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Enabling Problem Based Learning through Web 2.0 Technologies: PBL 2.0

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ABSTRACT

Advances in Information and Communications Technology (ICT), particularly the so-called Web 2.0, are affecting all aspects of our life: How we communicate, how we shop, how we socialise, how we learn. Facilitating learning through the use of ICT, also known as eLearning, is a vital part of modern educational systems. Established pedagogical strategies, such as Problem Based Learning (PBL), are being adapted for online use in conjunction with modern Web 2.0 technologies and tools. However, even though Web 2.0 and progressive social-networking technologies are automatically associated with ideals such as collaboration, sharing, and active learning, it is also possible to use them in a very conservative, teacher-centred way limiting thus their impact. In this paper, we present PBL 2.0 framework, i.e., a framework combining PBL practices with Web 2.0 technologies. More specifically, we (a) explain the theoretical considerations and construct the PBL 2.0 framework; (b) develop a learning platform to support the PBL 2.0 framework approach; and (c) apply PBL 2.0 in a real-world setting for lecturing University students. Pilot results are encouraging as overall satisfaction with the developed platform and good acceptance of the new learning practices is observed. Although the full potential of PBL 2.0 could not be achieved due to different institutional and cultural obstacles, authors believe that PBL 2.0 framework provides good guidance for designing and implementing a PBL course.

Keywords

Web 2.0, Problem based learning, Collaborative learning, eLearning platform

Introduction

Latest advances in ICT are also making an impact in the field of education and training. Social computing and Web 2.0 technologies have brought new and vigorous opportunities for learning (Ala-Mutka et al., 2009) and have realised a shift of Web's learning role from an information carrier to a facilitator for the creation and distribution of collective knowledge (Maloney, 2007). Technological advances have enhanced the potential of collaborative learning and peer-learning, where learners can become active participants and co-producers of knowledge, thereby providing the opportunity for more horizontal educational structures and contexts (Ryberg et al., 2010a).

Problem Based Learning (PBL) is a learner-centred pedagogy, which pre-dates these technological advances (Jones and Dirckinck-Holmfeld, 2009), but nevertheless incorporates many of the pedagogical ideals that are often associated with Web 2.0 learning. PBL, however, is a multi-faceted pedagogy, which can be organised in a number of ways. Some forms of PBL suggest a more individualised organisation where learners work on their own, whereas others promote a certain level of social organisation among learners e.g., forming loosely coupled learning sets, or more strongly-tied collaborative dependencies such as group work on a common project. Therefore, various technologies and environments have been employed to support such different organisations of PBL (Savin-Baden, 2007). Thus, there can be considerable variance in PBL practices and in the socio-technical solutions developed to support these. This variance is equally pronounced in relation to Web 2.0 learning, which covers a much wider spectrum of diverse and heterogeneous practices, although such differences may not be explicitly explored. In this paper we therefore present conceptual frameworks to differ between various organisations of PBL and different orchestrations of Web 2.0 learning. We call these PBL 2.0 framework, and while it enables the development of multiple pedagogical designs and collaborative dependencies, it also invites practitioners to be more explicit and reflexive about their design for PBL and Web 2.0 practices.

In this context, the main objective of this paper is to investigate Web 2.0 technologies' potential for enabling diverse, innovative pedagogies of PBL. To achieve this we follow a three-step approach: First, we study the theoretical

implication of PBL in relation to Web 2.0 social learning and develop a PBL 2.0 framework to underpin our proposition. Then, in the absence of suitable Web 2.0 learning environments, we develop a Web 2.0 platform to support the PBL 2.0 framework. Finally, we apply the theoretical framework and platform in a real-world context at an Enterprise Architecture (EA) course for undergraduate University students.

The rest of this paper commences with related theory, namely PBL and eLearning through Web 2.0 and social collaboration forms, and presentation of PBL 2.0 framework. It then presents the developed platform as an enabling means of theoretical work, and their application at a University course. Finally, we discuss our findings and plans for future work.

PBL and dimensions of control and power

PBL is a learner-centred pedagogy focusing on learners' active and often collaborative production of knowledge through engaging with real world problems or cases. PBL is not one commonly agreed upon concept, but rather encompasses a number of different interpretations and practices (Kolmos and Graaff, 2003; Ryberg et al., 2010b). Nonetheless, there are some general traits; e.g., problems are the starting point for the learning process; learners should build on their own experiences and learn through active engagement with cases or real-world problems. The latter often entails research activities such as empirical investigation and writing, often in collaboration with other learners (Dirckinck-Holmfeld, 2002; Kolmos & Graaff, 2003; Ryberg et al., 2010b; Savery, 2006). The same authors further argue that important aspects in relation to understanding the differences between various PBL practices are: the design of the problem, who formulates the problem, who is responsible for major decisions in relation to the problem solving process (teacher- or participant-directed process). PBL practices can span from teachers handing out a particular problem as part of a lecture, to problem and project based scenarios where learners collaborate for extended time periods to produce a project/report addressing a self-chosen problem. However, these vastly different interpretations or variances among PBL practices are not necessarily made salient in particular course designs or in technologies' design to support these practices.

One useful way of differing between these different constructions of PBL is to distinguish how control or power is distributed between teachers and learners across three dimensions: *the problem*, *the work process*, and *the solution* (Ryberg et al., 2006, Ryberg et al., 2010b). For example, are learners given a particular problem to solve, or are learners to define the problem on their own? Who manages the work process and decides which theories and methods to employ? Finally, to what degree is the solution open-ended or fixed (are learners expected to come up with a predefined solution to the problem or are they expected to produce new insights and knowledge?). The aforementioned considerations on the dimensions of power and control in PBL are graphically depicted in *Figure 1*.

