines since it might be unnecessary for some users to see the related discussions all the time within the content, this may even be unwanted by the editors of the document.

If there are many discussions about a section of a document this leads to overwhelming lists of links. Also the different categories of discussions cannot be viewed separately.

4. LIVING DOCUMENTS

LivingDocuments is a web-based application that is based on the collaborative editing paradigm and is implemented using AngularJS for the front-end and a Java-based backend, which is accessed through RESTful interfaces.

LivingDocuments aims at addressing the issue of the alternating patterns of changeability (phase II), stability (phase III), and again changeability (phase IV) of the knowledge maturing process, which is related to users' concerns about sharing and using less mature knowledge.

To overcome this, the LivingDocuments system has created an environment in which shared knowledge representations (such as local implementation plans) can be developed as living documents where (i) parts can be declared stable, (ii) comments and document parts can be associated with maturity indicators, and (iii) practice members can be notified about prescriptive changes.

The main part of the system consists of a **near real-time collaborative editor**. In the text, users can mark specific sections, comment on them, and start discussions for those sections, which creates new sub-documents. Such discussions can have different purposes, such as raising questions, proposing enhancements or contextualizations, or negotiation with others towards a common agreement.

Maturity indicators show users the maturity of such contributions, which are - at the moment - manually annotated, but there are plans to calculate them semi-automatically, e.g., based on a large set of measures, such as view time, editing time, sub documents, author expertise tags in comparison to content tags, among others.

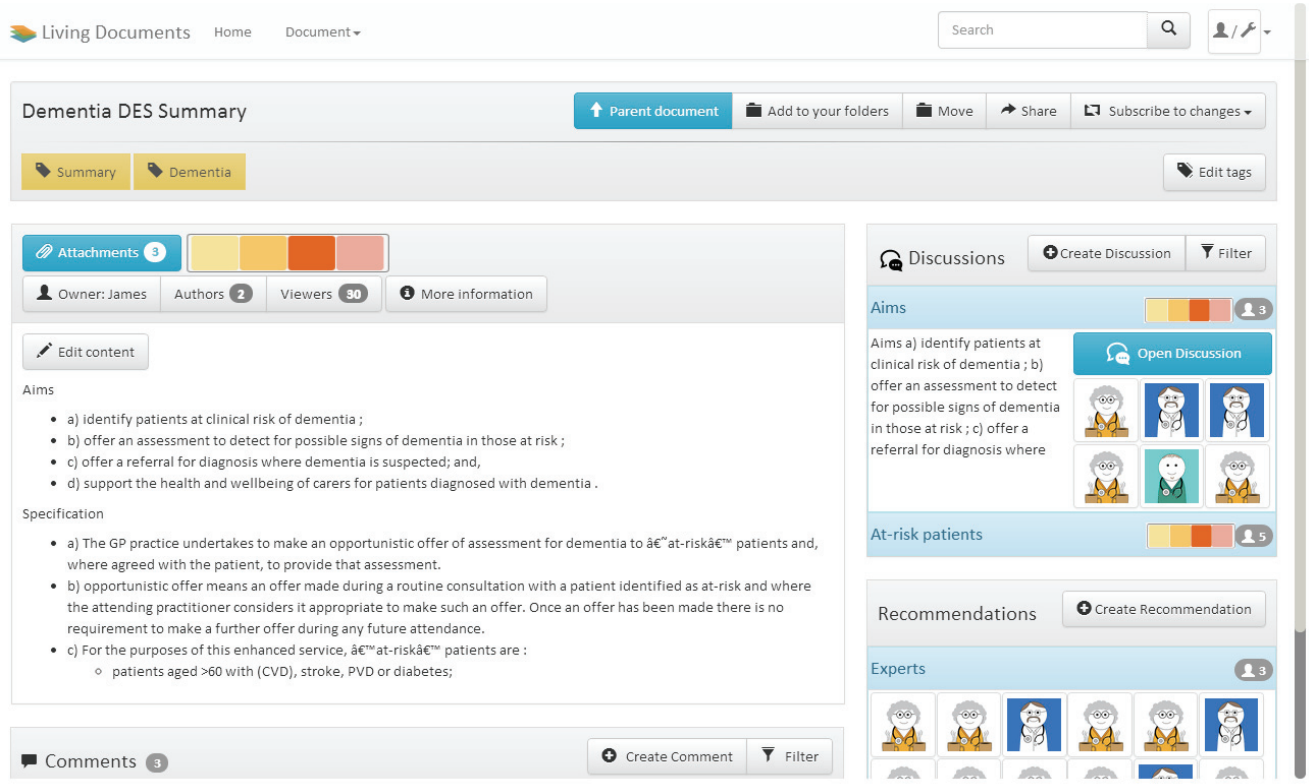

Figure 2: Screenshot of LivingDocuments

In addition to directly editing documents, it is also possible to declare documents as stable. To integrate insights from the discussions into the stable part of documents, the moderator of the document can receive "**pull requests**" similar to the Git version control model.

