
# PERSONALIZED WEB-BASED LEARNING 2.0

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Abstract. Educational content was among the first appearing on the Web. This applies not only for the "Read Web" presented as the Web 1.0, but also for the Adaptive Web with main concern on the personalization to each learner. Even though this is not true for the Social Web, or the Web 2.0, educational domain gets in the "Read-Write Web" too. This paper presents selected aspects of web-based educational systems, adaptive web-based educational systems and collaborative web-based educational systems. We discuss the web-based learning 2.0, which moves educational web-based systems to the activity, which is typical for learning – the collaboration. We present key features of adaptive learning framework ALEF, which aims at support of adaptive web-based learning 2.0. It addresses three key principles which should fulfill next generation LMS: flexible domain modeling with possibility to automate certain domain model parts creation and possibility of collaborative social aspects together with allowing to modify the domain model by students themselves; personalization and the course adaptation, and student active participation in the learning process.

Keywords: Web 2.0, adaptive learning, social learning, collaboration, personalization, domain model, user model, adaptive learning framework

## 1. INTRODUCTION

It has been a while since we cannot indicate term "Web 2.0" a neologism anymore. The Web shifted from a place where information was only published to be accessed later on, and became a platform where the content is created, updated and organized by masses without the need to understand deeply the underlying technologies. The initial vision of the "Read Web" transformation into the "Read-Write Web" has already been fulfilled in 2005 [14], [16] when a web user is no longer considered only as a content consumer, but also as a content creator. This is even more alleviated by emerging technologies, which allow web browsers to provide desktop-like experience when working with applications using the Web as an infrastructure.

User can simply add a new content into the blogosphere, she can alter the content over and over again and collaborate on it in wikis, she can tag, rate and annotate web resources. She can also discuss interesting or disputable topics virtually displaying "right next" to the original source. The rise of social networks allows for more effective sharing and interchanging of information and knowledge. The primary web content is no longer the only significant source that a user makes his decisions upon. She can leverage from so called collective intelligence phenomenon, where wisdom of crowds (reflected for example in a positive product rating or community-based recommendation) influence her behavior. The Web 2.0 represents not only technological but also a social revolution that has affected wide range of services available online, including the learning.

While first generation of web-based educational systems were only *delivering* static learning materials, the Web 2.0-enhanced learning brings a learner to the centre of a collaborative dynamic environment, where she can, apart from actual learning, *participate* on authoring (at least by commenting and annotating learning resources), organizing and sharing the content in the form of rather independent and reusable learning objects. More, she can gather information and knowledge not only from learning objects, but also from her peers.

The functionality introduced by Web 2.0 principles results into extended and advanced possibilities, more competences and overall better user experience supported by richer user interfaces. Stephen Downes, who coined a term e-learning 2.0, states: *"Learning is characterized not only by greater autonomy for the learner, but also a greater emphasis on active learning, with creation, communication and participation playing key roles, and on changing roles for the teacher, indeed, even a collapse of the distinction between teacher and student altogether"* [10]. The role of a student changed from a learning by passive reading of delivered instructional "packets" into the learning by collaborating in a social environment. In Web 2.0 era, a student expects to be able to use all the features he has used during the ordinary web surfing also while learning by means of web-based educational system.

Let us consider the following learning scenario in a C language programming course in order to reveal possibilities a student could have in such an environment:

- she starts a learning session by studying a learning topic of *"Pointers"* described by seven learning objects as scheduled by a teacher (or stated in the curricula) for an actual virtual lesson,

- she sees ten comments assigned to the learning content by other schoolmates, she quickly goes through the comments, carefully reading those concerning *"NULL pointer"* having difficulties with understanding it,
- she reads and contributes to a discussion related to subtopic *"NULL pointer"*, which is also tagged by her teacher as an important one,
- she adds comments to three learning objects,
- she annotates one topic to advice an additional learning resource, which she discovered yesterday,
- she tags two learning objects by a tag *"read again"* in order to find them more easily when she get back later,
- she discusses the learning content online with selected schoolmates who at the moment also study the same learning materials (as visible in the educational system) using integrated instant messaging,
- at the beginning of the next learning session, she starts by checking learning objects she collaborated on to see how the discussion evolved,
- she reviews learning objects tagged as *"read again"*,
- she takes a 20-question test in order to asses her knowledge on *"Pointers"* topic.

As we can see from the example, the user interaction is richer than in a typical case of a static, non-interactive educational course or an obsolete sequential multimedia presentation. The student uses a full potential of the Web 2.0 based collaborative virtual learning environment according to her needs and interests in order to improve her performance and to learn more efficiently.