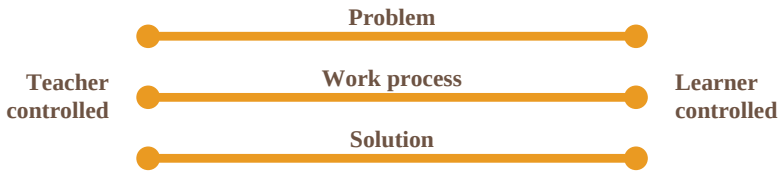

Figure 1. Central dimensions of PBL

eLearning 2.0

The notion of positioning learners as active and productive in real practices seems to correspond well with many of the ideas and ideals associated with Web 2.0 in learning (e.g., Crook and Harrison, 2008 p. 11; Glud et al., 2010; Ryberg et al., 2010a). However, it is important to distinguish between Web 2.0 as a range of technologies (e.g., blogs, podcasts, wikis) and Web 2.0 as particular practices (e.g., blogging, podcasting, writing collaboratively). We emphasise this distinction because employing a Web 2.0 technology does not necessarily entail pedagogically innovative Web 2.0 practices (Dohn, 2009; Glud et al., 2010), as it is still possible to use Web 2.0 tools in a very conservative, teacher-centred way. For example, a teacher may choose to create a blog, and then use it to disseminate information to learners, not allowing them to write or comment. Therefore, Web 2.0 learning is not only about adopting particular technologies, but equally about the degree to which teachers adopt more learner-centred,

participatory or collaborative practices. Therefore, we argue, we should be careful in ascribing too much power to perceived inert affordances of particular technologies, and focus equally on how technologies are enacted or taken into use by practitioners.

Therefore, adopting Web 2.0 learning includes more or less radical changes in the relations between learners and teachers in terms of power and control over the learning processes and environments. Thus, new tensions and challenges arise. Complementary to the model identifying central dimensions of PBL, we additionally propose another conceptual model. This second model maps the aforementioned tensions specifically in relation to Web 2.0; but also serves as a way of guiding designs for Web 2.0 learning (Buus et al., 2010; Glud et al., 2010, Ryberg et al., 2009; Ryberg et al, 2010b). These tensions can be mapped across four central axes (*Figure 2*), which practitioners can use to reflect on their design and values.

Figure 2. Central dimensions of Web2.0 learning

This model provokes questions in relation to who controls the flow of the learning process: Should learners be self-directed, should they decide how to collaborate? Is students' internal motivation enough or are external motivational factors needed? The notion of "motivation" also addresses potential pitfalls, such as assuming that the "tools" in themselves are motivating e.g., assuming that because students exchange social messages on Facebook, they will equally engage in sharing relevant learning resources as part of a course. Furthermore, one can ask who controls the technical infrastructure, decides which Web 2.0 tools/practices to use, and decides what can be posted, shared and produced. Will the teacher be the main provider of resources and content or will learners provide and share relevant material as well?

New forms of collaboration

A very interesting aspect of Web 2.0 developments is that they enable new social constellations or levels of social aggregation. Dron and Anderson (2007) point to three levels or types of social aggregation: The *group*, the *network* and the *collective*, with the learner placed in the centre (*Figure 3*).

Groups are tightly knit social constellations often mutually engaged in working with a common problem, project or task, whereas *networks* entail fleeting membership structures and boundaries; individuals can move more freely in and out of networks. Networks are emergent rather than designed and do not necessarily revolve around a particular task, although they could also be thought of as a "class of students" or "semester" (Dalsgaard, 2006). Networks often build upon shared interests, e.g., resources, bookmarks, websites, articles, material etc., which is of interest to oneself and potentially also to fellow students or other network members. Finally, the *collective* has an even looser and emergent structure with no sense of conscious membership or belonging. Collectives are aggregations of individuals' uncoordinated actions from which e.g., tag-clouds, recommendation systems or page-ranking systems emerge (Dron & Anderson, 2007).

Web 2.0 technologies have amplified and rendered the latter two levels of social aggregation visible through social networking technologies and systems building on the mass-aggregation of individual actions (e.g., Digg.com, tag clouds or various recommendation systems). We view this as an emerging re-conceptualisation of the role and form of online educational systems in relation to how they support collaboration between learners and teachers, and how they offer connections to various external resources or resource persons. This is strongly pronounced in current trends of moving the focus from Virtual Learning Environments, where the teacher organises the tools and structures the dialogue (Crook et al., 2008, p. 36), towards Personal Learning Environments, where learners customise their own learning environment (Attwell, 2007, p. 1; Conole et al., 2008).

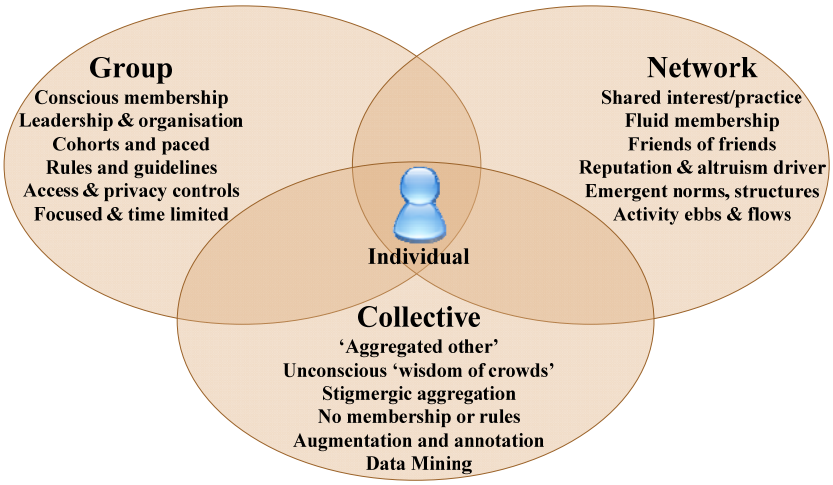

Figure 3. Taxonomy of the Many (Dron and Anderson, 2007)

