DOCUMENT RESUME

ED 477 010   IR 021 738

AUTHOR   Frizell, Sherri S.; Hubscher, Roland
TITLE   Supporting the Application of Design Patterns in Web-Course
                Design.
PUB DATE   2002-06-00
NOTE   7p.; In: ED-MEDIA 2002 World Conference on Educational
                Multimedia, Hypermedia & Telecommunications. Proceedings
                (14th, Denver, Colorado, June 24-29, 2002); see IR 021 687.
AVAILABLE FROM Association for the Advancement of Computing in Education
                (AACE), P.O. Box 3728, Norfolk, VA 23514. Tel: 757-623-7588;
                e-mail: info@aace.org; Web site: http://www.aace.org/DL/.
PUB TYPE   Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE   EDRS Price MF01/PC01 Plus Postage.
DESCRIPTORS   *Computer Assisted Instruction; Computer Software
                Development; *Courseware; *Design Preferences; Designers;
                *Instructional Design; Instructional Materials; Material
                Development; Scaffolding (Teaching Technique); Teachers;
                *World Wide Web

ABSTRACT
                Many instructors are expected to design and create Web
courses. The design of Web courses can be a difficult task for educators who
lack experience in interaction and instructional design. Design patterns have
emerged as a way to capture design experience and present design solutions to
novice designers. Design patterns are a widely accepted method of providing
design support to software engineers, and they have been proposed to support
designers of Web-based courses. However, end-users' abilities to use design
patterns are unclear especially since Web-course design and computer
programming are different activities. This paper presents a methodology for
supporting novices' use of patterns during Web-based instructional design.
This methodology consists of a pattern language for Web-based instruction and
a design environment that scaffolds the process of finding, selecting, and
applying patterns to design problems. (Contains 18 references and 2 figures.)
(Author)

Supporting the Application of Design Patterns in Web-Course Design

Sherri S. Frizell and Roland Hübscher
Department of Computer Science and Software Engineering
Auburn University, USA
{frizess, roland}@eng.auburn.edu

Abstract: Many instructors are expected to design and create web courses. The design of web courses can be a difficult task for educators who lack experience in interaction and instructional design. Design patterns have emerged as a way to capture design experience and present design solutions to novice designers. Design patterns are a widely accepted method of providing design support to software engineers, and they have been proposed to support designers of web-based courses. However, end-users' abilities to use design patterns are unclear especially since web-course design and computer programming are different activities. We present a methodology for supporting novices' use of patterns during web-based instructional design. This methodology consists of a pattern language for web-based instruction and a design environment that scaffolds the process of finding, selecting, and applying patterns to design problems.

1. Introduction

Design patterns provide a way to capture and present solutions to design problems and to facilitate communication among the many members of a design team. The use of patterns for design originated in the field of architecture during the late 1970s as a way to describe solutions to reoccurring problems encountered in architectural design (Alexander et al., 1977). The goal was to support both architects and the general public in designing quality towns, neighborhoods, and homes. Building upon this work, the concept moved into the software engineering discipline as a way to document design experience for less experienced software developers (Beck & Cunningham, 1987; Gamma et al., 1995). These patterns have since been used as an educational tool to teach computer science curriculum (Gelfand et al., 1998). Design pattern usage has also become a relatively new idea in the field of human-computer-interaction and educational technology to support designers in interaction and instructional design (Borchers, 2001; Frizell, 2001; Rossi et al., 1996).

The popularity of design patterns can be attributed to their ability to capture design experience and their concrete nature. Patterns are more flexible than static templates and more concrete than abstract guidelines. This suggests that end-users can better apply them to their design problems. Although the literature on design patterns makes claims to their effectiveness in helping novice designers, there is not a lot of empirical evidence with end-users utilizing patterns in actual design projects. The current research is from the area of software engineering, whose design solutions are often in the form of classes (in the object oriented paradigm) and describe how the classes relate to and communicate with each other and objects to solve a problem. The original architectural design patterns are somewhat different from software engineering patterns with the latter being more concerned with implementation than design. Just as the goal of the architectural patterns is to help architects build structures that possess a certain quality for their inhabitants, the goal of WBI patterns is to assist educators in designing web-based courses that are instructionally effective for students. Web-based instructional (WBI) design patterns are more closely related to architectural design patterns because the focus is more on the user's experience with the final product. Patterns can be a powerful resource tool for designers within these domains, but our

working hypothesis is that novice designers need additional support in the process of selecting and applying patterns to their design problems.

