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The role of structure, patterns, and people in blended learning

Michael Derntl*, Renate Motschnig-Pitrik[1]

Research Lab for Educational Technologies, Faculty of Computer Science, University of Vienna, Rathausstrasse 19/9, A-1010 Vienna, Austria

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Abstract

Recently, much e-learning research has been devoted to producing e-content, describing it with metadata, and to constructing e-learning systems. Considerably less attention has been paid to integrating technology to improve the learning process in terms of depth and scope. In this paper, that gap is filled by considering learning support from a technological as well as from a socio-psychological perspective. Didactically, well-proven educational principles from the Person-Centered Approach are adopted to drive educational processes. Technically, a layered framework for deriving Web-based support from these educational principles is proposed. The study focuses on the contribution of visual modeling of blended learning scenarios, on their semi-formal description as patterns, and on the use of patterns as sources for user-centered Web support modules. The experiences and evaluations of one major academic course on Web Engineering indicate that blended learning has added value only when facilitated by educators with high interpersonal skills, and accompanied by reliable, easy-to-use technology.

Keywords: Blended learning; Person-Centered e-Learning (PCeL); Learning design; Design patterns; Learning technology; Evaluation

1. Introduction

E-content, its description by metadata, and its delivery via e-learning platforms employ the minds and pockets of many researchers, practitioners, and administrators. The current conception of the

* Corresponding author. Tel.: +43 1 4277 39514; fax: +43 1 4277 9395.
E-mail addresses: michael.derntl@univie.ac.at (M. Derntl), renate.motschnig@univie.ac.at (R. Motschnig-Pitrik).
[1] Tel.: +43 1 4277 39515; fax: +43 1 4277 9395.

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whole complex phenomenon of e-learning seems strong with regard to delivering learning content anytime and everywhere. Also, standard features of learning technology such as blackboard, whiteboard, forum, chat, and others, are technically well defined. However, much remains to be done in reengineering *learning processes* such as to exploit technology to a degree that surpasses mere representation, sharing, and delivery, by offering radically novel learning scenarios (Motschnig-Pitrik & Holzinger, 2002; Papert, 1999). These scenarios blend face-to-face and Web-supported learning such that the strengths of both settings can be leveraged and exploited. The current focus on learning technology in traditional universities indicates the significance of blended learning research for both society and economy.

Psychological and pedagogical theories highly agree on viewing lectures that serve only to transmit information to several students as not being very effective in the long run (e.g., Salmon, 2000). Knowledge that is not used tends to be forgotten very quickly. Rather, a form of learning that takes into account individual needs, interests and styles, and that encourages social learning, is preferred (Wenger, 1998). In that respect the hypothesis of this study (that is substantiated by experiments, which are described later) is that modern information and communication technology (ICT) has the potential to play a significant part in approaching more effective, in the sense of more profound and more persistent learning processes (Motschnig-Pitrik & Holzinger, 2002), while the lead in effective learning still stays with persons, their capabilities, and interpersonal values. Technology has proven to be capable of supporting persons with regard to information transfer as well as organizational and administrative issues. In this way it has contributed to providing increased room for self-directed, meaningful interaction in class and richer learning experiences.

Hence, the overall question and target is: How can learning in class and e-learning be blended for maximum benefit, i.e. for deep, persistent learning? Inevitably, this question has a socio-psychological and a technological response, which are highly intertwined. Unfortunately, current learning technology standards fall short in explicitly including guidance on using several of the added options that innovative learning scenarios call for. For example, the Institute of Electrical and Electronics Engineers (IEEE), one of the most influential standardization bodies in computer science, has drafted a standard for Learning Technology Systems Architectures (LTSA) (IEEE, 2001). Although the LTSA is a useful, generic, technical architecture providing a versatile toolbox, designing up-to-date e-learning systems should start from the social and didactical aspects of e-learning and e-teaching processes. As a starting point for deriving the opportunities of an advanced blended learning solution, the following characterizes the current state of e-learning research and practice:

- Although there are numerous individual studies on employing new media in education, a coherent theory on which to hold on in designing blended learning courses is missing. The current state resembles rather a phase of experimentation (Nichols, 2003): reports are mostly descriptive, experience-based, and often lacking cues on how to generalize the employed scenarios to enable transfer to other domains and contexts.
- Scenarios for blended learning need to be discovered and tested incrementally to acquire skills and familiarity in employing them. Reuse on a larger scale is not yet supported.
- Redesigning a course exploiting the benefits of novel learning technologies is essential but requires much thought, time, experience, and both didactical and technical skills to implement the design.

- Focus is currently on e-content issues, while the process and setting of learning are too often neglected, despite findings from various learning theories (e.g., McConnell, 2000; Salmon, 2000).
- Different skills are required on the side of the educator, both socially/didactically and technically (Motschnig-Pitrik & Mallich, 2004). Many instructors lack time, didactical know-how, technical expertise, incentives, and flexibility, to use e-learning platforms for more than convenient repositories of slides.

The line of reasoning in addressing these issues throughout the paper is as follows: The second section deals with the complexity issue inherent in the transition from courses to their effective support by learning technology features by proposing a layered framework that is called the Blended Learning Systems Structure (BLESS) model. In particular, BLESS is intended to act as a reusable framework for decomposing complex blended learning processes into smaller, more tangible and reusable units that may subsequently be used to guide blended course design and effective use of technology. Section 3 illustrates the BLESS model by tracing a major laboratory course on Web Engineering through the individual layers. In the fourth section an overview of this paper's major contribution, the pattern repository for blended learning, is presented and complemented by the evaluation of pattern instantiations in Section 5. The final section discusses findings and points to directions of further research. The reader should note that while the BLESS model and the pattern repository act as a flexible and structured toolbox for blended learning, the final quality of the courses and students' learning inevitably depend on how educators use the toolbox to complement their personal and other resources in the educational process. As will be discussed later, the educators' interpersonal attitudes significantly influence students' learning, motivation, and even the way they use the learning platform.

2. The blended learning systems structure (BLESS)

2.1. Motivation

As computer scientists and educators with deep interest in facilitating significant and effective learning the authors soon realized that neither learning platforms nor learning theories in isolation can provide the support required to realize effective blended learning scenarios. The crucial point is that an integrated, blended approach has to constitute a significant add-on to the sum of its constituents (Garrison & Kanuka, 2004, p. 97). Therefore, a socio-technical solution that co-considers educational concerns and technical support is needed in order to promote technology-enhanced educational practices that are as intuitive and close to its users as possible. But how to bridge the wide gap between learning theory and learning platform elements, which are tailored to support these practices? And how to achieve that such theories and supporting learning platform elements can be reused in different courses, settings, and even across institutions? Computer science has a long tradition in building models of real-world phenomena in order to support them by computerized means. On several occasions–recall, for example the well-known Open Systems Interconnection reference model of the International Standardization Organization (better known as "ISO/OSI model"; ISO, 1994) for networked architectures–computer scientists have come up with layered approaches to decompose complexity inherent in real-world systems. Equally, a layered model that is depicted in Fig. 1 provides