PBL 2.0

As outlined previously terms such as Web 2.0 learning or PBL cover a diverse set of learning practices and vastly different pedagogical designs. Adopting "new," "innovative" technologies can often gloss over the fact that while new tools have been adopted the underlying structures of control have not been changed. However, when adopting new practices and roles it might be difficult to identify what tensions and contradictions might arise from such changes. The contribution of the conceptual *PBL 2.0 framework* is to enable practitioners to critically reflect on their own pedagogical designs, and be more explicitly aware about central values and tensions when employing PBL and Web 2.0 learning approaches. The aim is not to argue for a particular interpretation of what constitutes a "real" PBL design or a "true" Web 2.0 approach. Rather, providing practitioners with conceptual tools to reflexively and critically engage in designing innovative PBL pedagogies better reflect the landscape of varied practices that evidently exist within education today. Asking critical questions about dimensions of power and control between students and teachers, e.g., in terms of working processes and ownership of tools and resources, can furthermore help in developing or adopting learning technologies suited for particular purposes, or technologies that are sufficiently diverse to serve different purposes, e.g., both more teacher-driven and learner-driven activities, or closely-tied collaboration in groups as well as more loosely-tied interactions and exchanges within a larger network.

Platform implementation

Moving from theory to practice, we sought for an appropriate tool and came across a number of free online tools such as Elgg (Elgg.org) and Mahara (Mahara.org). However, we were not able to find a solution to fit all of our PBL 2.0 propositions. We therefore decided to base our practical implementation on a proprietary solution and expand it to fit our purposes.

We mainly targeted enhanced collaboration opportunities and flexibility at the teacher-learner continua, so the following functionality is included in the proposed platform:

- Use of popular Web 2.0 tools, e.g., blog, wiki, forum.
- Integration of existing standards, e.g., SCORM.
- Division of collaboration space into three embedded scopes, i.e., Class Desk, Group Desk, My Desk.
- Organisation of resources, based on scopes.
- Improved identification and searchability of resources, based on tagging, rating, and commenting system.
- Back office facility to support facilitator/teacher role.

There are four workspaces in the platform:

- *My Desk* is a workspace personal to a user. Here, he/she accesses all files, links, messages that have been shared solely with him/her.
- *Group Desk* is a workspace personal to a group. A user assigned to a group sees all files, bookmarks, messages that have been shared with his/her group, and accesses group's collaboration tools (e.g., wiki, forum).
- *Class Desk* is a workspace common to the entire class. Here, the user sees all files, bookmarks, and messages that have been shared with the class, and accesses class' collaboration tools (e.g., wiki, forum).
- *BackOffice* is a workspace accessed only by the teacher/facilitator. Here, he/she sees an overview of all courses, classes, students, groups, etc.

Using the workspace menu (Figure 4) a user can navigate to any workspace. Workspaces contain the actual content, whereas the notification panel on the homepage only contains notification feed about all platform activity. The faceted menu in the left sidebar displays a subset of all content or notifications, and the sharing panel is used for posting of user's statuses/comments.

