Teaching Web Development at the Eötvös Loránd University – results, difficulties, question-marks

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Absztrakt. Web has become rapidly an integrated part in our life and work, for many businesses Internet is a success factor. With the development of the Internet culture Web applications are becoming simpler with higher functionalities while users need less IT knowledge than earlier to be the content creator and editor. On the other side Web Applications are going to be an integrated part of the enterprises critical IT systems, replacing the "traditional" applications, at the same time the development of Web Applications are mainly ad-hoc without designing the development process, several developers (web developers as well), or decision-makers do not know the difference. Not only that Web Development (process) is different, but also the difference of Web Application and Web Site. This means for us, that teaching Web Development and Web Engineering is really important for Software developers and for economists as well.

1. Introduction

The predecessor of Eötvös Loránd University (ELTE) which is the biggest and oldest one in Hungary was founded in 1635. The Faculty of Informatics is founded only in 2004, but the training of the Software Developer Mathematician program started in 1972. Nowadays we have BSc and MSc programs of Software Development - traditionally based on Mathematics, Software Engineering and Information Systems -, and IT teacher. The education of Web Development started more than 10 years ago, first only on the IT teacher program. In those days the subjects were modern, at the same time for today the trainings structure is obsolete, and changing was slower than the web changed. University moves slower, because of some ureaucratic cause, our group, the Web Engineering Research Team which is one of the youngest Research Team in our Faculty has a chance to consider and to renew the web-based subjects. One of our main goals is to prove that Web Engineering and Web Development is a part of the Software Development and Web Applications are also part of the Information Systems.

In our days we have several practice-oriented courses on web-development and web-programming especially for Software Development students on BSc and on MSc programs.

In our article we summarize our experiences and proposals, anlayzing the current training structure with their disadvantages and those - partly realized - ideas to estabilish a Web Engi-

neering based web technology education in order to correspond to long- and short term industry expectations.

One of our proposal is a Search Engine Optimization contest which is announced between our students. This contest is such an activity that challenges search engine optimization practitioners to rank themselves among the major search engines using certain keyword(s). The students (participants) can showcase their skills and potentially discover and share new techniques for promoting websites.

Teaching of web development at ELTE started at the late 90'-s with two optional courses, HTML and Web programming (JavaScript, CGI, SSI, Perl and PHP programming), first only in the IT teacher program. The courses were quiet prosperous, few years later some new courses started, chronologicaly: Website editing (advanced HTML,CSS development with the basics of web design), Web programming II. (ASP.NET), Web animation (Flash), Web graphics (VRML, SVG), Web database programming (Multitier web application development with PHP), Datamaintenance-XML (XML, DTD, XSD, SAX, XPath, XQuery, XSLT, XSL-FO). Based on these subjects on 2002 started a Multimedia block for students on the IT teacher and on the Software Developer Mathematician program. The block consisted subjects of the topics of web and multimedia: Basics of multimedia, Multimedia editing, Website editing, Web-programming I-II., Web database programming, Web graphics and Web animation. The last Software Developer Mathematician and IT teacher training programs started on 2008, after that five new BSc, and MSc training programs are created: Software Developer BSc and MSc specialization in mathematician modelling, Software Developer BSc and MSc specialization in software technology, Software Developer BSc and MSc specialization in Information systems, Software Developer BSc and MSc specialization in media informatics and IT teacher BSc and MSc. At the same time the Multimedai block terminated, the web subjects got into the media informatics program, which is never started. In 2010 we has an opportunity to develop an 16 hours Web development optional block for all the MSc programs.

