Abstract. E-learning deals with knowledge management, for sure, and knowledge management very frequently results in learning. So far, there is an obviously close relationship between the two disciplines. However, deeper insights do not arise easily. Here we investigate how one approach to enhancing information-access interfaces may inspire an improvement in knowledge management for e-learning. Subjunctive interfaces support users in investigating and visualizing information obtained in parallel through multiple enquiries. A wide spectrum of exploratory e-learning approaches may benefit from adopting and adapting the subjunctive interface concept.

1 Introduction and Motivation

It seems that Knowledge Management and E-Learning have quite contrasting perspectives on knowledge. Knowledge management depends very much on the assumption that knowledge is carried by data, as knowledge management systems are quite typically complex information processing systems designed to serve the human user by a variety of interactive data manipulations. In contrast, the e-learning community believes that the knowledge they are interested in is not sitting in the data. Learning is understood as some process of knowledge (re-)construction. Therefore, different learners may learn quite different things when dealing with the same data.

Under these roughly sketched assumptions we are trying to bridge the gap by means of an original approach [9-11] that aims to go beyond the limits of current support for exploratory use of computer applications.

Knowing about deficiencies of many current e-learning systems and services, our point of departure is the urgent need to promote didactics in technology enhanced learning. Exploratory learning is just one of the prominent didactic concepts that should help to prove e-learning more successful by making it more cognitively adequate, entertaining and illustrating to the learner.
2 Perspectives on E-Learning

Complex e-learning systems in practical use (see [8] for an example) employ a wide spectrum of didactic concepts [3]. It is a folklore saying that there are as many didactic concepts in the literature as authors writing about didactics. Thus, the authors have chosen a pragmatic approach and decided to focus on a single didactic concept on which there is little debate: exploratory learning. In exploratory learning, learners who already have some motivation and are, perhaps, already driven by some learning goal are being presented with material that has to be explored carefully. Insights or even vague ideas gained through such explorations may be used systematically in subsequent learning phases\(^1\). This concept nicely fits the potentials of technology enhanced learning where computer systems and, in particular, the world-wide web may serve as a rich source of information to be explored. Exploratory learning goes clearly beyond the limits of traditional instruction practice where a teacher is very limited in the material he can present to his audience. Furthermore, e-learning allows for individually tailored explorations at any time and with any frequency and intensity preferred by an individual learner.

From this perspective, exploratory learning looks like a great idea that should be employed in e-learning wherever possible. A closer look reveals severe difficulties. When learners are sent out to search for information, to collect information, to compare information, to evaluate their results of comparison, and to draw conclusions from what they have explored with respect to their learning tasks or goals, they usually face serious problems of knowledge management.

When you get many pieces of information about some subject one after the other, how to do comparison? How to recognize trends? How to identify correlations? These are questions of knowledge management that are clearly fundamental to e-learning.

Depending on the goal/task of learning, on the knowledge source and on the structure of the information to be explored, a large variety of knowledge management technologies may apply.

The present paper does not intend to provide a universal answer to these questions. The proposed solution of subjunctive interfaces has been demonstrated in two kinds of domain relevant to e-learning: dynamic simulation, where a learner may need to explore how a simulation’s outcome is affected by various conditions, and information retrieval, including exploratory studies in which a student may systematically gather information from Internet sources.

It is worth mentioning that applications of the latter kind are particularly attractive to many learners, because they prove – at least implicitly – that the studies undertaken are based on the most recent information and deal with truly practical data. It is important to pay attention to such opportunities to motivate students [1,2].

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\(^1\) We do not go into further details of arranging deeply structured technology-enhanced learning experiences. Storyboarding is currently seen as the way in which learning processes are anticipated and learning experience is organized [6].
3 Subjunctive Interfaces Introduced and Illustrated

Exploratory access to computational results arises in a variety of domains – including the navigation of web sites, querying from databases, experimentation with simulations or spreadsheets, and exploratory design of artifacts. Typically, the applications available for such activities provide results only in response to explicit, pinpoint specifications by the user. Exploration thus requires the user to undertake an iterative process of requesting and comparing results, which can be burdensome in the following ways:

1. A high number of interface actions
   Making the different specifications needed to obtain the results may require many actions, such as mouse clicks or key presses – especially if the user wants to revisit earlier results.

