Proposing a Framework for Choice Assistance of a Technology Enhanced Learning System Dedicated to Project-Based Collaborative Learning

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Abstract: *In the context of Technology Enhanced Learning System (TELS) engineering, one of major issues for teachers is about designing, adapting or simply choosing a platform or a learning system that supports their instructional goals and strategy (proposed in a learning scenario). This paper proposes a model of functionalities dedicated to Project-Based Collaborative Learning (PBCL). This model allows teachers to choose a Learning Management System (LMS) the most suitable to their PBCL scenarios. Teachers are invited to choose a platform among many proposals or evaluate if a certain platform is well-suited to their PBCL scenarios. This model of functionalities is based on a PBCL meta-model, proposed in previous work. It has an objective consisting in minimizing the semantic "distance" between the PBCL and the chosen platform meta-models, since the MDA (Model Driven Architecture) approach was used, also in a previous work, to elaborate transformation rules between the PBCL meta-model and that of the learning system. This paper explains this model of functionalities and presents an example illustrating its use in Moodle platform case.*

1. Introduction

One of major issues for teachers is about designing, adapting or simply choosing a platform or a learning system, assisted by Information Technology and Communications (a website for example), that supports learning scenario they wish to implement. The end result, the platform, must reconcile the pedagogical and technological points of view: a tool that meets the pedagogical intentions of teachers in their real context. It is then necessary to propose approaches that promote the achievement of these goals. Especially since, in most situations, the support platform, such as Moodle, Claroline, BlackBoard, and so on is imposed on teachers.

This paper is positioned in the strategy of choice and adaptation of platform rather than design and development. This strategy is to assist teachers to implement their learning scenario in the chosen target platform, rather than developing a new one. This work seeks to capitalize and to reuse what it is offered in existing platforms. In this context, it is intended to propose a model of functionalities that help teachers / designers choosing a platform that best suits their needs formulated through their learning scenario. Teachers may be asked to choose a platform among several available to them or assess the extent to which

a certain platform is well suited to their needs (scenario).

This proposal is situated within the framework of vocational training in academia (training young adults in continuing education or classic, high school or university). In addition to the acquisition of knowledge in a specific field (computer science, biology, networks, communication,...), this is to develop "skills" such as organization, argumentation, confrontation of views, articulation personal versus collective... The vocational training aims the acquisition of such skills through new active teaching practices assisted by ICT and adapted to university. Project-Based Collaborative Learning (PBCL) is often recommended in the academic world. It has been a part of the instructional culture since Dewey, Decroly, Freinet, etc. and it is opposed to the behaviourist pedagogy which is based on a unilateral and passive transmission of knowledge from teacher to student.

In a previous work [1, 2], a meta-model dedicated to PBCL was proposed allowing teachers to elaborate PBCL scenarios. This challenging approach was proposed due to the limits of existing approach to express PBCL scenarios. Particularly, the major proposal made by the IMS Global Learning Consortium, the Instructional Management Systems-Learning Design (IMS-LD) [19, 10], is not satisfying to express PBCL scenarios by teachers.

Most of commercial or open sources learning systems are available [31], but few seems to respond immediately to the needs of the pedagogical and technological methods [24, 25, 23, 7, 3]. Especially, none of these systems seems to be adapted to PBCL context. Since the chosen strategy is to assist teachers to implement their PBCL scenarios in the chosen target platform, rather than developing a new one, a model transformation approach was proposed [2] allowing the integration of the PBCL scenarios in a platform. In the software engineering domain, the Model Driven Architecture (MDA) oriented approach [20] can be recommended in the instructional engineering field as well. Indeed, a design approach based on models, so-called Model-Driven Engineering (MDE), was supported. The MDE software process methodology considers that refining models develops a system. The model transformation technique is a principle key within this approach. Teachers can design a learning scenario based on the PBCL meta-model. Then, this PBCL scenario is transformed to a learning scenario conformed to the chosen platform meta-model [2]. Transformations between two different domains are not simple to be implemented in practice since the two meta-models (of the PBCL and that of the platform) specifying the concepts and relations of each domain are able to be close but also very distant in terms of semantic "distance". Such transformations can thus produce semantic losses (certain information specified in a scenario disappears) [11].

