A proposal for using visualisation to support collaborative learning

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Abstract: The paper addresses the problem of how to share knowledge between a small group of people engaged in learning activities. In existing systems that support collaborative learning there is some evidence that difficulties occur when we try to: (1) support the sharing of knowledge between users; (2) support the learning process across distributed groups within a given educational setting; and (3) provide distributed access to knowledge from different types of machines. The proposed work is based on the examination of how a common structure for knowledge sharing can be used in distributed environments for collaborative learning in a higher education context by providing a 3D interactive visualisation. This work proposes the development of a visualisation design to convey information of the common structure for knowledge sharing to be created and enhanced in an educational context. We defend that the use of both the visualisation design and the structure for knowledge sharing can support collaborative learning.

1 Introduction

Currently, there is some pressure to improve learning environments and use Information and Communication Technologies (ICT) in innovative educational contexts [Goodyear, 1999]. The ready availability of networks and computers allows for the development of computer-networked systems that support learning activities in classrooms or distributed situations.

However, current systems for collaborative learning [Britain and Liber, 1999] do not support the same knowledge sharing environment that face-to-face situations enjoy. In particular, there are difficulties to representing context and abstracting information about the knowledge theme being discussed. This is a problem that needs to be addressed in order to facilitate support for Computer Supported Collaborative Learning – CSCL. In particular, knowledge sharing becomes even a great problem in situations where more traditional teaching, based on the presence of the teacher, is expanded to allow for both local and distance education settings [Wan and Johnson, 1994].

Additionally, some authors argue that efforts to improve learning and education must emphasise not only content but also context. In fact, already [Lewin and Grabbe, 1945] defend both that learners play an active role in discovering knowledge for themselves and the strong influence that the social environment of the learner in promoting changes. Also [Vygotsky, 1978] defends that knowledge results, not from a transmission process, but from the internalisation of social interactions.

New technologies that use 3D visualisation facilities and interactivity within virtual worlds seem to assist in minimising the difficulties by allowing abstract information, in the form of structured knowledge for representing contexts and meanings, to be visually mapped and explored using direct manipulation techniques. Such a representation can complement existing tools to allow context sharing of a given knowledge theme – a view of organising information about a particular knowledge theme.

2 Collaborative learning and the use of visualisation facilities

Collaborative learning is defined as groups working together for a common learning propose [Resta, 1995]. To collaborate effectively in work group, each individual purpose must share a common grounding

of concepts and be able to specify them in a form that allows individual reflection within the group. Each user in the group must possess a common mental map representation for reference, to understand the meanings and relations underlying a particular situation, topic, or subject knowledge referred as view. The common use of a visual representation of such a mental map allows for collaborative construction and enhancement, providing the opportunity to augment both individual and collaborative learning. An example of a similar system is CSILE (computer-supported intentional learning environments), which is a collective networked database of students' thoughts in text and graphic form. Data is labelled and organised in such a way that it can be accessed allowing a student to analyse a given view and to access related information in another domain [Scardamalia and Bereiter, 1994]

Information to support the meanings and relations of a mental map can be seen as a common information set of which each user must be aware. As this information comprises abstract concepts and their relations we propose the need to develop a structure for supporting knowledge sharing for the view to be shared. Few systems explicitly support such abstract information or consider it an important issue for supporting collaborative learning [Beck-Wilson et al., 1999].

The following ideas are proposed to support both user and collaborative learning:

- ? a structure for representing the knowledge theme being shared;
- ? a visualisation design to convey information about the structure being shared;
- ? an environment to allow the use of the structure and visualisation design to discuss and collaboratively enhance the knowledge being shared.

The work attempts to propose a visualisation design addressing the problems of:

- ? cognitive overhead: by allowing a abstract high level for information representation [Norman, 1991] and thus providing the means to integrate data using Information Visualisation techniques [Card et al. 1999];
- ? information overload: by allowing each individual user to take advantage of a structure for knowledge sharing and thus providing a context for reasoning about a particular knowledge theme [Huhns and Singh, 1997].

Additionally, the work is also extended to propose:

- ? support for data source integration: by taking advantage of a visualisation to merge information about a data source with the common structure for knowledge sharing and a textual search engine for Information Retrieval.

These problems are addressed by using a 3D interactive visualisation based on a structure for knowledge sharing that describes the requisite information. The structure is used to organise abstract information that must be shared for collaborative learning. The proposed solution uses visualisation as means of creating a projected representation for the structure been shared among different users. This work extends previous research on Information and Communication Technologies in education, in particular using Internet facilities for supporting virtual environments for higher education [Gouveia, 1999].

