Recipe for an Intelligent Learning Management System (iLMS)

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Abstract: This paper looks at a recipe for the construction of an intelligent Learning Management System from the perspective of a learning community focussed LMS research and development team. Four key ingredients; the Educational Activity Toolset, the Learning Object Library, the Adaptive Intelligent Agent and the Learning Community Agents, are defined and mixed well. However, this basic recipe only sounds simple. This paper discusses technical, organisational and pedagogical problems and potential solutions of using an intelligent Learning Management System.

Introduction

The purpose of this paper is to propose a series of views concerning the ways in which the learning management systems currently available and in development could utilise artificial intelligence tools and techniques to develop learning management systems that more directly support the learning objectives that such systems are there to support. The views expressed here stem from the experience of a research and development group whose main focus is on supporting e-learning and e-teaching. We have put forward what we believe is an interesting and flexible recipe for constructing and using an intelligent learning management system (iLMS). The recipe reflects developments in the generation and use of learning objects and resources, their increasing availability and the increasing recognition for the value of collaborative and community-based learning without neglecting traditional pedagogical approaches.

1. The Ingredients

Before discussing our recipe for an iLMS, it is worth reviewing how traditional face-to-face teaching works, given that is what most teachers and learners are familiar with, and therefore what most future users of an iLMS, will be familiar with. In a traditional educational environment, a teacher has a range of tools and techniques available to them which they can use to organise purposeful learning activities that reflect specific pedagogical approaches. Furthermore, each teacher has a collection of resources to support learning, such as presentations, slides, textbooks, journal articles, images, video and audio tapes etc. One of the main intellectual and creative challenges for teachers preparing their courses is that of identifying and selecting the appropriate learning item/activity from the generic ‘pedagogical toolbox’, the item/s that meets the educational needs of a given student or group of students, in a given situation and then adding the appropriate content from the learning resource collection. Slowly, slowly, the trend also in traditional face-to-

face classrooms (even those in tertiary education) is more and more away from lecturing entire classes and towards individualised learning on the one hand and co-operative community-based learning on the other hand. That ability to cater for the specific and generic needs of learners and communities of learners becomes more and more prevalent in the drive towards 'personalised' education.

The other viewpoint to this situation, of course, is that of the learner. Whereas the learning experiences of many of the mature learners (an increasing number of tertiary education students) consist mainly of lecture-based classrooms, the educational backgrounds of many groups of younger students are rooted in flexible individualised and group-based learning from their primary education. As a consequence, for open and flexible learning to work effectively, there has to be more involvement by the learners in identifying their needs and their abilities. In the traditional face-to-face teaching model there is scope for this to happen and for students to determine to some extent how they use resources and in what way.

Teaching, and indeed learning, with a LMS has to have similar properties to those in the traditional process in order to enable, not only a group of early adopters, but also the vast majority of teachers and learners to use it. Therefore, we propose that a LMS that claims to be intelligent, needs to contain the following four components to support a meaningful educational process: 1) A pedagogical toolbox reflected in a set of templates set up to support sound educational activities. 2) A library of learning objects which equates to the collection of learning resources. 3) An agent that works in collaboration with or for a teacher to help fill the detail of the templates with the appropriate learning objects from the enormous collection of learning objects available world wide. 4) Intelligent mechanisms that add richness to the community and collaborative learning environment for both teachers and learners.

These four components are discussed in more depth, the current state of their development, together with related problems and potential solutions are also considered. At this stage, it is clear that the four components, namely:

1. The Educational Activity Toolset (templates)
2. The Learning Objects Library
3. The Adaptive Intelligent Teaching Support Agent and
4. The Learning Community Support Agent

are being discussed from the perspective of the teacher, rather than the learner. This is partly because the teacher perspective lends itself to the use of toolsets and agents (acting as assistants) and partly because it is less clear how the interaction between a teacher's agent and a learner's agent would occur. This point is discussed later in this paper, but for now the focus is on the four components suggested as core elements within an iLMS.

