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Collaborative Development of a PLE for Language Learning

Article (Published)
(Refereed)

Original Citation:

This version is available at: http://epub.wu.ac.at/6094/

Available in ePubWU: March 2018

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Abstract—This paper provides a report on the experimental collaborative and distributed development of a prototypic Widget-based PLE. The development process is described and detailed taking into account the requirements of a language learning scenario. First results are presented, and developer experiences are discussed critically with a focus on the development process as well as problems with current Widget technologies and interoperability.


I. INTRODUCTION

Current endeavors in the domain of Technology Enhanced Learning (TEL) exhibit the need for increased openness and responsiveness of current learning environments. While older learning technology generations were often central and closed systems, often merely focusing on the management of learning processes, the next generation of Personal Learning Environments (PLEs) tackles the ROLE project's 1 main goals by providing a highly distributed infrastructure that enables the learner-side integration of various learning services and tools from a plethora of heterogeneous sources into customized learning environments. One of the major goals of the ROLE project is to deliver an appropriate infrastructure for the establishment of such responsive open learning environments. Another goal is to establish a community of independent developers and to integrate responsive open learning environments. While the first two objectives addressed the consortium-wide collaboration, the last two clearly address a community of independent developers.

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The rest of this document is structured as follows. In Section II we describe the development process to give an insight into the challenge we faced during our work on the development process and the technologies we experimented with. After drawing the conclusion that current technology and development processes are often still insufficient for a seamless independent development of interoperating learning services and tools, we outline possible improvements.

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Collaborative Development of a PLE for Language Learning

communication, etc. However, given by the spatial distribution of the community, concepts requiring physical attendance emphasized in Agile approaches had to be replaced by communication technology in order to avoid roundtrip unrealistic in a larger scale community. Furthermore, such a distributed approach requires technical means for code and documentation sharing and an integration environment with low entry barriers. Table I briefly shows the rather lightweight abstract schedule we pursued during our experiments. It should be noted that this process can be iterated. However, the scenario here is likely to be subject to refinement or even re-placement in next phases of the ROLE project.

In the following, we provide details on the first iteration conducted during the ROLE Christmas Project.

All of the participants dedicated themselves to contribute components for an integration framework, individual learning services, either implemented or a模拟 mock-up to reach the common goal of defining an integrated PLE prototype.

After the collection of all contributions intended by the partners, we selected the ROLE Christmas Project Big Picture (cf. Figure 1). Given by the heterogeneity of the partners’ plans for contributions, we agreed on a common scenario serving as a concrete use case for a ROLE PLE prototype based on a Widget approach. For that purpose we chose a language learning scenario described in detail in Section III.

As a basis for ongoing documentation we decided to setup a document to be edited collaboratively by all partners, starting with the Big Picture, an elaborate description of the scenario and a timeline plan. Every partner added a description of his contribution and how it would fit with the scenario. Thereby, we did not require a perfect match, but at least a high degree of relevance.

A ROLE XMPP Server was set up for direct communication. A ROLE developer chat room was configured to log all group conversations on the server side. Thus, everybody could easily keep track of previous discussions, which turned out to be a helpful feature. However, restrictive firewall policies enforced by various partners in situations sometimes hindered the use of XMPP – a valuable experience for future considerations regarding the use of our software (cf. Section IV.E.)

Table I shows the rather lightweight abstract schedule we pursued during our experiments. It should be noted that this process can be iterated. However, the scenario here is likely to be subject to refinement or even re-placement in next phases of the ROLE project.

Table 1. ABSTRACT PROCESS SCHEDULE

<table>
<thead>
<tr>
<th>Planning Phase (collaborative)</th>
<th>Development Phase (distributed &amp; independent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Start with of story-based use case scenario</td>
<td>• Develop &amp; document components</td>
</tr>
<tr>
<td>• Extract (non-)functional requirements</td>
<td>• Use own development environment</td>
</tr>
<tr>
<td>• Identify components</td>
<td>• Communicate with other developers</td>
</tr>
<tr>
<td>• Structure &amp; categorize components</td>
<td>• Continuously share code &amp; documentation</td>
</tr>
<tr>
<td>• Identify interfacing components</td>
<td>• Continuously run latest version of components in integration environment</td>
</tr>
<tr>
<td>• Agree on time schedule</td>
<td></td>
</tr>
</tbody>
</table>

Furthermore, in order to maintain the source code of all partner contributions, we agreed on utilizing a Git-based repository at github.com for reasons of wide visibility and acceptance in the open source developer community. Besides SCM functionality, GitHub Provides an issue tracker, Wikis, repository statistics, etc. All of these features were frequently used during the development phase.