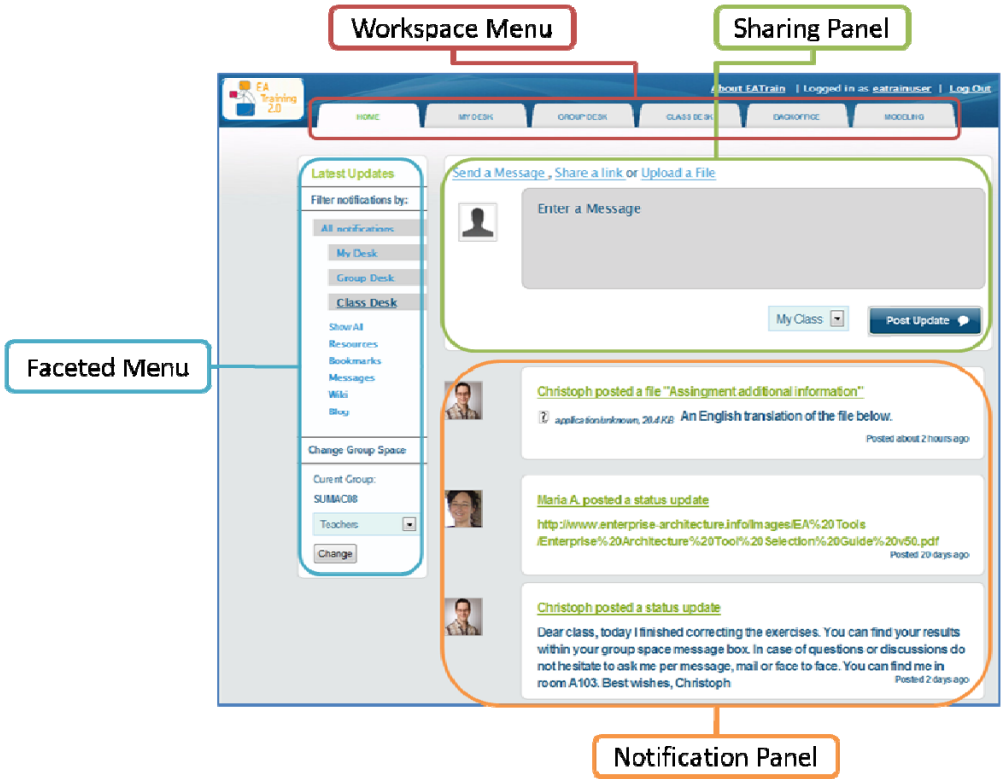

Figure 4. Platform Homepage

Regarding the central dimensions of PBL (*Figure 1*), the *problem*, the *work process* and the *solution*, the proposed platform can facilitate both a more teacher-controlled and a more learner-controlled approach for each of the three dimensions. While there are two distinct user roles: the *learner* role, who registers to the platform to collaborate with other members and have access to shared resources, and the *teacher* role, who is the facilitator of the platform and has an overview of all learner activity; the amount of freedom and control that learners have is decided on by the teacher role. Whether the teacher or the learner is defining the problem, work process, and solution, the same tools and functionality are available to the learners. Furthermore, the teacher/learner roles are not restricted explicitly to actual learners/teachers; even an actual learner could undertake teacher's role in a highly learner-controlled learning setting. For example, any approach to the problem dimension is supported by the platform: The teacher can simply announce the problem to the students by using the platform (fully teacher-controlled), or learners can collaboratively decide the problem e.g., by using wikis and sharing relevant resources (fully learner-controlled), or any other compromise between these two extremes. Similarly, the work process could be defined by the teacher, the learners or both. As regards the solution dimension, we recognise that the decision whether one fixed or open-ended solution

will be accepted is independent of the platform. Nevertheless, the platform still offers learners a wide range of tools for the solution's collaborative construction and presentation.

In relation to teacher/learner tensions in Web 2.0 learning (*Figure 2*), the proposed platform can again facilitate both a more teacher-controlled and a more learner-controlled approach for each of the four dimensions. The implemented Web 2.0 tools and facilities, such as blogs, wikis and forums as well as sharing, tagging, and rating of resources, allow for a wide range of control in *learning process*, *infrastructure* and *resources* dimensions. Notwithstanding however the fact explained previously that the provision of a range of Web 2.0 technologies does not necessarily entail pedagogically innovative Web 2.0 practices. For example, regarding the learning process the social character and tools of the platform allow for full learner control but also for directed teacher-to-learner control if needed. Regarding the technical infrastructure, learners and teacher have the same degree of flexibility for using the offered tools and they can select to rate, tag, post either to their group or to the whole class; thus there are no limits to the way the infrastructure can be utilised. As far as resources/content are concerned, the platform makes it possible for both teachers and learners to upload, share, tag, bookmark, retrieve, rate resources, etc.; thus it allows for any kind of mix of teacher and learner control. Regarding the *motivation* dimension, we recognise that this is something more intrinsic and that it cannot be claimed that a technological solution is able or not to facilitate this. Of course, there is a chance that the social character of the platform maximises users' interest; however this is not always the case for eLearning platforms, as opposed to entertaining platforms like Facebook and Twitter, and it depends on many imponderable factors (such as the educational setting, the bonding between learners, learners' character and behaviour, etc.) whose further exploration is outside the scope of this paper.

The platform supports personalisation but it also enables multiple connections between people and resources at different levels of social aggregation (Figure 5). While the platform could be used for internal communication and collaboration for a group of learners, e.g., a group working on a class project, it could equally act as a common space for a network of learners, e.g., students within the same class, or it could even act as a support community for a collective of learners, e.g., all students that attended the same class over current and past years/semesters. The level of the collective is thus supported in the sense that imported resources, shared bookmarks, tags, ratings, etc. remain in the database even after the class is finished; thus, new learners that attend the class can make use of the aggregated "knowledge" of their peers and further build on it for the learners to come.

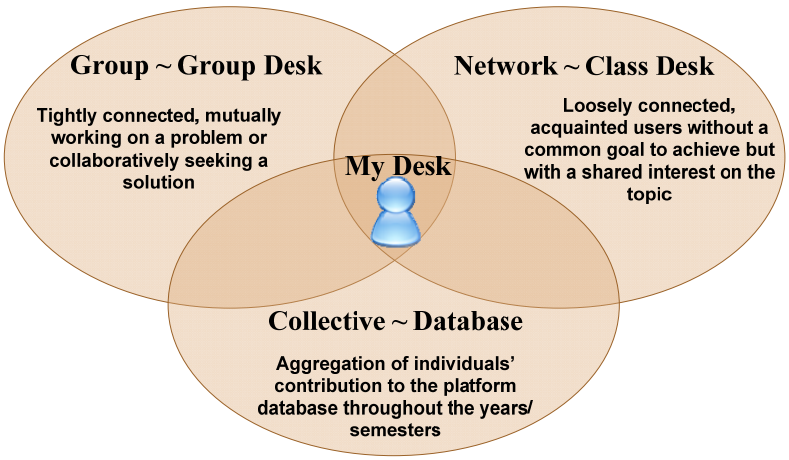

Figure 5. Levels of social aggregation in the proposed platform

While the developed platform in many ways resembles other popular tools for development of PLEs, such as Elgg or Mahara, the functionality of Class Desk and BackOffice distinguishes the developed platform from these systems. For example, in Elgg there are only '"groups/communities" (Group Desk) or "individual profiles" (somewhat similar to My Desk), whereas the level of aggregation of a Class with the associated specific tools for this scope is not present. Likewise, there are no particular tools for teachers such as the BackOffice (only an administrator's area which does not have particular functionality for "teachers"). The same is to some extent true for Mahara, although in Mahara people can be grouped into "institutions," which can mimic some aspects of belonging to a class or semester, but without the same level of functionality (shared tools like wikis and forums, overview of classes/courses and opportunities for grading).

