Collaborative Learning of Organisational Knowledge

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Abstract

This paper presents recent research into methods used in Australian Indigenous Knowledge sharing and looks at how these can support the creation of suitable collaborative environments for timely organisational learning. The protocols and practices as used today and in the past by Indigenous communities are presented and discussed in relation to their relevance to a personalised system of knowledge sharing in modern organisational cultures.
This research focuses on user models, knowledge acquisition and integration of data for constructivist learning in a networked repository of organisational knowledge. The data collected in the repository is searched to provide collections of up-to-date and relevant material for training in a Virtual Learning Environment. The aim is to improve knowledge collection and sharing in a team environment. This knowledge can then be collated into a story or workflow that represents the present knowledge in the organisation.

Keywords: Collaborative learning, Knowledge repository, Flexible learning.

1. INTRODUCTION

The process of in-house learning in large organisations, particularly engineering organisations, has limited support through electronic educational resources. This paper focuses on this context, considering learning frameworks, or generic systems that support the generation of learning material. Following the organisational model developed by Nonaka [1] for the Japanese corporate system, the significance of tacit knowledge in corporate learning and the need to make this knowledge explicit has been acknowledged as relevant in any organisation, especially as the working population become more mobile. It has also been found to be a significant factor in knowledge management for learning [2]. We wish to use this knowledge to support just-in-time learning by triggering learning activities in a manner different to previous studies

Research into the context to support user information access falls into four areas: feedback on relevance of information retrieval, implicit and explicit techniques for clarifying word-sense, developing users profile from implicit actions, and symbolic user modelling approaches [3]. However these methods lack flexibility. Much effort is required for any change in the domain of application of such a system, and they are quite restricted in what information they can gather on the users' active goals. However, there needs to be some ability to select and present information

from a learning repository in a coherent manner, which enables knowledge to be created by the user.

We look at a situation addressed previously (see [3], [4], [5]) using task or workflow models to define the learning context. For instance, the system can gather information on the user from their actions on the computer, the task or workflow they are involved in and their history on similar tasks. We have previously proposed that a system to support sharing of tacit knowledge can be developed using an Indigenous Knowledge sharing 'grammar' as the workflow [6], and we now show how the user modelling can be developed to enhance this system and its educational and organisational value. We also consider how this model can further link learning with the organisational context through pervasive systems.

The role of the social learning system discussed here is to provide a repository of personal knowledge of the organisation, its equipment and its processes. Much of this knowledge is at present often only available as audio comments or knowledge in individual's heads, which therefore needs to be recorded and stored, and has little coherency for learning. This paper deals with the situation where this knowledge is being stored and is to be made accessible in a format that supports learning of the organisational process and structure, as well as the enactment of that structure.

2. CONTEXT

To develop a model of how to relate users, the value of their knowledge data, and their role within an organisational learning context we consider how this data is used for the social construction of knowledge within the workplace.

We designed the system to be populated initially with existing material such as induction documents and training manuals, in document format, preferably from electronic versions. Alternatively, scanned versions can also be annotated with bookmarks for reference to further information on any item.

Management can then add information, such as details relevant to subsections of the organisation, the original induction introductory session video, slides or audio, which further describe the induction document. Each member of the organisation can then add to this repository, through submissions, reports, document templates, or short audio/text comments on other material. This approach has been used in the development of Pedagogically Enhanced Video on Demand systems [7] with specific learning goals.

One aim of this work is to reduce the role of management beyond this initial setup. For instance, while the contributions to the repository would be classified as learning objects, with specific focus and context of applicability, there may be some requirements for the establishment of rules relating to specific learning goals and processes ([8], [9]) linking these objects into the learning environment.

When submitting information, the author can select the format of their contribution, and the access level they wish the document to have. Also they define the learning role of the item. They will link it to an existing repository item as pre-amble, further explanation, update, cautionary note, etc. Also relevant is the section of work it relates to in the organisation. Finally, the user model defining the author's position and role in the organisation will describe the level of significance or relevance their comments may have to the entire repository. As such their models have to be regularly updated by the personnel department, not only as they move through, or out of, the organisation, but also by the system as their contributions to the system are found to be more useful, or less, to others.