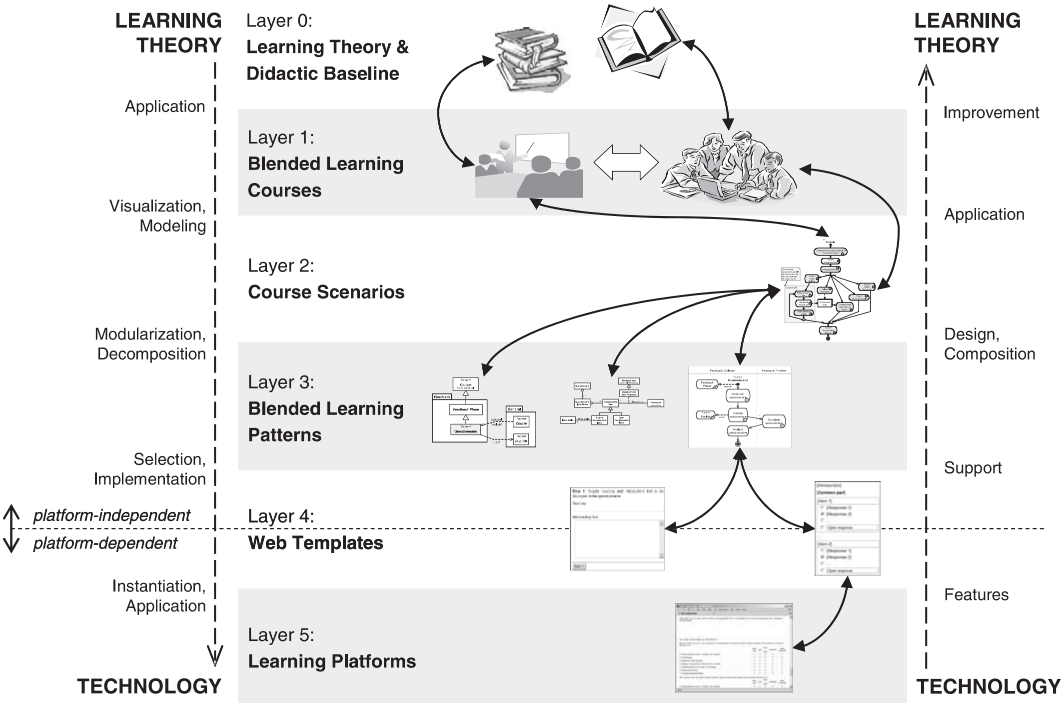

Fig. 1. The Blended Learning Systems Structure (BLESS) model.

the core structure in this paper's proposed approach and allows for considering individual issues highly systematically, time at a time in the transition process from teaching/learning situations to their technological support.

2.2. Origin and structure

In order to capture and also to better understand and support one's own blended teaching/learning practices, it has proven useful to visually model these teaching/learning scenarios, to collect students' feedback, and to figure how the scenarios could best be supported by Web technology. Through continuing students' feedback as well as through summative evaluation it was easy to realize that a number of scenarios proved effective in different courses. This led to generalizing them and to model and describe them as *patterns*, including structure, flow of activities, and several other parameters discussed in Section 4. While good design practice requires these patterns be kept independent of any specific implementation as long as possible, they finally need to be implemented. This requirement introduces another layer into the model: the Web template layer. Essentially, *Web templates* are sequences of interactive screens (similar to wizards) specifying the implementation of precisely those interactions like uploading files, issuing comment, responding to questionnaires, etc., that are part of the Web-based thread of the teaching and learning processes. Thus, while scenarios and patterns model Web-based as well as face-to-face practices, Web templates provide implementation specifications for those Web-supported features that closely match their users' needs within the educational process in action. Note that, while some Web templates (e.g., discussion forum on some topic) can more or less easily be realized by elements provided by commercial platforms, others, like performing a peer evaluation, cannot.

2.3. The layers of the BLESS model

In the Person-Centered e-Learning (PCeL) patterns project (Derntl, 2004; Derntl & Motschnig-Pitrik, 2004), the BLESS model as depicted in Fig. 1 is used as a framework for mining, applying, evaluating, and improving blended, person-centered learning scenarios. Note that each intermediate layer intertwines didactic and technological issues such that both aspects are co-developed.

2.3.1. Layer 0: Learning theory and didactic baseline

The topmost layer is the driving one in that it provides the philosophy or value-orientation of the whole enterprise. It sets the overall educational targets and resulting interpersonal attitudes and, as a consequence, delivers requirements and constraints on the technological solution. Undoubtedly, the majority of the Web-based courses today are designed using constructivist educational principles (Bangert, 2004). The blended learning strategy employed in the PCeL project is consistent with these principles, yet it focuses on the provision of a facilitative learning atmosphere based on person-centered interpersonal attitudes (Rogers, 1983).

2.3.2. Layer 1: Blended learning courses

The next layer represents *concrete* blended learning courses. It realizes and applies the didactic orientation flowing in from the topmost level and integrates technology-enhanced elements from level 4 into the basic educational philosophy. Note that in order to be fully effective, both didactic and technological elements need to match smoothly. Learning technology features have to be selected and arranged such as to enhance learning processes by supporting the underlying didactic baseline.

2.3.3. Layer 2: Course scenarios

This layer constitutes the first level of abstraction from reality. It provides semi-formal, conceptual models and visualizations of concrete scenarios by modeling their sequences as activity diagrams in the standard Unified Modeling Language (UML) (Object Management Group, 2003) notation and by documenting the activities in accompanying textual descriptions. Layer 2 constitutes the first step towards pattern mining, which is allocated to layer 3.

2.3.4. Layer 3: Blended learning patterns

Course activities–basically fragments of scenarios–considered effective in following the learning targets are decomposed and generalized into self-contained learning activity patterns. Examples of patterns include online knowledge gathering and construction in teams or groups, publishing of electronic content, interactive elements like online or face-to-face brainstorming, several forms of feedback, evaluation and assessment, or any other frequently used activity in blended learning. The modularization transition from layer 2 to layer 3 enables more tightly focused and selective implementation (link to layer 4) as well as evaluation of patterns. Vice versa, by compiling and combining single patterns, a new course or learning activity scenario model can be composed (link to layer 2) and subsequently applied and evaluated in concrete courses (layer 1). Further information on patterns is postponed to Section 4.

2.3.5. Layer 4: Web templates

The Web templates at layer 4 are derived from the patterns and show parameterized, interactive Web pages that describe how learning platform utilities (*atoms*) can be arranged and combined such as to build *molecules* in a way that optimally maps the underlying process pattern onto the learning platform (link to layer 5). Web templates are restricted to utilization of basic hypermedia Web technologies such as hypertext, multimedia, and Web forms. Each Web template shows three complementary views: *participant* view (see an example in Section 3), *administration* view, and *report* view.

2.3.6. Layer 5: Learning platform

To support a pattern's learning scenario on a learning platform, the respective Web templates as well as those of dependent and included patterns have to be implemented and applied on that learning platform. This can either be achieved by arranging existing features offered by a platform, or by realizing a custom implementation of the respective Web templates in the sense of a platform extension. In such cases, the Web templates may be used as generic specifications for implementing custom platform extension modules that allow for the optimal set of configuration and usage options.

3. The BLESS model as instantiated in Web Engineering laboratories

3.1. Layer 0: Learning theory and didactic baseline

The Person-Centered Approach developed by Rogers (1983) was adopted as the didactic baseline for Web Engineering. Person-Centered learning is a personally significant kind of learning that integrates new elements, knowledge, or insights to the current repertoire of the learner's own resources such that he or she moves to an advanced constellation of meaning and resourcefulness (Barrett-Lennard, 1998). It can be characterized by the following goals (Rogers, 1983, p. 17):

- A participatory mode in all aspects of learning and decision-making, furthering and experiencing self-responsibility for learning and for assessing gains.
- A climate of trust in which curiosity and can be nourished and enhanced.
- Helping students to achieve results they appreciate and consider worthwhile and inwardly meaningful, such as to build their self-esteem and confidence.
- Increasing a person's capabilities to experience and explore his or her own processes, thus raising the awareness of meaningful ways of inquiry, in other words, learning how to learn. This generic meta capability enhances the person's disposition to successful problem solving in new and unforeseen situations.