While the notion of grouping learners into manageable, gradable "classrooms" may seem to run counter to some of the intentions of PLEs and Web 2.0 practices, this functionality first of all reflects the reality of most universities, schools and training institutions, and furthermore it might be an enabler in terms of supporting increased transparency at the level of a network or a collective. Experiences with Elgg and Mahara at Aalborg University (Ryberg et al., 2010a; Ryberg & Wentzer, 2011) suggest that it can be difficult to enable sharing of resources at these levels. This for one thing has to do with the pedagogical and technological scaffolding of these activities. They show that caution should be exercised in assuming that students possess advanced skills in relation to social software technologies, and that they can unproblematically "translate" experiences from using similar tools within informal contexts (e.g., Facebook or Twitter) into making good academic use of social software technologies for their own and others' learning (Ryberg et al., 2010a). Although a "status-update" field in a learning platform may structurally be the same as on a social network site the field of relevant activities might be different (socialisation vs. sharing of resources and collective learning). However, this might also have to do with uncertainties of whom one is sharing with (e.g., if the system spans users from different semesters or even different programmes). In this sense having an aggregate of a class or semester might resonate better with students' experience and need for having a meaningful social context.

Elaborating at a more technical level, the developed platform is based on MVC (Model-View-Controller Model) software architecture pattern. Figure 6 presents the platform's deployment diagram using the Unified Modelling Language (UML); platform is hosted on an Apache2 web server, running the Debian OS. The PASTE Python WebServer is the application server used, as the platform is written in the Python programming language. MySQL is used as the database management system.

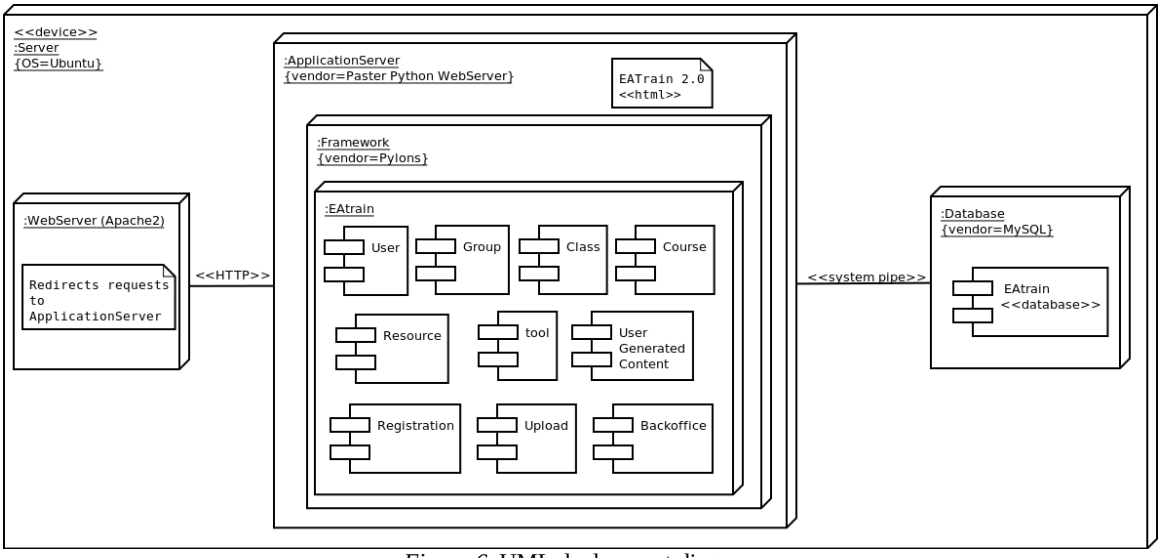

Figure 6. UML deployment diagram

Pilot application

The aforementioned learning considerations are particularly relevant to lifelong education and training of multidisciplinary topics, such as Enterprise Architecture (EA). Since its introduction by Zachman (1987), EA is gaining increased recognition worldwide (IFEAD, 2005). However, EA is a topic in need of deep and diverse background competencies (technical, business, organisation-specific competencies as well as enhanced personal and communication skills, see Tambouris et al., 2009) that are often acquired within a collaborative PBL context. Therefore, EA is the topic selected for piloting the aforementioned theoretical work and the proposed platform.

Four pilots have been performed in different settings and countries, involving three stakeholder groups: University students, private employees and public servants. We decided to elaborate on one of these pilots, the one involving University students, due to space limitations, results' similarity and the fact that this pilot redesigned a pre-existing course. The pilot was carried out at the University of Macedonia, during the spring semester 2010 targeting the

students of the “Enterprise Architecture” course for the degree of Technology Management. The course is taught in the fifth semester of an eight-semester curriculum, and aims at presenting a holistic framework of managerial analysis and modelling, which unifies technological with managerial aspects of an organisation. The course is attended by IT literate students in their early twenties without previous working experience.

In this pilot we applied new PBL practices with enhanced student control compared to the usual University practice. However, there have been certain restrictions to our degree of freedom to apply radical changes due to the nature of the pilot, e.g., being part of an academic degree-awarding curriculum. Specifically, the course could not be organised solely as an eLearning course, it had to have physical attendance for a three-hour lecture every week and it had to have a mandatory written exam at the end of the semester which would count for the majority of the awarded course credits. Moreover, the basic background knowledge and lack of professional experience of undergraduate students is another restrictive factor for enhanced learner-control especially in highly complex topics as EA. Nonetheless, the academic course could still benefit from the PBL 2.0 approach so that students could exercise more control in their education, i.e., have the chance for more participation in and out of the classroom and for getting involved in solving EA related problems together with their peers.

For redesigning the University course, we commenced by rethinking the current learning practices and tensions and studying how to apply the new PBL practices and move tensions more on the students’ side. We did this for each part of the course, namely theory, practice and assessment. The high-level structure of the redesigned course is depicted in *Figure 7*, the blue solid and the brown dashed line depicting the redesigned and original courses respectively. The theoretical content was not much differentiated, although it was now enhanced and also uploaded in the platform. The redesigned course’s practical part was quite differentiated with the inclusion of weekly assignments. In terms of assessment the new feature of group presentation in classroom was also added.