Features for supporting awareness about changes and contributions are as important as features for contributing. Therefore **subscriptions** are supported, which can refer to different parts of a document so that overload of notifications can be avoided. Individuals can choose to be informed about contributions to discussions or just to changes of the stable part so that these subscription can be considered maturity-aware. Furthermore, activity streams are supported.

Documents can be enriched by multimedia attachments and placing links to external content. Furthermore, documents as well as users can be tagged with respect to topic/expertise. This forms the basis for recommending related documents/resources, which allow for discovering links between issues that span longer time frames.

5. FORMATIVE EVALUATION & OUTLOOK

The Living Documents tool has followed a design-based research approach to ensure user engagement and continuous feedback during various phases of development from idea conception till the current state of the tool. This has included:

- *Focus groups and application partner days*: Application Partner Days were part of the explorative studies which took place in year 1 of the Learning Layers project. They were then followed by a series of *focus groups* where initial ideas about the tool emerged, got discussed and were refined by the users.
- *Wireframe development*: Afterwards users were presented with wireframes in order to get concrete feedback on certain functionalities and the flow of the system.
- *Monthly co-design meetings*: Since then users were continuously engaged in the development by conducting monthly meeting that are being held by our local partners in Leeds, England.
- Lab-style feedback workshops have been conducted in which users are asked to complete pre-defined tasks. This have

The feedback has been very positive, and we could identity two additional scenarios (apart from developing local implementation plans for clinical guidelines):

Significant event analysis. Practices are obliged to conduct regular meetings (e.g., monthly) to discuss and analyse any significant event that have recently occurred and to plan for how to improve their processes and practices in the future. Currently, these meetings are recorded in minutes, which are filed in documents. After a longer period (e.g., half a year or a year), the notes are reviewed by the practice owner and aggregated into a report. The current way of dealing with the analysis process makes it hard to follow-up with topics that span across different events. Also minutes are rarely read by those who did not attend the meeting. The solution does not intend to replace the significant event audit meetings, but to make their results persistent and to ensure follow-up actions. Instead of a monolithic minutes document, the different events are added as individual sections that can be tagged with a topic. The text of the minutes will go into the stable part. Users can add their opinions, their actions, and the experiences to these sections that can be later reviewed by the moderator of the process. Through assigning common topic tags, different significant events that share the same topic can be easily grouped together, which simplifies the process of aggregating topics and monitoring activities.

Cascading training. To be updated about changes in medical practice, e.g., in the course of an updated guidelines, selected staff members of a practice attend training events. The new insights gained from participating in those events are not only relevant for the participants, but also for other staff members. Sharing those in a meaningful way would help to promote the learning of all practice members, but just forwarding the training material creates a lot of "information noise" so that relevant new insights are not acknowledged. After attending a training, the participants can create new documents in the LivingDocuments system. They can assign them to topics to which other practice members can subscribe so that they are updated about new content in this area. Original training material can be attached, but a quick summary is useful that translates the new information into the context of the practice. This can then evolve into a broader discussion around changes to the everyday work practice.

These additional scenarios show that our analysis has identified a generic problem and solution approach for supporting knowledge maturing in a healthcare context. Based on the feedback, the tools will be refined to prepare for trialing the tool in the next months as part of everyday practice of a network of General Practitioners. This trial will cover several weeks and extend into incremental improvements of the tool. Towards that end, integration of the tool into an existing practice management software is underway.

It will be further explored in which other domains the tool is also useful. Towards that end, several trials have been started, such as for discussion about administrative procedures. In general, areas seem to be promising in which stable (i.e., more mature knowledge) needs to be augmented by knowledge for contextualizing the stable knowledge and where this augmentation would ideally feed back into the development and revision of the stable elements.

6. ACKNOWLEDGMENTS

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