1.1. Research Areas of the Web Engineering Research Team

In 2010 we have founded a Web Engineering Research Team to coordinate researches and to modernize web related courses. Our research areas are the following:

- Web Engineering, Web Application Development methods.
- Web Business Models, Enterprise 2.0 Web Applications.
- Mobil Web Development.
- Establish mobile, online office.
- Web technology teaching methodology.
- Measurement of the Quality of Web Applications.
- Web Economics
- Web 2.0
- E-learning

2. Criticism of the subjects - state of web education

At that time the subjects were modern, however technology moves faster than the academic world, a part of the subjects are obsoleted already, fragmented, the connection of courses is weak. Can curriculum keep up with the technology and also suit the industry expectations? We believe that is required. Now, we have a chance to plan an optional block of six web-based subjects. The renewal is not only modernization. By planning, restructuring the curriculum we need to consider a long-term and high range of industry requirements, from SME's to large sized enterprises with complex IT structure. This means that we need to examine the WEB-world in a wide range aspect of view and then to choose what and how deeply is advisable to know in order to help graduated students, professionals to be capable to make technology decisions in a project. Issues to consider while planning a Web Education curriculum:

- Technology and methodology decisions, what to teach:
    - Technologies, languages: HTTP, HTML, CSS, XML, Client-side Business Logic: JavaScript, AJAX, Flash-ActionScript, Flex, Silverlight. Dynamic Web Pages and Server-Side Business Logic: PHP, Java, .NET, Python, Ruby, etc., Web Services and Remote Business Logic: Java Message Services, Web Services, Service-Oriented Architecture, special Enterprise solutions, like SAP's WebDynpro, etc.
    - Standards: HTML, CSS, XML, mobile web standards, WCAG 2, etc.
    - Methodologies: Web Ergonomy, Web Accessibility, Search Engine Marketing and Search Engine Optimization, Architecting Enterprise Web Applications, Web Application design and development models, like WebML, OOHDM, UWE, etc. Quality Assesments and testing methods. Semantic Web.
    - Methods and Frameworks: Design patterns (Movell-View-Controller, FrontController, etc.), Java and PHP Frameworks, usage of Web API's, etc.
- Timing estimations, define learning hours of lectures and practices.
- Define connections and overlaps of subjects.
- Input knowledge: in our case the students already have knowledge of database systems (SQL, XML), programming languages: Java (Java EE), .NET (C#), modeling tools: UML and on Information Systems MSc program Enterprise Architecture and ERP systems.

Output knowledge: To define the expected output, it is necessary to know the requirements of the employers. For the exact analyzation a wide-range survey is expected with employers and with graduated students about what were useful, and what is missing. Until now we made only a non-representative survey which tells us three main things, first that there is a high labour-demand despite of the today's financial crisis. Our second statement is that employers likes the fresh workforce being placed promptly into work, and they also would not plan to invest money and time to training them, at the same time they are going to open increasingly onto cooperation with the universities, mainly in the practical fields. It is to be regretted that few of them is interested in research cooperation. Finally our third statement is that we can aim at two separated field: the large sized enterprise IT environments with complex, highly integrated structure and the SME's small or middle sized web applications projects, which are with increasingly growing number built in into large IT environments. Based the high market demand we decided to focus to the "SME's way".

3. Requirements of web education training

On a university based training program we will be unable to train senior web developers, but web developers with a good view of the web world's current things, methodologies, ones who can make decisions, who can be a part of a development team and also ones who are capable to work alone on a particular, specific problem. It is necessary for a programmer to position the web of things in the area of software development, software engineering in an IT system, maybe a programmer did not touch an actual language but based on his or her general knowledge he or she are able to found to the solution of the problem. Accordingly we need to teach web algorithms, programming theorems, patterns, realistic techniques, but with adequate theoretical ground.

Based on the above we defined a requirements list of web education training's key competences:

- Designing: although this is a graphical task, a part of the topic, like web ergonomy, usability, and an overall image of the whole web development processes, web project's tasks is crucial. Especially as we require that a web developer can be able to create simple web sites as well.
- Website building: creation of valid HTML and CSS template from a picture and from an order's requirement list.
- Usage of templates in an application based on the black box technique.
- The principle of the making of searchable sites (SEO).
- The making of accessible web pages (WCAG).
- Client side web programming, Javascript.
- Server side web programming: PHP, Java, .NET.
- The planning, testing and the knowledge for maintenance of data-driven, multilayer Web Applications.
- Let them be able to decide from among the different opportunities, technologies onto the solution of a given task - that is because of the complexity of the task, depend of the project size let them be able to choose between technology and a language.
- Modelling Web Applications and Model-Driven Development.
- Web Project Management.
- Basic web marketing, web economy knowledge.
- Aspects of Security of Web Applications.