Research in the Student Centered Approach substantiates (Aspy, 1972; Baxter & Gray, 2001; Chase & Geldenhuys, 2001; Cornelius-White, Hoey, Cornelius-White, Motschnig-Pitrik, & Figl, 2004; Gamboa, Perez-Silva, Lara-Rosano, Cabiedes, & Miranda, 2001; Rogers, 1961; Rogers & Freiberg, 1994; Tausch & Tausch, 1998) that students achieve superior results along with higher self confidence, creativity, openness to experience, and respect, if they learn in an atmosphere or climate in which the facilitator (instructor, teacher, etc.) holds three core attitudinal conditions and if they perceive them, at least to some degree (Rogers, 1961). The core conditions are: *Congruence*, also called realness, genuineness, transparency, authenticity, openness; *acceptance*, also called respect or unconditional positive regard; and *empathic understanding*, a deep understanding for the feelings and meanings of the other.

3.2. Layer 1: Blended learning courses

The Web Engineering laboratory course was held during one semester and lasted 2 h per week. It is part of the new Business Informatics bachelor's degree curriculum at the University of Vienna. Students of each of the twelve groups (average initial group size was 29) worked in small teams of typically three students to implement a minor Web application of their choice. For Web support of the course's learning activities, the CEWebS platform (see Layer 5) in its initial version was employed in combination with the team workspace facility of a commercial content management system.

3.3. Layer 2: Course scenario for web engineering

In the following, the flow of learning activities in the Web Engineering laboratory course as depicted in Fig. 2 is described verbally:

- *Initial meeting*: Information on the course mode, the schedule, and the learning platform is exchanged. Participants' expectations are elaborated and shared in small teams and in the whole group. The project milestone structure is motivated and explained. All available organizational information is put online prior to the initial meeting.
- *Team building and project proposal*: Students assign themselves to small teams (about three members each), decide on a project and elaborate the project proposal. The topic is either derived from a catalog of themes provided by the instructor, or it can be suggested by the team to be presented and discussed in the following project proposal meeting.
- For each of the three *project milestones*:
  - Participants elaborate their milestone solutions and prepare them for presentation. Any document may be stored in the online team workspace and, after completion, must be published such that it can be accessed by other participants for review and commentary. Subsequently, participants present their milestone solutions to the whole group or to a partner team in order to receive feedback on their solutions and presentations by their peers and the facilitator. Online feedback facilities are provided to allow for directly commenting individual contributions, and for making them visible for others to benefit from them as well.
  - After a team has finished all milestone activities they reflect on their experiences by submitting an online form, which is accessible to the instructor and to all participants, and which is discussed in the following presentation meeting.
- Finally, the *assessment phases* include:
  - A mix of self evaluation and evaluation by the instructor is employed to provide multiple perspectives on the teams' contributions. Learners provide feedback through supplying online reaction sheets and completing a final questionnaire.

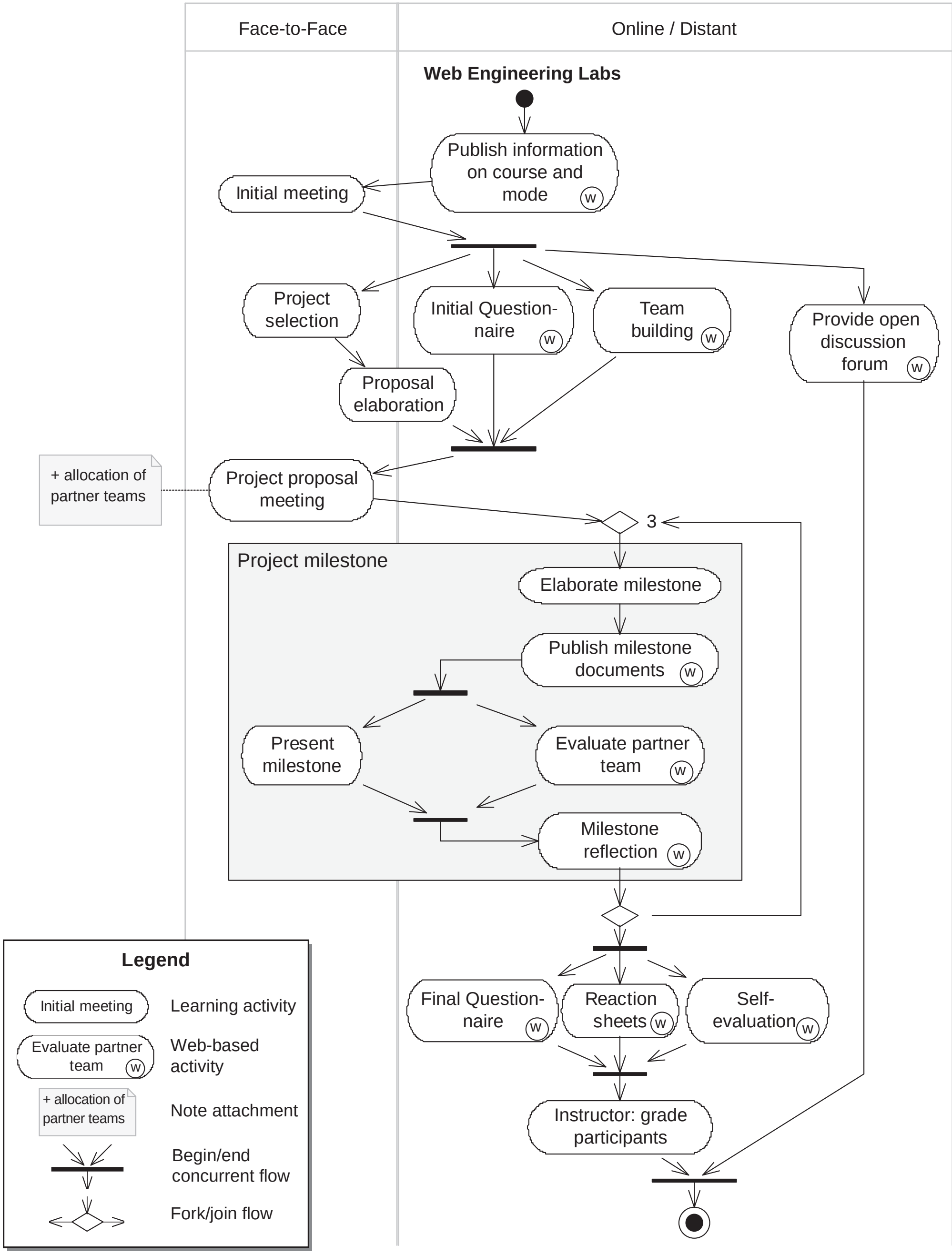

Fig. 2. Scenario of the Web Engineering laboratories.

○ In a final session the instructor holds brief colloquial sessions with each team. Their project and all contributions are discussed and grades are assigned based on the multitude of perspectives and contributions of each individual.

3.4. Discussion of the scenario

A first look reveals that the scenario is more complex than traditional instructor driven education, for example a laboratory course that is based on individual assignments. It is postulated here that this additional complexity adds significant value to the learning process, such as:

- More active participation of students and instructors and more communication lead to increased team and group orientation, motivation, cooperation, and more self-directed learning with more responsibilities of the learners and the group.
- More perspectives on the content/theories can be discussed.
- A higher degree of authenticity can be achieved by encouraging students to select and propose problems and appropriate material and to raise questions they personally find worth considering.
- Students develop soft skills "on the job", since they present their results, need to negotiate schedules and solutions, employ new media, and communicate virtually as well as face to face.
- Students take on multiple roles. Besides being authors and presenters, they are resourceful peers, reviewers, and active listeners. Furthermore, they are encouraged to develop reflective capabilities.