## 2. ADAPTIVE EDUCATIONAL WEB-BASED SYSTEMS

Almost 20 years before the rise of the Web 2.0 principles, web-based educational systems were naturally embraced by adaptive hypermedia, an alternative to "one-size-fits-all" approach in realization of web-based systems, which resulted in the field of adaptive educational hypermedia [2]. In fact, adaptive educational hypermedia were one of the first and most popular adaptive hypermedia applications [7].

Educational domain is a domain ideally suitable for personalization as each learner has individual learning style, she is obviously interested in different topics, she has different learning progress, etc. so it is helpful to adapt to each learner individually as human teachers often do. Personalized educational web-based system can tailor the presentation as well as underlying pedagogical models leading to adaptive content and navigation to make the learning process more efficient for the learner.

Adaptive web-based educational systems follow intelligent tutoring systems with a long tradition. Intelligent tutoring systems assist a learner in the learning process, especially in solving tasks providing help on each step (or even suggesting these steps). Educational web-based systems are more oriented towards the content and provide the learner with linked content employing various forms of recommendations. Recommendations are realized often by link sorting, link and content annotating, or guiding the learner while navigating in the content [6], [19]. Several systems are oriented towards a specialized type of the content, e.g. exercises [1] or program examples [8].

In order to deliver personalized learning experience, any educational web-based system (as any other system performing a personalization) should include a set of components realizing the actual personalization, i.e. the adaptation to particular user (student, learner). From the high-level point of view, we can identify four basic components in each adaptive educational web-based system:

- *Domain Model* – defines domain conceptualization (knowledge to be learnt) along with its connection to educational content;
- *Student Model* – represents the student's characteristics (typically levels of knowledge of domain concept);
- *Pedagogical Model* – defines rules of access to parts of the domain model according to the information from student model and the overall context;
- *Adaptive Engine* – entire software environment for creating and adapting domain concepts and links.

The personalization process is divided into two distinct stages:

1. *user (learner, student) modeling*, when an adaptive web-based educational system collects and interprets data from user interaction with the educational resources and other users within the learning environment and actual;
2. *personalization*, when the system employs various methods and techniques of adaptive hypermedia on the top of the student model in order to tailor the learning environment to the user's needs and goals.

The core components are domain and student models as these provide the basis for all steps of the personalization process. Early web-based educational systems often mixed the educational content and metadata. However, their separation is important for better maintenance and reuse (including application of educational standards). Current systems represent the domain model by two distinct layers (Fig. 1):

- *metadata layer*, which consists of concepts and relationships between them representing data about the content being taught. Concepts are domain knowledge elements related to the educational content. They are mutually interconnected and form a structure, which typically resembles an ontology. Different types of relationships have different semantics: e.g., concept relatedness, hyper-/hyponymy, prerequisite. Concepts are also associated with course content represented by learning objects.

- *educational content layer*, with learning objects representing actual learning material typically provided in an interchangeable data formats.

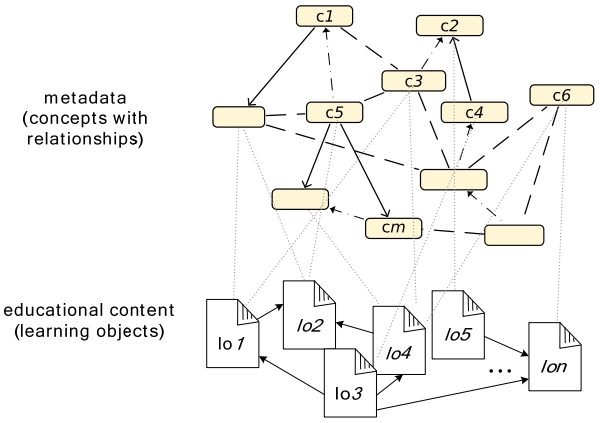


Fig. 1. A scheme of a domain model of an adaptive educational web-based system.

User (student, learner) model is usually realized as an overlay model on the top of the domain model. As such, it is possible to represent various user characteristics related to particular domain items (e.g., user *has seen* a learning object, user *understands* a concept).

It is useful to divide user model into two layers, which follow the process of model creation:

1. *evidence layer* holding evidence of user actions, observable facts and
2. *upper characteristics layer*, which holds characteristics such as knowledge, which are inferred from the observed facts of the evidence layer.