4. Web Education training framework

Our Web-technology Research Group has an opportunity to create an 16 hours Web development block on the MSc program instead of our old optional subjects on the Multimedia block. The web education training at ELTE consists of the following subjects, two optional subjects on BSc, the Web development block on MSc and few optional supplementary courses on MSc.

4.1. Ground courses on BSc

Web-development I.

Target audience: optional ground course on BSc.

Schedule: 2 lecture + 2 practice classes / week.

Course description:

The course covers ground topics of Internet technologies, and clients-side standards like (X)HTML (with HTML5 included) and CSS standards, the fundamentals of Search Engine Optimalization, the basics of Web Ergonomy and Web Design, so the basic methodologies of presentation. The subject has a portal (http://webfejlesztes.inf.elte.hu/) which contains the most popular Hungarian HTML curriculum.

Objectives / Learning Outcomes:

- Define the standards of web development: (X)HTML, HTML5, CSS and of Web ergonomics, like WCAG 2.0
- Explain the basics of static (client-side) web development.
- Demonstrate the theories of the presentation on the web, the web ergonomy.

Web-development II.

Target audience: optional ground course on BSc.

Schedule: 2 lecture + 2 practice classes / week.

Course description:

The course introduces the dynamic web development with the basics of client-side development. The subject is divided into two separated part, client-side programming with JavaScript on the first part and the basics of server-side programming with PHP, but introduced with SSI, shell script and Perl languages also. Both of the topic is necessary for fundamental purposes. As the same time as JavaScript is already more than a form-controller tool and the available timing is not enough, that is why in long term we need to create a client-side development course with JavaScript, Flash, Silverlight, etc instead of the course of Web graphic.

PHP is very significant as PHP is one of the most popular open source scripting language used to produce web pages, access databases, produce dynamic web pages for small to large websites, web applications, the obtainable knowledge is multipurpose, Leaving also the bottom-up web application development approach which is enough only for smaller web development projects. On the new model the practices covers only server-side programming with PHP.

Objectives / Learning Outcomes:

- Define the protocols and systems used on the Web (such as HTTP, CGI-SSI, XML).
- Explain the functions of clients and servers on the Web.
- Students will be familiar with one of the JavaScript frameworks and be able to build client-side logic of an application.
- Students will have a good knowledge of the PHP language elements, object-oriented PHP, form processing in PHP, sessions, cookies, file-management.
- Learns how the separate client- and server side logic.
- Shows a PHP development environment.
- Implement reusable server-side scripts using PHP design patterns.
- Design and implement an interactive web site with regard to issues of usability, accessibility and internationalization.

4.2. Web Development block courses on MSc

Designing web site – from functional design to enterprise image

Target audience: Web Development block course on Media MSc at the 1st semester.

Schedule: 0 lecture + 2 practice classes / week

Course description:

The course is the continuation of the Web-development I. course. As this course also deals with the static web sites and client-side applications. The subject covers the following topics: the fundamentals of Web marketing with Search Engine Marketing. Ergonomics of enterprise web sites and webshops. Methods and tools of functional design: paper prototype, mockups. Practical usage of graphic applications and tools by the design and creation of the corporate image. The Formal and substantive elements of style guides, fundamentals of logo design in theory and in practice as well. Layout implementation, separation of content and presentation, using templates and style sheets in various WYSIWYG applications. A complex web site (corporate design, layout) realization from specification. Creating Web sites optimized for mobile browsers. Markup languages (XHTML, CSS), ergonomic considerations. Overview of client-side adaptation techniques.