The model of functionalities proposed in this paper has an objective to minimize the semantic losses after the transformations. It allows teachers / designers to choose the platform that best suits their PBCL scenarios. In other sense, it allows choosing the platform having its meta-model concepts and relations closest to the meta-model concepts and relations that define teachers' PBCL scenarios.

Throughout the remainder of this paper (Section 2), concepts of the Socio-constructivist Project-Based Collaborative Learning (PBCL) approach are presented. In section 3, PBCL concepts and their relationships are presented in a meta-model. In section 4, it is proposed a model of functionalities that guides the target platform choices of teachers and pedagogical engineers. In section 5, an approach on the platform Moodle is illustrated. In a final section, a conclusion and perspectives elements are given.

2. The Project Based Collaborative Learning

The Project Based Collaborative Learning or PBCL is a method of active pedagogy belonging to socio-constructivism [14] combining the two active methods: Project Based Learning (PBL) and Collaborative Learning (CL). It is difficult to define an accurate Project-Based Collaborative Learning since it

implements so many processes and practices [22]. From the existing literature on this topic, George PBCL characteristics were selected [9] to describe the Project-Based Collaborative Learning. This approach has been carried out according to six criteria:

- *The emotional engagement of learners who need to take ownership of the project. The project should not be the project of the teacher.* The high affinity of the student to be engaged in the project is an indispensable factor that helps in its evolution. This is not granted in advance, it is not self-evident.
- *Social context has an impact on the success of the training and the project.* It has been proved that such a criterion promotes negotiation, simplification and socialization of the action.
- *The great importance of common work*: it is necessary to succeed all together by producing a common end product [26].
- *Follow-up and achievement with current project management techniques*: such criteria require specific skills and project management tools that are sometimes lacking [25].
- *Teachers should act as inter-mediators more than "knowledge providers"*. They are not supposed to do learner's job [25, 28].
- *The evaluation of the project is completed by a public presentation and a mark* [28].

In the literature there are complementary points of views such as those of [14, 26, 28] who recommend that the work must be initiated from a concrete theme of life (required, lacking, socio-cognitive conflict, desire to achieve a goal) either by the teacher or by learners. Another point of view is that of the Collaborative Learning consisting in making learners work in groups sufficiently restricted to give everyone the opportunity to participate in a collaborative task, in production, and in information access and organization [14]. This learning type, allowing the group knowledge construction, is interactive and collaborative because it formulates tasks with a way that a student cannot solve it alone [14]. In this case it is talked about Project-Based Collaborative Learning (PBCL).

3. The PBCL meta-model

A meta-model is a domain specific modeling language which is used to express the common concepts for models in the same area. It then provides an additional abstraction level facilitating the understanding of the phenomenon or process concerned. It is build from informal models, recommendations in a natural language and semiformal models usually written in the Unified Modeling Language [27].

In this context, to allow teachers elaborating PBCL scenarios and to help them choosing a Learning System, a meta-model dedicated to PBCL is proposed (Figure 1). It is presented and explained in more details

in [1]. It was elaborated from a theoretical and practical study of Project-Based Collaborative Learning. Mepulco-Université developed by [24, 25] provides a PBCL example method. It has been used particularly in helping building the PBCL meta-model and implementing the chosen research approach.

This approach has been used in other work: the CPM (Cooperative Problem-based learning Meta-model) Modeling Language [12] is dedicated to Problem Based Learning. The LDL (Learning Design Language) is based on a meta-model for the Computer Supported Collaborative Work (CSCW) [15]. The PBCL meta-model is a challenging proposal to the limits of existing approach to express PBCL scenarios. In particular, the major proposal made by the IMS Global Learning Consortium, the Instructional Management Systems-Learning Design IMSLD [10], [15], is not satisfying to express PBCL scenarios by teachers. Many experiments have been carried out that shown the limits of this approach [18, 4].

Figure 1. The PBCL meta-model.

4. Choice assistance of a platform dedicated to Project-Based Collaborative Learning: The model of functionalities

A model for quality assurance is a standardized or selected set of quality system elements associated to satisfy the quality insurance needs in a given situation (ISO 8402). To ensure the best quality of a learning situation of Project Based Collaborative Learning (PBCL), a quality model called functionalities model is proposed. This latter would represent the PBCL functionalities expected to implement PBCL pedagogy. Functionalities would be associated to concepts and their relationships defined by the proposed PBCL meta-model. It would permit later to characterize features of a learning system compared to specific needs identified by teachers according to their learning scenarios designed from the meta-model.