2. Educational Activity Toolset (EAT)

The call for a set of templates to facilitate the process of setting up meaningful online learning environments is not new. Lyardet and his colleagues (1998) suggested the use of 'design patterns' to develop educational multimedia.

> *"[Design patterns] describe problems that occur repeatedly, and describe the core of the solution to that problem, in such a way that we can use this solution many times in different contexts and applications."* [1].

Although Lyardet and his colleagues suggest design patterns from a software engineering perspective, other authors put forward similar ideas from an educational point of view. Diana Laurillard (2002) called for the development of generic, customisable shells for learning activities based on an agreed set of characteristic forms of effective e-learning

which place the control of learning design with the teacher [2]. An initiative of the Australian University Teaching Committee (AUTC) is heading in precisely the same direction: identification of learning designs that foster high quality learning, development of a series of re-usable templates for these identified learning designs and provide a series of guidelines for the use of these templates [3].

All these initiatives agree on the need for generic templates to facilitate efficient and effective online teaching. Teachers are faced repeatedly with similar problems, in different educational contexts, where they have to develop similar solutions. Having templates that can be customised according to the specific situation would make teaching much easier from a technical and workload management perspective. Using such templates may also foster the dissemination of best practice teaching. However, many authors also agree on the need to identify what are effective online learning activity models [2,3,4]. While awaiting the outcome of such studies, we can look at good face-to-face teaching practice. Based on the assumption that teaching with information and communication technologies (ICT) does not require a new pedagogy [5] and that computers and the Internet are nothing more than vehicles for education [6], we can refer to the vast amount of research undertaken during the last three decades about effective teaching methods and techniques. Very comprehensive meta-analyses of educational productivity research have been published and are excellent starting points to identify best practice of teaching in the analogue world [7,8,9].

If we look at existing LMSs, it is immediately apparent that none of them offer generic, customisable templates to organise educationally sound learning activities. There are attempts in this direction, e.g. ARIADNE (http://www.ariadne-eu.org/en/system/index.html) offers a set of tools. However, these tools aim more at the creation of new learning objects than being an empty shell in which to place existing learning objects. The University of Waikato's WICeD team has begun developing a set of "wizards", which guide teachers through a step by step process to incorporate the content material in an underlying template of a learning activity. These tools are built into the LMS named PLACE™. Currently, there are wizards for setting up individual and group workbooks and peer assessment. They are generic and can be tailored according to needs and context. An interesting reflection on this is that, it was intriguing to observe lecturers using the workbook wizard for quite a range of different purposes: reflective journals, assignment-upload, individualised feedback, project work and portfolios [10].

2.1 Key issues in the development of learning templates and the EAT

"Re-purposable" and customisable:
Once an effective learning activity has been identified, the challenge is to convert it into a template that allows teachers to use it in many educational situations and to tailor it according to their personal preferences. When developing templates, they are most often optimised for a specific course, and cannot be easily adapted and customised for any other purpose. Therefore, templates for setting up learning activities have to be designed as generic without losing their educational core effectiveness.

Easy to use:
Teachers in the analogue world are used to photocopying diagrams, cutting and pasting them it into their work sheets, etc. Using an online LMS to organise learning activities should be as easy as that. Agents that divide technically complicated processes into easy to handle steps are a "must" not just a "nice-to-have".

3. Learning Objects Library (LOL)

Economic issues triggered the work on interoperable, reusable components of e-learning resources and raised the issue of standardisation. Among the most comprehensive discussions of standards relating to learning objects and learning object metadata to date is the draft IEEE 1484 Learning Object Metadata Standard proposed by the IEEE Learning Technology Standards Committee that defines a structure for interoperable descriptions of learning objects.

