The Virtual Learning Machine: Integrating Web and Non-Web Technologies

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Abstract

Web-based courseware packages have rapidly gained popularity in universities as practical tools which streamline the authoring and administration of web-based learning. However, evidence suggests that they are less popular among students, due in part to limits inherent in their web browser-based interface.

The Virtual Learning Machine is a prototype tool for the authoring and delivery of computer-based distance education that extends the multidimensional and collaborative learning environment of a university. By paying careful attention to the design of the student interface and by integrating Web-based and non-Web technologies behind-the-scenes, it is able to combine the greater functionality and interactivity of standalone computer-based learning systems with the collaborative, networking strengths of web-based systems.

1. Introduction

In the course of our research [1] we have conducted an extensive survey of courseware and other educational technologies relevant to computer-based distance learning. We found that while most existing online learning systems may effectively support internal university courses and in-house training programmes, they are often ineffective for delivering distance education to remote students, offering few, if any, advantages over traditional hard copy study guides and textbooks.

As a result we concluded that a fresh look at this problem was merited. We decided to build and test a computer-based distance learning environment from first principles, by identifying the key requirements for computer-based distance learning without making any assumptions regarding preferred technologies or platforms. Our research identified seven key requirements for computer-based learning systems to meet the needs of university-level distance students. These are:

Identify the users clearly. Distance students may have quite different requirements (and computer experience) from other users of online educational software.

Prioritise interface design. For the distance student, the interface is the system.

Recognise the university itself as the most important learning community. Focus upon techniques for drawing distance students into this university learning environment.

Design as an information system, in which some tasks may be better handled by a human tutor, or by the student users themselves, than by computer automation.

Recognise the limits of web-based technology for distance education. Consider integrating other technologies.

Provide some level of adaptation to the individual learning task and/or student. There are no doors to knock on or shoulders to look over for the distance student.

Evaluate for functionality, usability and accessibility. Distance learning systems must not only run on the information super highway. They must work on the copper wire byways as well.

The Virtual Learning Machine (VLM) presents a stripped-down, integrated and individualised learning environment, providing all the functions, features and tools a distance student needs for studying a particular subject through a single interface, and nothing else. In the rest of this paper we discuss the main features of the VLM.

2. Fat-client architecture

The VLM system architecture flows from the requirements of a computer-based distance learning environment:

Asynchronous. Anytime, anywhere study, including in different time zones and with different levels of sophistication in telecommunications. We cannot assume high-speed network connections, and must make provision for an unreliable network. This requires an asynchronous communication model.

Distributed. Most system functionality resides on the student machine. There is no requirement for centralised monitoring of students' usage patterns and performance.

Co-operative. Students collaborate and communicate with each other over the network. This requires centralised synchronisation and updating.

In the VLM approach, the network is a delivery mechanism, not an essential element of its interaction with the user. It requires one-way broadband only, to enable the
downloading of learning material from a central repository in the form of text, graphics, audio and video. Collaboration and communication between students is supported by narrow band two-way telecommunications similar to Internet email.

3. Integrated, Individualised and Invisible

The VLM is first and foremost about careful design of the student interface. There are three facets to this interface:

Integrated Interface. It integrates material from different sources and media seamlessly into a single interface. It integrates all the required functionality from the operating system, the browser and the application itself into this interface.

Individualised interface. The student can choose what to study and how learning material will be presented to them. The system tracks the student through the course material and can provide context sensitive help.

Invisible interface. It shields the user from the complexities of windowing operating systems and web browsers by implementing all the required functionality through a virtual computer focussed upon the learning task, thereby rendering all the unwanted general purpose features and functions invisible.

The VLM draws upon an analogy with the embedded computer, which simplifies the use of modern appliances such as washing machines and televisions, while remaining invisible to the user.

An internal student has many options for learning a topic - lectures, textbook, library study, laboratories, seminars, group projects, personal tutoring, etc. The VLM aims to present a similar range of options to external students. This means that a student can switch dimensions at any time in order to try a fresh approach to solving the learning task at hand, without losing their place in the course. Each learning dimension (study mode) is defined by a set of components corresponding to key elements that have been identified in real world learning. Each learning element - e.g. lecture, lecture slides, tutorial and student notebook - is implemented as a separate software component encapsulating the particular learning/teaching tool. The component may display a file stored on the user's machine; it may link seamlessly to remote resources and applications via the Internet; or it may execute another (hidden) application installed on the student's computer.

To implement the Learning Machine as a virtual computer requires specialised management routines akin to those of an operating system, such as managing the file system and handling generic functions like printing. The System Tree, defined by the underlying structure of the course itself, is the core of the virtual computer, providing the framework for the virtual directory system, synchronisation between modes, the student model and the context-sensitive help system.

The VLM minimises the isolation of the distance learner by integrating help, communication, and collaboration so that students can work together over a network on joint projects and on helping each other to solve problems. They can also seek help and guidance from the course tutor when necessary, and from the system itself as an avenue of first or last resort.

To advance beyond the "one-size-fits-all" approach of courseware, the VLM implements an adaptable strategy. Adaptation is provided by students being able to navigate their own path through a course; by determining how, what and when to study (within the constraints of assessment and group work); and by defining and refining help queries. This adaptability is made possible through reference to the system's underlying data structures and models, especially the System Tree.

A human tutor is an integral part of the VLM approach. One of the tutor's main responsibilities is to monitor student discussions and dynamically build the help subsystem in response to student queries.

The VLM supports authoring by non-programmers on two levels:

Authoring the course content. The system requires only basic editing tools like a word processor and an HTML editor, and a few simple on-screen forms. The starting point is a study guide divided into sections and subsections. Additional modules for tutorials, discussion groups etc are then added to provide alternative study modes. The modules are installed using a simple form interface, requiring no knowledge of the virtual directory structure, or other implementation details.

Customising the learning environment. The available study modes can be defined or re-defined by selecting from a list of pre-installed learning components.

The VLM can readily accommodate multiple courses and even multiple users. However, it is primarily intended as a single user, single course, and single semester system. This makes maintenance straightforward because updated software is distributed with course content at the start of each semester. The object-oriented, component-based design also facilitates modular updates and extensibility.

4. Conclusion

The Virtual Learning Machine provides a robust computer-based distance learning environment, developed from first principles, that works as well on the copper wire byways as on the information super highway.