

Putting Order to Episodic and Semantic Learning Memories: The Case for KLeOS

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Abstract

KLeOS is a Knowledge and Learning Organisation System which reflects the hierarchical organisation of learning into activities, episodes and projects (Tough, 1971; Vavoula & Sharples, 2002), and allows the user to organize and manage their learning experiences and resources as a visual timeline, while at the same time visualising their episodic learning memories. The prototype demonstrates functionality at three different levels, allowing the user to (a) manage their learning projects; (b) monitor the learning episodes they complete and associate them with projects where applicable; and (c) perform learning activities within episodes. In addition, it incorporates a knowledge map, which the user updates as they progress through their learning experiences and which reflects their semantic learning memories. The learning episodes (episodic learning memories) are interlinked with the relevant knowledge nodes in the map (semantic learning memories) allowing for browsing of past learning experiences and knowledge. KLeOS has been evaluated to assess its (a) usability and desirability, and (b) its effectiveness as a knowledge retrieval tool, against R-KLeOS, a reduced version of the software which does not support the interlinking between episodic and semantic learning memories. Although the users identified some shortcomings in the interface design of KLeOS, overall it was rated as a usable and useful tool that they would be willing to adopt. No significant difference was found between the effectiveness of KLeOS and R-KLeOS as knowledge retrieval tools, however there was some evidence that more prolonged use with real-world meaningful learning tasks might favour KLeOS.

1 Introduction

A distinction has been made between episodic and semantic memory (Tulving, 1983). Episodic memory is involved in the recording and subsequent retrieval of memories of personal happenings and doings, whereas semantic memory relates to knowledge of the world that is independent of a person's identity and past (Tulving, 1983). Electronic records of people's episodic memories have been used in the past for information retrieval (Bovey, 1996; Lamming & Newman, 1991; Lansdale & Edmonds, 1992). The system presented in this paper, KLeOS, maintains an interlinked record of the user's semantic as well as episodic learning memories.

KLeOS is an aid for the recording, organisation and recall of learning. It was designed to reflect the three-level organisation of the learning practice into activities, episodes and projects (Tough, 1971; Vavoula & Sharples, 2002) by supporting: learning activities, i.e. discrete learning acts like reading and discussing; learning episodes, i.e. collections of activities that are performed in a given time interval; and learning projects, i.e. collections of episodes related thematically or by purpose. Projects, episodes and activities are displayed as segments on a timeline, and together they represent the user's episodic learning memories.

In addition, the system incorporates a map of the user's acquired knowledge in the form of notes made on a concept map, which represents the user's semantic learning memories. Each node in the map represents a note, and is tagged with information about the relevant activity, episode and project. Navigation mechanisms are provided for the user to explore their knowledge map, to

traverse their learning episodes on the timeline, and to move from the map to the timeline and vice versa.

KLeOS provides a device for testing the effectiveness of the combination of episodic and semantic learning memories as a knowledge retrieval aid. A reduced version of the software, R-KLeOS, was implemented that was identical to KLeOS except for the interlinking mechanism: there was no direct connection between an episodic memory and related semantic memories, or vice versa. Two groups of seven people each performed a (pre-determined) learning task relating to learning about earthquakes using the two versions of the software. Measurements were made of the time taken to retrieve knowledge in order to complete a quiz immediately after the learning task and a second quiz two weeks later. The same people participated to a questionnaire-based usability evaluation after the second quiz. Section 2 of this paper describes the two versions of the software in more detail, and section 3 briefly presents the results of the usability study and the learning task experiment.

2 KLeOS: A Knowledge and Learning Organisation System

Project Timelines: A timeline is a common graphical representation of events (Plaisant et al., 1998; Plaisant, Rose, Rubloff, Salter, & Shneiderman, 1999). Time is depicted on a line and events of a specific type are shown on the respective time points. In KLeOS, learning projects are represented as lines parallel to a timeline (see fig. 1a). The timeline itself extends indefinitely into the past and future, whereas the project lines start and end at the moments specified by the user and their learning activities. The projects timeline offers zooming facilities, as well as a facility for moving forwards and backwards in time. Four different views (daily, weekly, monthly and yearly) are supported in the current version. The vertical arrangement of the project lines codifies information about the order of creating the project lines: the closer a project line lies to the timeline, the less recently it was created. The width of a project line codifies information about the project's importance: the wider the line, the more important the project.

Episodes Interface: In KLeOS episodes are shown as blue marks at the appropriate location (i.e. time) on a project line (see fig. 1a). KLeOS allows the user to carry out and monitor learning episodes and review them at a later time.