> *Metadata is information about an object, be it physical or digital. As the number of objects grows exponentially and our needs for learning expand equally dramatically, the lack of information or metadata about objects places a critical and fundamental constraint on our ability to discover, manage, and use objects.*[11]

However there are a number of initiatives in this field, arguably the most popular is the Advanced Distributed Learning's Sharable Content Object Reference Model (ADL SCORM) which uses the IEEE 1484 object metadata standard. SCORM however does have its critics. Stephen Lahanas, a senior systems engineer and developer of e-learning systems at Cisco Systems, fears that the SCORM standard is heading down the same path as the CORBA object standard, whose complexity was so great that the time spent implementing the standard was greater than the time saved using it [12]. The difficulty in creating a standard appears to be in maintaining the appropriate compromise between flexibility and simplicity.

From a software engineering perspective, learning objects have to be independently reusable, cohesive and de-coupled [13]. From an educational perspective, learning objects must easily fit into and be compounded within templates of an educational activity toolset as described above.

The Learning Object Library (LOL) is not a phenomenon that is waiting for the establishment of standards. Many large collections are available today in almost any field of study. If the enormous numbers of traditional textbook publishers offer are not counted, it is still possible to easily locate dozens of significant general and subject specific repositories of Learning Objects with simple searches on the web. With basic searches for "Learning Object Library" and "Learning Object Store" using the Google search engine, finding more than fifty significant and respectable object stores available from sources such as ARIADNE, Apple, MERLOT etc. is not difficult.

There are almost as many organizations attempting to collate and categorise these collections. The Center for International Education at The University of Wisconsin at Milwaukee lists ten independent international organizations working towards global standardization of learning object interoperability (http://www.uwm.edu/Dept/CIE/AOP/LO_orgs.html).

Considering the enormous wealth of learning objects that are being placed in a non-exportable form into today's leading LMSs by teachers world wide, it is easy to see that this is a problem that is very quickly becoming unmanageable.

3.1 Key issues for learning object libraries (LOL)

Customisable:

As experienced teachers, we would suggest that most teachers are very good at re-inventing the wheel. It can also be called “but my situation is different” syndrome. When we find an existing learning resource, we tailor it to suit our approach. For example when working

with a textbook, we write a few pages here and there that either explain the same thing in a different way or add more detail; getting a work-sheet from one of our colleagues, we change some of the exercises; having an educational video-tape, we use only 5 minutes of it to make one point, and so on. The same thing happens when teaching within a LMS; teachers like to make changes to learning objects. Therefore, within an intelligent LMS, teachers would be able to edit learning objects and customise them.

Expandable:
In order to build a LOL, each object needs to come with appropriate metadata [14]. Normally teachers who add a learning object to a LOL have to provide meta-data by, what turns out to be, quite a complicated process. It would be very helpful, if as much of the required metadata could be collected for the teacher, perhaps one of the ways in which an intelligent agent could support the teacher would be to take over this part of the process.

4. Adaptive Intelligent Teaching Support Agent

On the one hand, there is the Educational Activity Toolset (EAT), which provides generic templates of learning activities. On the other hand, there is the LOL with domain specific content that can be added to the templates. What is needed now is something that can reflect what happens in the traditional teaching world and take on the role of identifying, finding and linking individual learning objects with a specific template. An agent is one option here. Such agents, not necessarily viewed as intelligent, of course, are notorious as part of Microsoft Office's suite, where they appear from nowhere to deliver their hints and tips. In an iLMS, agents may not necessarily be required to be at the forefront of the system, running more in the background. There are already developments in reconnaissance agents and agents that support searching behaviours that show how some aspects of how agents could be incorporated into iLMSs. One of the tasks of an iLMS agent could be to find appropriate learning objects within a reasonable amount of time. This is because there is a time dependency, partly based on supporting the idea of the learning moment and partly because the expectations that people have of interactivity with computer based systems would necessitate a reasonable response time. The step-by-step wizards of the EAT might feature, to a certain degree as part of an interface for such agents.

