E-LEARNING 2.0 ADAPTIVE AND INTELLIGENT APPLICATIONS

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Abstract: This overview paper will outline the current state-of-the-art in E-learning 2.0 with respect to adaptive applications. It will identify issues concerning learning applications in Web 2.0 including pedagogical, business, legal and technological ones. Lessons learned from development of an E-learning 2.0 platform will be presented. Finally, visions and future trends in this area will be discussed.

Keywords: E-learning 2.0, Web 2.0, adaptive systems

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1. E-LEARNING IN WEB 2.0

1.1. What is E-learning 2.0?

Prominent e-learning experts, namely Downes (2006) and Alexander (2006) compare the traditional view of e-learning with the expected Web 2.0 level of e-learning services. Currently, e-learning is represented by (Pitner & Drášil, 2006):

- (Reusable) *learning objects* (LO) that can be assembled together. The typical LOs adhere to established international-, consortial- or just de-facto industry standards, ranging from low-level ones (such as content – text, image, multimedia – formats) through packaging formats (SCORM) to high-level (metadata, ontology) standards.
- E-learning takes the form of *online courses* that may be driven by a formalized, explicitly modeled *Learning Design*, or may be *adaptive* (usually not both).
- It is controlled by *Learning Management Systems* (LMS) that are typically monolithic, large-scale systems including open-source ones.
- In the optimistic case, they are integrated with the *institution's information system* in order to complete and enhance the *collaborative environment*.

LMS implement traditional theories of distance learning (Moore, 1991) in online world. They aim at content organization and delivery; they provide training supported by quizzes, tests and discussions. Many authors thus noticed that e-learning and LMS (i.e. "E-learning 1.0"), as characterized above, does not fulfil current needs in pedagogy (Delgado, 2007). Learner- (person-/student-) centred learning – the student is not just the subject of teaching. They dislike being controlled by a LMS and live in the closed and unreal LMS world. The student more and more becomes a client of the learning service.

While constructivism tries to force the learner to understand by meaning-making tasks (Huang, 2002), it is not enough in the present chaotic world. The concept of connectivism builds on finding the right connections and is by prominent authors considered as "a learning theory for the Digital Age" (Siemens, 2004).

Simultaneously, Web 2.0 helps those paradigms to change the learning landscape so significantly that it desires a new name – *E-learning 2.0* (Downes, 2006). Wilson (2006) and MacManus (2007) further discuss the concept of E-learning 2.0 from the teaching viewpoint.

Before we show a vision of truly E-learning 2.0 platform/environment, let us map the present situation – including traditional LMS and adaptive systems, role of modern concepts like e-portfolios, user and stakeholders issues concerning Web 2.0 itself as all these aspects significantly influence the future of E-learning 2.0.

1.2. Current LMS vs. E-learning 2.0

In this section, we will illustrate that present LMS including the very popular open-source ones belong predominantly to the Web 1.0 Generation – and do not meet current E-learning 2.0 needs.

Primarily, they are *weakly integrated* with the "outside world" represented by Web 2.0 services and their users. They usually provide their own closed communication facilities. They disallow to transparently share artifacts with outside users and – vice-versa – they are weak in integrating outside content like web pages, feeds, or multimedia.

From the institutional (stakeholder) point of view, nearly all legacy LMS including the open-source ones mean products that need to be installed, maintained, patched, updated, upgraded. This does not correspond with the Web 2.0 idea of services that evolve "automatically" in the background, without user effort.

Too liberal policy in contributing to OSS projects including popular LMS leads often to chaotic incorporation of many features that may be *unstable*, *not mature enough* or not well documented. *Maintenance* of such system might become a *nightmare* – especially for smaller educational institutions without a strong infrastructure and experienced technical staff.