This paper presents our approach for scaffolding the pattern user's design tasks. In Section 2, we take a closer look at design patterns and current research results. Section 3 discusses design environments that have been proposed to support design pattern usage. In Section 4, we present our methodology for providing support for the application of patterns in web-course design and the resulting design environment. Section 5 concludes with a brief overview of our research objectives and future research directions.

2. Design Patterns

A design pattern captures a solution to a problem and presents it in such a way that the solution can be adapted and used repeatedly. Patterns go beyond simply presenting a solution; they also tell the user *why* the solution is needed and the context in which the solution can be applied. This information is presented in a format usually organized into several sections including the *pattern name*, which describes the design problem and provides a way to communicate about the pattern, the *problem*, which describes the design issues the pattern addresses, the *context*, which explains when to apply the pattern, the *solution*, which tells the user how to solve the problem, and the *forces*, which describe the trade-offs of applying the solution. Patterns usually exist within a language with other patterns addressing design problems in that same domain. A pattern language is a collection of patterns that are connected, thus allowing the designer to see how all the patterns within the language work together.

Our research is concerned with design patterns for WBI design. The need for design support has become a major issue in the design of web courses. The poor design of the instructional materials in web courses is one of the key problems with learning from the web (Bork & Britton, 1999; Kessler et al., 1999). Design patterns provide a mechanism for capturing pedagogical strategies and good design practices in a way that can assist educators in designing instructionally sound web courses. WBI design patterns vary in content from dealing with navigation design issues to addressing problems with student learning activities (Frizell, 2001; Rossi, 1996; Anthony, 1995). As in other areas of pattern usage, the goal is to support less experienced designers. Figure 1 gives an abbreviated example of a design pattern that has been proposed for web-course design (Frizell, 2001). This pattern addresses the isolation problem some web-based students have, and the solution describes to the designer a method for alleviating the problem.