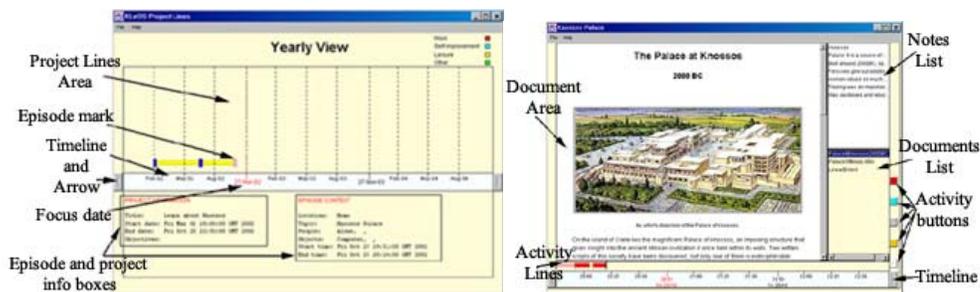


Figure 1: (a) Project timelines (left), (b) Episodes interface (right)

A recorded episode can be reviewed by locating its mark on the project line and clicking on it. A new window opens that displays the information for that episode. A Notes List and a Documents List are displayed in this window. The Documents List contains all the documents that were used during the episode, in chronological order, with repeated entries where necessary. The manipulation of documents is done in the course of performing learning activities: an activity involves the manipulation of a document of some type, for example a report for reading, a transcript for a discussion, etc. At the bottom of the window, appears a timeline against which are drawn Activity Lines, i.e. lines that correspond to the activities for the respective documents in the

Documents List, and signify how long an activity lasted. Clicking on a document in the Documents List, or on an Activity Line, will take the user back to the document and its respective activity. The relevant document is opened in the Document Area (fig. 1b), and the Notes List displays all the notes that were made during that activity. The four buttons “R, W, D and S” represent the different activities that the user can perform (reading, writing, discussing and searching) In the current version, only “R” is supported. The button “P” stands for Pause, and is used whenever the user wants/has to pause their activity for any reason. In review mode the buttons are disabled: the user cannot alter the structure of a past episode while revisiting it by performing new activities. Reviewing is also not implemented as a learning activity itself; however, this is considered for implementation in future versions.

Basic Concept Mapping Tool: Notes in KLeOS are made using the Basic Concept Mapping Tool, on a knowledge map. A concept map (Buzan, 1995), or knowledge map, is a network of nodes, which represent concepts, facts, or ideas, and links between those nodes representing relations between them. The Basic Concept Mapping Tool provides this kind of functionality as a method for making notes. In the current version the navigation mechanism implemented in the concept map itself is restricted to visually following links and scrolling. However, the map is also navigable through the Notes List: if the user wishes to review a note in the map that appears in the Notes List, they can click on the list item and they will be transferred to the map, with the relevant note highlighted. The notes in the map are tagged with information about the episode/activity during which they were created. Thus, while in the map, the user can revisit the relevant episode/activity of a node by activating a pop-up menu. This functionality allows the user to navigate between their semantic (knowledge map) learning memories and their episodic (episodes interface) learning memories, using combinations of cues from both to retrieve past knowledge.

R-KLeOS: The reduced version of KLeOS, R-KLeOS, is identical to the original software except that the episodes interface does not provide the Notes List; instead, a button is available for the user to access their concept map whenever needed. Similarly, the concept mapping tool in R-KLeOS does not have the feature of accessing a node’s context, i.e. the user cannot move from a node in the map to the relevant episode/activity of that node.

3 Evaluating KLeOS

An evaluation session was designed to (a) assess KLeOS’s usability, usefulness and desirability and (b) test whether and to what extent the combination of episodic and semantic learning memories offered by KLeOS would affect the efficiency of knowledge retrieval. The two versions of KLeOS described in section two were used for the latter. The experiment was designed with two conditions, a control group who used R-KLeOS and an experimental group who used KLeOS, to perform identical learning tasks. The task involved the reading of 15 documents containing information about earthquakes. Pre-tests secured that both groups had comparable prior knowledge of the topic. The learning task lasted for one hour, with a five-minute break halfway through, and was preceded by a five-minute demonstration of the software. Both groups answered two knowledge quizzes, one immediately after and one two weeks after the learning task. The participants were timed during the two quizzes, to compare response times. 14 people participated in total, seven in each group. After the second quiz, they were asked to use the Product Reaction Cards from the Desirability Toolkit (Benedek & Miner, 2002) and to fill in a questionnaire with questions about the usability of KLeOS and the general appeal of the concept. Those using R-KLeOS were first given a demonstration of KLeOS, with data recorded during their own session.