Legacy LMS are *centralized* – they resemble more Britannica Online than Wikipedia (Pitner & Drášil, 2006). It is a one-way publishing or at least a non-symmetric one, as teachers/tutors are preferred over learners. E-learning is also not about creating and publishing *stable* content in a single step. It is about *continuous improvement*, modifications and *quick publishing*. In legacy LMS, publishing a resource often means creating it in an external authoring tool, uploading it into the LMS and associating necessary metadata with it. On the other hand, full content management functionality as offered by many LMS, is not always required.

The same applies for the content *organization*. Legacy CMS tend to organize documents into hierarchies, pre-designed by a "guru" who must have known the structure in advance. Once an e-learning course starts, the learning community tends to semantically self-re-organize the learning content by *tagging* it, applying *folksonomy* (Wal, 2007) in opposite to (predefined) taxonomy.

1.3. E-Portfolios

E-portfolios represent another present movement in learning specifically in the English-speaking world (in countries like USA, Canada, UK, New Zealand and Australia) but gaining popularity in continental Europe (Denmark), too. E-portfolios may be seen as a digital-age extension of classical portfolios collecting individual's learning goals and achievements, theoretically at all levels of learning, practically mostly used in tertiary and lifelong learning.

Barrett (2006) provides a deep overview about the importance of e-portfolios on Web 2.0 and proposes services to manage them. In loosely coupled Web 2.0-based learning environments, e-portfolios play a crucial role in collecting and maintaining learning achievements for both individuals and institutions. While traditional LMS support logging of the learning process and recording of the achievements in some form, in an E-learning 2.0 educational setup/platform, it will be natural to prefer a separate, single-purpose service for individual e-portfolio creation and maintenance. Systems like ePortfolio (http://www.eportfolio.org) or rCampus (http://www.rcampus.com/) allow free creation and maintenance of personal portfolios online, independently on actual (Web 2.0) learning environment where the education itself took place.

1.4. Adaptive Systems

Theory and praxis of adaptive systems in education has a long tradition (Brusilovsky, Specht & Weber, 1995). There are already also several studies focusing adaptive e-learning methods and learning design (Burgos & Specht, 2006). Learning Design, as defined by IMS standards (IMS, 2003) and having several alternatives, helps to specify and manage the learning process.

Since management of learning process in E-learning 2.0 is not a fully resolved issue, as long as the management affects mainly learning resources within one E-learning 2.0 platform (Elgg, Nuvvo, or eLeaP).

Although the motivation to provide Web 2.0 adaptive learning services is not a priority for commercial vendors, we can expect an agent- and/or grid- based Web 2.0 service oriented architecture for e-learning to appear soon. The works of Andreev & Troyanova (2006) and Hernández et al. (2006) already provide solid theoretical foundation for implementing such architecture.

Even though they do not explicitly refer to Web 2.0 as "the platform", they already reflect the collaborative, user-centric sense of it. The next step towards adaptive E-learning 2.0 must be to design and develop an architecture corresponding to the principles defined in the above-mentioned research but being interoperable with present Web 2.0 services, namely for content creation (wikis, blogs, multimedia recording tools), identity management (see further), and presentation.

1.5. User Concerns and Issues

1.5.1. Distributed Identity & Access Rights Management

A serious non-functional, not-yet-resolved usage issue on Web 2.0 is the need for having multiple identities – typically one identity per service – but it may vary. It can be meaningful having more than one identity per service to achieve pseudonymity, or, under some circumstances, one identity may be shared among more services. In general, managing identity is considered to be one the most important issues in the future information society, as signalized by activities like *FIDIS* EU Network of Excellence (see FIDIS). Ruth Halperin (2006) notes the main research and development issues.

From the practical point of view, managing multiple identities has many undesired consequences. Namely, users must maintain many credentials (usernames, e-mails and passwords). This fact increases the risk of compromising and sometimes also irreversible loss when there is no password recovery. Currently, we can find Web 2.0 services helping to reduce this burden – such as *Agatra*, http://www.agatra.com. Agatra allows not just safely storing and accessing username/password pairs for services but enables to seamlessly login to of them. Therefore, Agatra is not reducing the identity diversity but tries to manage it.

