RC23579 (W0504-026) April 6, 2005
Computer Science

IBM Research Report

Dynamic Assembly and Customization of Web-based Courses

Robert G. Farrell, John C. Thomas
IBM Research Division
Thomas J. Watson Research Center
P.O. Box 704
Yorktown Heights, NY 10598

Research Division
Almaden - Austin - Beijing - Haifa - India - T. J. Watson - Tokyo - Zurich

Dynamic Assembly and Customization of Web-based Courses

Robert G. Farrell and John C. Thomas
IBM T. J. Watson Research Center
19 Skyline Drive
Hawthorne, NY 10532
{robfarr, jcthomas}@us.ibm.com

1. INTRODUCTION

This paper describes a user interaction technique for assembling and customizing courses. Users specify a query, preferences, and constraints on the desired course material and then customize the resulting sequence of lessons prior to learning. This interaction has been implemented and tested in Dynamic Learning Experience (DLE), a Web-based interactive system.

2. Problem

Finding and organizing information is central to human learning [8] but these processes have not been sufficiently explored in the design of user interfaces for web-based learning environments and support tools. In this work, we investigate how give learners significant control over course topics and sequencing while maintaining learning effectiveness and usability.

3. System

We developed DLE over a period of two and a half years at IBM Research. The system has been deployed in three different pilot studies with several hundred users 7~~[1]~~[2]. In our pilot studies, learners were able to use DLE to generate their own learning paths using modular learning objects as needed. This section describes the user experience and system architecture.

3.1 User Interaction

Users enter a topic query, desired course duration, and desired depth of study (See Figure 1). Advanced search options let users restrict the course to a particular type of material (e.g., code listings or diagrams) and level of difficulty. There is also a manual assembly option that allows users to select particular learning objects from a list of search results, each displayed with title, description, difficulty, and duration.

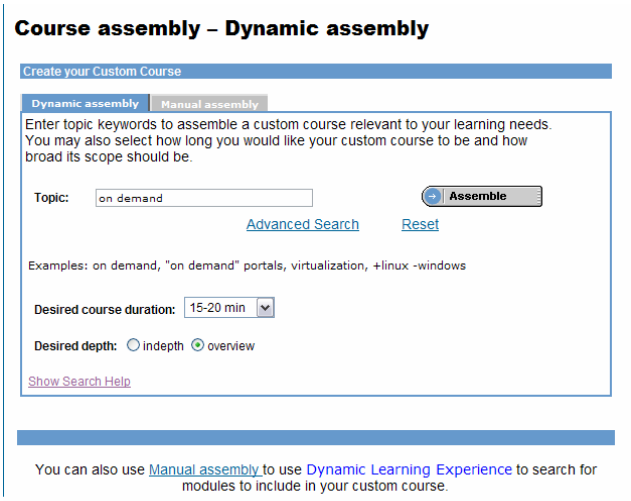

Figure 1: The Course Assembly page

The system retrieves short sections of reference books, units of course material from classroom presentations, and other modular learning content, and then assembles and sequences the search results into a custom course consisting of numbered lessons (see Figure 2). The user can drag and drop learning object lessons to reorder them and perform other customizations. When done, they can play the course immediately.

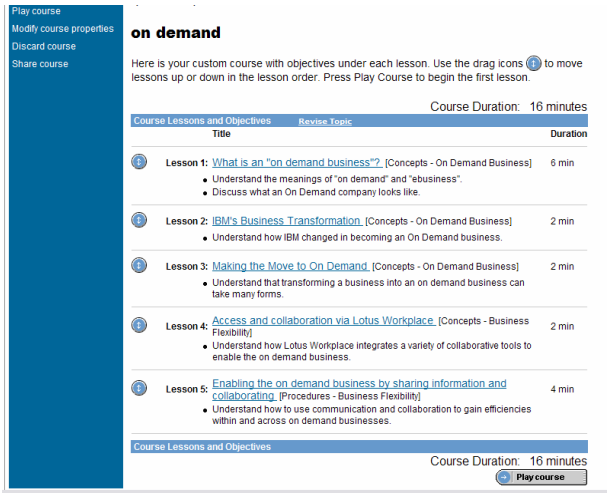

Figure 2: A Custom Course

Custom courses are stored in each user's personal course catalog for later reference accessible through a "My Courses" page. Courses can be easily shared from expert to novice or amongst

peers. A full demonstration of the system is available for download at IBM alphaWorks [4].

3.2 System Architecture

DLE consists of a Search Engine, a Dynamic Assembly Engine, and a Course Player, shown in Figure 1 [5].