There have been some preliminary studies on the effectiveness of pattern usage during the design process (Prechelt, 1997; Schmidt, 1995; Beck, 1987). Although this evidence has been in the realm of software engineering, preliminary results from these studies do show that patterns may prove beneficial to the design process. The benefits of design patterns may be greatly harnessed by coupling the patterns within an environment that supports the designer in working with the patterns in the language. We believe this to be especially true in a domain such as web-based instruction where the course designer may not have any experience in interaction and instructional design, and also in domains where the pattern language has grown to include a large number of patterns.
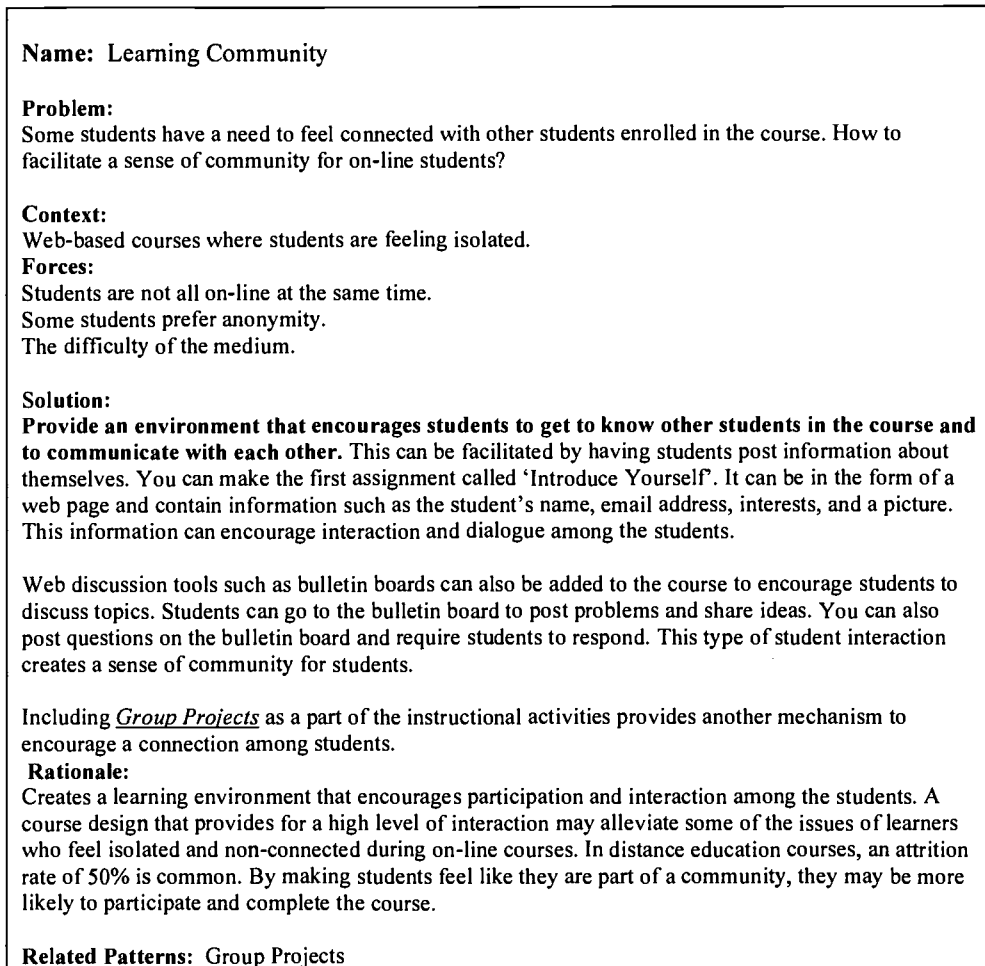
```
Name: Learning Community

Problem:
Some students have a need to feel connected with other students enrolled in the course. How to
facilitate a sense of community for on-line students?

Context:
Web-based courses where students are feeling isolated.
Forces:
Students are not all on-line at the same time.
Some students prefer anonymity.
The difficulty of the medium.

Solution:
Provide an environment that encourages students to get to know other students in the course and
to communicate with each other. This can be facilitated by having students post information about
themselves. You can make the first assignment called 'Introduce Yourself'. It can be in the form of a
web page and contain information such as the student's name, email address, interests, and a picture.
This information can encourage interaction and dialogue among the students.

Web discussion tools such as bulletin boards can also be added to the course to encourage students to
discuss topics. Students can go to the bulletin board to post problems and share ideas. You can also
post questions on the bulletin board and require students to respond. This type of student interaction
creates a sense of community for students.

Including Group Projects as a part of the instructional activities provides another mechanism to
encourage a connection among students.
Rationale:
Creates a learning environment that encourages participation and interaction among the students. A
course design that provides for a high level of interaction may alleviate some of the issues of learners
who feel isolated and non-connected during on-line courses. In distance education courses, an attrition
rate of 50% is common. By making students feel like they are part of a community, they may be more
likely to participate and complete the course.

Related Patterns: Group Projects
```

Figure 1: WBI Design Pattern

3. Pattern Support Environments

Within the software engineering community, there has been some research on providing computer support for working with design patterns. Budinsky (1996) presents a design tool to support the implementation of design patterns in object-oriented software. Their tool supports browsing the patterns on-line and automatically generates the code for the pattern's implementation based on information collected from the software designer. The objective was to automate the implementation of design patterns for the software developer. However, with this work they found that the problem that may exist in pattern application is not in the coding or development; it is in the designer understanding his problem and deciding which pattern(s) helps solve it best (Chambers et al., 2000).

Web-course design environments such as Shih (2000) and Thomson (2000) recognize the need for design support for pattern usage, but these environments mostly provide support for the navigational structure of web-based courses. Patterns are used to model optimal paths through the course and a design tool guides the designer in developing courses based on these paths.

