A PROPOSAL TO SUPPORT COLLABORATIVE LEARNING: USING A STRUCTURE TO SHARE CONTEXT

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Based on the idea that knowledge construction activities can enhance collaborative learning, the author proposes the use of a structure for knowledge sharing and to support interaction between group members. The knowledge to be shared is represented using a simple structure composed by concepts, keywords and keyword rates.
Preliminary evaluation results show that the proposed structure can be used to describe and share context knowledge views of a particular topic. Each user involved can explore and propose structure enhancements for voting. The paper presents a structure proposing an approach to support collaborative learning by providing a context to share and enhance.

1 Introduction

The problem to be addressed can be stated as the use of a shared structure for knowledge sharing, applied to collaborative learning tasks in a Higher Education context.
A definition of the term "knowledge" is required. The knowledge to be shared is provided by the structure for knowledge sharing. It provides a simple and understandable network of concepts, which eases individual participation in the building of a common structure, and thus, of the knowledge itself. It also describes the view of an expert or a group of users on a particular knowledge theme and provides the context to reason about a given domain or topic – tacit knowledge. Tacit knowledge is defined by Sveiby as the knowledge that is used as a tool to handle or improve what is in focus [9].
This paper presents a structure to address the sharing of knowledge, and allow the support of collaborative learning among a group of people.

2 The context for the knowledge sharing

Students may find it difficult to fully understand and put into context a given knowledge theme for which they need to construct their own structured mental model, in order to reason [11].
As an example, for a computer science student learning about Human-Computer Interaction (HCI), a group of concepts about human factors are addressed along with more technical ones. The students need to have a clear mental model of the relationships between HCI, human factors and computers to understand, retrieve and use information about each topic given the general framework. If this knowledge does not provide a clear understanding for each of the concepts, the reasoning about the knowledge theme is, at least, limited.
In general, any problem where information structure and complexity are important is a candidate for such a structure for knowledge sharing. Examples of applications are Web Information Retrieval and Personal Information Management and Collaborative learning.

2.1 How the problem is currently solved

Current knowledge sharing in a higher education context is provided by lectures, seminars and lab sessions as the most traditional solutions [8].

- In lectures, an expert gives a structured perspective by introducing a particular knowledge theme and students take part normally as passive receptors of the information. One example can be a talk about Usability in HCI.
- In seminars, one or more experts give a group of integrated perspectives about a particular knowledge theme. One example can be a seminar in Usability theory and practices.

- Labs sessions allow each student to learn by doing, or experimenting on a given problem. One example is a lab session to test and evaluate the usability of a particular application interface.

To support lectures, seminars and labs, information for further student development is given as lists of readings, including papers, books and printed material and also as some multimedia material as video and CD-ROMS. In some cases hypertext-based material is also used, which is normally accessed on the web. This material serves as chunks of an information database that must be referenced. Recent developments allow the use of Computer Supported Collaborative Learning (CSCL), Computer Supported Cooperative Work (CSCW) and Web-based learning environments, most of the times only to extend current knowledge sharing paradigms [6].

2.2 Limitations of existing solutions and alternative solutions

The lecture, seminar and lab solutions, though valid for knowledge transmission, where one teacher engages in passing structured information to the students, have some limitations for knowledge sharing, where teacher and students are engaged in sharing their own opinions and difficulties. In particular, lectures, seminars and labs have a number of limitations:

- they provide a consumer model where each student receives information to form his/her own knowledge, and do not consider the student as a valid information producer. For example during a lecture, each student takes his/her own notes and does not usually describe his/her perspective about a particular lecture topic;
- information support usually relies on fostering information access, not facilitating student informed participation and empowerment [1]. For example during a seminar, a number of references may be given as topics for further reading, but no provisions are made to discover how relevant each student considers these references to be;
- they do not promote the collaborative organisation of common knowledge structures and the involvement of each of the students because of typical individual learning orientation. For example, assessment of students' knowledge is typically made through individual exams, which can be complemented, with other information following an individual approach for assessment;
- the support for learning is based on a closed system from the student perspective because neither his/her notes become part of the available reading material nor are reflected in it. For example, some student notes address understanding problems related to concepts and links between different content. This can be made available to others but within current practices it is done on a non-integrated individual basis.