Hampel (2004) points out the importance of access right management that is highly interconnected with the notion of identity in the e-learning and collaboration context.

We also recently encounter strong efforts on providing infrastructures for single-sign-on identity management (Marwick, 2006). As typical representatives, the *OpenID* (Becker & Norlin, 2006) and *Liberty* (2007) activities as well as commercial efforts like Microsoft's *CardSpace* (Microsoft, 2007) can be named. Although not only open-source initiatives but also proprietary solutions emerged, many of the vendors declare their support for open standards, like Microsoft did in the case of OpenID.

Movement to this "identity consolidation" (Gradman, 2004) and building a federated identity has attracted attention from a broad audience, spanning from the researchers to practitioners – developers of Web 2.0 services. Despite of the current progress, the identity management will remain an issue and may represent a serious obstacle when dealing with Web 2.0 as an open groupware platform (Tapiador et al, 2006) as it is required in E-learning 2.0.

1.5.2. Identity of Web 2.0 Artifacts

In a Web 2.0 learning environment, the artifacts created and maintain mostly by users (teachers, instructors, tutors, and learners) rather than, formally, by institutions. Therefore, it is inevitable to claim identity of those artifacts and help to protect intellectual property rights as well as to ensure the terms of use.

One step even further in user self-identification on Web 2.0 is represented by services providing space for "claiming" the identity of various web resources – like websites or blogs – and for binding them to an open identity, such as the one provided by an OpenID identifier. In fact, such a service maintains a specific, extended user profile bound to an identity and containing links to other resources.

One system providing such functionality is *ClaimID*, http://www.claimid.com. In the future, such systems may represent a viable solution to manage the Web 2.0 heterogeneity. Similar approach

has been taken by *Meecard* (Grimshaw, 2007), an online service aimed at covering distributed personal presence on the Web under one roof.

1.6. Business Issues

Choosing a right business model is still mostly the subject of many practitioners' views rather than of a serious research. It is closely bound to the concept of Web 2.0 itself. Paul Graham (2005) sees Web 2.0 as a web rid of bad practices of the Internet (dot-com) bubble thus inherently better from business point of view – which is highly disputable. However, as Rob Hof (2005) claims that there are two main reasons for "more sustainable" investment in Web 2.0. a) It costs a whole lot less to fund companies to revenue these days. b) Even though venture capital investment seems to stay level, cheaper costs mean that much more companies are being funded with the same level of investment. Furthermore, cheaper costs also mean that more companies can be funded by non venture-capital funds.

Joe Kraus (2005) recognized that also the outside conditions are different than in the dot-com bubble era: *Hardware is 100x cheaper, Infrastructure software is free, Access to Global Labor Markets, Internet marketing is cheap and efficient for niche markets.*

Richard MacManus (2006) identified the following business models for Web 2.0 applications – namely mashups:

- **Advertising** – a contextualized Web 2.0 service can provide a targeted advertisement to the clients and build the business upon it.
- **Lead generation and affiliate programs** – a mashup can generate the lead and help to attract more users to the service via affiliate programs. The targeted service can share the profit with the mashup.
- **Transactional (mashups)** – allowing performing transactions directly from within a mashup-service, possibly attracting more people saving the resource.

Further, he finds more models – not yet fully proven – namely *subscriptions*, *pay-per-transaction*, *premium services*, or *charging-businesses-but-not-individuals*. In the typical Web 2.0 services, usually a mixture of these models is applied, mostly combining advertisement with subscription fees and premium services.

Almost all of the business models presented above rely on reaching a critical mass of users in order to achieve sustainability and profitability that might be difficult specifically for educational services in small language territories or niche communities.