Similar work has been done for learning environment [8, 30, 17], for instructional theory [29] and in the context of collaborative tools [21]. DeVries [8] proposed a typology of learning systems according three axes: instructional theories, instructional functions and status of the presented knowledge. Wenger [29] defined instructional goals and communication strategies for selecting communication tools and facilitating communications goals in web-based instruction. The majority of comparison and evaluation studies of Learning Management Systems (LMS) found on the Moodle site [30] are based on more on qualitative evaluations (usability evaluation, heuristic evaluation, survey of students opinions,…) of its pedagogical value, support of financial concerns, appropriate assessment criteria for administration, integration with the information technology services on campus, offer dependable long-term solutions,…. Nevertheless, these studies are not sufficient; some studies are not very precise, not comprehensive enough or contain weak criteria.

In particular, they do not allow to practically guiding teachers in the implementation of their instructional goals. Oubahssi *et al.* [21] proposes an interesting typology of functionalities for learning platforms. They based their typology on the life cycle of the Global Open and Distance Learning process (content elaboration, orientation, learning, evaluation, management and adaptation). This typology allows implementing a kernel of functionalities for learning platforms. Other works concerned the study of functionalities and their use, proposed by some

learning platforms in the context of cooperative work (groupware) or cooperative learning systems (Virtual campus). Caron [5] identified some functionalities necessary to implement a socio-constructivist approach:

- Administration tools that allow creating learning entities and their relationships composing the learning system;
- Synchronous and asynchronous group retroaction tools (rating tools, wiki peer reviewing…);
- Group production tools (Wiki, word processing, spreadsheets with a cooperative option, glossary…);
- Conflict resolution tools (tool of survey, vote…);
- Workflow tools that allow supporting conflict.

Caron continued this work and studied relations between pedagogical models and functionalities offered by dedicated learning management systems. He has based his work on the typology of six functionalities proposed by Landon [13]. The comparison site Edutools has been designed on the basis of these functionalities: *Communicate*, *Increase the productivity*, *Conduct an evaluation*, *Manage*, *Teaching*, and *Respect the platform norms and standards*.

On the basis of this typology, in the context of the work on the PBCL, these functionalities are grouped in several axes. Then, "Teaching" is no more useful as we are in non-transmissive pedagogy. It is integrated in a "Pedagogy" axis with the "Conduct an evaluation" functionality [16]. New axes of functionalities "Cooperation/Collaboration" and "Coordination" appear to take into account the collective actions (collaborative and cooperative) in the context of PBCL. The functionality "Respect platforms norms and standards" is without object in the context of this study. Then, the following six axes are gotten:

- **Pedagogy:** gathering functionalities meeting pedagogical needs of the Project-Based Collaborative Learning;
- **Management:** gathering management functionalities of a platform that hosts the pedagogical situation in the PBCL context;
- **Production:** gathering functionalities being used for producing individually and sharing results of these individual productions in PBCL context;
- **Communication:** gathering functionalities allowing participants to exchange information through writing, speech or gesture. In the context of PBCL, there are two interrelated forms of communication: instructor-learner communication and learner-content communication. This communication can be synchronous or asynchronous;
- **Coordination:** gathering all coordination tools necessary to a technical synergy of various members;

- **Cooperation/Collaboration:** gathering all functionalities allowing actors to work collectively.

The traditional cooperative systems group of functions such as communication, coordination, collaboration and production are found in this typology. The study of functionalities needed to implement a PBCL scenario is based in this work. It is supposed that the Learning Management System chosen by teachers will propose all standards functionalities needed to process training like: content creation, content integration tools, indexation, search engine …

4.1. The Model of Functionalities

The model of functionalities proposed has been designed on the basis of the six functionalities axes described previously. Functionalities of each axe are characterized on the basis of the PBCL meta-model. This model offers a mean to characterize platforms and identify those most particularly dedicated to PBCL.