Even students' reactions substantiate the added value of the more complex, blended learning scenario. Yet it requires more time and effort from the instructor. Consequently, information and communication technologies have to be used for the purpose of reducing the extra effort needed for the organization and administration of courses. The proposed solution based on the BLESS model lies in the provision of clear guidance through the process via a series of Web templates and in simplicity of usage of any learning platform service (see layers 4 and 5, respectively).

3.5. Layer 3: Blended learning patterns—example: Project-Based Learning

The Web Engineering laboratory course includes a concrete instance of the general *Project-Based Learning* pattern, which is depicted in Fig. 3, and briefly explained in Table 1. While the scenario in Fig. 2 shows an authentic flow of learning activities from a concrete course, the pattern represents a more generalized flow that may be applied with variations in several concrete courses that employ project-based learning as the primary teaching and learning approach. In terms of the pattern repository, the *Project-Based Learning* pattern is mainly composed of a number of consecutive instances of the *Project Milestone* pattern, resulting in a general model of an iterative problem solving process. It is a generic pattern, as it does neither define a specific type of project, nor the concrete number or targets of its milestones. Note that, in comparison to the Web Engineering course's activity diagram, the pattern's activity diagram utilizes more advanced features of the UML, which are described in more detail in Section 4.

3.6. Layer 4: Web templates

Web templates show interactive Web pages that describe how forums, team workspaces, Web forms, and other learning platform utilities can be arranged to optimally support the pattern's flow of activities. The left-hand side of Fig. 4 shows a Web page template from the participant view of the *Team Building* pattern. The figure is intended to illustrate the customized and user-centered application of Web

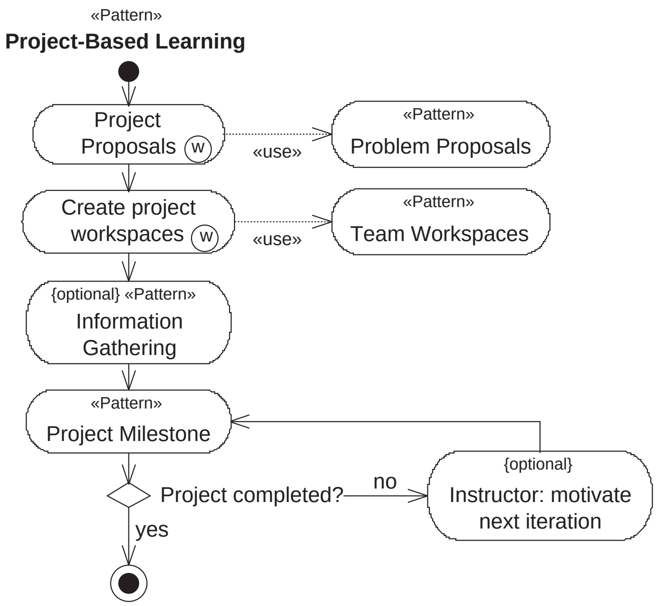

Fig. 3. The *Project-Based Learning* pattern.

technology making the latter intuitive to use by both students and instructors. Adhering to the principle of simplicity, the Web page template in Fig. 4 consists of three major sections:

- General information on the team building process, as well as a contextual help text to be supplied by the instructor.
- The participant pool, a list of participants who have not yet joined a team.
- A list of currently existing teams, i.e., the current team constellation.

3.7. Layer 5: Learning platform

The team building Web template was implemented on top of the open source *CEWebS architecture*, which provides a Web-Service-based architecture for cooperative learning environments (Derntl & Mangler, 2004; Mangler & Derntl, 2004). The right-hand side of Fig. 4 gives a screenshot of the team

Table 1
Description of core activities in the Project-Based Learning pattern

Activity	Description
Project proposals	As in any person-centered setting, participants are entitled to propose their own topics of interest for projects (*Problem Proposals*)
Create project workspaces	For project teams to manage their documents, they are provided with online *Team Workspaces* for elaborations
Information gathering	When required by the project setting, any concrete form of *Information Gathering* (e.g., *Brainstorming*, *Theory Elaboration*, *Computer-Mediated Communication*, etc.) can be used to elaborate relevant theories, techniques, and content underlying the project work

Note that references to other patterns are printed in italics.

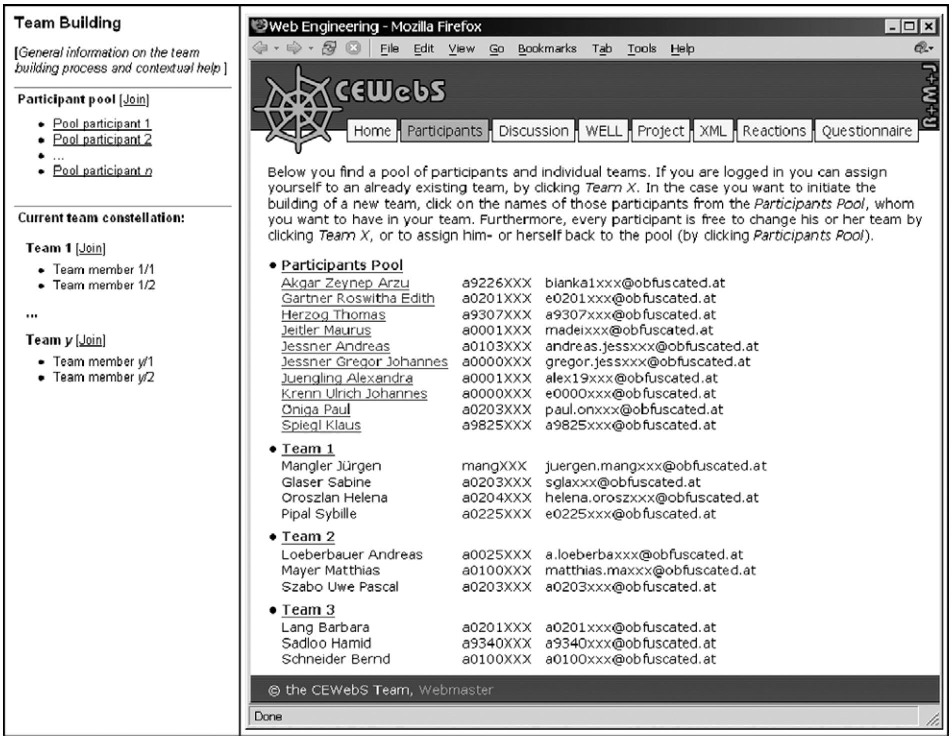

Fig. 4. Team building Web template (on the left-hand side) and its implementation on the CEWebS learning platform (screenshot on the right-hand side, translated from German).

building Web page implementing the Web template. Visually, there are minor deviations from the Web template's visual specification, but its behavior is as specified. The screen shows that three teams have already been created, and a number of participants from the pool are still available for joining and/or creating a team.

4. The pattern approach to blended learning

Careful course design requires instructors who are willing to allocate additional time and resources to the design process. In order to capture successful scenarios and reuse (parts of) them, the approach proposed in this paper is targeted at building a pattern repository along with reusable and adaptable Web templates instantiating the online activities of the patterns. The task of the instructor is then to select the appropriate pattern or family of patterns for a course and put the patterns into practice by designing the learning and teaching processes according to the models, descriptions, and Web templates provided by the patterns. Just as architect Christopher Alexander (Alexander, 1979; Alexander et al., 1977) has employed patterns to deal with the construction of towns and buildings using architectural design and arrangement techniques, the pattern approach to blended learning as presented in this section employs patterns for developing courses and course modules.