1.7. Legal Issues

Classical legal problems of collaborative content creation and reuse (which is typical for Web 2.0) including intellectual property rights are often solved by choosing a liberal IPR model, such as under *Creative Commons* licenses (see Creative Commons) if applicable. However, although this kind of licenses allows free use or even repurposing of the content, there exist several variants of this license, namely *CC Attribution-NonCommercial-ShareAlike*, prohibiting commercial use.

Web 2.0 is also about content aggregation and repurposing, for example via syndication feeds (RSS/Atom). This behavior is normally judged as fair use (e.g. publishing on a personal blog or for educational purposes among others) assuming the credit to the original content creator is given.

This opinion may change if, for example, the original content has been provided for free and a mashup earns money with it, as already encountered in the Adam Curry's case (Garlic, 2006).

Web 2.0 brings also specific problems with mashups. Mashups are services based upon other (primary) services functionality and/or data, typically developed using a publicly available API (SOAP or REST-oriented) but we may encounter services conceived as "parasite" – accessing the

primary service directly via user interface ("screen scraping"). This may be considered as a breach of fair use because it may allow user of the respective mashup to bypass advertisement in the primary service. Cases claiming these practices to be illegal has already appeared, e.g. the case *ShopLocal LLC v. Cairo, Inc., 2006 WL 495942 (Slip.Op. Feb. 27, 2006)*, as cited by Gerber (2006).

Gerber also maps and describes several other legal issues that can be encountered on Web 2.0 and noted specifically that even for government- and non-profit organizations, a use of mashed-up third party services for enhancing revenue might be breaking the "only-for-non-profit" terms of use. If a mashup is running without an explicit consent from the original data owner/service providers (e.g. by signing a license/terms of use) or even without notifying them, it would also break copyright law by creating a service producing a *derivative work* with data from an abusively accessed service.

In some legal environments, such as in the U.S., *software patents* may also be a Web 2.0 issue if a mashup tries to "abuse" a specific patented implementation of algorithms in a service.

Very typically, a mashup creator may face *trademark issues* that can be offended by improper citation or attribution of the original service owner. Some service providers (eBay, Yahoo!, Google and many others) are very careful about these matters, specifically prescribing what is allowed when repurposing the service or data by incorporating into mashups.

Figure 1. A GoogleMaps-based mashup

Last but not least, classical *privacy issues* may be violated by mashups, too. For instance, an author and IPR owner of pictures or videos publicly available on sites like Flickr, YouTube, or Google's Picasa may not even be aware of the fact that the material is reused and published in a different (possibly inappropriate, misleading, obtrusive, or offending) context.

Proponents of the so-called *Deleting Online Predators Act* (Fitzpatrick, 2006) have misused arguments like this in order to propose a legal regulation that if accepted *would require schools and libraries that receive E-rate funding to protect minors from online predators in the absence of parental supervision when using "Commercial Social Networking Websites" and "Chat Rooms".*

This would, taken to extreme, seriously undermine the future of E-learning 2.0 by actual prohibiting of activities that are the very nature of E-learning 2.0 (O'Hear, 2007). Fortunately, the proposal is practically dead since its author Rep. M. Fitzpatrick left the U.S. House of Representatives in the 2006.

2. SHAPING E-LEARNING 2.0

2.1. Learning Methodology and Scenarios

Selection of appropriate learning methodology is indispensable in E-learning 2.0. The ambitions and potential of E-learning 2.0 are much broader than with "E-learning 1.0", as the environment is

a) open and bound with the "outside world", b) the learning goals are less easy to identify and grasp, c) the Web 2.0 environment is quickly evolving – in both content and services.

The learning process helped by E-learning 2.0 is inherently loosely structured, thus requiring more experienced mentors and carefully chosen/constructed methodology. Derntl & Motschnig (2007) have proposed a set of learning scenarios based on an extension of *Universal Access* (UA) which is further referred to as *Inclusive Universal Access*. From the classical UA viewpoint, services and systems are universally accessible when they are inclusive of all potential users, adaptable to specific needs, usable even by non-specialist target users, and involving users in all phases of the system life cycle. Simultaneously, we recognized that in many ways these aspects apply to the concept and intent of Web 2.0 as well.