Other solutions that exist for sharing knowledge and supporting collaborative learning are Web-Based Learning Environments [3], CSCL and CSCW systems designed for collaborative learning [7]. Although these solutions address the collaboration issues, they do not support an externalisation that provides a common model for knowledge sharing that can be collaboratively enhanced.

Existing efforts to represent meta-data and knowledge representations for easing information access related to educational settings are given, among others, by the IMS Learning Resource Meta-data Information Model, IEEE' LOM – Learning Object Meta-data, the Dublin core, RDF – Resource Description Framework, and Topic Maps.

We propose a different approach where the knowledge to be shared provides a context, which is one of the many possible views for the knowledge theme. We do not attempt to provide a unique definition for the knowledge theme being shared or even to classify content as most of the meta-data efforts do.

2.3 Additional support needed

Collaborative learning will allow each student to take advantage but also to contribute with his/her own effort to the group. This way, the consumer model where the student merely receives information can be transformed in a consumer/producer model, where the student also produces information to be shared among all.

Each individual needs to be involved in the knowledge construction and actively participate. As Clark and

Schaefer claim, for knowledge co-construction to occur, participants must not only make a contribution, but must also get their contribution accepted by others [4]. This involves a notion of building something together by engaging each of the group members in a common activity – the enhancing of the structure for knowledge sharing. The notion of a common activity is central to collaborative learning where a group works together for a common purpose.
A structure that can support a network of concepts can be used and shared among students to provide a common structure as an external representation. A network of concepts that represents the HCI theme gives one example of such a structure, where we can enumerate *Interface*, *Computer*, *User*, *Information*, *Data*, *Interaction*, *Usability*, among others. We can also list a number of characteristics for each concept and based on that, specify relationships among existing concepts. For example, *Usability*, *Interaction* and *User* can have in common a characteristic named *user*. A characteristic named *data* can be associated with *Computer*, *Information* and *Data* concepts. Note that we can have a concept and a characteristic with the same name. They are different because the concept is a list of characteristics and the characteristic itself can belong to any concept.

3 The structure for knowledge sharing

A structure for knowledge sharing addresses the above limitations. It does that by proposing (with the teacher's involvement):

- the use of a structured concept description that can be enhanced by students because of the implicit and explicit rules that such a structure represents, which in turn, when understood, facilitates the contribution of each individual;
- involving students in the co-construction of the structure and fostering the knowledge construction with as many group members as possible actively involved;
- use collaborative facilities to allow students' interaction with the structure by using a visual image that can be shared and modified, taking advantage of the way we thought, and providing a tangible externalisation for the knowledge been shared [5];
- the use of a common structure can allow students' notes to be considered and integrated along with the knowledge sharing structure that evolves over the time. This provides a means of supporting reuse and a growing corpus of related knowledge;
- provides a high-level abstraction structure to be used for integration with available information. Also, it provides a high level layer to support access to unstructured information. Due to its structured characteristics and textual form, it eases the process of integrate available information;
- as a text-based structure, it allows integration with current text search systems to seek content associated with groups of terms (concepts and its characteristics). This means that with some operations on the shared structure, ordered sets of terms can be generated to access a particular data source using a text search engine;
- by allowing sharing and collaboration, the structure can be enhanced and used to include new users' contributions. This will provide the conditions to foster knowledge construction;
- because it is open to each student's contributions the structure can be enhanced and used more easily than other meta-data specifications that are bound to more formal rules (as IMS), or context creators such as those provided by the Topic Maps standard [2]. It provides a possible link between data and context by not embedding context data but by specifying context independent representations.

3.1 How the support is provided

To overcome the described limitations, we proposed a simple solution based on a high abstraction textual structure, keyword based, for discussion among users. The textual structure provides an easy way for supporting discussion among a group of people and takes advantage of the role of language in both thought and social interaction [10]. The structure provides a description for the knowledge to be shared thus providing a relation between each user's mental map and a collective description of a knowledge theme view, providing the creation of a shared context.

The proposed structure is composed of concepts and keywords. A keyword is any word that can be used to describe a particular characteristic of knowledge. A given keyword can be repeated as wanting to be included in different groups of keywords. Each keyword group represents a concept. The keywords associated to each concept have a rating that represents the degree of relation with the concept (similar to a fuzzy logic membership function).