"Pedagogical" functionality axis: the main observed concept in the PBCL meta-model is "Project". This concept can be decomposed into "Step" and "Task". A platform implementing PBCL should allow defining a project and its organization and then the definition of one or more levels of decomposition according to needs of the designer, the teacher or the learner. It must allow moreover the navigation between these different project levels of organization. This need refers to the category of tools of a socio-constructivist approach allowing creating learning entities and their relationships defining pedagogy.

In the PBCL meta-model, the concept "Learning Objective" is associated to the concepts "Project" and "Step", to give the opportunity to teachers to describe instructional goals of the project and its steps. In order to describe instructional prerequisites and knowledge domains implemented during a step of project, the concept "Prerequisite" and "Domain" are associated to the concept "Step". A task will also have instructional prerequisites and specific realization objectives. On the platform level, that will result in the possibility of defining fields of description associated to the concepts "Project", "Step" and "Task".

The concept "Factor" is also associated to the concepts "Project", "Step" and "Task", to define the evaluation factors of a project, a step or a task. The concept "Metric" is used to describe metric evaluation of these factors [6]. To implement this need, the PBCL platform should include functionalities of evaluation implemented by tools of rating, wiki peer reviewing, or quiz for example… The PBCL platform should also allow answering this aspect of evaluation of project, learners and work process.

"Management" functionality axis: In the PBCL meta-model, many actors have been met; being able to play many roles organized in team or not. The learning platform should make possible defining these various

actors, their roles, the teams or groups referring to the concepts "Actor", "Role" and "Staff". This will be done by management tools of users, teams, rights, privileges associated to learner in his group and to group in the training.

"Production" functionality axis: In project-based collaborative learning, learners should produce a common work. The production activity, in particular the document, is thus important. So, in the PBCL meta-model, the "Production" concept associated to a project, a step of project or a task, is identified. The articulation individual work/collective work of PBCL is highlighted. This articulation does not appear in figure 1 which is a simplified representation of the meta-model explained in more details in [1]. The following functionalities could be associated with this production axis: individual production and its communication thanks to the file management and the versioning tools allowing PBCL actors to bring their individual effort to the collective one.

"Communication" functionality axis: The communication plays a central role in distance learning environment. In particular, in the context of PBCL, to achieve their project, learners need to communicate with other actors of projects (students of the project team, teachers/tutors, expert of a knowledge domain…). The communication has as an ultimate goal of organizing activities, coordinating in the production of various tasks to carry out. This communication can be organized in synchronous or asynchronous mode.

"Coordination" functionality axis: In PBCL, the notion of coordination or organization is also important. Learners are placed in a relatively autonomous situation to achieve various tasks which contribute to the realization of a common work. The learning objective of the project is more to succeed together then the goal to reach. Within this intention, they need to coordinate and organize their work by implementing traditional techniques of project management: project decomposition in steps and tasks, sharing out work between members of the project… This concern recovers several functionalities corresponding to functionalities based on synchronous, asynchronous or collective coordination (Gantt chart, shared calendar …).

"Cooperation/Collaboration" functionality axis: In the PBCL meta-model, the concept "task" related to a level of project organization is defined. In PBCL, a task may be implemented by learner individually or with other members collaboratively or cooperatively. In the PBCL context, this functionality axis contributes to the implementation of "negotiation, simplification and socialization of the action". This kind of task is supported in collaborative platforms by the following functionalities: group work, conflict resolution, group evaluation, awareness.

In the PBCL meta-model, the concept "Tool" refers to different kinds of tools installed to perform the various tasks (group work, individual work, communication…) of a project. These tools will help implementing functionalities of various functionality axes (communication, production, cooperation/ collaboration, coordination). Figure 2 represents these axes and their related functionalities in a model of functionalities.

5. Implementation of the model of functionalities

Among the great number of platforms available [31], [30], Moodle is chosen initially to be studied. This platform is currently the most used and has been designed to implement socio-constructivist pedagogy. This platform is briefly presented to study the implementation of the model of functionalities allowing deciding if Moodle would be appropriate to implement a PBCL situation.