IA proposes a significant extension to the concept of UA. It aims to actively involve learners in all aspects learning and assessment; to primarily address them on all levels of learning including intellect, skills, and personality; and to employ universally accessible tools to support the educational activities. The IA scenarios have the following general characteristics:

- **Levels of learning**: Address students on all levels of learning, i.e. intellect, skills, and personality.
- **Responsibility, empowerment**: Offer students to take responsibility for the educational process by involving them in setting learning goals, in evaluation of their own and their peers' learning, and in assessment of course quality.
- **Active participation**: Inspire students to actively participate in educational activities including practical exercises, collaboration with peers, presentations of results and projects, proposing and solving problems of personal relevance, or evaluating their own and their peers' contributions.
- **Interpersonal sharing**: Engage students in interpersonal sharing and communication with their peers and the instructor.
- **Person-centeredness**: Promote and live the attitudes of acceptance, realness, and understanding to a perceptible degree and equally try to express these attitudes in the design and conduct of learning activities.
- **Universal access**: Use methods and tools for learning and teaching support (e.g. a web-based learning platform) in compliance with classic UA.

In our recent research (Pitner, Derntl, Hampel & Motschnig-Pitrik, 2007), we identified the following set of Web 2.0 learning scenarios: *Considering goals and expectations, Teamwork, Project-based learning, Sharing and presentation of contributions, Peer teaching, Interactive elements, Computer-mediated communication, Problem proposals, Learning contracts, Collecting feedback and opinions, Blended evaluation***.**

We accompanied each scenario with concrete examples of appropriate Web 2.0 tools and services, providing a solid theoretical background and a practical guideline for implementing E-learning 2.0.

2.2. Platforms

The characteristics of an E-learning 2.0 platform have already been identified several times, see (Pitner & Drášil, 2006) and (Delgado, 2007). The first approach means building e-learning around a one central platform like Elgg, edu 2.0, or Nuvvo – these concrete platforms will be discussed now. The second approach builds upon a set of tools with no central platform.

2.2.1. Elgg, Nuvvo, and Edu 2.0

Elgg (Werdmuller & Tosh, 2004) developed Elgg as a Web 2.0 alternative to present LMS. The purpose is different – try to provide an open environment for establishing communities for both formal and informal learning. It is available freely as open-source and is currently implemented also on large-scale basis by many universities, such as University of Westminster, Brighton, UHI, Swansea University and Leeds University.

Elgg allows to create user accounts (either Elgg-centric or OpenID-based) with personal profiles, to establish blogs, enable to aggregate content via feeds, and join communities including supra-institutional ones.

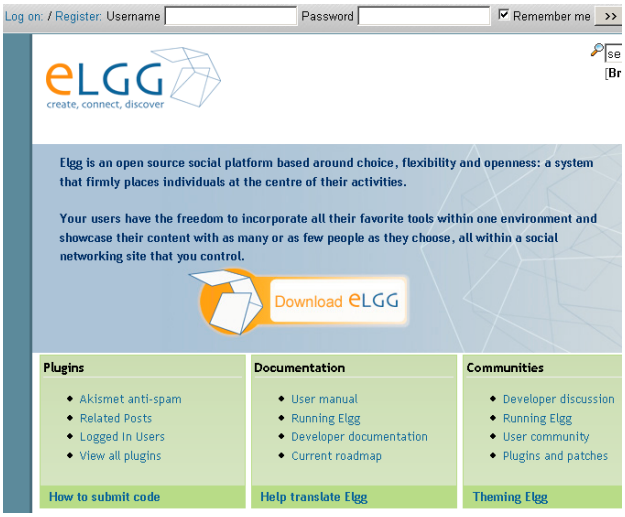

Figure 2. Elgg Platform

Nuvvo (http://nuvvo.com) is a similar but commercial effort to provide an easy-to-use learning platform for both individuals and institutions.