The learning system interface will be a display of various pieces of information relevant to the user. This can be done in many ways. For instance the central system can note the item or action (such as filing a report) that the user has selected and offering similar, relevant items. Alternatively the user can run a search and the system can load all relevant data and provide them as a multi-view interface. The data available to a user will depend on the user model which will include data on their role in the organisation [10] and their previous generic workflow activities (compare [5]).

For instance if a user uploads a document on a piece of machinery they wish to use, maybe for the first time, then all relevant comments or annotations by other users in the same section, will be either uploaded to be played as introduction, or stored as links to be displayed when the reader accesses a specified page, or when they finish the original document.

Data Restrictions
The learning system can be on a web interface or on intranet-based software. The knowledge repository covers generally public data from the organisation: orientation material; organisational structure; training sessions; document templates; reports; and individual's experiences.

We focus on the collaboration of employees based on the assumption that most individual work will not be logged due to privacy constraints and partly to avoid any requirement on the individual to enter their individual data into a personal model. What can be included automatically in the repository is data that is public within the organisation, such as training attendance, or the work modules that have completed and by whom and any formal contributions to team projects.

Tagging data
Using techniques developed for the semantic web, we are developing a XML wrapper that provides a model for making the content of the repository understandable to humans and able to be processed by machines [11] In this paper we consider the second phase of designing intelligent functionality using the semantic descriptors.

We consider also exiting story telling systems used to elicit tactic knowledge through conceptual maps developed with a Coordinator role in a closed learning environment (see [12]) and using an Editor role to extract innovative features form a work repository [13]. These systems have developed their own grammar in tagging and linking objects, within a specialised domain or study.

3. MODELLING BASED ON INDIGENOUS PROTOCOLS

We now explain the relevance of the recent research into Indigenous knowledge, and its sharing protocols [6]. Indigenous people have been sharing knowledge of how to live in and maintain both their physical and social environment through oral means for thousands of years. Those who are expert in the relevant stories present this oral history publicly at ceremonies. The content of the public ceremony is selected by a meeting of experts to determine what is relevant and what processes and order of presentation will assist those present to understand the knowledge being conveyed in the information. This process can be related to the process of using an archival collection of information or even anecdotal material, to find material relevant to new experiences or knowledge. In both cases we need to consider the processes required to provide a coherent repository of information, and to ensure that sensitive information is handled appropriately and not taken out of context. This is enacted through the three models developed for this system, those of the organisation, the user and the author of each item.

We consider the modelling of the process used for the transmission of this form of knowledge. The protocols used in Indigenous Australian Knowledge management involves a communal inheritance process, rather than a rigid hierarchy of many oral traditions, which provides a useful model for data sharing in collaborative learning environment [14]. Nakata [15] summarises the differences between Indigenous and non-Indigenous knowledge so we do not go into detail here.

However, we do include in the following specific features which apply to organisational learning and decision-making based on this form of shared knowledge management [16].

The main requirement on the system is that when presenting items from the repository for learning, the presentation must be in a manner that is timely, relevant and coherent. This will be achieved through the three models:

1. Organisational Model. The organisational structure, its hierarchy and processes, is used to locate items in a learning sequence. For instance items are allocated to a division of the organisation depending on the division of the author. Any overlap between divisions will be described in the initial model and may be further enhanced over time. Also some structuring of the generic workflows within the organisation should be developed, and later tailored to different contexts by employees' additions. Finally, management can initiate a tagging system based on the hierarchy and processes of the organisation.

2. Author Model. The jargon used in any submitted item will require a user to have a certain depth of knowledge before they can understand. The depth of an item will match the role of the author. Also when presented to the user, items need to be placed in a sequential format in the learning context, providing simpler material first at the level of the user, with the option to search more deeply over time. The author, or their user model, selects the required knowledge level when they insert an item in the repository.

3. User Model. The user will only be allowed to access information relevant to their present depth of required knowledge, relating to their work team and their present role. The User can then select the items they wish to view, using tags such as author, time since creation, or keywords.

Since we are trying to emulate a human knowledge sharing system on computer, we need to now consider how to generate these models from existing data, and data that can be made available through various monitoring and feedback systems.