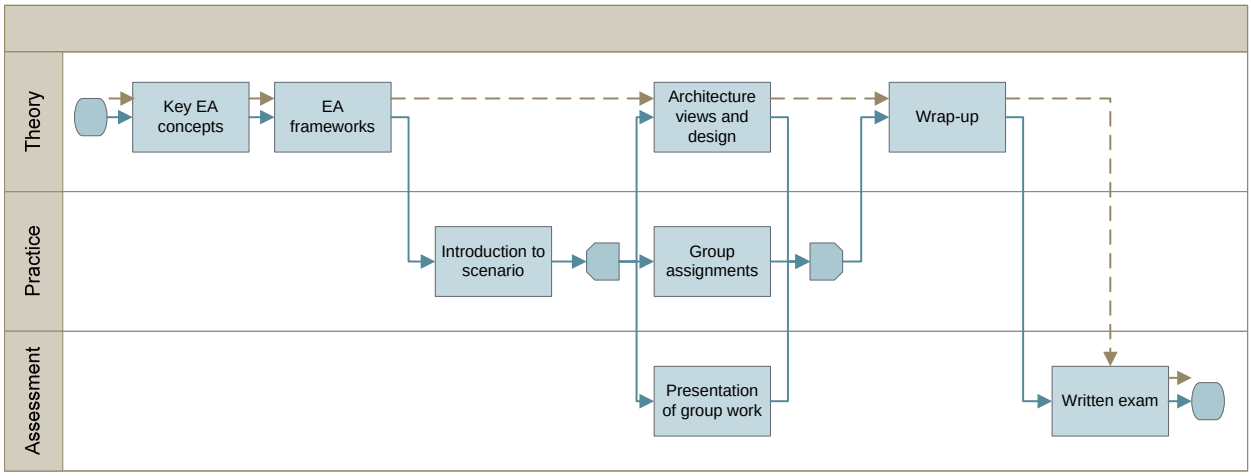

Figure 7. Pilot course high-level structure

Contrary to the original course design that was fully teacher-controlled, the redesigned course allows for more learner control. This is depicted in the teacher versus learner tensions of *Figure 8* with the stripped areas denoting the range of control. We use areas (not points) of control as we want to depict the potential offered to students to exercise more or less control.

The PBL continua show that the theoretical part of the course remains as it was before the redesign; fully controlled by the Professor. This decision was taken due to different limitations such as the strict University curricula, the learners’ elementary level of skills and experience, and the complexity of the EA topic. However, there is large degree of learner control in the practical part of the redesigned course, as students are now able to choose the assignments’ topic and work towards an open-ended solution. As regards the work process, students theoretically are allowed to use any kind of relevant theories and methodologies, realistically however it is expected that students will ground their assignments on the theoretical background and methodologies provided by the Professor during the theoretical part.

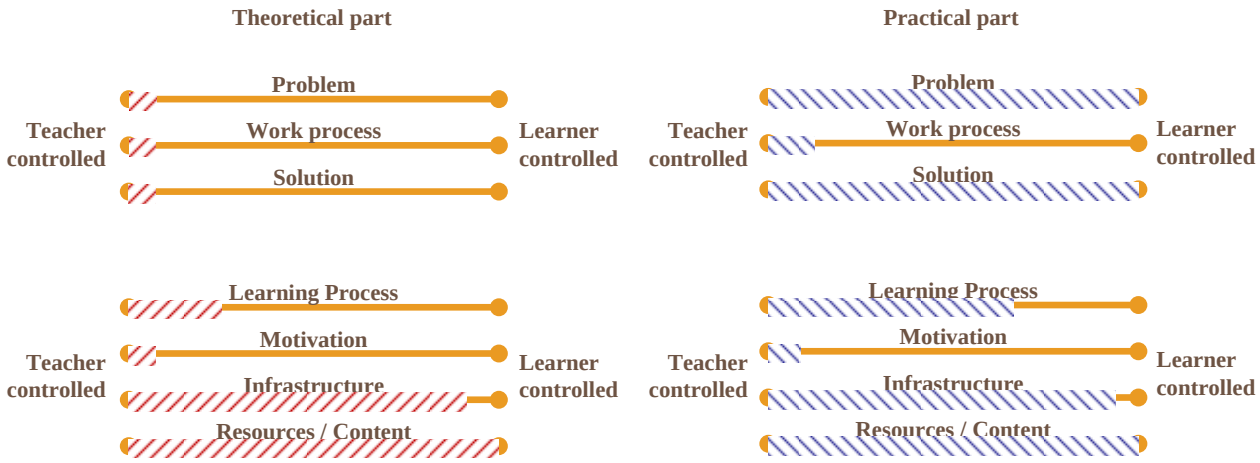

Figure 8. Teacher vs. learner tensions in the pilot application for theoretical and practical part of the course

Nonetheless, at the Web 2.0 learning continua there is now more control exercised by learners both at the theoretical and at the practical part of the course. Regarding the learning process, there is now more learner control as students can, even in the theoretical part, share, bookmark and tag different relevant resources additionally to the ones provided by the Professor. Moreover, and as regards the practical part, students now have the opportunity to choose the case studies for their assignments, to form their own groups and decide the best way of collaboration within each group. However, the Professor still decides upon the scope, the deadlines and the timing of assignments' presentation to the class. As regards infrastructure, the Web 2.0 platform is now available providing the same level of control to both Professor and students. The only feature restricted to the teacher role is the assignment of students to groups which has been intentionally kept teacher-controlled for internal organisation purposes (assuring that the selected groups will remain as chosen until the end of the semester in order to efficiently facilitate evaluation of group work). As regards the resources/content dimension, students can now have much more control both in theory and practice. As mentioned previously, the Professor remains the main provider of theoretical resources and content; however students may also participate with own contributions or through rating, commenting, tagging, etc. In the practical part, students can now not only find, add, share, tag, comment resources but also organise resources within My Desk and Group Desk. Finally, as regards motivation, we have no evidence that the redesign can have a significant impact on motivation, since the main motivation for students to commit to this specific course is that it remains a mandatory course for obtaining the University degree.