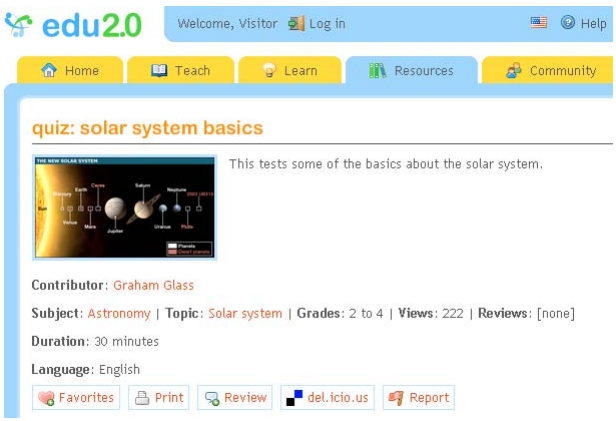

Figure 3. Edu 2.0 Platform

Edu 2.0 (http://www.edu20.com) calls itself "next generation education", *free web-based education site with comprehensive features for teachers, students and parents. Anyone can teach and/or learn using the system, whether it's at school, at home, or on the move.* In many aspects, edu 2.0 resembles traditional LMS with a very liberal registration and access policy but it offers a set of typical Web 2.0 features like RSS feeds or personalized study according to the chosen curriculum. Members can also apply for expert status and help shape the evolution of the site. The pages in edu 2.0 are edited as wikis.

2.2.2. Sakai Project

Sakai is an *online Collaboration and Learning Environment* (http://sakaiproject.org). It is typically deployed to support teaching and learning, ad hoc group collaboration, portfolios and research collaboration. Sakai is a free and open source product that is built and maintained by the Sakai community representing many large higher-education institutions mainly in UK and North America. Sakai natively incorporates many of the Web 2.0 ideas (namely strong focus on collaboration) and is now implemented by many universities worldwide.

2.2.3. Google Apps Education Edition

Google offers *Google Apps Education Edition* (GAEE, http://www.google.com/a/edu/), a suite providing a simple but industry-strength infrastructure to serve members of an educational institution. It represents a simple collaborative environment with comprehensive e-mail service (*GMail*), *GTalk* allowing instant messaging, *GCalendar* as online planning tool well suitable for educational purposes, and a set of content-creation and sharing tools like *Start Page* (personal web sites) and *Docs & Spreadsheets*. It also includes conference rooms and event scheduling features. Individual users then become Google accounts enabling to create personal *blogs*.

From the business model point of view, the GAEE is an educational-tailored version of a commercial Google Apps *Premier Edition* suite, offering typical platform facilities like single-sign-on or even API access to the services.

See (Pitner, Derntl, Hampel & Motschnig-Pitrik, 2007) for concrete scenarios using GAEE applications.

2.3. Tools and Ad-hoc Approach

Beside of fully-fledged Web 2.0 platforms presented above, the second approach can be built around freely ad-hoc selected third-party tools together with appropriate Web 2.0 services. Applying the "ad-hoc" approach, the crucial problem is to find the right set of primary tools (content provision tools such as editors, testing & assessment tools, or communication, see Lauer & Ottmann, 2002) and to combine them with Web 2.0 services. We will concentrate on one class of primary, content creation tools suitable for integration into a Web 2.0-based solution – audio/video recording.

2.3.1. Audio/video Recording and Maintenance

Advances in new technologies and Internet have led to increasingly use of digital audiovisual libraries in many fields. Video is now becoming one of the most employed media where Web 2.0 significantly contributed to this trend by providing services like *YouTube* offering publication and sharing of the multimedia content.