Organisational data
Traditionally, oral knowledge must be presented in a coherent and repetitive manner to enable memorising. In the organisation repository, knowledge is initially presented as a simple framework that over time is gradually embellished with further detail, while retaining the same basic story line. In this work the storyline is the organisational induction material, report writing processes, and other generic workflows within the organisation. Knowledge cannot be presented without this context or it’s meaning would be lost or misinterpreted.

However the organisation changes, for instance divisions are added and merged. Some of this information will need to be extracted from changes to organisational documents in the repository. The document editor for the repository is designed to store this data in XML format for auto-generation of data for the agents that sort knowledge at the organisational level.

Authors will be able to add tags or descriptors that categorise items into topic themes or organisational divisions. While these tags will inherit their status from the author generating them, they will need to be centrally edited to verify their classification according to the organisation level encapsulated in each term. This classification is considered analogous to the traditional technique of using places as the focus for each section of the story, and the depth or sacredness of the place name used (compare the complexity of language used) will reflect the intricacies of the story being related. This assists the user interface to collect further items that are relevant to the present user's search, which may not yet be linked by other users.

Author data
Knowledge is learnt from many people, not just immediate supervisors. Other people in the same role as the superior, but in other groups, also contribute to that knowledge telling. The knowledge

as presented in oral stories has many meanings, because it includes the experience of other storytellers that are then combined into a coherent repository of social knowledge within a particular context. Again knowledge cannot be repeated or decision made on the basis of this knowledge, without representation from all participants in the context, or the holders of the different aspects relating to that story. Thus any interface to the knowledge repository would need to provide methods for searching and linking all relevant information before the story is presented.

This prevents knowledge division, preventing decisions by individuals or small groups from affecting the whole group. It ensures all views are considered in the decision making process and is therefore reflected in how meetings are conducted, dependant on those present and whom they represent, and at what level.

As mentioned above, some pervasive methods can be used to enhance the system. An example within an organisation is to use the sensory system developed in [17] to select music on the basis of who is in the room, to update a meeting agenda on the basis of who is attending and hence what topics can be covered to what depth. Also the attendance at meetings can be automatically recorded. Furthermore, it is possible to make private meetings more secure. The meeting group can be alerted if a member of the organisation who has lower 'knowledge access' chances to approach within hearing distance of the room.

The author model is designed initially as a record of the users position in the organisation and their general knowledge level. The author model has to be updated by the personnel department as they change roles in the organisation and as they contribute to the repository. A user can view their organisational position in their model, and view public details of other team members by selecting them.

If an author's knowledge is accessed and linked to by others in the organisation, then it is considered to be of use, or value to the system, and hence rated as of higher status. The information in the model relating to the author's contribution to the repository includes creation data (creation date, the size and number of contributions), linkage data (the type of data linking to any item, and how many links by creation date, and viewed data (not including linkages, how many views taken by date). The sample of data collected from a trial system set up to compare traditional knowledge and organisational stories, is shown in FIGURE 1.

The data is also recorded separately for the author when they are linking or viewing their own files. It is possible for a user to create a repository of information relating to their work area, that has few links outside their own work products. This provides a history for that job role and as such has status within that field. However the existence of links from external documents is more relevant to the user-modelling scenario.

