

A basic framework for integrating social and collaborative applications into learning environments

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The successful integration of web2.0 applications in learning environments depends on their compatibility with the learners' objectives and requirements. Therefore, understanding the learners' view of the environment in any given scenario can facilitate this integration. In this paper we present a learner-centered strategy for integrating web2.0 applications in learning environments. This strategy is based on a novel framework for identifying the learners' requirements and composing a model of the environment. The framework's methods parametrise four concerns, being the amount and diversity of required information, and the interaction's duration and centrality. The modelling technique uses the notion of interaction contexts which is shown to be useful for this integration.

Keywords Web2.0 applications; learning environments; learner-centered design, conceptual models

1. Introduction

The spreading usage of web2.0 is accompanied by the rise of a new generation of learning environments where the learner's pedagogical activities share a strong parallelism with those supported by web2.0 applications [13]. This justifies the integration of these applications into learning environments to support the learner's activities and connect learning communities to social and collaborative networks. This connection also provides an interface between learning environments and multimedia sharing websites and makes the large dynamic collections they host available for the learning communities. On the other hand, the integration of web2.0 applications facilitates the development of learning environments and lowers its cost by outsourcing the support of learners' activities to these third party applications. In previous works we studied how a small learning community uses successfully a learning environment composed of a learning player connected through embedded links to a community blog for informal interaction, and to a forum for formal conversations with the community's tutor [1]. However, as learning environments grow in size and complexity, they offer more services to support the production, evaluation, sharing, and acquisition of knowledge. This makes the integration of web2.0 applications a more sensitive task because of the inherent risks of adding conflicting or overlapping functionalities.

We present a simple framework for integrating web2.0 applications into existing learning environments or environments under development. The methods presented by this framework facilitate this integration by identifying the learner's activities that ought to be covered by web2.0 applications and then separate them from those covered by the learning environment itself. Based on this segregation, the appropriate bundle of web2.0 applications can be selected from the diversified pool of existing ones, and later integrated in the adequate position(s) within the learning environment. The framework is composed of two main components, the first of which is a parameterized technique for capturing learner-centred design requirements. Four parameters being Recall, Precision, Duration and Centrality are used to capture requirements analyze them. The framework's second component is a modelling method that formulates a conceptual model representing the environment's design from the perspective of the learner. This representation rests upon an abstract definition of interaction contexts. According to this definition, the learner's design requirements can be clustered into different abstract sets, or interaction contexts, each addressed by a distinct part of the environment's functionalities. The resulting learner-centred conceptual model facilitates the isolation of learner's activities that could be supported by web2.0 applications, and shows where and how the integration of these applications can take place. A procedure for selecting web2.0 applications and mapping them onto the system's conceptual model, and the subsequent learner-centred testing and evaluation of such integrations are also discussed.

In this paper, we discuss related works before explaining the framework and two main components where we detail on the capturing the learners' requirements with parameterized methods works, and then discuss the modelling technique conceived for representing a learner-centered conceptual model of the learning environment. Examples of the application of each component on different scenarios are illustrated. This is followed by a brief discussion of practices for ordering and selecting the proper web2.0 applications, and

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evaluating their integration in a given scenario. Afterwards we discuss our experience with the usage of this framework and conclude with future work plans.

2. Related Works

In order to grant the integration of web2.0 applications a greater success, designers need to make sure that the applications are integrated in accordance with the learner's perspective, and that these applications are adequately chosen to support the learner's activities in this context. Therefore, our work draws heavily on the user-centred design philosophy that places the user in the middle of the design process, which consequently becomes more focused on the user's requirements and expectations [2]. Contextual design is a popular user-centred method which relies on contextual enquiries and observations that are conducted by the designers prior to development [3].

