

A Hypermedia Learning Environment by Students for Students

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Abstract: This article discusses an cooperative approach for developing educational hypermedia in an university environment. We report about experiences from the development of ORWelt, a hypermedia learning environment for Operations Research. The project team consists of researchers and varying groups of students. We argue that if adequate support is provided this model is a way to address lack of resources, while at the same time providing a valuable educational experience for students. We describe the development process with special focus on quality assurance and offer some suggestions for transferring this approach to other problem domains.

Background

The objective of the ORWelt project is the development of a complex hypermedia environment for business students learning Operations Research (OR). OR is a complex subject area dealing with the use of mathematical methods to solve business problems. OR methods are used by faculty and practitioners in several fields, e.g. production planning, transportation, personnel planning and finance. The fundamentals of OR teaching are comparatively stable over time and there is an established standard content for introductory classes including linear programming, mixed-integer programming, modeling techniques, network algorithms and often basic discrete simulation. Though our students differ in their faculty background (we have business students, students of business computing as well as engineering students) they all have one in common: They need OR as a basic technique and they need to transfer this basic knowledge to very different real problem situations. Realizing that traditional forms of education do not support the adequate transfer of knowledge, the need for a new way of teaching was acknowledged [Cunningham, Duffy, Knuth 93].

The ORWelt project started in February 1996 with the intention of providing a hypermedia learning system covering all standard introductory material, supplemented by tests. Additional case studies are meant to provide different contexts for the methodological content. In some subject areas that are of special interest to OR teaching at the University of Paderborn advanced topics should also be included.

The long-term objective of the ORWelt project is to change the way of teaching towards application-oriented learning [Blumstengel, Kassarke, Suhl 97]. Lecture time should be used more efficiently to discuss realistic problems while teams of students learn part of the material (especially basic algorithms) with support from the learning environment. It can also be used as a reference and for exam preparation.

In 1996, the researchers were faced with a situation of very limited resources. At this time, no external funding was immediately available while on the other hand there was a lot of content to be covered.

In addition, we expected the participation of students in the development process to be a valuable educational experience for them. It is recommended that students not only learn how to navigate in a hypermedia information space, but how to create one [Honebein, Duffy, Fishman 91]. Writing hypertext is not intuitive and requires certain skills in structuring information. "Unfortunately, even though you can easily get some ideas about hypertext authoring from your experience as a hypertext reader, we face the general problem that people have not learned how to structure information in hypertext networks the same way they have learnt to write linear reports through writing endless numbers of essays at school." [Nielsen 95]. Furthermore it is quite demanding for students to develop educational material.

Development Process

Preparation of the Project

Before starting the actual development, a questionnaire was mailed to OR instructors in Germany. It included questions about the content of relevant classes, the use of software (especially educational software), the additional need for such software as well as instructors' expectations and concerns.

Students are questioned on a regular basis about their computer literacy, frequency of computer use, available hardware equipment and attitudes towards computer-based learning, including expected advantages and disadvantages.

The project started with an experimental phase followed by iterative refinements of the development process leading to the process steps presented here.

From the beginning students were participating in the development of ORWelt. We used teams of typically 2-3 students attending a project seminar with a total of 2-6 groups per semester. The students are majoring in different fields, namely business studies, business computing, industrial engineering, computer science or business education. The seminar is held by a group of two problem domain specialists and one or two programming specialists. The authoring environment we use is Asymetrix Toolbook, currently version 5.0 (Instructor II).

After an initial agreement about the content scope students are required to give a midterm presentation of their storyboard. This gives a detailed account of their concept for presenting and visualizing the material. Students use a two-level storyboard approach [Fisher 94]. On the first level they present the overall structure of their hypermedia network. The second level consists of detailed visual outlines for all pages. The storyboard can either be presented in electronic or in non-electronic form while students show clear preference for the electronic form.

At the end of the term the student teams give final presentations of their modules. The seminar sessions are mainly used to discuss different ways to visualize a certain concept, programming techniques and guidelines or particular problems the participants face.

Since initially instructors and students were inexperienced alike in hypermedia design, the first semester was used as an experimental phase. Students had to cover certain topic areas, but no styleguide was available. The intention was to collect ideas and promote creativity concerning navigational tools, styles, designs, user interface elements and the use of hypermedia elements in a phase of explorative prototyping.

The resulting programs were indeed very different, but all quite colorful. Students experimented with different media and interface design styles. Most prototypes were mainly linear and while navigational support was provided, it was not sufficient for more complex systems.

ORWelt Approach

We chose a modular approach for structuring ORWelt, so students can work quite independently in their problem domains. Requirements for navigation and features of the system were derived from the explorative prototypes. For getting a consistent user interface, basic guidelines and module templates with common navigational features were developed for the next semester.

A few methodological core areas were implemented as first modules of ORWelt:

- Linear Programming,
- Simplex-Algorithm,

- Duality,
- Sensitivity Analysis and
- Branch and Bound.