The reason, why educational domain is the most utilized domain for adaptive hypermedia lies in the relatively straightforward process of automatic creation and maintenance of a student model, as it can heavily rely on implicit feedback coming from students taking short quizzes, questions and exercises that typically form an integral part of the educational content. Each time a student answers a question, she does not only receive a feedback and supplementary explanations from the system which helps her to better grasp the discussed topic, but also gives a clear information about her current knowledge on that topic to the system.

Moreover, study phase obviously alternates with testing or evaluation phase of the learning process. Testing serves as an excellent source for the evaluation student's actual level of knowledge, so facilitates in maintaining the user model. Testing is combined with other approaches to the user model maintenance, which consider user characteristics change [18].

More, as students are usually motivated to get the best possible experience from the system, they do not hesitate to provide explicit feedback as well, to indicate whether they have understood the discussed topics or not, whether they are interested in it or prefer to focus on something else for that moment. All these information represent an important input for the user modeling process.

On the other hand, adaptive educational web-based systems require a very precise and consistent domain and pedagogical models in order to deliver accurate content for particular student.

## 3. ADAPTIVE LEARNING MEETS WEB 2.0

Despite the advantages of adaptive educational web-based systems over the "one-size-fits-all" approaches, their adoption into the "real world" teaching is stated to be poor [15]. The main reasons might be the complexity of adaptive course authoring process and unsatisfied learner experience caused by a non-interactive course platform. In recent years researchers started to realize these drawbacks and there are several attempts to improve architectural design of adaptive educational systems to address the needs of learning emerging from Web 2.0 [11], [15], [17].

The main challenge for adaptive educational web-based systems is to adopt and weave in the concepts of Web 2.0.

To better imagine the added value of both adaptive learning and Web 2.0 possibilities, let us reconsider the learning scenario in a C language programming course concerning adaptation (personalization in particular):

- she starts a learning session by studying a learning topic of *"Pointers"*, system adaptively selects learning objects according to her user model,
- she sees adaptively pre-filtered comments related to her interests assigned to the learning content by some of her schoolmates,
- she reads and contributes to a discussion related to subtopic *"NULL pointer"*, which was recognized by the adaptive system as an important one,
- she adds comments to three learning objects, which were recommended to her,
- she discusses the learning content online with selected schoolmates using integrated instant messaging; the peer for discussion is recommended by an educational system as most suitable by means of learning goals similarity and actual knowledge,
- at the beginning of the next learning session, she starts by checking recommended learning objects she collaborated on to see how the discussion evolved,
- she takes a test composed of adaptively selected questions in order to asses her knowledge on *"Pointers"*

As we can see from the slightly modified example, adaptation may relate to a wide range of services, from recommending learning materials to collaboratively filtering user-generated content as well as recommending most

suitable mates for discussion. Web-based learning 2.0 becomes *Adaptive* Web-based Learning 2.0.

In order to adapt accurately, a domain model of the adaptive system has to be rich enough to allow adaptive engine to make "correct" decisions. In addition to a traditional adaptive system, a Web 2.0-enhanced adaptive system's domain model has to consider also social and collaborative aspects of learning.

User-generated content has two facets. It is an annotation describing (representing) the annotated resource but at the same time, it also can be seen as an additional content, a contribution to the learning materials authored by a teacher or course author.

In any case, when a student contributes any kind of annotation (e.g., comments, tags) to the learning content, we need to map this annotation to the existing domain conceptualization, instead of only binding it directly to the learning content represented by the learning object itself (Fig. 2). Like that the annotation itself becomes a lightweight part of the conceptualization, which causes the shift of purely conceptual layer of the domain model into the metadata layer holding different types of metadata with different semantic power.

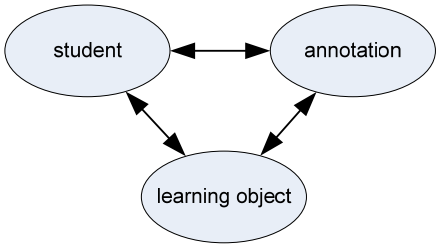


Fig. 2. The Web 2.0 core concept of annotations adapted to e-learning. By a term annotation, we mean any type of data or metadata which can be added to a learning object.

While a course author (either a human being or a method for course authoring support) can describe the domain knowledge by using concepts with stronger semantic expressivity, it is very difficult to actually estimate the semantics of user generated annotations. As reported by Heynmann et al., only 50% of social annotations on the web are related to the resource content [13]. A significant part of annotations is also used to identify an owner of a resource, a type of a resource, qualities or characteristics of resource or organize one owns tasks [12].