Specifically in vocational and educational training (VET) and lifelong learning in general, many organizations are now producing videos of class lectures in order to deliver them online either as course supports or as graduate programs. These developments are revolutionizing educational delivery. In order to help users to find and retrieve the relevant information, with the exponentially increasing of number of videos available, three main questions have to be correctly answered: what metadata to index, what database models and finally how to search, browse and retrieve the relevant information from digital libraries.

Content-based video indexing: Different video features have been used to index videos. They can be grouped into low- and high-level features. Low-level features are also known also as perceptual content because they are perceptible features and directly measurable: object shape (e.g. Mokhtarian, Abbasi, & Kittler 1996), region intensity, color (e.g. Swain, & Ballard, 1991), texture (e.g. Manjunath, 1996), motion descriptor, audio. High-level features, known also as semantic content such as objects, events, text (e.g. Chen, Bourlard, & Thiran 2001), human faces (e.g.

Srihari, Zhang, & Rao, 2000), voice identification, character recognition, and human action, etc. Effective video indexing in vocational and educational training needs to be performed on multiple levels (file, segment and frame) and through a multimodal approach: text, audio and image. A survey on multimodal video indexing has been provided by Snoek & Worring (2002). Manual content-based indexing of existing large video collections would be very low and costly; therefore it has to be automatic, real-time and directly in compressed domain. The above problems are mainly related to commercial existing video. Indexing process is mostly performed in a post production step. In VET environments, however, videos are mainly issued from presentation captures. Despite the fact that equipment is affordable, capture and publication process still remain difficult for unspecialized peoples, so that capture, indexing and publication systems have to be simple, automatic and synchronous. On the user side, digital libraries have to provide an efficient and a user-friendly environment. Among the features mentioned above, two of them remain relevant for videos issued from captures of presentations: digital text of presentation and instructor speech. Considerable efforts on have been made in the recent year on this topic.

On of the most important research work is the project called Informedia Digital Video Library initiated in 1994 at Carnegie Mellon University as. This project was one of the six core projects of the US Digital Library Initiative (DLI) Phase I. It pioneered the automatic video indexing, as well as the search and retrieval for use in education. The first phase of this project (Informedia I: 1994-1999) has been supported by the National Science Foundation, DARPA, and NASA. It aimed at combining speech, image and natural language understanding to provide full-content searchable digital video library.

Einhorn, Olbrich, & Nejdl (2003) have presented a metadata model for capturing different presentation types such as slides and instructor speech. This model is part of the VACE project started in 2000. The objective of this project was to fully automate the content-based indexing of videos (text, speech and image analysis) and provides mechanisms for search and retrieval.

Figure 4. V3 Recording Tool

To see such achievements in praxis, let us have a look at a concrete set of tools produced within a European project. The Leonardo Programme-funded project V3 (Versatile Vocational and educational training Vehicle, http://www.leonardo-v3.eu) is aimed at designing, implementing, deploying, evaluating and exploiting a versatile, user-friendly, ICT-based Vocational and Educational Training (VET) framework suited for both young people in initial training as well as adult involved in lifelong learning activities (Pitner et al, 2006).

The recording tool (see Fig. 4) has been built on top of existing open-source tool *CamStudio* which has been ported to all relevant Windows versions, user-friendliness has been improved and many technical issues concerning various hardware configurations have been solved.

However, the recording tool is not the only V3 goal. The recordings can be uploaded, tagged with metadata and stored in a specialized *V3 Resource Center*. No special software is required at the students' side – and the only client software at the teachers' side is the recording tool, running directly "out-of-the-box" on virtually any Windows installation. It can be plugged into MS PowerPoint so that recording can be launched together with the presentation just by clicking a button. Compared to other recording solutions, this tool also does not depend on any costly hardware, for sound recording just a simple webcam (acting as a microphone) or Bluetooth headset is enough.