Considering an example using a HCI context, we can propose a concept named *Interface*. The *Interface* concept can have several associated keywords as *computer*, *usability* and *user*. For each keyword we give a particular rating (a value between 0 and 1 that represents the degree of membership of the keyword in the concept): for example, 0.46 for *computer*, 0.80 to *usability*, and 0.67 to *human*. These values give an order of importance to the relation between the concept and each of the keywords – they are not probabilities, so their sum does not need to equal 1. These values are proposed and voted among group elements in order to specify an association degree between the concept and the keyword.

Later, the structure can be modified by adding and deleting concepts, and keywords, or modifying existing keyword ratings, providing full flexibility to reorganise the context for a particular knowledge theme.

Figure 1 presents an example of a structure for knowledge sharing about the HCI theme with ten concepts.

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Computer: the information artefact "par excellence"
Data: the raw material to represent reality
Database: the technology to store and retrieve data
Enterprise: a group of people and resources organised to meet a goal
Ergonomics: to deal with better systems to support human operations
Information: the relevant data that support decision-making
Interface: the mediation between computers and users
System: a ground concept of unity and utility
Technology: the tools that help humans
User: humans that operate (use) the technology
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Figure 1: List of concepts and their meaning

Considering the ten concepts in the structure, many more can be added by any of the users, although, at first, users must propose keywords to describe each of these concepts. A possible resulting structure for the HCI theme is presented in Table 1.

Several keywords were added to each concept. For example, the *structure* keyword was added to the *System*, *Computer*, *Information*, *Database* and *Enterprise* concepts (highlighted in Table 1). Notice that the keywords used to describe the *Human* concept were included in the *Interface* concept. The values (between 0 and 1) placed with each keyword give the degree of relation (membership) between the keyword and the concept. The structure is composed of the concepts, and for each concept there is a keyword set. The rating of each keyword also serves to establish an ordered list of importance for all the keywords belonging to the concept. A concept can be better described by including more keywords. The relation between two concepts is given by the existence of the same keywords even with different values associated. In the example, the keyword structure relates to nine concepts.

Notice that the resulting structure represents a mental map specification based upon the contribution of a group of individuals about the HCI theme. It provides a concept map for relating HCI concepts based on a common agreement between the group of people involved.

Based on the same keywords and their values it is possible to obtain a value of similarity between two concepts. The keyword values from each concept are used in order to select which keywords are the most important for the context that deserve to be compared with the other concepts. For example, *User* and *Interface* have a strong relation based on the keywords *human* and *operation*. If we modify the value for the *human* keyword in *Interface* from 0.8 to 0.3, the relation between *User* and *Interface* is not as strong as before, although it still exists. However, the relation between two concepts exists in cases where keywords are shared among them. Based on the structure, it is possible to establish the relationships between concepts of the knowledge theme being shared by the structure.

Table 1 A partial structure for sharing knowledge about the HCI theme

System **structure**, 0.24 order, 0.27 lifecycle, 0.45 component, 0.49	User human, 0.78 operation, 0.65	Interface order, 0.34 operation, 0.76 human, 0.8 computer, 0.56
Data operation, 0.5 data, 0.78	Information **structure**, 0.67 decision, 0.67 retrieval, 0.4 cost, 0.56	Database **structure**, 0.78 order, 0.7 data, 0.6 retrieval, 0.5 storage, 0.55
Computer order, 0.67 technology, 0.7 automatic, 0.67 processing, 0.8 **structure**, 0.7	Enterprise value, 0.56 technology, 0.44 **structure**, 0.24 system, 0.23	Technology lifecycle, 0.55 value, 0.78 operation, 0.68 change, 0.34

The simple use of concept, keywords and keyword ratings provide the means for a group of people engaged in the construction of a concept space expressing the knowledge being shared. It provides a simple but usable way to share knowledge between a group of people using language as the main tool, as claimed by Vygotsky [10].

4 Conclusion

The idea of using a structure for knowledge sharing derives from the use of concept maps and other knowledge representations. Based on the problem of how to share knowledge between a group engaged in learning activities, a structure for knowledge sharing was proposed.
It provides a structured way for specifying a common mental map to be used by a group for collaborative learning. Taking advantage of discussion resulting from the structure enhancement, allows for a small group of students to interact and co-construct a knowledge representation of a given theme.

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