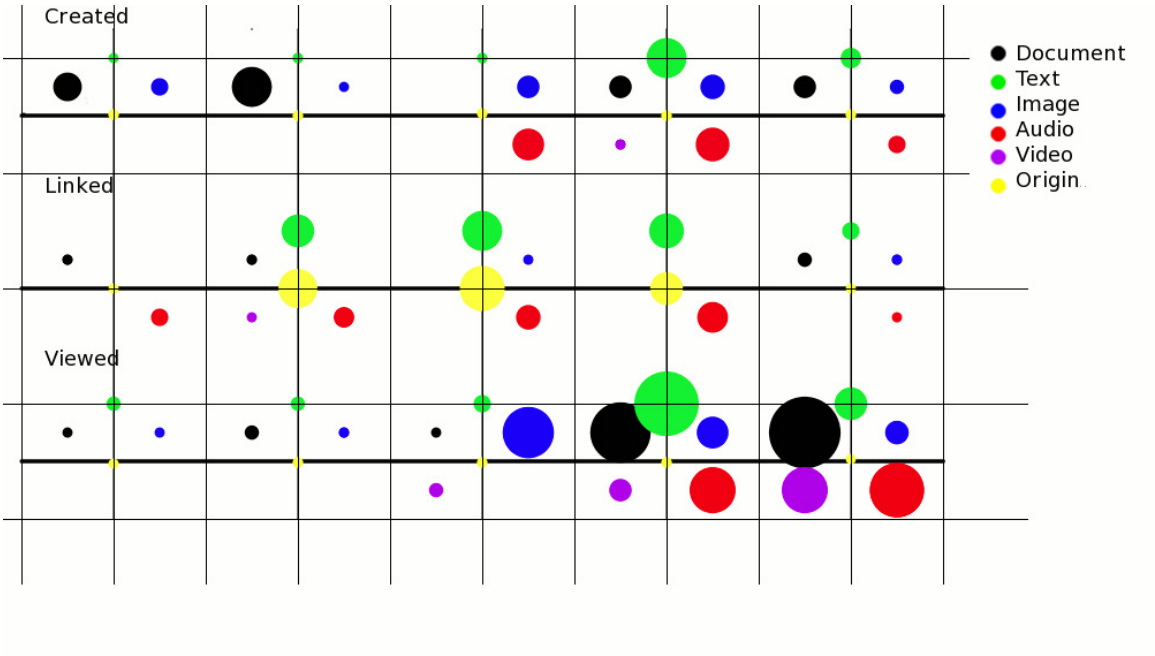

FIGURE 1 Usage Model excluding Author self-reference. Time scale on x-axis is in months

This Usage Model shows bubble plots of the square root of the number of items per month, distributed as petals around a central yellow stamen. This is based on the wattle graphs [18]. The centre is simply a location point for that month, except when displaying the linkage data where the number of originating documents can be displayed. While utilising the same notion of flowers, this system is designed to incorporate more data than previous designs (see [19]).

User data

A user will search information relevant to a particular work item using the central tagging system. The repository knowledge returned to any user's search will depend on them having the requisite background knowledge to understand any new knowledge. As such, knowledge is built incrementally, with many concepts being expanded within the initial context.

These contexts or stories must always remain coherent, rather than leaving gaps for questioning and development of incorrect concepts. Therefore knowledge is often not shared between certain people. Those who have different roles in society do not share these responsibilities to those outside their knowledge context. This is equivalent to considering what knowledge to share between teams. The user model will therefore contain information on the user's level of involvement in the organisation, and hence determine the depth of information they may receive in a particular context.

The results of a search for information will be displayed as a collection of items from the repository, showing linked information. Some links will auto-play if selected by the author, others need to be selected by the user. At other times information will be displayed based on users actions. For instance if the user accesses the organisational database to upload a report or file this may match a task in a workflow generated for their division. If the user has previously accessed information relating to this workflow, the section relevant to their present activity (such as a check list for submission) can be displayed as a pertinent part of the 'story' they are involved in developing, or suggested as an annotation point in the repository (see FIGURE 2).