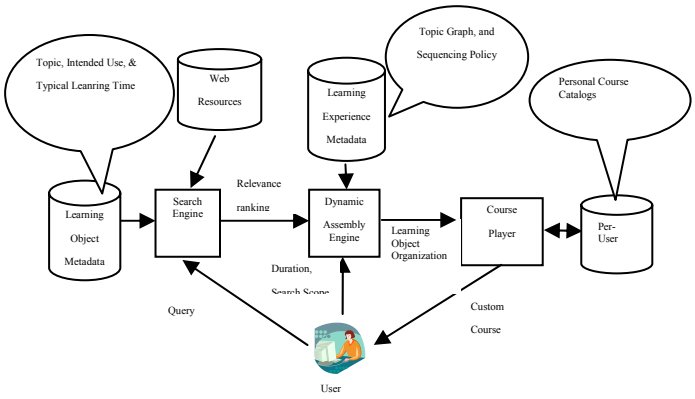

Figure 3: Dynamic Learning Experience architecture

The Search Engine returns a relevance ranking of search results. The Dynamic Assembly Engine maps these search results to nodes in a topic graph, computes statistics for each topic node based upon the mapped learning objects, and then uses both the statistics for each topic node and the relationships between topic nodes to find a best path through the graph. The learning objects on the path are then organized according to a customizable sequencing policy. For example, the policy may specify that learning objects should be listed first by topic and then by instructional role or use.

4. Results and Discussion

The "assemble and customize" interaction provides a simple but effective interactive approach to organizing information for learning. In one study, when compared with using a search engine alone, users spent more time learning and less time searching [3]. Users in this study with sufficient background knowledge to formulate suitable queries performed better on a transfer design task when using DLE compared with using a search engine alone. Based on a pilot study questionnaire, technical professionals using the system for a month to prepare for customer engagements reported that assembly and customization were easy to do, saved time, and improved their productivity on the job[1].

There are several explanations for the apparent effectiveness of the interaction. First, the interaction may support users with high task demands by allowing them to construct and complete a coherent learning sequence in the time available, thus minimizing context switching and interruptions during learning. Second, actively constructing and manipulating the lesson sequence could motivate and empower users and improve retention. A course with a clear objective for each lesson may also serve as a useful advanced organizer [8] and thus improve comprehension. Finally, focusing learners on a small set of relevant learning materials may avoid "tangled problems" [7] that inhibit learning of complex material.

5. Conclusion

Typical web-based self-paced courses provide no affordances for active learners to construct their own paths through learning material beyond the confines of a particular course. We have described an interaction technique to allow users to address gaps in their knowledge and skills by assembling and customizing learning paths through a large collection of course material in the form of modular learning objects. This interaction is effective to the extent that learners are motivated to understand and address these gaps and have sufficient background knowledge to formulate suitable queries to explore and learn from the custom courses. We have implemented, tested, and deployed this interaction for technical learning in corporate settings.

6. ACKNOWLEDGMENTS

We would like to acknowledge the contributions of the team at IBM Research that helped develop the system: Sam Dooley, Steve Levy, Soyini D. Liburd, Bill Rubin, Danny Oppenheim, Doug Gordin, Brian White, and Amy Katriel. Thanks also to Yael Ravin for her encouragement and support.

7. REFERENCES

[1] Farrell, R. et.al. "Learner-driven Assembly of Web-based Courseware". *Proceedings of E-Learn 2003* (Phoenix AZ, Nov 2003).

[2] Farrell, R. et.al. "Personalized Just-in-time Dynamic Assembly of Learning Objects". *Proceedings of E-Learn 2004* (Washington, D.C., Nov 2004).

[3] Thomas, R. and Farrell, R.G., "An Experimental Investigation on the Effectiveness of Individualized Web-based Learning based on the Dynamic Assembly of Learning Objects" IBM Technical Report RC23338.

[4] Dynamic Learning Experience. http://www.alphaworks.ibm.com/tech/dle

[5] Farrell, R., Liburd, S., and Thomas, J. "Dynamic Assembly of Learning Objects", *Proceedings of the 13th International World-Wide Web Conference* (New York, NY, May 2004).

[6] Brookfield, S., D. (1986) Understanding *and Facilitating Adult Learning*. San Francisco: Jossey-Bass.

[7] Carroll, J. M. and Mack, R. L. (1984). Learning to use a word processor: By doing, by thinking, by knowing. In J. C. Thomas & M. L. Schenider (Eds.), *Human factors in computer systems.* Norwood, N.J.: Ablex.

[8] Ausubel, D.P. (1960). The use of advance organizers in the learning and retention of meaningful verbal material. *Journal of Educational Psychology*, **51**, 267-272.

[9] Pirolli, P. and S. Card, *Information Foraging in Information Access Environments,* in *CHI '95, ACMConference on Human Factors in Software.* 1995, 15.ACM: New York. p. 51-58.

[10] Terveen, L, Hill, W., and Amento, B. Constructing, Organizing, and Visualizing Collections of Topically Related Web Resources. *ACM Transactions on Computer-Human Interaction,* 6,1 (March 1999), 67-94.