We complement contextual inquiries with formal definition and analysis of use cases to represent scenarios where learners interact with the learning environment. Use case analysis is a powerful requirements extraction technique that is used in engineering. This technique works well with use cases defined by instantiating a well-defined use case model, such as the one presented in [4]. We employ a system of four parameters that increases the efficiency of use case analysis in extracting design requirements by parameterizing the requirements definition process. These four parameters are Recall, Precision, Duration, and Centricity. Recall and Precision are classic parameters that address consecutively the quantity and diversity of information objects that the learner wishes to interact with. Both are commonly used in information retrieval and statistical analysis to measure the performance of information extraction processes [5]. Price et al. have previously studied Duration as a parameter that affects brain activity during moments of concentration by [6]. We use Duration to quantify the length in time of the learner's interaction with the required information. Finally, Centricity is a newly defined parameter that aims at quantifying the dependency of the learner's objectives on interacting with the system. This system of parameters was previously introduced and studied by Moghnieh et al in [7].

We use data from contextual enquiries and use case analysis to build a conceptual model that represents the learning environment as viewed by the learners. In order to consolidate the value of the produced model, we define it as a cluster of interconnected interaction contexts. A context is a prominent notion that surfaces across different academic domains, from psychology and cognitive science to HCI and system engineering. Akaishi et al. defines it as a modular representation of information under different perspectives in their description of a framework for context-based generation of information access spaces [8]. Same notion is repeated in the works of Theodorakis et al. who define context as a cognitive container which encapsulates a particular information view [9].

3. The simple framework and its application to learning environments

The methodological framework presented in this section is a first effort to focus the integration of web2.0 applications in learning environment on the learners' conceptual model. It provides a set of methods and techniques that help designers tackle such integration and increase its success. These methods support designers to formulate a good understanding of the learners' point-of-view and model it, and then use the resulting model to decide which web2.0 applications are suitable for integration and where such integration can take place. The evaluation of the integration's success is discussed on the basis of its compliance with the learner's requirements and conceptual model, and the benefits it brings to the learning environment's community.

3.1 □ learner-centred detection of design requirements

In user-centred design, a considerable effort is spent on activities that directly involve users in the drafting of design requirements. We therefore use three inquisitive techniques (discussions, semi-structured interviews, and contextual inquiries) to understand the learner's view of the learning environment, and his/her expectations, goals, and interests. We parameterize these techniques in order to lower the effort that their application requires, and to increment their outcomes' efficiency by decreasing the ambiguity in the information that these techniques provide. With parameterization, the practical objective behind applying a certain technique becomes determining the parameters' values to characterize the scenarios that this technique is addressing.

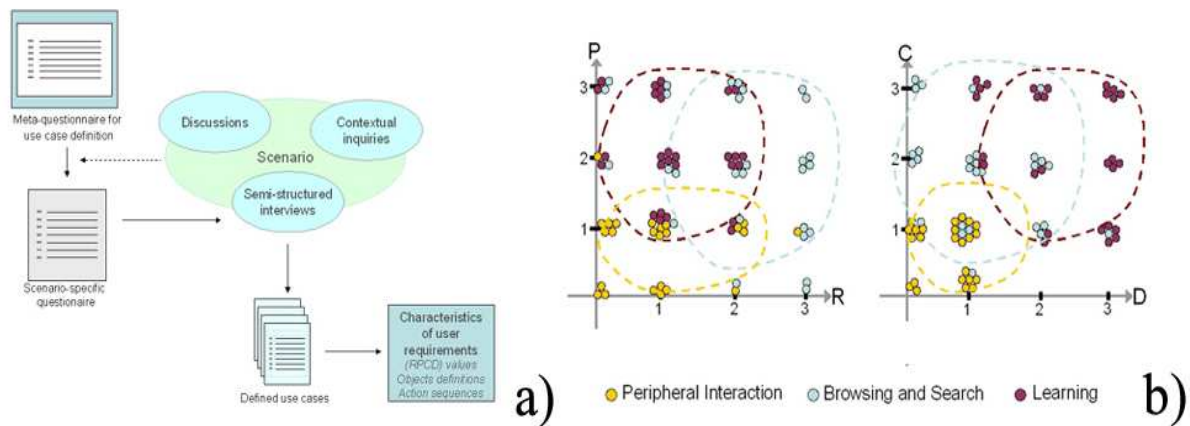


Fig. 1 (a) *Parameterized procedure for extracting design requirements.* (b) *Comparison of analysis data from three distinct scenarios*