One of the most influential pattern collections in pattern research was written by the so-called 'Gang of Four' (Gamma, Helm, Johnson, & Vlissides, 1995) to describe well-proven practices in the field of object-oriented software design. The 23 design patterns in their collection are described uniformly by using a description template consisting of about a dozen of named sections, such as '*Intent*' or '*Implementation*'. This form of pattern description is being widely used today, because it supports the user in quickly locating relevant information on the one hand, and comparing related patterns on the other hand. This is why the approach proposed in this paper borrows from Gamma et al. (1995) in using a template of named sections. These are given in Table 2 along with the respective section descriptions.

Even though the pattern approach has found its way into many different disciplines, the field of blended learning clearly seems to lag behind. Only recently, the (e-)learning community has started to notice the potential benefits of the pattern approach:

- The E-LEN Project (2003) aims to create a network of e-learning centers and organizations to develop and disseminate pedagogically informed technology for effective e-learning experiences in the form of design patterns. Four special interest groups have been created to achieve this goal.
- The Pedagogical Patterns Project (2002) provides a compilation of prose-style patterns for many educational scenarios. However, these patterns are neither tied to any pedagogical baseline, nor do they include or address explicitly the use of learning technology.
- A pattern-based methodology for designing Web-based instruction has been proposed by Frizell & Hübscher (2002a,b), aiming to help course designers in putting various instructional theories into practice. The main design problem areas addressed are content, learning activity, and learning support.
- Approaches that are somehow conceptually related to the e-learning pattern approach include the e-learning and pedagogy program of the Joint Information Systems Committee (JISC, 2004), which aims at collecting and disseminating advice on effective e-learning practice, as well as the ICT-based

Table 2
Sections in the PCeL pattern description template

Section	Description
Pattern name	Meaningful descriptor for the pattern, capable of succinctly conveying its essence
Intent	Short statement about the situation or scenario the pattern addresses
Motivation	Outlines motivation for the pattern, e.g., deficiencies of the traditional scenario or special learning effects of an existing or novel scenario
Sequence	Shows sequences of activities in the scenario modeled as UML activity diagrams, along with a verbal description of activities
Structure	Shows associations and relations between entities involved in the scenario as UML static structure diagrams
Taxonomy/dependencies	This section embeds the pattern into a generalization/specialization hierarchy and a network of related patterns
Parameters	Lists the pattern's values with respect to various parameters, such as number of participants, level of expertise required, target skills, time for preparation and provision of resources, input and output documents, variants, presence type, and others as appropriate
Web template	When appropriate, shows how the pattern's processes can be supported on a Web-based learning platform, in the form of prototypical user interfaces and interactions
Examples	This section shows examples of putting the pattern into practice
Evaluation	Presents previously collected data from questionnaires or reaction sheets, which evaluate some aspect of the pattern's (learning) activities
References	A list of literature references used in the pattern's sections

learning designs project (AUTC, 2003), which provides examples, guides, and tools for supporting instructors in developing "high quality e-learning experiences".

- Other approaches primarily address design and usability issues in Web-based environments while not explicitly referring to Web-based learning systems, such as patterns for hypermedia design (e.g., Nanard, Nanard, & Kahn, 1998), or for Human-Computer Interaction in general (e.g., Borchers, 2001; Tidwell, 2002).

4.1. Pattern organization

The PCeL patterns are arranged at different levels of detail and abstraction. Unlike many other pattern approaches that specify pattern relationships only textually, the PCeL pattern repository provides conceptual models of the patterns and of the relationships among the patterns using static structure diagrams of the standard Unified Modeling Language (UML) notation (Object Management Group, 2003). A specific view on the overall model of the PCeL pattern collection describing the core patterns involved in the project-based learning scenario from Section 3 is given in Fig. 5. It illustrates the pattern organization concept by showing one pattern for a whole course (*Project-Based Learning Course*), some patterns for complex didactic concepts (e.g., *Project-Based Learning*), and some patterns for series of phases (e.g., *Assessment Phases*).

Generally, families of related patterns are organized in packages, which contain the pattern definitions, e.g., the *Preliminary Phases* pattern is located in the *General* package. The patterns are modeled using classes which are stereotyped with the custom keyword «Pattern». Relationships between patterns can take on one of two different types:

- *Generalization/Specialization*: This relationship interconnects a more concrete lower-level pattern with a more abstract higher-level pattern. For example, in Fig. 5 the *Generic Evaluation* pattern (which is included in *Assessment Phases*) is specialized by the *Blended Evaluation* pattern.

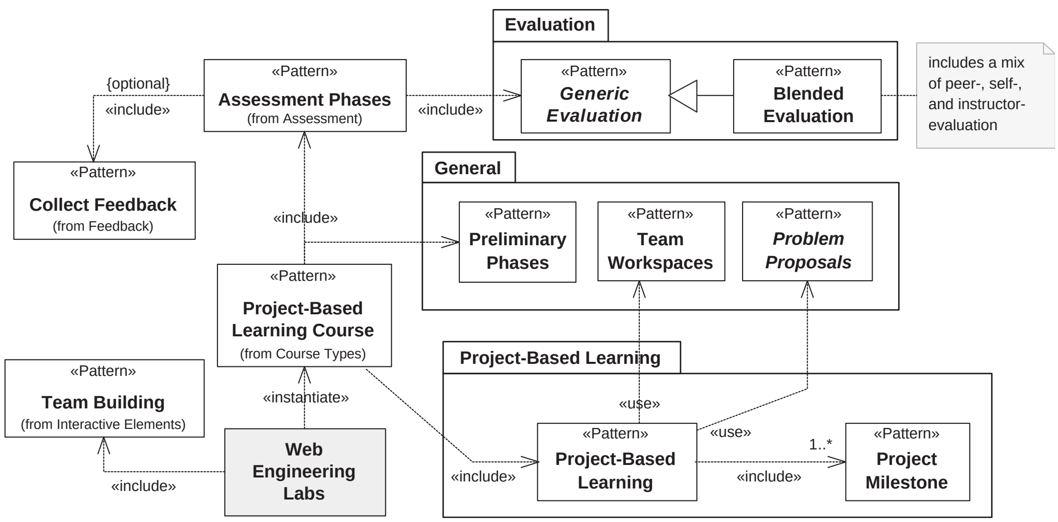

Fig. 5. Conceptual model fragment of the patterns related to *Project-Based Learning*.

- *Dependency*: The dependency relation is used to model the usage, inclusion, or adaptation of another pattern. For example, in Fig. 5 the *Project-Based Learning* pattern depends on the *Project Milestone* pattern as it includes at least one (1..*) instance of it in its sequence (compare also Fig. 3), however without refining the activities modeled in *Project Milestone*.

4.2. Modeling blended learning patterns

The UML not only plays an important role in the overall conceptual model of the pattern repository, it is also employed to model structural and in particular dynamic aspects inside each pattern as part of the 'Structure' and 'Sequence' sections, respectively. Thus the fairly intuitive high-level visual models should make the patterns easily comprehensible for the user on the one hand and facilitate the derivation of generic Web templates to implement and to support the structure and learnflow of the patterns on the other hand. Fig. 6 shows activity diagrams from the 'Sequence' sections of two selected, generic patterns:

- *Project-Based Learning Course*: This pattern has been created by arranging three other patterns in its sequence according to the project-based learning scenario depicted in Section 3. For example, every compound activity in the *Project-Based Learning Course* sequence references another pattern, namely *Preliminary Phases*, *Project-Based Learning*, and *Assessment Phases*, respectively. This activity diagram depicts a highly generalized form of the Web Engineering laboratory course activities depicted in Fig. 2.
- *Assessment Phases*: This pattern shows typical activities in the grading or assessment phase of blended learning courses: *Collect Feedback* for providing the instructor with participants' comments on the course, and *Generic Evaluation*, an abstract pattern describing how to supply the instructor also with participants' perceptions of their own (*Self Evaluation*) or their peers' (*Peer Evaluation*) contributions and efforts. Finally, the instructor assigns a grade for each participant (a necessity in almost any educational setting).