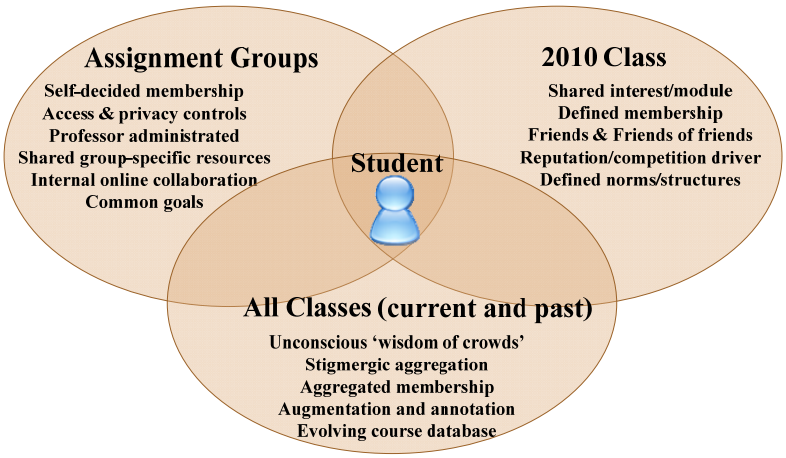

Figure 9. Pilot's levels of social aggregation

The pilot's levels of social aggregation are depicted in *Figure 9*. At the group level, students now form groups for preparing and delivering their assignments. These groups collaborate within the dedicated Group Desk area of the platform where the final assignments for grading are also uploaded. The network level corresponds to the whole

class of 2010 spring semester of the EA course. It encompasses an amount of students that may or may not know each other and retains some distinct network characteristics such as shared interest on the course and reputation driver. The collective level corresponds to the total number of students that have taken and will take the EA course at the University of Macedonia and to their Professors; after a few years the platform will have a large amount of aggregated knowledge at students' disposal.

Pilot evaluation

To evaluate the pilot we performed an assessment of students' and Professor's experience. Students provided feedback by anonymously answering an online questionnaire after the course ended, while the Professor provided feedback through a semi-structured interview. Hence, a mixed method of quantitative (students' survey) and qualitative (Professor's interview) evaluation was applied.

Students' evaluation was based on the method proposed by Shee and Wang (2008) for evaluating a web-based e-learning system in a college context. It comprises 4 dimensions: learner interface, learning community, system content and personalisation; however, we disregard the latter as not relevant to our platform. Due to our intention to keep the questionnaire short we selected eight questions assessing the first three dimensions; we also added demographic questions.

Out of 50 registered students we finally gathered 12 answered questionnaires (24%); an adequate response rate considering that non-mandatory presence in University lectures resulted in about 8 students fully attending the course, and that the survey timing was after the semester exams when most students were on summer vacation. Most respondents were male (58%), 25% took the course for the first time, and most respondents were regular course attendants throughout the semester.

Surveyed questions and responses are provided in Table 1. Collected data was processed in SPSS 19 software; reliability was tested using Cronbach's alpha and validity was tested through confirmatory factor analysis. Table 2 displays the results of the factor analysis showing that responses load to three factors: the first factor corresponds to learning community dimension, the second factor to learner interface dimension and the third factor to system content dimension. Table 3 presents Cronbach's alpha for each of the dimensions; learner interface and learning community can be considered highly reliable whereas system content reliability is just acceptable.

Table 1. Students' feedback to questionnaire survey

			Possible answers				
Dimensions	**Criteria**	**Survey Questions**	***Applies completely***	***Applies a lot***	***Applies partly***	***Applies a little***	***Does not apply at all***
Learner Interface	**User-friendliness**	**The navigation and structure is clear and consistent. The needed resources can be found easily**	14.29%	42.86%	28.57%	14.29%	0.00%
	Ease of understanding	**The platform provides the functionality expected/known from a learning**	14.29%	57.14%	28.57%	0.00%	0.00%
		The didactics applied are understandable	8.33%	66.67%	25.00%	0.00%	0.00%
		Material provided online is usable and regarded as good support for the course	8.33%	41.67%	50.00%	0.00%	0.00%
Learning Community	**Ease of discussion with other learners**	**The communication and collaboration means (blogging, email, messaging, chat, forum) provide an applicable environment for collaboration with my co-students**	28.57%	28.57%	14.29%	28.57%	0.00%
	Ease of discussion with teacher	**The communication and collaboration means (blogging, email, messaging, chat, forum) provide an applicable environment for collaboration with the tutor**	28.57%	14.29%	28.57%	14.29%	14.29%
System Content	**Sufficient content**	**Lecturer provided sufficient working aids**	8.33%	58.33%	33.33%	0.00%	0.00%
	Useful content	**Content presented is understandable and can be followed**	25.00%	33.33%	41.67%	0.00%	0.00%

In overall, student feedback has been satisfactory. 71% gave positive answers to whether the platform provides the functionality expected from a learning environment, while only 14% were negatively positioned regarding navigation/structure clarity and easiness of locating resources online. 3 out of 4 students found the applied didactics understandable, and none of the students has a negative opinion on the online material. Regarding the provided content 2 out of 3 students found it sufficient and 58% found it understandable. In average, students have a positive

opinion of collaboration facilities; however collaboration/communication opportunities with the Professor is not that highly assessed as with the co-students. We thus assume that students would prefer some extra communication channel with the tutor than plainly utilising the same channels and means as with their peers. However, this seems to be in a way against the notion of moving towards the learner-controlled side of PBL; therefore we may conclude that students were hesitant to fully work under an environment of high learner control—maybe there is some inertia involved when moving from the teacher-controlled to the learner-control side of the model.