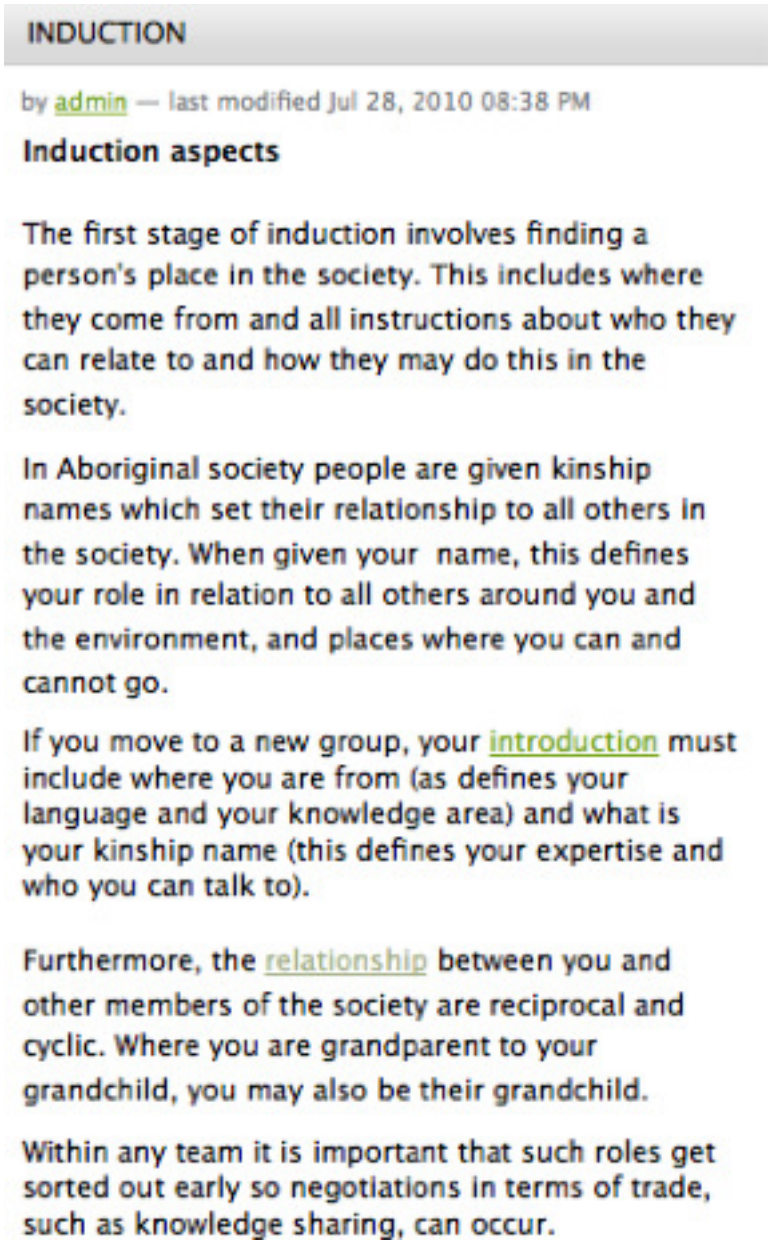

FIGURE 2 Returned data for 'Induction'. Links are audio, played when mouse hovers over

Some times there is need for knowledge to be shared informally in shorthand between those in similar roles but with responsibility for different parts of the organisation. This process occurs in organisations where informal communication across teams and divisions speeds up the process of transfer of crucial information [20]. For instance if there is a crisis on one division, this information will be conveyed by a short call to the heads of other divisions, who may not be directly effected by the crisis, but need to know the overall situation. This information will be background used in future meetings. The following scenario shows how information can be strengthened in these cross-divisional networks:

> Data is stored as an audio memo with only high-level access. Those have access to this information is alerted that an update has been made at their level to repository. The other

parties can then access this information. The audio file is made non-accessible by each user after first hearing, and then deleted after a certain period.

4. MAINTENANCE OF COHERENCY

In providing flexible environments to share knowledge, the theme and content of the knowledge is not known beforehand, hence some generic structure needs to be developed before the system can be populated. This is provided by the organisation induction descriptions, as well as generic workflows set up at system start up. The aim is to avoid work in coding workflows, so the aim is to develop generic patterns and systems that are cross-division and cross-organisation. Brady et al. [21] provide a more pedagogically strict version of this approach for designing personalised learning objects. It is important that the context of each task is retained using workflows, as described in work by Budzik et al [3]}.

There are three main concerns relating to maintenance of the repository and providing an interface to the large amount of data. These are discussed in the following subsections.

Linking information in interface for learning context

The tags and any linkages that are defined initially from the induction documents, then regularly edited as users add new tags, will provide the main structure of the learning interface. The aim is to reduce the need for central editing and allow the users to develop the learning sequences through how they link information in the repository. For instance informative workflows can be developed from generic descriptions developed at the organisational level, by allowing the authors to add items at each task of a workflow as an example or description of that stage relevant to their section, or a particular workflow type.