Hence, we rely on discussions with learners, contextual inquiries, and semi-structured interviews to draft a battery of use cases that represent the learners' viewpoint on the learning environment. The drafting of the use case battery is supported by a meta-questionnaire containing a set of generic and parameterized questions that guide experts in their interaction with learners. The meta-questionnaire inquires about the learners' goals and the related activity sequences, along with the information objects with which the learners wish to interact. The activity sequence is characterized by the duration (D) and centrality (C) parameters, while the related interaction with information objects is characterized by the recall (R) and precision (P) parameters. Hence, for each use case, a quadruple (RPCD) is calculated to determine the use case duration, the inherent actions' relation with the learner's goal, the amount of information with which the learner interacts, and the thematic diversity of this information. These quadruples facilitate use case analysis and the implication of its findings in mapping the environment's conceptual model [7]. Figure 1(a) shows the parameterized process for detecting learner's requirements and drafting the use case battery.

The parameterized detection of requirements was applied in several scenarios related to the European TENCompetence project where 56 parameterized use cases were gathered from contextual inquiries, discussions, and interviews. The use cases were analyzed and clustered according to their learners' objectives. This identified three different scenarios which are peripheral interaction, browsing and search, and learning. The peripheral interaction is a scenario that addresses the learners' interaction with secondary or supporting services. Browsing and search tackles the learner's needs for learning and multimedia resources. The learning scenario centers around the actual learning process that represents the main objective of the learner. Figure 1(b) shows how use cases from three different scenarios cluster when they are plotted according to their (RPCD) values. The plottings in figure 1(b) reveal many differences among the three scenarios and show how the parameterization of the inquiries help characterizing learner requirements in a given scenario more clearly. The plottings also show variations within each scenario in terms of the four parameters.

3.2 □ A context-based modelling technique for learning environments

By empirical experience, we find that twenty use cases or more are needed to tackle the incompleteness and parsimony in the mental model of a single learner, since this number is sufficient to identifying major conceptual components, the functionalities that each should provide, and the interrelations among them. In order to model the learning environments, we introduce the notion of interaction context which describes a single conceptual component. From a conceptual perspective, one interaction context corresponds to one generic usage objective, or goal, and encapsulates the interactive functionalities that correspond to this particular objective. Hence, the interaction contexts are identified by clustering the use cases according to the inherent learners' objectives, and then consolidating the set of actions covered by each context. The relationships between interaction contexts correspond to the motivations behind context-switching for accomplishing a certain task.

The obtained model is refined by minimizing the occurrence of context-switching, and reinforcing the independence of each interaction context from the others in terms of inherent functionalities. This refinement can be done by tracing the activity sequence of each use case on the model and identifying inconsistencies. Consequently, the conceptual model can be reiterated by introducing new interaction contexts and/or translating learner's activities from one interaction context to another. However, it is recommended to keep the number of interaction contexts below seven to respect the human's psychophysical limitations described by Miller [10]. In

essence, this refinement helps to reduce the inherent inconsistencies in mental models and concretize its logical view of the learning environment. The context-based modelling technique was first introduced in [11].

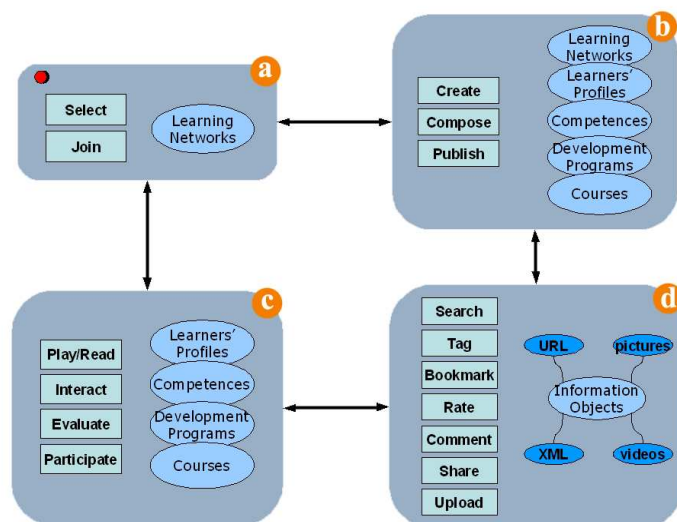


Fig. 2 Context-based modelling of the TENCompetence learning environment. (a) Root. (b) Peripheral Interaction. (c) Learning (d) Browsing and Search