5.1. Presentation of Moodle

Moodle is a software package for producing internet-based courses and web sites. This project benefits of an active development support and has been designed to support a socio-constructivist pedagogical approach. Moodle is provided freely as Open Source software and its modular design means that people can develop additional functionality [30]. It is being used to create communities of learners around contents and teaching activities. In comparison to a Content Management System (CMS), Moodle adds functionalities of teaching and communication to create an e-learning environment. Moodle integrates tools or learning activities oriented to: synchronous communication (on-line connection visible, chat…), asynchronous communications (email, forum), collaborative learning (group, glossary module, wiki module, workshop module, and database), critical thinking (poll: vote, consultation: expectations), personalization (homepage: profile, personal blog). It should be noted that the development of some advanced tools make it possible to ensure several functionalities. The glossary module allows as well the communication as the collective work. In this part, the functionalities of the model are associated to the Moodle's activities (in Moodle an activity corresponds to a tool). There can be several learning platform strategies of use and the proposal is given only as an illustration and corresponds to the version 1.8 of Moodle. Moreover, in a real case, this association should be assisted through computer tools, and not a simple table, in order to make it possible to advice and to specify to the user the scope and limits of each proposed tool in comparison to pedagogical goals.
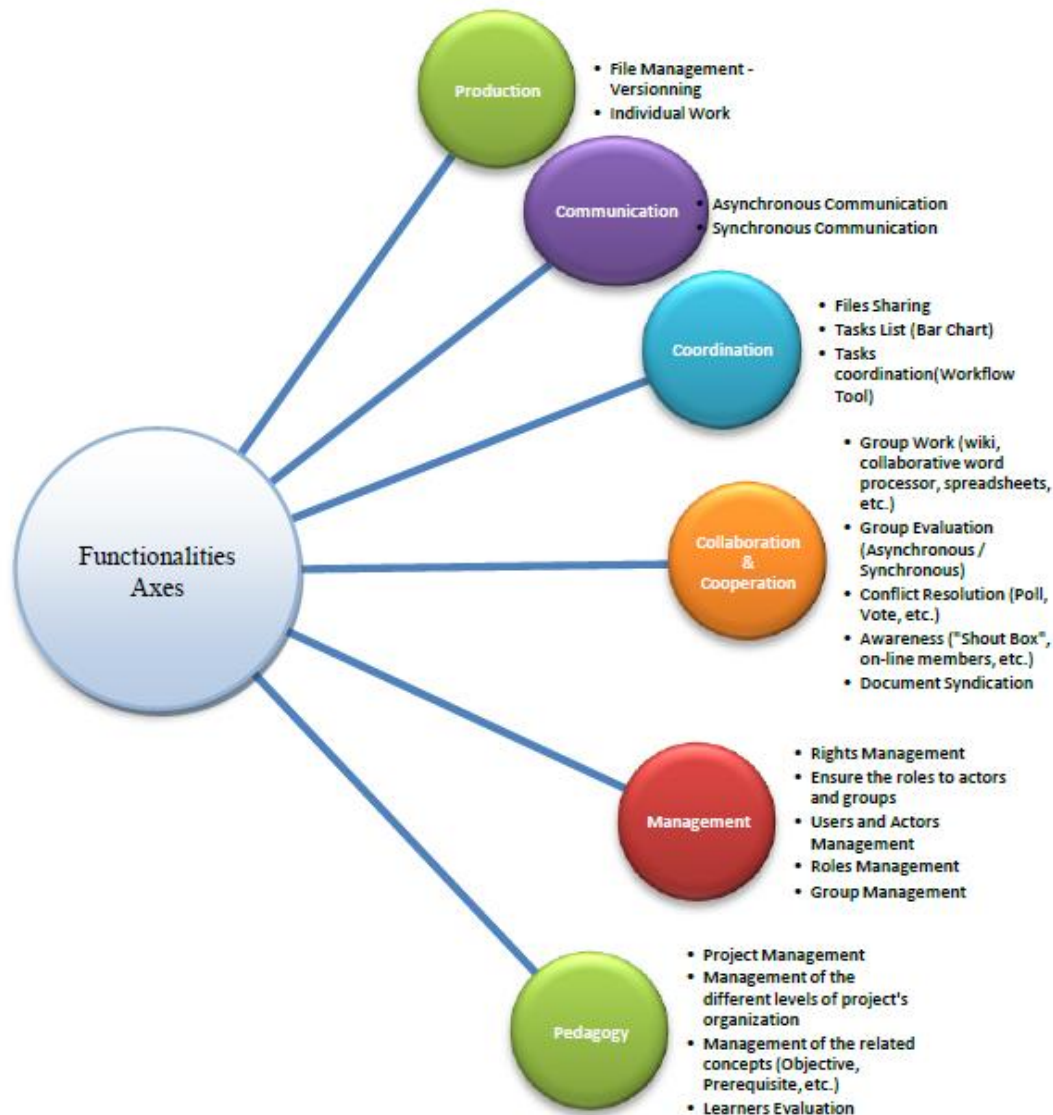
Figure 2. The model of functionalities.