Design environments such as the ones described above are heavily implementation oriented; a support environment for pattern usage in web-course design must also provide support for pattern selection.

4. Supporting the application of patterns in web-course design

Our research with design patterns is two-fold. We are working on a pattern language for web-based instruction to support designers in the creation of web courses and on a design environment to support our language. We focus the remainder of this paper on our methodology for providing this support and the resulting design environment.

Our goal is to provide support for three main activities, *finding* and *selecting* the appropriate patterns, and the *application* of the selected patterns into the course's design.

- Finding Patterns: We utilize a hypertext rendition of our pattern language to support browsing and quickly navigating through the patterns in the language. Patterns are grouped into categories based on the type of problems they address with cross-referencing between related patterns. This allows quick access to the patterns.

- Selecting Patterns: To support course designers in selecting the appropriate pattern(s) to solve their design problems, we provide support for pattern selection in two ways. We provide a menu-based approach, which allows the designer to search for patterns based on their course goal or problem. We also use a decision support system to guide the designer through the process of designing a course using a standard instructional design process combined with the patterns that address problems within each phase.

- Applying Patterns: After the course designer chooses the patterns he wants to use in his course's design, a design specification for the web-course is developed based on these selected patterns. The course design specification acts as a bridge from design to implementation. It gives the instructor an idea of how the course is structured based on his particular design decisions.

A designer that is experienced with working with the pattern language may not only know which patterns to select and how to apply them, but also follows an effective design process that includes the use of patterns as a subtask. It is important that the novice designer learns to not only work with the pattern language, but also gains a better understanding of design in general and design with patterns specifically. The process of finding, selecting, and applying patterns should be scaffolded for the novice designer. One of the characteristics of scaffolding is that support can be faded away over time giving the learner the control to apply their new knowledge and skills (Vygotsky, 1978).

We are developing a design tool named PatternEdge to explore the combination of a pattern language coupled with a method that scaffolds pattern usage for the designer. PatternEdge employs a dynamic web-based interface implemented with PHP and uses a relational database for storing patterns. A rule-based system supports the designer in the selection of patterns taking into consideration the characteristics of the learners and the goals and objectives of the course designer.

The overall approach is depicted in Figure 2. The patterns within the language are annotated for how and when they are best used. The inference engine can then use this information during the pattern selection process. When interacting with the system, the designer is able to browse through the patterns and select and apply them on their own as they would if the patterns were presented

without design support. Users also have the option of being able to seek design advice for working with the patterns. The system will collect information about the course to be designed such as learner characteristics and the instructor's goals and objectives. Based on the information known about the course and interaction with the instructor, the tool suggests design solutions (i.e. patterns) to the instructor. The solution given could be a pattern to solve a particular design issue or a collection or subset of design patterns from the language to cover all aspects of a course's design. After the selection of patterns, the tool generates a design specification for the web-based course based on these patterns. We believe this design specification could be integrated into an authoring tool to support the instructor in developing the course based on the design decisions.
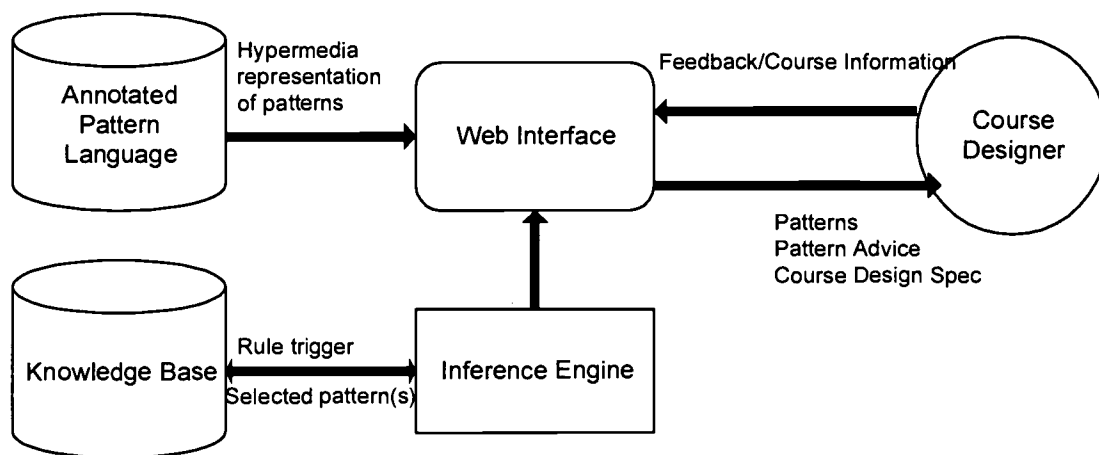
Figure 2: Design Environment