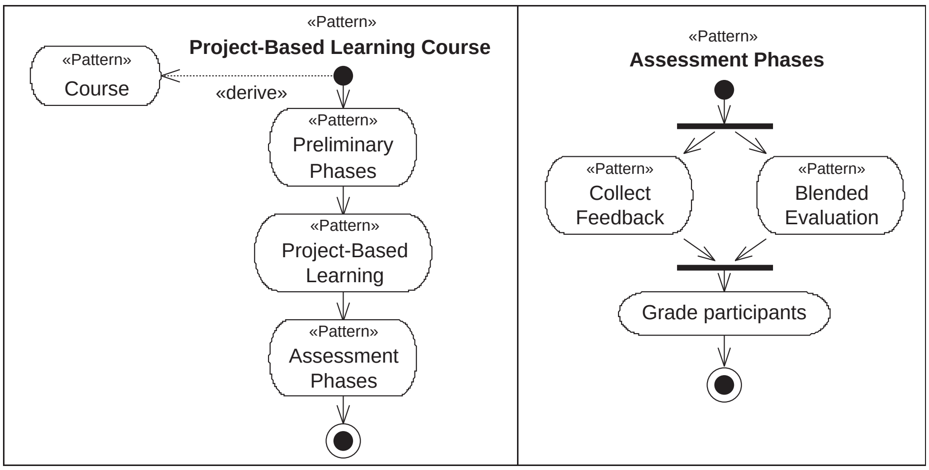

Fig. 6. Activity sequences of the *Project-Based Learning Course* and *Assessment Phases* patterns.

To convey the intent of the activities and their arrangement in a pattern's sequence in detail, the activity diagrams are complemented by tabular overviews of the activities and their respective verbal descriptions. This method is useful for pattern documentation and improvement purposes.

5. Experiences and evaluation

The *Project-Based Learning* pattern (Fig. 3) including three major project milestones (inception, elaboration, and construction/transition) was applied in the Web Engineering course with 355 enrolled participants. The application of that pattern for that many participants demonstrates that online support is capable of enabling innovative project-based scenarios that could hardly be followed for more than a few students without appropriate computer support.

Quantitative data was obtained by electronic survey distribution via the learning platform to all enrolled participants, both at the beginning and at the end of the course. Completion of the questionnaire was voluntary. The initial questionnaire was completed by 260 students. The final questionnaire was completed by 160 students, of which 131 students have also completed the initial questionnaire. Those students, who completed both questionnaires, form the basis for the comparative analyses. Additionally, to match statistics with students' opinions, online reaction sheets were collected from the students soliciting honest feedback on any aspect of the course. For example, one student writes that, "[the course] showed that one can teach even a rather conservative laboratory subject matter like programming in a new style. It does not depend on the subject, but only on attitudes. In the beginning I was convinced that this is only possible with diffuse subjects, but it turned out that instructors can even provide enough freedom (not only through self-chosen project topics) despite the exact nature of the requirements." Another student writes: "Summary of feedback: an innovative course, far from one-sided lecturing with sufficient space for self-initiated work that significantly increases the effect of learning. On the shadow side: only partly successful time-schedule for the project phases."

Regarding students' motivation, paired t-tests were used to find out whether the blended course style contributed to an increase in motivation for participating in the course. The respective item, which is displayed at the top of the histogram in Fig. 8, is interval scaled from 1 ("very low") to 5 ("very high"). Normal distribution was tested and can be assumed for all samples. Surprisingly, the general data collected in the end of the term showed that motivation to participate in Web Engineering slightly (insignificantly at $p=0.796$, $t=0.259$) decreased when compared with the motivation to participate as measured in the beginning of the term. While it is known that, in general, the motivation assessed in the end of the semester tends to decrease due to stress caused by taking exams (Rogers & Freiberg, 1994), a more differentiated investigation revealed that students' motivation strongly depended on the interpersonal dispositions of the individual instructors. The instructor who was ranked highest in the three person-centered core conditions of transparency, acceptance, and empathic understanding as shown in Fig. 7, was capable of significantly increasing the motivation of the students due to course style (instructor 1: $p=0.005$, $t=-2.961$). Motivation was retained with the instructor who was perceived as high in person-centered attitudes (instructor 2: $p=0.275$, $t=-1.108$). However, motivation decreased with both instructors who were perceived just as moderately high (instructor 3: $p=0.006$, $t=2.932$; instructor 4: $p=0.002$, $t=3.535$). Note that questionnaire data from the most recent Web Engineering course, which is currently being analyzed, confirm these observations, as do questionnaires from other comparable courses in the authors' context. These findings should be considered as initial support for the

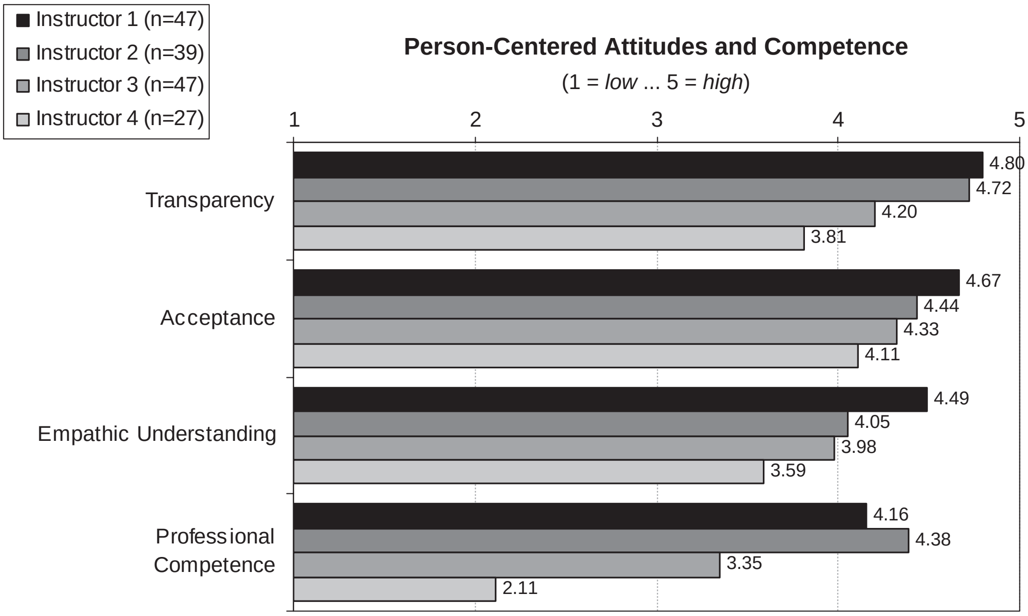

Fig. 7. Person-centered attitudes and competence in subject area of four instructors in Web Engineering (Motschnig-Pitrik & Mallich, 2004).

hypothesis saying that a flexible, facilitative teaching style *and* personal resources are required to make blended learning and teaching scenarios superior to traditional ones.

Interestingly, the degree to which students profited from Web-based communication and the degree to which they profited from interaction and communication with their instructor *both* significantly depended on the instructor's attitudes of transparency, acceptance, and understanding (see Table 3). In view of the fact that student-instructor interaction is one of the primary aspects in making learning communities effective (Hiltz & Turoff, 2002), this finding is a further indication of the enormous impact of personal skills and attitudes of the instructor. Additionally, as shown in Fig. 8, students benefited from exchange and discussions with peers significantly more strongly than from the virtual communication on the learning platform ($p<0.001$, $t=-12.813$). In fact, their expectations on the degree they would profit from Web-based communication were not fully met. This could be due to insufficient usability of the platform (which has been used for the first time in a large course), as individual reaction sheets reveal, or, equally, a general phenomenon in blended learning. Further research is required to indicate the cause.