With regard to a development environment for the individual part in ter contributions, we defined the following simple policy:

1. All partners setup development environments.
2. One partner maintains the integration environment and regularly pulls from the ROLE Github.

During a later physical meeting we discussed a few options and suggestions regarding the choice of technologies as a basis for development and integration environments. The following considerations were taken into account:

1. How to quickly move forward and succeed with Christmas Project on schedule.
2. Avoid using technologies that will hinder us or force us to start over completely later on.
3. Make as few decisions as possible at this point in time.

Since the prototype should be Widget-based, we discussed a pre-selection of promising technologies for software components such as Widget engines, containers, stores and repositories, and inter-Widget communication mechanisms, protocols, etc. and started our developments after a first decision for one configuration.

All components of the ROLE prototype were Widget-based, used a technical foundation for our work. Some promising technologies for inter-widget communication were eventually discarded and browser independent – unfortunately, this assumption was far from being fulfilled. It turned out that all regarded alternatives were still in an early experimental development stage. The consequence was an increased communication overhead among the partners for the purpose of finding agreement on a framework for more acceptable solutions. Due to the fact that we could never rely upon the software components of our development and integration environments, continuous integration was hardly possible, leading to the usual longer and error-prone final integration phase.
shortly before the prototype delivery deadline. The details of the technical problems we faced will be discussed in Section V. In the next section we present detailed requirements for the ROLE Christmas Project.

### III. Requirements

In this section we present an overview of the requirements elicited for the realization of the ROLE Christmas Project. We start with the language learning scenario we agreed upon as well as the underlying psycho-pedagogical model. We then continue with technical requirements for the realization of our prototype and considerations on how to fulfill them.

#### A. Scenario

In our language learning scenario, the learner, Tim, is an employee at Travel Books that sells books and videos on travel destinations. He works in the sales department and has to go to international fairs and to speak with distributors, bookshops and other business partners. As most business communication is in English, Tim needs to improve his English skills, especially in Business English.

One part of his learning strategy is to read texts and to learn its vocabulary using his PLE. For that purpose he adds three widgets: a Language Resource Browser, a Vocabulary Trainer and a Translator widget. All of them are visible on one webpage.

In the Language Resource Browser, Tim searches for a text and starts reading it. Each time he misses a word he selects it and opens a context menu on it. The system then proposes him to either look it up in the Translator widget or send it to the Vocabulary Trainer widget (cf. Figure 2).

So he adds words that he considers as important to the Vocabulary Trainer and others he only looks up.

After reading the text, he has gathered a list of words he considers important to be repeated in future using the Vocabulary Trainer widget.

In the next day-s he continues reading new papers and articles regularly and his Vocabulary Trainer widget obtains more and more words. In an analogous manner he uses the Language Resource Browser widget to look up words in the Vocabulary Trainer and others he only looks up.

One day, he is learning with his Vocabulary Trainer with other students. Remembering the words on the list and testing whether he knows them sufficiently well, he recognizes that he has problems to remember a certain word because he does not know the context anymore where it originally appeared.

Fortunately the Vocabulary Trainer always stores the link to the original text. So Tim clicks on the word and the original text appears in the Language Resource Browser widget and shows the sentence where the word was taken from.

Reading the sentence and thinking of the context facilitates him to memorize the vocabulary. Furthermore he improves his language proficiency by knowing situations where he can use the word.