One of our proposal is a Search Engine Optimization contest which is announced between our students. This contest is such an activity that challenges search engine optimization practitioners to rank themselves among the major search engines using certain keyword(s). The students (participants) can showcase their skills and potentially discover and share new techniques

for promoting websites. The other exercise of the students is organized as a second contest to create a (static) web site based on real or realistic example as the students should develop a SME's web portal. The requirements comes from an existing enterprise.

Objectives / Learning Outcomes:

- Explain the basics of Web marketing and Search Engine Optimization.
- Demonstrate realistic requirements for students.

Web graphic

Target audience: Web Development block course on Media MSc at the 2nd semester.

Schedule: 0 lecture + 2 practice classes / week

Course description:

The course deals with the creation of dynamic and static web graphics based on VRML, SVG (XML), SMIL, X3D, HTML5 Canvas and JavaScript. As importance of the client-side development (JavaScript, Silverlight, Flash, etc) growing, the course should change into a client-side development course with built-in web graphic topics covered the present course.

Objectives / Learning Outcomes:

- Define the multimedia web standards, based on HTML5 standard.
- Explain the basics of the XML based Scalable Vector Graphics (SVG), X3D, SMIL
- Demonstrate the drawing techniques of HTML5Canvas and JavaScript.

Web technologies I. (PHP)

Target audience: Web Development block course on Media MSc at the 2nd semester.

Schedule: 1 lecture + 1 practice classes / week

Course description:

At this part of the course the students already learned Database systems and the basics of PHP. This course is helps students to dive into advanced PHP with usage of database system, AJAX, Rich Internet Applications (RIA), and professional PHP frameworks. The subject concerns also with web application modeling, with the usage of design patterns, like MVC, MVVM and PHP frameworks and the lectures still provide a wide overview of Internet technology.

At this time students should know how to separate the client and the server side logic. An other goal is to create mobile web applications. The students create a complex, multi-tier web

application in PHP. At the end of the course student will be able to model and create web applications and web sites for small and medium enterprises (SMEs) in PHP.

Objectives / Learning Outcomes:

- Students will be familiar with one of the PHP frameworks and be able to build real world web sites with PHP.
- Students will have a good knowledge of the usage of AJAX to create Rich Internet (RIA), Web 2.0 Applications.
- Define a PHP development process.
- Demonstrate the ability to retrieve data from a database and present it in a web page.
- Introduces the Model-View-Controller, Model View, ViewModel pattern.
- Students will be familiar with server-side web applications and be able to separate the client- and the server side logic.
- Explain security issues, like authentication, authorization, defend and avoid malicious attack.
- Realizes the Object Relational Mapping (ORM) principle on Web platform with PHP.
- Introduces the Web Service paradigm.
- Demonstrate the deployment and management of web applications.

Web technologies II. (ASP.NET)

Target audience: Web Development block course on Media MSc at the 3rd semester.

Schedule: 1 lecture + 1 practice classes / week

Course description:

The course is not the continuation of Web-application development I, as it deals with ASP.NET Web Application development in C#. At this time our students will be familiar with C# already as they have an obligatory C# Windows form development subject. At this semester students will learn the philosophy of ASP.NET webform applications, the differences of the desktop and the web development. The course also covers the basics of Silverlight as well. Mainly the course covers similar topics like Web technologies I, but in ASP.NET viewpoint, which means that at the end of the course student will be able to model and create web and mobile web applications, and Enterprise web sites as well in ASP.NET.

Objectives / Learning Outcomes:

- Introduces the basics of ASP.NET web development.
- Demonstrate the ability to retrieve data from a database and present it in a web page with ADO.NET Entity Framework and LINQ, as well.
- Define the basics of Web Services, Windows Communication Foundation (WCF) model and the Service Oriented communication methods.
- Students will be familiar with server-side web applications and be able to separate the client- and the server side logic.
- Students will have a good knowledge of Silverlight and AJAX to create Rich Internet (RIA), Web 2.0 Applications.
- Designing and modeling ASP.NET web and mobile web applications.
- Demonstrate the deployment and management of web applications.