4.1 Key issues for Adaptive Intelligent Agents

Precision, comprehensiveness and accuracy in searching:
A teacher may want to search the LOL for information irrespective of file format. For example, a lecturer wanting to put together a case study about in-vitro fertilisation of a human could search for audio and video clips as well as text files (.htm/.doc/.txt/.pdf etc.) and html pages which deal with this issue. Another teacher might be looking for images and animations of volcanic eruptions that are similar to a picture s/he has found on the internet, but which is copyright protected. There are two approaches to solving such problems: On the one hand, extensive metadata can be added when putting the learning objects into the LOL. This is inconvenient in that it most certainly complicates the process of submitting an object. Alternatively, if the search engine is relatively sophisticated it can help those who add objects to the LOL. A smart search engine must, however, be able to search not only the meta-data information, but also text, audio and visual information and ought to be coupled with a smart categorisation and meta-information extraction engine.

Adaptable:
Every teacher has her/his personal preference about the type and style of learning objects s/he uses in teaching; e.g. some prefer cartoon-like illustrations to photos; some never use multiple-choice questions for tests; some prefer to use their own learning objects. Therefore, in all cases there is a need for being able to sort out the 'unwelcome' or 'irrelevant' search results. Lecturers may teach whole courses, or the same topic within different courses, in a similar way when they have to do it repeatedly. An adaptable agent could "observe" the behaviour of its users and "learn" about their preferences. When it comes to the point where a user has to do the same or similar action repeatedly, such as filtering search results, setting up a topic or structuring a given course every term, the agent can help with smart suggestions, thus accelerating the process.

5. Learning Community Support Agent

Many historical discussions about LMSs include the cliché that that "content is king". In the recent past however, there have been many challengers to this edict. *"In a course, content is not king. In a course it is the activity that you are pursuing and the discussions you have with other students and instructors - these are kings."* [15]. Although there is no teaching without content, we contend that the content developed through the teachers and learners discussions and collaborations during the process of teaching, is among the most important content used in an e-education environment.

An iLMS agent would be available both to learners and to teachers to assist in the development of conceptual understanding. Teachers could use agents to analyse the contributions of learners in synchronous or asynchronous discussions to determine how learners were (or were not) grasping key concepts. Learners on the other hand, could use agents to suggest to them further study of appropriate learning objects built with the EAT based on learner initiated analysis of their own conceptions compared to other students and teachers model answers.

5.1 Key issues for Learning Community Agents

Adaptability and suitability:
Opening the door for intelligent agents to make comments and suggestions about learner contributions is fraught with many 'scary' issues. Teachers will need the agent to be adaptable to their teaching style, their assessment needs and to their personal paradigms. Teachers will also need to be able to correct and 'train' agents to make them suit their teaching style and needs. Learners also will need to feel comfortable consulting an agent about advice on their learning path.
User acceptance:
This is the aspect of iLMSs which has the potential to make the most fundamental change to the way teachers and learners interact. Unless there are mechanisms in place to allow users (both teachers and learners) to adapt the agents to their personal needs then user acceptance will be difficult to gain. Teachers especially may feel threatened by such agents. They may feel that the agent is taking away key elements of their teaching input and reducing the value of their expertise. These feelings are often seen when expert systems are introduced.

6. Conclusions

In this paper we propose that there should be at least four components to an intelligent LMS from the perspective of a teacher: First an Educational Activity Toolset which is basically a collection of empty generic pedagogical shells that are "re-purposable" and customisable and that is must be easy to fill these shells with appropriate content. The second element is a Learning Object Library, which is based on standard database applications or is at least accessible with standard programming languages. The individual learning objects should offer the possibility to be modified by the teacher and it must be quick and easy to add new learning objects to an existing library. Thirdly, an Adaptive Intelligent Agent that connects the first two components by offering a powerful search tool, which can deal with any format of media files and which adapts to the behaviour of its users. Although not yet very clearly outlined, however to keep in mind for future development, we foster a fourth component, a Learning Community Agent which supports learners as well as teachers managing and gaining most of their community-based learning experiences.