Table 2. Factor analysis output

Rotated Component Matrix[a]

	Component		
	1	2	3
The navigation and structure is clear and consistent. The needed resources can be found easily.	-,232	,873	,032
The platform provides the functionality expected/known from a learning environment	-,606	,610	,190
The didactics applied are understandable	,371	,667	,322
Material applied online is usable and perceived as good support for the course	,307	,820	-,262
The communication and collaboration means (blogging, email, messaging, chat, forum) provide a applicable environment for collaboration with my co-students	,885	,009	-,329
The communication and collaboration means (blogging, email, messaging, chat, forum) provide a applicable environment for collaboration with the tutor	,933	,152	-,176
The lecturer did provide sufficient working aids	-,218	-,106	,728
The content presented by the lecturer is understandable and can be followed	-,187	,170	,867

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

Table 3. Reliability analysis per criterion

Reliability Statistics

	Cronbach's Alpha	N of Items
Learner Interface	,817	4
Learning Community	,968	2
System Content	,591	2

Sample questions for Professor's interview referred to four dimensions: competence development, learning methodology, content and technologies. The semi-structured nature of Professor's interview enabled us to draw more qualitative conclusions as well as to shed more light into students' responses. The main conclusions from Professor's evaluation are as follows.

- When left free to choose the assignment case topic, students showed difficulty handling this option. They clearly felt more comfortable when provided with a pre-defined case from their Professor. The case finally proposed by Professor was in eProcurement, an area that proved difficult for students to follow; they could easily remain in a superficial description but could only with difficulty go deeper as the required domain knowledge proved to be too technical and complicated for undergraduate students.

- Regarding students' interaction with the online content, students did not really interact with theoretical content; assignments were the main "experimental" playground for students mostly for downloading/uploading relevant material. However, students' online communication has been limited since students met anyway at the campus. Thus, students preferred physical face-to-face contact instead of a purely online collaborative model. Due to this, each group usually used a proxy-person to perform most online activities and upload the group assignment.
- Professor reported that PBL 2.0 methodology is very powerful and appropriate for university courses. However, it assumes a certain level of students' maturity which is not always in place (depending of course of students' general standards and accustomed way of working). Overall, it seems that good students like a lot this way of working while weak students cannot easily meet such expectations.

Rest pilots reported similar evaluation results. Additional comments include the wish for more interactive content (e.g., multimedia), more concrete examples and case studies and the implementation of additional Web 2.0 services. Detailed pilot results are publicly available in the relevant project deliverable (removed to ensure authors' anonymity).

Discussion and conclusions

PBL is a learner-centred pedagogy that has been discussed for decades among the education and learning community. Although at a first glance PBL seems like a simple approach to implement, our involvement in practically applying it at a University setting proved the theoretic notions that there is a wide range of possible interpretations. The approach finally decided has been largely influenced by the discussed institutional restrictions, incorporating nevertheless many PBL characteristics, such as: Learners are empowered to actively engage in the course and build on the collective knowledge/experience of the group/class/collective; a case (problem) is the starting point of students' assignments; this case is self-chosen and without a pre-determined solution; group assignments allow enhanced freedom for further investigation, collaboration and decision-making within a group context. At the same time, the pilot application managed through the utilisation of the proposed Web 2.0 platform to incorporate the eLearning 2.0 propositions. Focus has been shifted to the learners empowering them to become more active, collaborative and productive, by producing sustainable knowledge rather than only consuming. Moreover, through the overall redesign of the course attention was shifted from Web 2.0 tools to Web 2.0 practices, e.g., how the platform tools would serve the PBL learning approaches decided.

However, the overarching question is whether and to what extent the pilot application was successful. This question comes with no clear, straightforward answer. On the one hand, the pilot application may be considered a success due to the evidence provided by the course evaluation. The redesigned course has been executed smoothly and the new learning practices have been accepted effortless by the students. Students also seem satisfied from the platform, its user-friendliness and the means of communication and collaboration. On the other hand, the full potential of PBL 2.0 could not be reached as students did not fully exploit all opportunities resulting from the control shift towards the learner side of the continua. Moreover, students were not that active online as it was expected; they did not contribute many resources and they preferred face-to-face collaboration for their group assignments.

The overall conclusion is that PBL practices may be enhanced by the usage of Web 2.0 tools. The proposed PBL 2.0 framework provides good guidance to anyone trying to design and implement such a course. Moreover, the proposed Web 2.0 platform has the potential to facilitate learning settings implementing PBL 2.0 practices. Nevertheless, there are certain criteria and restrictions to be considered when designing such a course. Our pilot application enabled us to recognise such issues relevant to institutional/organisational requirements and cultural barriers, such as resistance to change and difficulty to adapt to new ways of working.

Our plans for future work span towards two directions; enhancing the Web 2.0 platform with new features and applying the PBL 2.0 framework in different learning contexts. Ideas for further enhancing the platform refer to the back office facilities and to integrating semantic technologies and algorithms for dynamically analysing connections between individuals and groups (e.g., to be able to suggest resources your group mates have visited or bookmarked). Furthermore, we are planning to further pilot test the framework in different educational and training environments with different goals and limitations. Examples of different pilot settings include different levels of education (e.g., graduate or summer courses), different training sessions and seminars within an organisational context (e.g., employees' development courses within an enterprise), etc.

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