There will need to be an interface to edit the organisational divisions and depth dimension of data, by specifying the sub-themes, topics and tags that may be used in a particular workflow. For example, while different employees in different teams and divisions may utilise equipment, write similar tenders and reports, or be working on a related system, they will need to see annotations and comments that relate to their division when using the data for learning. Also the type of bookmarks specifying where one item will link into another will expand from and initially simple set (e.g. before, linked to word, or after), as people become more adept at locating their comments more closely to the material to which it is related

Promoting Contribution

Part of the success of such a system is that the employees contribute. The use of mobile services linked to the repository to enable staff to upload pictures and comments wherever they are in the building will assist this process. The cleaning process described below can reduce the growth in trivial data and this will enable more active knowledge to be recorded and stored.

The main aspect of promotion will be ensuring organisational leadership on this issue, through a thorough initial set up of orientation material and the selection of the initial relevant keywords and workflow processes.

Repository Clean Up

Rather than using the system to link those requiring information synchronously with suitable knowledge holders (compare iHelp [22] we look at how to store such knowledge for asynchronous access. At any time the user can follow up information by contacting the author, if they are still with the organisation. This storage of advice, data and other comments, as well as final documents, will create a large repository, and the material needs to be sorted and cleaned regularly.

The knowledge that is retained is that which the group decides is worthy of repetition. The collective deletion or removal of data or stories that lack value in a workflow (or story path), as

occurs in existing traditional story telling, could be matched by logging the access to and usage of learning artefacts in the repository, and promote or remove stories based on this criteria. The author's usage model logs the recent viewing of an item and the viewing status of the documents that have been linked to that item. The selection of data for clean up would rely on its usage within the author usage model, and any such changes would have to be sent as an alert to the author or knowledge holder, if they are still at the company.

5. COMPARATIVE ANALYSIS OF MODEL

The presented data in this research was based around a structured learning environment, rather than an open work place. This data provided the repository for testing the XML wrapper and user modelling tools. It was noted that the author model was useful for enabling reflection on personal involvement in the repository. While the interface is more complex than that developed for a similar system which functions as a personal trainer [19], it provides a succinct summary of an individual's activities.

Data about other authors in the repository is not available for self-comparison (cf. [18]). However aspects of others model come through in the priority given to contributions by specific authors. Given the audio nature of the system, we expect the hierarchy of authors will closely match their 'offline' status, in terms of who is consulted and who is emulated. In this way we have adapted the learning approach used in iHelp [22]. while including past asynchronous data.

Another issue raised in the trial was the need for users to be able to question or comment on authors. For instance is material is outdated, or unclear, the user needs to privately contact the author and present their query. This will allow the author to update their material. We do not plan to make such conversations public, as there are too detailed. What we aim to collect is the resolution of their conflict in understanding. In this way we emulate the development of storytelling ceremonies, where the experts or elders collect the desired information relevant to that occasion, and present this in a coherent story, linked by a location theme [14].

The issue with the analysis of the system is that the open nature of the content, and the lack of learning editors or coordinators (cf. [23], [[12] and [13]) necessitates a more flexible approach to learning goals in the analysis. Hence we will be using a research model based on the TAM3 model [24] to focus on user satisfaction and technological acceptance of the Virtual Learning Environment to ensure optimum data upload and re-use.

Finally we have considered existing software used for collaborative story telling. As well as StoryMaker [23] mentioned above, there is the use of CAST [25] for segmenting and linking purely audio comments from each specific requirements gathering project.

6. CONCLUSION & FUTURE WORK

There is scope for recording, linking and displaying organisational data to improve cross-divisional communication [20], and the modelling of knowledge sharing using collaborative user models. At the same time these models need to be transparent as they affect employee's learning experience beyond formal training sessions. In particular, visual models of personal contributions can provide stimulus to reflective learning [18] and motivation [19].

This work considers how the employees can be involved in developing such a system, through transparent storage of knowledge, and enabling annotation and linkage of items in the repository so that a search of the repository can provide a coherent story about the processes relevant to the particular work section of the user. In particular we are looking at how technologically enhanced learning can increase motivation through reliving real life tasks [26].

This is the early stage of work to support such a system. The model of the user interface and how the data is linked and tagged to enable a more complex interface context for the data is still being studied.

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