3.1 Usability and desirability

The software scored well in learnability (4.13 out of 5), controllability (3.74) and suitability for learning (3.69). Despite the slowness of the interface and the occasional instability of the software,

most participants (10 out of 14) said that they would use it as a learning tool. The greatest advantages of using the software were thought to be (a) the ability to keep a record of one's learning and revisit that record (mentioned 7 times), (b) the ability to organise learning resources and knowledge and relationships between them (mentioned 6 times), and (c) the simple and easy to use interface (mentioned 3 times). The greatest disadvantages of using the software were thought to be (a) that it is time consuming to maintain, (b) it is not flexible enough (e.g. to work in cases where the relevant material is not on the computer, or to integrate with other tools), and (c) it is lacking a text search facility. The questionnaire also examined which features of KLeOS were most likeable as well as their utility as recall aids. Among the most likeable features the Basic Concept Mapping Tool was the most common, followed by the linking (between the documents, the activities and the relevant notes) and the Documents List. The least likeable features related mostly to aspects of the interface, like limited navigation and manipulation of concept map objects, the colours, shapes and general appearance of the GUI, the slowness of screen refreshing, etc. The Documents List and the Concept Map scored higher than the participants' own memory as recall aids. The Notes List did not score as high although it was identified as a useful feature. The Activity Timelines were not thought to be of help as recall aids. In fact, the participants did not make any use of this feature.

3.2 Effectiveness of Knowledge Retrieval

The two groups achieved comparable scores in the two post-task quizzes. In the first quiz, the control group achieved an average score of 48.57 and the experimental group 47.14. In the second quiz, the control group achieved 73.21 and the experimental 71.43. Both groups did significantly better in the second quiz, however, the comparable results between the two groups in the two tests suggest that this improvement in performance is likely to be due to different difficulty levels of the two quizzes rather than the use of the software.

The overall time it took to complete a quiz was, on average, slightly greater for the experimental group for both quizzes by approximately one minute. The times that were measured were:

- (a) *The time it took to produce a non-answer*: this equates to the time it took a participant to conclude that they had not previously accessed the information needed to answer a question. This time increased for both groups in the second test in relation to the first.
- (b) *The time it took to produce a correct answer, without accessing the (previously read) documents with the relevant information*: this equates to the time it took a participant to produce a correct answer based on memory. These times were comparable between the two groups in both tests, and no difference between the two tests was observed.
- (c) *The time it took to produce a correct answer while reviewing the (previously read) documents with the relevant information*: this equates to the time it took a participant to produce a correct answer when they could not remember the answer. These times were significantly reduced for both groups in the second test in relation to the first. However, between the groups the results were similar.
- (d) *The time it took to access a (previously read) document that contains information about the current question*. In the case of questions that referred to more than one documents, the time to access the first document was measured. Both groups were slightly faster in the second test, and the experimental group was slightly faster than the control group in both tests; however, no significant difference was observed.

Overall, the times taken by the two groups to answer the two tests were comparable, with only minor trends supporting the hypothesis that the linking between semantic and episodic learning memories would make knowledge retrieval more efficient.

Visiting documents was the feature that was most used by both groups, during both tests. The control group visited an average of 2.09 documents per question in the first test, and 2.32 in the

second test. This is an increase of 11%. The experimental group visited an average of 2.02 documents in the first test, and 1.57 in the second test. This is a decrease of 22%.

The linking was used by the experimental group an average of 0.20 times per question in the first test, and 0.34 times in the second test. The low use of the linking feature in relation to direct document access could be attributed to the newness of such a facility.

Although no significant difference in the use of the system between the two groups in the two tests was found, the above constitute some evidence that the linking facility gets more used the more time has elapsed since the original learning episode; and the full version of the software which includes this facility allows the user to reach the previously read relevant documents after less navigation within the documents pool, in less time. Further testing, with longer time intervals between tests and in naturalistic settings where the users perform everyday, personally meaningful learning tasks and retrievals, is necessary before this can be positively confirmed.

4 Conclusions

KLeOS provides the user with a graphical, timeline-based representation of their episodic learning memories, by depicting learning episodes and activities against a timeline, in the context of a learning project. It also allows them to associate their learning activities with relevant notes that they make using a concept-mapping tool. In an initial evaluation, users found this as a useful representation and considered it as an easy to use, desirable, and novel learning tool. A comparison of KLeOS with a reduced version of it, which did not provide the interlinking between the timelines and the knowledge map, did not find any substantial difference in the effectiveness of the two systems in knowledge retrieval.

5 References

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