Table 3
One-tailed Pearson correlations of two selected questionnaire items with the instructors' person-centered attitudes of transparency, acceptance, and empathic understanding

I benefited from...		Transparency	Acceptance	Understanding
...the web-based communication on a learning platform	r =	0.223	0.228	0.189
	p =	0.003**	0.002**	0.010*
...exchange and discussion with the instructor	r =	0.571	0.434	0.550
	p =	0.000***	0.000***	0.000***

$n=160$; * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

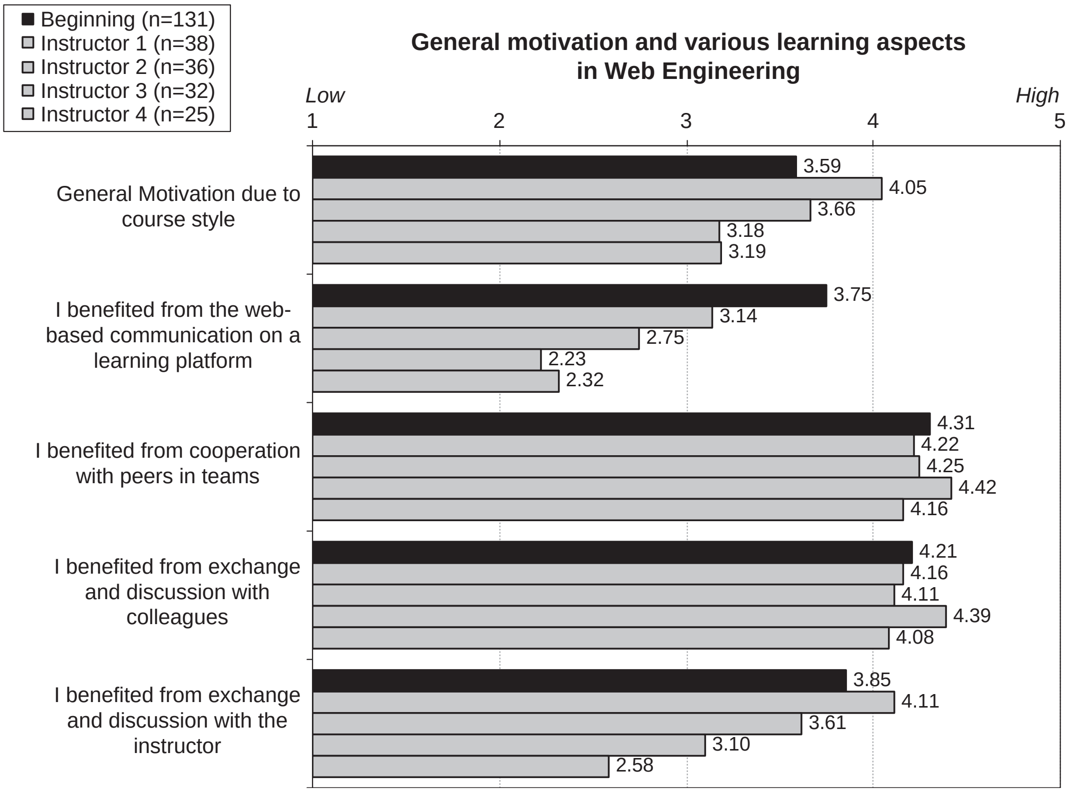

Fig. 8. Motivation due to course style (i.e., working climate/atmosphere, collaboration with colleagues, room for active participation, and discussions) and various learning aspects in Web Engineering as expected in the beginning of the course and as perceived in the end of the course grouped by instructors 1–4 ($n = 131$).

Finally, Fig. 9 illustrates the support that the learning platform provided regarding specific tasks. Clearly, the provision of online materials and the capability of storing different kinds of resources heavily outweigh the perceived support of communicative aspects. This tends to be particularly true for blended learning, where students still prefer to make major arrangements personally and complement their contacts by computer-mediated means. In a reaction sheet, one student writes, "We could agree on the major issues while we met personally right after the course. In the meantime, we elaborated the documents and exchanged comments via the learning platform and e-mail."

6. Conclusions and further work

This paper introduced a layered, systematic way of breaking down complexity in blended learning design and illustrated its application in a socio-technical, pattern-based approach that emphasizes educational processes with situated use of learning technology. It was argued that modeling such processes as patterns allows one to reuse successful didactic scenarios and thus improves the effectiveness of course design. The approach is capable of creating a common vocabulary, taxonomy, and repository as a basis for improved communication and sharing among practitioners and researchers

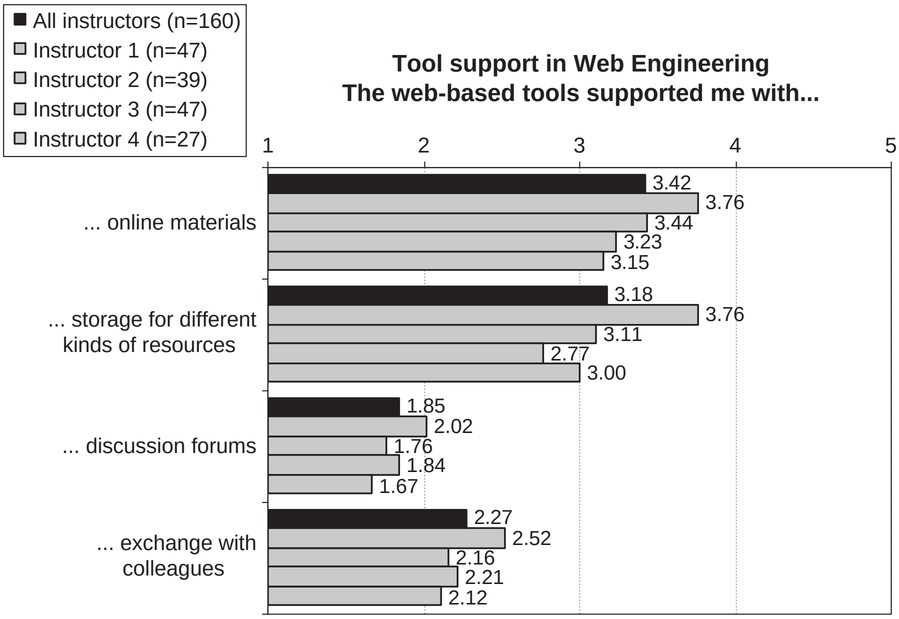

Fig. 9. Selected aspects of tool support in Web Engineering.

in technology-enhanced learning. Unlike other existing approaches, and in line with the claim that pattern approaches to learning design should *not* be pedagogically neutral (Goodyear et al., 2004), the approach presented here is fundamentally based on the pedagogical principles of the Person-Centered Approach (Rogers, 1961). Organizing the patterns at different levels of detail and granularity makes them reusable (Alexander et al., 1977) and extensible, and thus easier adaptable to specific needs. This benefit is further substantiated in the case that the patterns are implemented in the form of customized, parameterized Web pages, which are intended to support users in performing specific tasks such as team building, provision of feedback, or evaluation, and thus noticeably reduce the effort spent on organizational issues.

The empirical evaluation confirmed that following the pattern of blended project-based learning contributed to an increase in students' motivation to actively participate in the course, given the instructor was experienced as a highly open, respectful, and understanding person. Such dependence on well developed interpersonal values, which was indicated by Rogers (1983) long ago, still holds true in our age of technology-enhanced learning processes and environments. Supporting Hiltz and Turoff's (2002) emphasis on the importance of instructor-student interaction, the pivotal conclusion here is that in order to improve learning effectiveness and motivation of students, technological advances must go hand in hand with improved interpersonal skills and attitudes of educators. Novel scenarios need to be matched with respect to increased freedom and self-initiated activities of learners. Nevertheless, these initial findings need to be further substantiated in subsequent studies spanning different contexts.