Such sets of tools are helpful in pure Web 2.0 setup using video-sharing services like *YouTube*, too. Most of the present Web 2.0 multimedia delivery services pragmatically do not rely on provision of complete and accurate multimedia metadata necessary for in-depth search in multimedia collection and repurposing – at least today. In spite of this, it is always good to think about the "semantic future" of the web and try to select those content creation tools that are able to accompany the multimedia content with as rich metadata as possible. V3 Recording Tool is such kind of tool – and is freely available, in contrast with costly commercial solutions like *MediaSite*.

3. CONCLUSION AND OPEN ISSUES

In (Pitner & Drášil, 2006), we identified the main characteristics of a future E-learning 2.0 platform and proposed a prototype *L2* satisfying the basic needs. Lessons learned from the development of L2 together with experience from the research of Derntl & Motschnig-Pitrik (2007) revealed a number of pedagogical and technical challenges. Let us summarized them in the conclusion.

In the future, a successful platform functionality should actually be kept to absolute minimum because most of the primary functionality is already there – and better implemented by other (often single-purpose) services. On the other hand, the integration capability must be maximized, including ability to build upon outsourced infrastructure functionality like *identity and rights management* (using OpenID, for instance), *data storage services* or perhaps even *presentation services* (like on-the-fly PDF generators, format converters).

However, the integration has boundaries caused by *legal issues* arising around mixing and integrating services, specifically for large-scale or commercial applications: functionality or at least number of queries to foreign services may be limited, commercial mashups may even be prohibited etc. (Gerber, 2006). Anyway, as there is currently enough good content in present LMS and LO repositories (Lustigova, 2004), *interoperability* of future E-learning 2.0 platforms with legacy systems must be ensured.

Think about an appropriate *business model* in advance (MacManus, 2006). While many traditional educational tools and apps could serve a limited number of users quite well, the desired Web 2.0 added value of a service goes hand in hand with *creating social networks*. Therefore, the service must satisfy the needs of enough users for enough long time in order to create the critical mass (Steinbring et al, 2007). Generally, the ease-of-use enhanced by highly interactive behavior based on AJAX is preferred over extensive functionality.

From the *learning content* point of view, an E-learning 2.0 environment is characterized by loose coupling of learning objects either following formal standards or not. Actually, standards are not so important on Web 2.0, as the content is accessed through (remote) services instead of being put *as-is* into "local" LMS. Growing number of small reusable objects (such as multimedia recordings, factoids, wiki or blog entries) demonstrates this shift.

When planning to develop an E-learning 2.0 platform, consider also right *technological base* and *tools*. The idea of a REST-based architectural style (Fielding, 2000) has proved as highly practical (Pitner & Drášil, 2006), simplifying easy content reuse and repurposing using syndication feeds (RSS, Atom) as well as (almost) arbitrary content integration via *Adaptive XML Inclusions* (Pitner & Adámek, 2005).

One quite challenging trend for server-based Web 2.0 services is browser pluggability, resulting today in plethora of single-purpose browser plugins. Services like *Clipmarks* (http://www.clipmarks.com) enhance the user experience or even enable some kind of functionality (like "clipping" of arbitrary content) by client-side plugins while storing this content online for access from anywhere.

From the developer's point of view, one classical property of Web 2.0 is *agility*. The services are evolving as *perpetual beta* and the functionality grows *incrementally* – mainly because the user community itself changes and evolves internally. No deep in-advance analysis anticipating the user requirements is realistic. Thus, modern dynamic agile development environments like Ruby on Rails or Grails together with appropriate agile methodology are probably the right choice, especially when they maximize code reuse and legacy software integration. If they are built upon an enterprise-strong platform (like Grails on JavaEE web frameworks and servers), they provide a solid foundation for a safe future.

To conclude, Web 2.0 rapidly changes e-learning to support pro-active, learner-centered, self-paced lifelong learning crossing boundaries of traditional educational institutions. Although not all services and even learning concepts are mature enough, they already represent a quickly evolving fascinating world of chances for learners, teachers, institutions, and researchers.

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