At the same time guidelines for navigation, animations, use of colors, hyperlinks and the common glossary were developed and refined.

As a next step, components for other topic areas like:

- Simulation,
- Warehouse Location Problems,
- Basic Stock Control,
- Modeling Techniques,
- Applications in Production Planning and
- Case Studies

were developed with additional test modules for most of them.

During the whole development process navigational tools were refined and system functions centralized by researchers of DS&ORLab. By now the features of the system include a graphical browser, customizable guided tours, bookmarking, annotations, history function, full-text search and anonymized log files.

Introducing Students to hypermedia design

For introduction into Toolbook and its programming language OpenScript we decided to start each semester with a whole-day Toolbook workshop.

A very detailed programming styleguide is available by now as well as documentation guidelines and refined module templates for topic and test components.

The feedback process for the modules written by students was refined several times. Besides the permanent detailed feedback during the development process we conduct an evaluation session after the final presentation.

Evaluation Cycle

The modules are evaluated by the problem domain specialists together with at least one programming/system design-specialist. Evaluation sessions typically last for 3 to 4 hours per module. The criteria we use are (ranked):

1. content: correctness (the scope was agreed upon already at the beginning of the semester)
2. adequacy: usefulness of hypermedia elements
3. formal correctness: adherence to programming-, style- and documentation-guidelines

Based on the detailed evaluation protocol, a separate meeting with each group is held. It is used for discussion of the protocol and to reach agreement upon further changes that are still necessary. The student teams get about two weeks time for revision of their work followed by a second evaluation session. In some cases, a second revision is necessary. The documentation is due about two weeks after completion of the software. The formal grading uses the following criteria (ranked):

1. level of creativity, adequate visualization, realization of agreed upon changes
2. quality of midterm and final presentations in class
3. formal criteria (documentation etc.)

Outlook

During the last two years we have developed more than 500 pages of content with lots of animations and interactive elements as well as additional 170 glossary entries. All main topic areas are covered on an introductory level, some even deeper. So far, a total of 30 students has participated in the development process.

Further development will concentrate on case studies and advanced topics (like genetic algorithms). A further integration of linear optimization software (like it is already used in the component about modeling techniques) is also planned and a translation into English is intended.

The prototype is currently tested by 60 students in an introductory OR class. It is used as an additional resource for learning by individual students or student teams. To further confirm positive feedback from students we conduct a thorough evaluation using log files and questionnaires. The results will be available by April 1998.

Experiences , Suggestions and Conclusions

One potential problem of the described approach is that quality of content and content representation developed by students might be low or at least not sufficient for learning purposes. Since there is a large group of students involved, there might be very different styles of writing and visualization which affect the common “look and feel” of the system. Also, the need for standardization in such a large system limits the creativity of the students involved to a certain degree.

So, quality assurance is a major concern during the whole development process. Our experience suggests:

- If the instructors’ initial skills on hypermedia design are quite low, an experimental phase is very helpful to determine system requirements and potential problems.
- Standards and guidelines are crucial, but can hardly be stated in detail right from the beginning. Instead, they have to be developed and refined over time.
- Good hypermedia design is not intuitive! Today’s students usually start with a presentation of the content very close to a paper-based form: The first designs are mostly linear, text-focussed, use illustrations with few interactive elements and often make inadequate use of animation. So, it is very important to give continuous feedback starting in the early stages and discuss in detail different representation forms and their specific use for educational purposes. Since good design is much more demanding for students, it has to be supported by instructors.
- For good quality, programming / design and content specialists’ support is equally important.
- An advantage of the presented approach is that students generally understand very well how to teach fellow students. They know of the specific learning problems and needs concerning the material from their own recent experience. Often it is easier for them than for instructors to assess what is difficult and what not.
- Diverse development teams are definitely a plus because they allow to take advantage of different skills and talents of team members. If there are inexperienced programmers in the teams (which is almost always the case in our project) it is crucial to keep the level of programming skills required as low as possible. This gives students time to concentrate on content and content representation. Also, it avoids unnecessary bugs and frustration. Therefore, we use a specialized authoring environment which offers a powerful script language, graphical tools and direct manipulation. In this case, ease of use for the developer is more important than performance. A large part of the system’s common functionality is encapsulated in system components. Also, through templates, a library of functions and strict guidelines we provide a clear and easy framework for the technical realization of planned representations.

Through the cooperative development involving student teams a system covering a large scope of content could be realized in short time. Good quality can also be achieved, but permanent support is essential. However, the selected approach does not only provide one possible solution for capacity problems, it is also useful for the students involved. They acquire a deep understanding of the particular subject area and different contexts of its use. Students are encouraged to present the material in a way that supports learning. They have to develop good representations, examples and test items and to relate their modules to the existing parts of the system through hyperlinks. In addition, they learn useful skills in hypermedia design and programming fundamentals.

From our experience with the ORWelt project we recommend to transfer the cooperative approach to other problem domains.

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