Further research follows multiple threads. One of them addresses the capturing and implementation of further patterns as well as the organization and implementation of a shared pattern repository. Currently, the authors' working group members are in the process of implementing the patterns on top of CEWebS, an open source framework based on interacting Web Services. In light of the fact that patterns as skeletons still need interpersonal skills as muscles to allow for real movement in the educational scene, appropriate staff-development strategies will be vitally important as a key factor for cultivating the skills and attitudes required to use patterns in a way to promote whole-person, life-long learning.

References

Alexander, C. (1979). *The timeless way of building*. New York: Oxford University Press.

Alexander, C., Ishikawa, S., Silverstein, M., Jacobson, M., Fiksdahl-King, I., & Angel, S. (1977). *A pattern language—towns, buildings, construction*. New York: Oxford University Press.

Aspy, D. N. (1972). *Toward a technology for humanizing education*. Champaign, IL: Research Press Company.

AUTC. (2003). *Learning Designs.* [Online]. Retrieved Sept 8, 2004, from http://www.learningdesigns.uow.edu.au/

Bangert, A. W. (2004). The seven principles of good practice: A framework for evaluating on-line teaching. *The Internet and Higher Education*, *7*(3), 217–232.

Barrett-Lennard, G. T. (1998). *Carl Rogers' helping system—journey and substance*. London: Sage Publications.

Baxter, S., & Gray, C. (2001). The application of student-centred learning approaches to clinical education. *International Journal of Language and Communication Disorders*, *36*, 396–400.

Borchers, J. (2001). A pattern approach to interaction design. *Journal of Human-Centred Systems and Machine Intelligence*, *15*(4), 359–376.

Chase, C. C., & Geldenhuys, K. M. (2001). Student-centred teaching in a large heterogeneous class. *Medical Education*, *35*(11), 1071.

Cornelius-White, J. H. D., Hoey, A., Cornelius-White, C., Motschnig-Pitrik, R., & Figl, K. (2004). Person-centered education: A meta-analysis of care in progress. *Journal of Border Educational Research*, *3*(1), 81–87.

Derntl, M. (2004). The Person-Centered e-Learning pattern repository: Design for reuse and extensibility. *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications, Lugano, Switzerland* (pp. 3856–3861).

Derntl, M., & Mangler, J. (2004). Web services for blended learning patterns. *Proceedings of 4th IEEE International Conference on Advanced Learning Technologies, Joensuu, Finland* (pp. 614–618).

Derntl, M., & Motschnig-Pitrik, R. (2004). Patterns for blended, person-centered learning: strategy, concepts, experiences, and evaluation. *Proceedings of 2004 ACM Symposium on Applied Computing, Nicosia, Cyprus* (pp. 916–923).

E-LEN Project. (2003). *E-LEN project homepage.* [Online]. Retrieved Jan 14, 2004, from http://www.tisip.no/E-LEN/

Frizell, S.S., & Hübscher, S. (2002a). Aligning theory and web-based instructional design practice with design patterns. *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education, Montreal, Canada* (pp. 298–304).

Frizell, S. S., & Hübscher, S. S. (2002b). Supporting the application of design patterns in web-course design. *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications, Denver, Colorado* (pp. 544–549).

Gamboa, F., Perez-Silva, J. L., Lara-Rosano, F., Cabiedes, F., & Miranda, A. I. (2001). A student centered methodology for the development of a physics video based laboratory. *Interacting with Computers*, *13*(5), 527–548.

Gamma, E., Helm, R., Johnson, R., & Vlissides, J. (1995). *Design patterns—elements of reusable object-oriented software*. Reading, MA: Addison-Wesley.

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *Internet and Higher Education*, *7*(2), 95–105.

Goodyear, P., Avgeriou, P., Baggetun, R., Bartoluzzi, S., Retalis, S., Ronteltap, F., et al. (2004). Towards a pattern language for networked learning. *Proceedings of 4th International Conference on Networked Learning, Lancaster, England* (pp. 449–455).

Hiltz, S. R., & Turoff, M. (2002). What makes learning networks effective? *Communications of the ACM*, *45*(4), 56–59.

IEEE. (2001). *Draft Standard for Learning Technology-Learning Technology Systems Architecture (LTSA) (IEEE P1484.1/D9).* [Online]. Retrieved Aug 29, 2003, from http://ltsc.ieee.org/doc/wg1/IEEE_1484_01_D09_LTSA.pdf

ISO. (1994). *Open Systems Interconnection-Basic Reference Model: The Basic Model (ISO/IEC 7498-1:1994).* [Online]. Retrieved April 16, 2004, from http://www.iso.ch/iso/en/CatalogueDetailPage.CatalogueDetail?CSNUMBER=20269&ICS1=35&ICS2=100&ICS3=1

JISC. (2004). *e-Learning and Pedagogy Programme.* [Online]. Retrieved Oct 30, 2004, from http://www.jisc.ac.uk/elearning_pedagogy.html

Mangler, J., & Derntl, M. (2004). CEWebS—cooperative environment web services. *Proceedings of 4th International Conference on Knowledge Management, Graz, Austria* (pp. 617–624).

McConnell, D. (2000). Implementing computer supported collaborative learning (2nd ed.). London: Kogan Page.

Motschnig-Pitrik, R., & Holzinger, A. (2002). Student-centered teaching meets new media: concept and case study. *Journal of Educational Technology and Society*, *5*(4), 160–172.

Motschnig-Pitrik, R., & Mallich, K. (2004). Effects of person-centered attitudes on professional and social competence in a blended learning paradigm. *Journal of Educational Technology and Society*, *7*(4), 176–192.

Nanard, M., Nanard, J., & Kahn, P. (1998). Pushing reuse in hypermedia design: Golden rules, design patterns and constructive templates. *Proceedings of 9th ACM Conference on Hypertext and Hypermedia, Pittsburgh, Pennsylvania* (pp. 11–20).

Nichols, M. (2003). A theory for eLearning. *Journal of Educational Technology and Society*, *6*(2), 1–10.

Object Management Group. (2003). *OMG Unified Modeling Language Specification, Version 1.5, March 2003.* [Online]. Retrieved May 12, 2003, from http://www.omg.org/cgi-bin/doc?formal/03-03-01

Papert, S. A. (1999). *Mindstorms* (2nd ed.). New York: Basic Books.

Pedagogical Patterns Project. (2002). *Pedagogical Patterns Project homepage.* [Online]. Retrieved Nov 5, 2002, from http://www.pedagogicalpatterns.org

Rogers, C. R. (1961). *On becoming a person—a psychotherapists view of psychotherapy*. London: Constable.

Rogers, C. R. (1983). *Freedom to learn for the 80's*. Columbus, OH: Charles E. Merrill Publishing Company.

Rogers, C. R., & Freiberg, H. J. (1994). Freedom to learn (3rd ed.). Columbus, OH: Charles E. Merrill Publishing Co.

Salmon, G. (2000). *E-moderating—the key to teaching and learning online*. London: Kogan Page.

Tausch, R., & Tausch, A. -M. (1998). *Erziehungs-Psychologie*. Göttingen, Germany: Hogrefe.

Tidwell, J. (2002). *UI Patterns and Techniques.* [Online]. Retrieved Nov 19, 2002, from http://time-tripper.com/uipatterns

Wenger, E. (1998). *Communities of practice—learning, meaning, and identity*. Cambridge: Cambridge University Press.