3 Approach of the work

The study of existing practices in collaborative learning and education environments serves as an initial starting point to get insight into ways of using abstract information and how it can be of value for and between students. The study of literature about face-to-face collaborative learning situations and knowledge construction provide important insights to inform about the characteristics that a virtual world system must have, to support similar functionality.

Based on the existing empirical data and from technical solutions developed on existent systems, a number of design solutions where considered. One of those solutions is the use of a structure as the main support for sharing knowledge about a particular theme view ? context. Huhns and Singh propose that users can contribute to enhance an existent domain knowledge model [Huhns and Singh, 1997]. Additionally, Huhns and Stephens efend the idea of using a set of symbols to represent a knowledge domain to be used by each individual [Huhns and Stephens, 1999].

The use of a set of symbols in the visualisation design provides a visual mental map representation that can help to keep cognitive overhead and information overload problems minimised. [Tufte, 1990].

As one of the main characteristics of the structure that must be represented is its relationship network, the visualisation design must provide some clues to organise and orient users. The exploration of

a three-dimensional space for human interaction seems a natural option to do this: Cyberspace is claimed to provide a three-dimensional field of action and interaction with recorded and live data, with machines, sensors, and with other people [Benedikt, 1991]. According to Wexelblat, a well-structured view can make things obvious to the viewer and empower interaction. The view structure can convey an underlying mental model and can indicate possibilities for interaction in what Wexelblat proposes as semantic spaces [Wexelblat, 1991].

The strategy followed for the visualisation design is to take advantage of collaboration between users to enhance domain knowledge that can be visualised and manipulated by each user for their own information needs and to allow different data sources to be integrated with the structure for knowledge sharing. This will lead to the combination of data source information and knowledge in a way that there is an independent layer between the knowledge been shared and a given data source. Thus provides the user with additional support to both analysing the data source and help in information retrieval activities.

This high level approach allows for a different kind of integration with existing data sources. It allows, in opposite to alternative low level – data – approaches no need to alter existent data sources and apply precise rules for previous identification – classification – of relevant information.

In order to test both the use of the structure for knowledge sharing and the visualisation design, a prototype has been developed to allow a group of students to use the visualisation design for sharing knowledge [Gouveia and Gouveia, 2002]. The prototype intends to test both the functionality and effectiveness of the use of the structure for knowledge sharing and a visualisation design to support user learning. The learning results from a group of activities such as collaboratively sharing, discussing and enhancing a structure for knowledge sharing.

4 Final remarks

The work defends the need to consider information about tacit knowledge as one of the requirements that must be presented in using Computer Support Collaborative Learning. Other authors defend a similar approach [Lewis, 1999; Mercer, 1995]. One main contribution of the work is the proposal of a structure for knowledge sharing to describe a knowledge theme view. This structure presents a base structure that can be extended to include and reference more information and thus provide richer semantics by adding new elements.

We claim that an appropriate approach to use the proposed structure for knowledge sharing is to provide a visual interface as a 3D interactive visualisation. A direct advantage of this approach is the possibility to represent structure relationships and integrate both knowledge and data source information.

The general outcomes of this research are:

- ? use of a structure to represent a knowledge theme view: conveying information to be enhanced by collaboration. The structure allows the knowledge specification, knowledge sharing and supports the visualisation generation.
- ? a 3D interactive visualisation to convey structure information: allowing the visual sharing and individual exploration of the structure for knowledge sharing.
- ? proposing a generic support to knowledge for collaborative learning: resulting in the joint use of the structure for knowledge sharing and a 3D interactive visualisation to support collaborative learning.
- ? provide the means for integration knowledge and a data source in the same interface: by giving a visual representation for the knowledge. The integration is made possible by using Information Visualisation techniques [Card et al., 1999].

The novel aspect is the proposal of the use of knowledge to render a 3D interactive visualisation design and an integrated Information Visualisation to comb ine data source information with the visualisation of the structured for knowledge sharing. Together these facilities provide an environment for collaborative learning support.

The system can be integrated with a data source, providing a tool for sharing and manipulating the visualised structured information as a knowledge map. This means that the system assists users in information retrieval actions within a specific knowledge theme view. The system provides the support for more informed browse and search tactics to be undertaken by the user. It also provides support for sharing,

discussing, and exploring the structure for knowledge sharing, providing an environment for collaborative learning.

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