Furthermore, if we consider annotations such as comments or discussions, the estimation of their semantics get even more complicated, due to the very informal nature of these types of user generated annotations. The challenge for the adaptive web 2.0-based educational system lies in the integration of these two distinct types of metadata with different semantics. We believe that the following three key principles need to be considered by adaptive educational web-based systems designers in order to benefit from the Web 2.0 user-centered paradigm [17]:

- *Domain modeling* with respect to *(i)* possibility to automate certain domain model parts creation, *(ii)* collaborative social aspect and the need to modify or alter domain model by students themselves.
- *Extensible personalization and course adaptation* based on comprehensive user model, which allows for simultaneous employment of different adaptive techniques to enhance the student's learning experience.
- *Student active participation in a learning process* with the ability to collaborate, interact and create the content by means of read-write web vision, mainly by different types of annotations allowing for rich interactions on the top of the presented content.

By following these principles based on our previous experience with adaptive educational web-based systems [4], [5] we designed and developed an adaptive learning

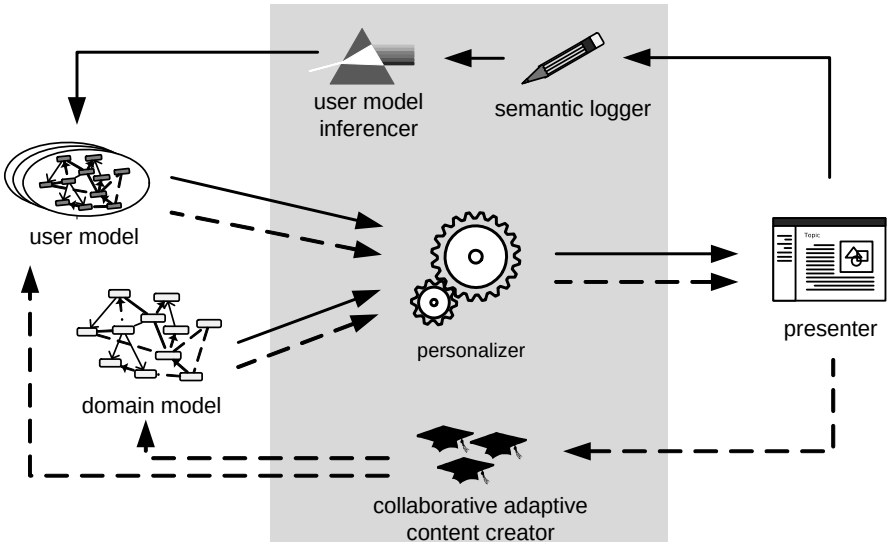


Fig. 3. Activity flows within the Adaptive Web-based learning 2.0 environment. Learning flow (solid line) is supported by collaboration/creation flow (dashed line).

framework ALEF [3]. It supports two main activity flows: *learning flow* and *collaboration/ creation flow* (Fig. 3). The core of the learning flow is formed by personalizers, extensible modules realizing the actual personalization within the learning environment. Each student's interaction with the system is tracked by specialized logging facility (semantic logger producing the aforementioned evidence layer of the user model) and evaluated by user model inferences, producing upper level student characteristics stored in the student model.

Collaboration/creation flow is built around a set of collaborative adaptive content creators, modules providing students with means for adding or modifying various types of annotations such as comments or tags (see ALEF screen in Fig. 4, which contains one personalizer and two collaborative creators). Content type added by the student varies depending on particular collaborative adaptive content creator used. Enrichment can be realized e.g., by assigning annotations that can have different forms: highlighted text, tags, comments or discussion threads.

The content is created with respect to the student context, obtained from her user model. And vice versa, performing an action related to the content creation reflects into the user model update.

## 4. CONCLUSIONS

The web-based learning 2.0 presents a natural step in evolution of the Web as an infrastructure for educational applications. Considering personalization is consistent with the Web evolution too and it is especially important in the educational domain where learning efficiency and motivation are important factors that strongly depend on different characteristics of particular learners.

There is still a lot of room for improvement. Web 2.0 based adaptive educational applications should better exploit mutual interconnection. The model based integration will ease spreading educational content and user characteristics, which will result in natural personalization as each component (an agent) will be able to find out necessary information about current learner.