5.2. The model of functionalities in the Moodle use cases

In this case study, functionalities of Moodle learning platform are compared with the model of functionalities to decide if this platform is well suited to a PBCL situation. In further work, functionalities of other platforms should be compared to the reference model to choose the most adequate solution to the learning situation proposed by teachers.

This study illustrates how Moodle is well suited to PBCL pedagogy. If the matrix has been completed with more details, some limits of parameterization and of respect of the concept of role in the PBCL would be appeared. Caron's work [5] and constant evolution of learning platform will answer these limits.

6. Conclusion

The model of functionalities proposed is constructed from the six main features presented previously. This paper has tried to characterize features of each axis

model. This model offers a way to categorize platforms and to identify those that are dedicated specifically to PBCL. The proposed grid features facilitates communication between teachers and engineers and helps to streamline the selection of a platform under PBCL scenario. In other words, teachers that consider the pedagogical functionality axis as essential in their PBCL scenarios do not choose the same platform chosen by teachers that consider the communication functionality axis as essential.

From other part, the model proposed minimizes the semantic losses after the PBCL scenario transformations into a PBCL scenario able to be implemented in the target platform. When teachers choose the platform that best suits their PBCL scenarios, it means that the chosen platform has a meta-model closest to the PBCL meta-model part allowing describing their PBCL specific scenario.

The use of this model not only encouraged to make a choice compatible with PBCL but it also provides 'de facto' the main lines of the parameterization of the

platform selected. However, it is clear that a use as shown in the last paragraph, without any computer tool, even if it has already been used, is not optimal

and is reserved for specialists. It is intended to give it a tool of assistance and to experiment it on real cases.

Table 1. Functionalities Matrix analysis.

Functionality axes	Moodle Functionality

Pedagogy
- Creation relationships and entities component educational organization
    o   Project management
    o   Management of different levels of project's organization
    o   Management of related concepts (objective, prerequisite…)
- Learners evaluation
    o   By the teachers or tutors
    o   By pairs (wiki peer reviewing)
	Organization in "course" module
	Teacher defines a module, resources and activities related, authorized persons to consult it, duration of the course. A module is described by various fields: abstract, introduction … allowing supporting associated concepts.
	Wikis make it possible "to simulate" the organization (Actually Moodle has a Project management activity, that solves the problem more completely).
	Definition of activities of evaluation (quiz, test, assignment…)

Management
- Management of the staff
    o   Users and actors management
    o   Group management
- Ensure responsibilities
    o   Rights management
    o   Roles management
    o   Ensure roles to actors and groups
	Site and User Management
	Definition of roles : predefined roles (teacher, learner, tutor) and possibility to define new roles (with the Moodle notion of Capacity)
	Definition of group. Application of this concept to activities used (with the Moodle notion of Context). Moreover the notion of "group separated" make it possible to declare a single wiki and Moodle creates automatically to each group member with a copy of wiki its own.

Production - Individual work - File management-Versioning	Blog Glossary (individual or collective activity) Creation of internal text pages or web pages
Communication - Synchronous communication - Asynchronous communication	Files can be uploaded and managed (zipped, unzipped, renamed…) Folders can be created and managed on the server and linked to the activities Communication tools: chat, forum, email
Coordination -Tasks coordination (workflow tool) - Tasks list (bar chart) - Files sharing	Shared calendar Assignment
Co-operation/Collaboration - Group work (wiki, collaborative word processor, spreadsheets…) - Conflict resolution (poll, vote…) - Group evaluation asynchronous/ synchronous - Document syndication - Awareness ("shout box", on-line members…)	Wiki Glossary Poll List of connected users

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