Web technologies III. (Java Web, Java EE)

Target audience: Web Development block course on Media MSc at the 2nd semester.

Schedule: 1 lecture + 1 practice classes / week

Course description:

Mainly the course covers similar topics like Web technologies I. and II, but in Java EE viewpoint, which means that at the end of the course student will be able to model and create web and mobile web applications, and Enterprise web sites as well in Java EE. The course deals with Java Web Development with frameworks.

Objectives / Learning Outcomes:

- Introduces the basics of Java Enterprise Edition and Java Web development.
- Gives an introduction of Java servlet, Java Server Pages (JSP) and Java Server Faces (JSF) programming.
- Define a Java Web Application Development process.
- Demonstrate the ability to retrieve data from a database and present it in a web page.
- Demonstrates the Object Relational Mapping (ORM) principle with Hibernate.
- Introduces the Model-View-Controller pattern.
- Shows the main Java Web Frameworks, like Struts 2, Google Web Toolkit (GWT), Spring.

- Students will be familiar with server-side web applications and be able to separate the client- and the server side logic.

- Students will have a good knowledge on to model and create enterprise web applications with Java.

Portal development

Target audience: Web Development block course on Media MSc at the 4th semester.

Schedule: 0 lecture + 2 practice classes / week

Course description:

The course deals with the portal development, built on the knowledge of PHP, Java and ASP.NET development. The semester starts with an introduction of the basic elements of the topic, like: characteristics and the comperation of Content Management System (CMS), Content Management Framework (CMF), Web Application Framework (WAF), and blogging, microblogging, wiki systems. The course continues with a demonstration with several portal systems (Wordpress, Nukes, Zope, Drupal, Wiki, Joomla, Mambo, Sharepoint, and Java portals, like: Jetspeed-2, OpenPortal, WebSphere Portal, etc.) examine the followings: advantages and disadvantages of the portal systems, installation extensibility, customization, content management, performance and scalability, administration. Course covers also the basics of the CMS, modul development methods in Drupal. Joomla, Wordpress and Sharepoint Server. The course discuss also the methods of implementing Enterprise Web 2.0 and social media functions, like blogs, wikis into portals. The semester finishes with a task of groups to produce an independent, fully customized portal system, with exercises of modification and creation of modules. The main goal of the subject is to create modules, portals which match the Web Content Accessibility Guidelines (WCAG) 2.0.

Objectives / Learning Outcomes:

- Define portal types, task roles.

- Explain portal functions.

- Students will be able to choose portal system for a project.

- Design and implement portal system.

- Discuss the portal development methods and tools.

Web Engineering

Target audience: Web Development block course on Media MSc at the 4th semester.

Schedule: 2 lecture + 2 practice classes / week

Course description:

Web Engineering course introduces a structured methodology for Web development projects, addresses the concepts, methods, technologies, and techniques of developing Web Applications.

Topics covered include requirements engineering for Web applications, design methods, like Model-Driven Development, Developing Applications with WebML, and technologies, interface design, Testing ,Usability and Quality management of Web Applications, metrics, operation and maintenance of Web applications, security, and Project management of Web Applications, Service-Oriented-Architectures (SOA), Cloud Applications, specialties of mobile web development.

Objectives / Learning Outcomes:

- Explain the specialties of web and mobile web applications and the web architectures, so define Web Engineering.
- Helps students to summarize their knowledge of web based technologies with a practical comparison of PHP, Java, ASP.NET, Ruby on Rails, Python, Flex. After the course students will be able to compare and to choose the appropriate technologies.
- Explain the Web Applications development process.
- Specialties of large enterprise and SME's Web Applications.
- Developing Web 2.0 and Enterprise 2.0 Web Applications.
- Modeling and developing Semantic Web Applications and integrate it to the Enterprise information systems.
- Introduce the basics of complex IT environments with the usage of SOA model.
- Modeling and establish Service Oriented Architecture, transform Enterprise Applications with Web Services.
- Web Application models, like Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), Infrastructure-as-a-Service (IaaS), Cloud computing.