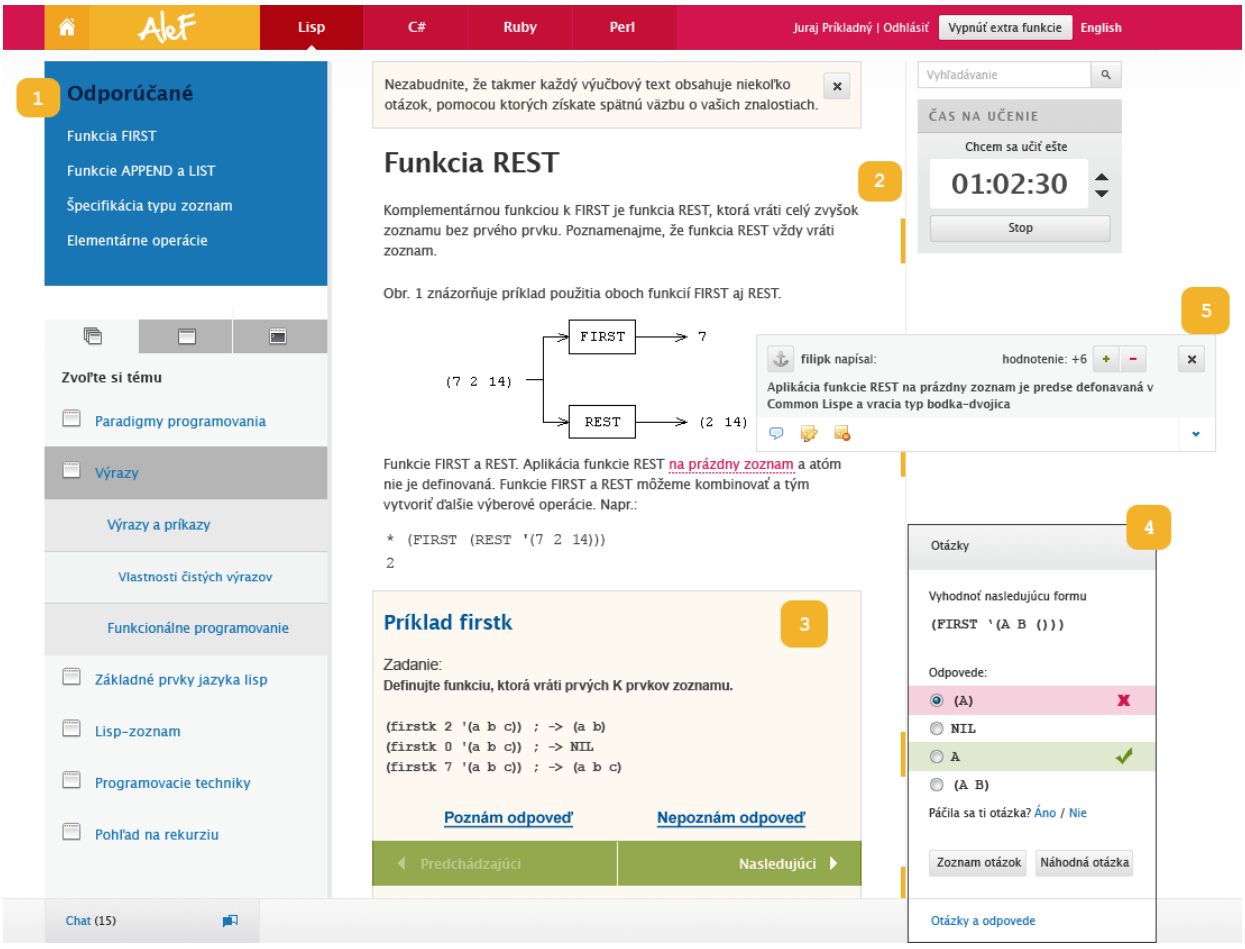


Fig. 4. Screenshot of ALEF user interface for learning lisp programming (in Slovak). Recommendations coming from *content recommender* are presented either in a separate box (1) above the menu or can be embedded within the main content in the form of interactive examples (3). *Sidebar navigator* visually emphasizes more often read text (2). *Collaboratively created questions* related to current learning object are visualized on-demand in a pop-up widget (4). Displayed content is enriched by adding different types of *annotations*, accessed by hovering the mouse over the underlined sections of text (5).

We still underestimate a potential of full comprehension of social collaboration via social networks. We should think not only about developing applications with more and more functionality, about authoring a new content, we should think also about integrating learning experience into everyday activities. As social networking becomes core part of our everyday life, it is integrated almost everywhere, the educational applications should not be excluded.

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