This paper has focussed on the use of the iLMS and its agents from the perspective of the teacher. There is, of course, a similarly exciting prospect for the development of agents and the incorporation of artificial intelligence research into providing support for the learner, that is directed by the learner. If we are looking to develop ideas for iLMSs based on what we know is good practice for teachers in traditional teaching, then perhaps we can look at discussing ideas for iLMSs for learners, based on what we know is good practice for them.

We are LMS architects and developers, we are aware of the interesting and exciting prospects for using the products of research in machine learning, data-mining and intelligent agents. These could all be useful in the development of the first iLMS. In our own LMS development we have not implemented any of the four components discussed in this paper – yet. We have seen the need for them and have been thinking a lot about them during our own design and development processes. We present these four components as suggestions for the roadmap to the first truly intelligent Learning Management System.

References

[1] Lyardet, F., Rossi, G., & Schwabe, D. (1998). *Using Design Patterns in Educational Multimedia applications (p.904)*. Paper presented at the ED-MEDIA 1999, Freiburg i. Br.

[2] Laurillard, D. (2002). *Design Tools for e-Learning (p.4)*. Paper presented at the 19th Annual Conference of the Australian Society for Computers in Learning in Tertiary Education, Auckland, New Zealand: UNITEC Institute of Technology.

[3] Harper, B., Oliver, R., & Agostinho, S. (2001). *Developing Generic Tools for Use in Flexible Learning: A Preliminary Progress Report (p.255)*. Paper presented at the 18th Annual Conference of the Australian Society for Computers in Learning in Tertiary Education, Melbourne: Biomedical Multimedia Unit, The University of Melbourne.

[4] Agostinho, S., Oliver, R., Harper, B., Hedberg, J., & Wills, S. (2002). *A Tool to Evaluate the Potential for an ICT-Based Learning Design to Foster 'High Quality Learning' (p.31)*. Paper presented at the 19th Annual Conference of the Australian Society for Computers in Learning in Tertiary Education, Auckland, New Zealand: UNITEC Institute of Technology.

[5] Kunz, P. (2001). *Do new media need new didactic methods?* Paper presented at the ED-MEDIA 2001, Tampere, Finland.
[6] Clark, R. E. (1983). Reconsidering research on learning from media. *Review of Educational Research, 53*(4), 445-459.
[7] Fraser, B. J., Walberg, H. J., Welch, W. W., & Hattie, J. A. (1987). Synthesis of educational productivity research. *International journal of educational research, 11*, 145-252.
[8] Kulik, C.-L., Kulik, J. A., & Bangert-Drowns, R. L. (1990). Effectiveness of mastery learning programs: a meta-analysis. *Review of educational research, 60.*
[9] Walberg, H. J. (1988). *Productive teaching and instruction: Assessing the knowledge base.* Chicago: University of Illinois, School of Education.
[10] Moodie, P. (2002). *Developing a WICeD® Team.* Paper presented at the E-LEARN 2002 Conference, Montreal, Canada.
[11] IEEE Learning Standards Committee. (2002). *Draft Standard for Learning Object Metadata*. IEEE 1484.12.1-2002. Institute of Electrical and Electronics Engineers, Inc, New York.
[12] Welsch, E. (2003). *SCORM: Clarity or Calamity?* Web Article accessed April 11 2003, http://www.onlinelearningmag.com/onlinelearning/magazine/article_display.jsp?vnu_content_id=1526769.
[13] Boyle, T. (2003). Design principles for authoring dynamic, reusable learning objects. *Australian Journal of Educational Technology, 19*(1), 46-58, p.48.
[14] Duval, E. (2001). *Standardized Metadata for Education: a Status Report.* Paper presented at the ED-MEDIA 2001, Tampere, Finland.
[15] Norman, D. (2001). *Exclusive Interview with Donald Norman*. Web Article accessed April 15 2003, http://www.elearningpost.com/features/archives/001016.asp

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