The scenario can be extended by a group of learners, e.g. students that part icipate in an English Lan guage course. The instructor sends them a list of newspaper articles that are available online. The students are asked to read and analyze the text and to learn the vocabulary. As they come from the same background (high school English level), they decide to jointly create a vocabulary list using the Vocabulary Trainer widget. Whenever a student finds an unknown word in the newspaper article, he adds it to the joint vocabulary list. The Vocabulary Trainer widget will also display words added by other students who have the same level in the English language. Words that have been added more often are sorted ed higher. Each learner in dividually trains his list of words and the vocabulary widget keeps track of each student's individual vocabulary knowledge. The group's average knowledge (number of words learned) is displayed in the widget, together with the current student's knowledge. Nevertheless it should be possible to deactivate the group functionality if the learner only wants to learn for herself.

#### B. Psycho Pedagogical Model

In this section we briefly present the ROLE Psycho Pedagogical model [4]. The central element of this model is a cyclic learning process model consisting of several learning phases related to learning activities. Flowing the connections between learning phases, activities and tools, a sequence of learning tools can be derived. Furthermore, two different kinds of learning tools are identified, i.e. learning tools, tools for self-regulating the own learning process.

A navigation tool guiding the learner through a self-regulated learning process by recognizing activities and tools was proposed. The partners created an interactive mock-up of such a navigation tool (cf. Figure 3) and presented it in the context of the scenario from the previous section.

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Figure 2. PLE with three Learning Widgets

![PLE with three Learning Widgets](image)

Figure 3. Learner Navigation Tool Mockup

![Learner Navigation Tool Mockup](image)
The contribution of education professionals had a great impact on the technical developments and showed us once more that technical and nontechnical work should be conducted hand-in-hand.

C. Technical Requirements

For the technical realization of a first ROLE PLE prototype, we decided to follow an approach of intercommunicating Widgets. The expectations from choosing such an approach were a relatively loose coupling between individual widgets and different parts. It should not be forgotten that we also experimented with such an approach, because now future projects are based on it. The individual widget should be independent of other developers.

First, a technical infrastructure needed to be a basis for our prototype. Starting from the Big Picture, we identified requirements for the following components of such an infrastructure:

1. Widget Container/Engine
2. Widget Store/Repository
3. Widget Interoperability Mechanisms
4. Widget User Interface

As promised, a WidgetContainer/Engine, we considered experiments with Apache Shindig [5], the reference implementation of an OpenSocial [6] container currently under incubation at Apache. OpenSocial defines a common API for social applications across multiple websites and also includes a specification for widgets – gadgets in OpenSocial terminology. As a further alternative, we considered SocialSite [7], based on Glassfish and Apache Shindig with the ability to run OpenSocial gadgets and have them backed by the same social graph. Furthermore, Apache Wookie [8] was taken into consideration as a solution for adding W3C Widgets [9] as well as OpenSocial and Google (Wave) Gadgets to web applications.

1) As solutions for a Widget store/repository, we considered the following four solutions:
   - No store/repository, fixed list.
   - Wookie
   - Google gadget directory
   - ROLE widget store (remains to be built)

A fundamental requirement to Widget interoperability was the support of multiple OpenSocial containers. This should be no major configuration needed on the side of end users assembling widgets. Furthermore, it should be easy to build containers for the chosen widget technology. Integration into existing systems, like LMS should be possible. Preferably, standard containers should also support these technologies. The following technologies were taken into closer consideration as potential candidates:
   - Gadget pubsub [6]
   - OpenAjax Alliance hub2.0 pubsub [10]
   - Open Application (draft) [11]
   - HTML5 DnD[16]

2) Regarding a Widget user interface, a couple of different approaches were considered, e.g. portal pages such as iGoogle, Wiki or LMS approaches, etc. However, we decided to keep things simple using a fixed HTML page. A additional solution experimented with was the integration in Graasp (http://graaasp.epfl.ch), a Web 2.0 contextual aggregator of people, spaces, and assets and tools, in order to be able to make use of its built-in mechanisms for sharing, commenting, and recommendation.

For the first experiments, we decided to use a configuration of SocialSite as a container, no widget store, simple HTML page or Graasp as user interface and OpenApplication based on Gadget pubsub for inter-widget communication. Further, the first prototype, the primary focus was thus put on the development of communicating widgets.

IV. Partner Contributions

In this section we will present the contributions of all partners for the Christmas Project prototype. The first two contributions are targeting at an integration framework focus on the communication between widgets. All remaining contributions consist of different types of widgets either especially for the language learning scenario or with rather general functionality.