2. A need to remember results
   When only one result is visible at a time, comparing results requires the user to remember the relevant details of those that are currently out of sight.

3. Mental effort in organizing the exploration
   In cases where the results of interest depend on varying two or more aspects of the specification, the user must expend effort in working through the desired combinations of settings for those aspects.

An application equipped with a subjunctive interface lets the user establish and control multiple scenarios, based on alternative specifications, at the same time. The key features of a subjunctive interface are therefore as follows:

The user should be able to set up multiple scenarios that differ in arbitrary ways. In general, when offered some choice in the application’s interface, the user should be able to say ‘maybe I want value $X$, but maybe $Y$ or $Z$ – so let me try all three and see how things turn out in each case’.

The scenarios should be viewable side by side, in a way that helps the user to compare them and also to understand each scenario individually – i.e., the correspondence between a given input specification and its results.

The user should be able to control scenarios in parallel, for example by adjusting an input parameter that is shared by many scenarios and seeing instantaneously the effect of this adjustment on each scenario.

By making use of such facilities, a user can reduce the need to re-specify a scenario to revisit its results, can make side-by-side comparisons that would not be possible in a single-scenario interface, and can efficiently work through large numbers of alternative specifications.

The concept of subjunctive interfaces was inspired by Hofstadter’s [5] playful notion of a subjunc-TV – a magical television whose tuning knobs would provide access to alternative versions of a given broadcast.

Figure 1 shows how a subjunctive interface can be used in studying a simulation. This simulation, of the food-foraging behaviour of ants, takes into account three parameters that can be varied by the user. In the normal, single-scenario presentation,
it may be difficult for a student to grasp the effect of some parameter variation; with the addition of a subjunctive interface it becomes possible to create and observe many scenarios side by side (the current interface supports up to twelve scenarios), which can help in observing even subtle differences.

Figure 2 shows one case in the use of a tool called C3W (Clip, Connect and Clone for the Web – see [4]), which allows a user to capture Web-based information retrievals and then to apply subjunctive-interface principles to pursue multiple alternative retrievals in parallel.
4 Exploration and the Potential of Subjunctive Interfaces in the Data Mining Tutor DaMiT

DaMiT (e.g., see [7,8]) is an e-learning system for the domain of data mining; its name is an abbreviation of ‘Data Mining Tutor’.

Data mining focuses on the problem of investigating complex, usually distributed data bases for the construction of models over these data bases that allow for the derivation of commercially, scientifically or politically useful insights. The construction of such models is both a science and an art. With DaMiT, learners can study the science and experience the art of data mining.

Especially for the purpose of ‘experiencing the art’, the DaMiT system offers many opportunities for exploratory learning.

Fig. 3. Cutouts from five successive cases in an applet for exploratory studies

In the case study displayed in Figure 3, the learner can set up data for successive construction of decision trees over regular patterns. The input data are shown in the applet input form of the leftmost screenshot. The exploration task consists of choosing patterns for nodes of a decision tree and investigating the quality of the resulting classification behaviour. By changing the patterns in the nodes, the learner can tune the decision tree’s classification power. Every cutout shows the classification results at the bottom.

Figure 4 shows one example of how subjunctive-interface techniques could assist such exploratory learning in DaMiT. The results from the various cases have been gathered into a single view, helping the student to compare them side by side.
Summary and Conclusions

The subjunctive-interface approach (see [10] for a range of examples, and pointers to related work) suggests a certain explicit relationship between knowledge management and e-learning. It is the authors’ intention to encourage the two communities to seize the suggestion of integrating subjunctive interfaces as a variant of knowledge-management support into exploratory e-learning systems.

References