We have applied this modelling technique to represent different scenarios within the TENCompetence project by using the information extracted from the related batteries of use cases. We studied the three scenarios identified by the analysis of the TENCompetence use cases to determine the learner's activities and information and interaction requirements associated to each scenario. Each of the three scenarios was then treated as an interaction context, and a fourth context, which we called "root" was added to encapsulate the activities found in all scenarios and separate them. The resulting context-based model and its four components are shown in figure 2 below. Hence, based on this context-based modelling techniques we identify the browsing and search context as the adequate part of the learning environment where web2.0 applications can be integrated. This is due to the compatibility between the activities it aims to support and those supported by web2.0 applications. The same applies for the objects that these activities treat.

3.3 Selecting web2.0 applications, and evaluating their integration

In practice, for each service there are several similar web2.0 applications that compete to support it. These applications can have different designs and functionalities, but they all are viable solutions to support a given set of learner activities. Moreover, it is sometimes difficult to find a set of web2.0 applications to cover exactly the learner's activities defined in one interaction context. Therefore, we use a selection mechanism that orders the web2.0 applications according to a given criteria, and facilitates selecting the set that maps closest to a given interaction context. From the pool of available applications we select those that support or are interoperable with the types of data objects that the interaction context treats, and whose functionalities do not conflict with those available in other interaction contexts. The resulting choices are then ordered by the number of learner activities they cover in the interaction context. This ordering reveals if a single application covers the learning activities entirely, and exposes possible combinations of applications in the case where such elementary choice does not exist. This selection mechanism is discussed in details in [11].

The success of the integration can be measured by a compilation of evaluation procedures that address both pre-development and post-development evaluation. In general, the use of the context-based modelling technique can support the conduction of pre-development evaluations such as early heuristic evaluations and usability inspections to assess how a conceptual model responds to general design recommendations, such as simplicity and conformity, and others such as those described by Nielsen [12]. Post-development evaluations assess how the learners perceive the integrated web2.0 applications. They use inquiries to understand the circumstances and motivations that encouraged the learner to use the service, the frequency and duration of these solicitations, and the learner's satisfaction. In parallel, we log information about the connections made to the service, which includes the learner's identification number, the connection duration, the amount and variety of information objects with which the learner interacted, and his/her destination at exiting the service. The analysis of this information can complement the qualitative data provided by the inquiries with quantitative data, which helps understand the phenomena described by learners and identify their circumstances.

4. Discussion and future work

In this paper, we have presented a learner-centered strategy for integrating web2.0 applications in learning environments. The two main components of the framework that encapsulate this strategy has been explained and exemplified to show how their methods and techniques have been applied successfully to learning environments. We also briefly introduced as part of this framework, a procedure for ordering web2.0 applications for selecting the most appropriate for integration, and a learner-centered evaluation plan that assesses how learners interact with web2.0 applications after their integration.

The framework can be used to support the user-centered design of applications outside the realm of learning, such as multimedia interaction, content management systems, and others. It has the advantage of diminishing the costs of capturing user requirements in terms of information and interaction without compromising their user-centering aspect. The results that this framework provides are more easily translatable into design recommendations because of parameterization. The four parameters (RPCD) used are related to general design aspects of human-information interaction and this can support a wide range of scenarios. It's contribution lies in bridging between the users and the system's design to increase the success of the latter.

This work is followed by ongoing evaluation activities that aim to consolidate a parameterized evaluation procedure that uses the same system of parameters to evaluate the conceptual design of systems. The ongoing evaluation activities treat a learning component that integrate the services of six web2.0 applications into a learning environment. These activities focus on understanding how the context-based modelling of environments maps to reality. The traffic between the component's physical parts, and between the component and the learning environment is been monitored to be used in modelling the traffic and action flows inside this component. These flows will be compared to the models generated by the context-based techniques and conclusions will be drawn.

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