4.3. Optional and supplementary web-based courses on MSc

Web animation

Target audience: Media Development block course on Media MSc.

Schedule: 0 lecture + 2 practice classes / week

Course description:

Former Web animation deals only with Flash editing and development with Actionscript, where students created independent animations, mainly serious games, educational animations, simple web sites. With the appearance of JavaScript frameworks, HTML5 Canvas and Silverlight Flash is not anymore the only web animation platform. Todays news tells us that Flash's web video era is at risk. Education has to respond these changes. Animations are integrated part of the web applications as visual tools, added functionalities, although a modern web application should work also on mobile devices without these Flash animation, JavaScript, etc. The course mainly based on Flash editing, Actionscript development, interoperability with PHP, but at the same time based on Website editing course also discuss the topic of JavasScript and HTML5 Canvas animations with a little bit of SVG. At the and of the course shortly introduces Silverlight, the Flex application model and the web video formats.

Objectives / Learning Outcomes:

- Introduces the Flash platform and Flash editing tools.
- Explain the Actionscript language.
- Implement animations into web projects.
- Students will be able to decide of animation platforms.

Web Marketing

Target audience: optional course on MSc

Schedule: 0 lecture + 2 practice classes / week

Course description:

The course introduces the multi-layer architectures in practice, helps students to summarize their knowledge of web based technologies with a practical comparsion of PHP, JSP (JAVA), ASP.NET (.NET). The course also covers the following topics: Methodology of Web-based Application Development, Web Engineering. Complex Web Application development. Web API based development, creating mashups. Service-Oriented-Architectures (SOA). Cloud Applications. Specialties of Mobile Web Development.

Objectives / Learning Outcomes:

- Define Web Engineering.
- Compare web based technologies.
- Introduce the basics of complex IT environments with the usage of SOA model.
- Explain the specialties of mobile applications.

Web Technologies in Information Systems

Target audience: Information system development and operating environment block course on Information Systems MSc at the 4th semester.

Schedule: 2 lecture + 2 practice classes / week

Course description:

The course covers principles, techniques, architectures, and technologies for the development of the different components and layers of complex Information Systems. The lecture discusses Enterprise Architectures and functions, enterprise applications development using Java Enterprise Edition, Web services and business process modeling, inter-enterprise message exchange. During the lecture, advanced concepts for developing complex enterprise information systems are studied. These comprise standards to describe service-oriented architectures (SOA) in enterprise environment, Web services (WSDL), their retrieval (UDDI), their composition (BPEL, BPMN 2.0) as well as ontology-based approaches to describe their semantics, like Resource Description Framework (RDF), Web Ontology Language (OWL), Web Service Modeling Ontology (WSMO), The Web Service Modeling Language (WSML) Web Service Modeling Environment (WSMX).

Objectives / Learning Outcomes:

- Define Enterprise Architectures, like Zachman Framework, The Open Group Architecture Framework (TOGAF) and Service Oriented Architecture as Enterprise Information System Architecture.
- Describe different architectural design approaches and their role in Enterprise Application Integration
- Apply the concept of Business Process, Business Process Management.
- Students will be competent in designing and developing applications using SOA concepts and related technologies
- Explain the Business Process Management Notation (BPMN 2.0) and the Business Process Execution Language (BPEL) methods.
- Introduce the basics and the utilization of Semantic Web in Enterprise Information Systems.

5. Summary

We believe that inside the barriers we faced we covered the topic a number of things are still missing: Client-side Web Development, Web Security, Maintenance of Web Application, Web Project management. In addition the Web Development block fits more into the Information

Systems MSc, where there is only one course the Web Technologies in Information Systems which covers web based methodology, but without the proper foundation.

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