5. Conclusion and Future Work

An objective of our research is to develop an environment that fosters educators in designing instructionally sound web-based courses through the development of a WBI pattern language and a method to support the effective use of this language. We believe end-users can benefit from having a design environment that scaffolds design pattern usage for them. Instead of merely focusing on implementation issues, this environment should provide support for finding and selecting the appropriate patterns. With PatternEdge, we provide this support. Future work includes evaluations with users to assess the effectiveness of the design environment in supporting pattern usage.

6. References

Alexander, C., Ishikawa, S., Silverstein, M., Jacobson, M., Fiksdhl-King, I. and Angel, S. (1977). *A Pattern Language*. Oxford University Press, New York.

Anthony, D. (1995). Patterns for Classroom Education. *Pattern Languages of Program Conference.*

Beck, K. and Cunningham, W. (1987). Using Patterns languages for Object-Oriented Programs. *OOPSLA Workshop on Specification and Design for Object-Oriented Programming.*

Borchers, J. (2001). *A Pattern Approach to Interaction Design.* John Wiley & Sons.

Bork, A. and Britton, D.R. (1998). The Web is Not Yet Suitable for Learning. *Computer*, 31(6), (pp. 115-116).

Budinsky, F.J., Finnie, M.A. Vlissides, J.M., and Yu, P.S. (1996). Automatic code generation from design patterns. *IBM Systems Journal*, 35(2).

Chambers, C., Harrison, B., and Vlissides, J. (2000). A Debate on Language and Tool Support for Design Patterns. *Pattern Languages of Program Conference*, Boston, MA.

Frizell, S. (2001). A Pattern-based Design Methodology for Web-based Instruction (Thesis Research Proposal). Auburn University.

Gamma, E., Helm, R., Johnson, R. and Vlissides, J. (1995). *Design Patterns: Elements of Reusable Object-Oriented Software*. Addison-Wesley.

Gelfand, N., Goodrich, M., and Tamassia, R. (1998). Teaching Data Structure Design Patterns. *SIGCSE*, ACM Press.

Kessler, G.C., Rosenblad, K., and Shepard S.D. (1999). The Web Can Be Suitable for Learning. *Computer* 32(2), (pp. 114-115).

Prechelt, L., Unger, B., and Schmidt, D. (1997). Replication of the first controlled experiment on the usefulness of design patterns: Detailed description and evaluation (Technical Report Wucs-97-34). Washington University.

Rossi, G., Schwabe, D., and Garrido, A. (1996). Towards a Pattern Language for Hypermedia Applications. *Proceedings of the Third Annual Conference on Pattern Languages of Programs*.

Schmidt, D.C. (1995). Experience Using Design Patterns to Develop Reusable Object-Oriented Communication Software. *Communications of the ACM, Special Issue on Object-Oriented Experiences*, 38(10).

Shih, T., Chang, S. and Arndt, T. (2000). Database Support of Web Course Development with Design Patterns. *First International Conference on Web Information Systems Engineering (WISE'00)*, IEEE.

Thomas, J. (2000). Applying Patterns to Hypermedia Instructional Design (APHID). PhD Thesis, Department of Computer Science, University of Saskatchewan, Saskatoon, UK.

Vygotsky, L.S. (1978). *Mind in Society*. Harvard Press.

NOTICE

Reproduction Basis

EFF-089 (1/2003)