A. Inter-Widget Communication

Uppsala University introduced the Open Application Container Event API to provide a generic solution to the requirement of inter-widget communication in the scenario. The most important aspect of the solution is that widgets need not be “hard-wired” against each other. Instead, they communicate using well-known data expressions, with the intention that widgets will understand the parts that are important to them.

The basic principle behind the event API is that all widgets are notified of all events. No specific subscription step is necessary. All widgets are given the opportunity to react to any event, which they may choose to do depending on event type, message type, message content, etc.

1) Events types

The event types include: state, load, modify, save, select, unselect, startDrag and stopDrag. A state event is different from the other events in that it has no relation to any event resource, and therefore no resource is sent along. Instead, a state event indicates a change of state in the widget that sent it.

2) Event Structure

Notifications of events are sent out as messages. The message consists of the relevant resource, if any, depending on the event. The message is wrapped in an envelope containing further event information.

- event - the event type (see previous section).
- type - the message type
- message - The message, for example a resource.
- uri - The message's URI, if any.
- date - Timestamp of when the event occurred
- sharing - How the event is allowed to be used.

At the moment, the event API consists of a Gadgets PubSub channel, in which the messages are published and thereafter sent out to all widgets.

An Open Application compliant widget subscribes to the PubSub channel when the widget is loaded. The shar-
C. Monitoring of User Behaviour

To provide recommendation and self-evaluation mechanisms, Fraunhofer FIT developed a CAM [17] widget to unobtrusively monitor user behaviour. Other widgets, like the vocabulary trainer widget (cf. next section), trigger events on different user actions which are then broadcasted to other widgets using Open Application. The CAM schema provides a standardized data format to store user activities and thus foster widget interoperability since every widget could access these data.

Since the CAM widget is a simple subscriber widget, it listens to every event published from any other widget and collects the data. The collected events are then transferred into the CAM schema and afterwards stored in a database. As all control should be with the user, she can decide between different storage modes. For the Christmas project, we therefore specified three different storage modes which can be selected by the user (cf. Figure 5).

If the user decides to store her activities remotely, the CAM widget transfers the data to a central CAM repository, where all events of every user are stored. After creating a CAM instance, the CAM widget calls a Web service [18] passing the CAM information which is then stored in a database. The local storage mode uses the Gears plug-in [19] to store CAM information in a local database. The Gears plug-in is available for any platform and supports all common browsers. It provides a SQLite [20] interface to easily create a database and store information inside of the browser profile. An alternative approach to Gears is using HTML5 [16]. Since the specification of HTML5 is not finished yet and is currently not supported by every browser, we have chosen Gears. If the user does not want to use the browser to account as well. The different storage modes have an effect on the generation of recommendations. In the remote mode, the user can get recommendations, but also allows the system to use her information to generate recommendations to other users. The local storage mode only allows retrieving recommendations and disallows the system to use her information to generate recommendations to other users. The user does not want her usage behavior to be monitored should be with the user, she can decide on the selected storage mode.

As we had no Vocabulary Trainer CAM data for the Christmas project, we transferred some PLE monitoring data [21] into the CAM schema and provided a separate Web service which offers methods to generate recommendations and self-evaluation statistics.

D. Visualization of Monitored Activity

KU Leuven developed a dashboard that enables students and teachers to monitor learning activities. In the dashboard, students can monitor the progress they made...
An important feature of the dashboard is learning material recommendation. Based on the learning material other students have used, who have progressed further, we can recommend interesting learning material to the student. A student can compare his activities with other students and a teacher can get a general overview of what is going on in the course, see if it meets expectations and detect potential problems.

Figure 9 illustrates the first version of the user interface for our application. The student can select the course and will be presented with 2 different charts, a course analytics overview and document recommendations. Every line in the chart in figure 1 is a student. The chart shows when the student worked (horizontal axis) and how long he worked on the course (vertical axis). The red line shows a selected student, we see that the student was very late in finishing the course and that he spent a lot of work in a small number of sessions. This view enables a student to compare his progress with that of his fellow students. Another visualization uses parallel coordinates [22]. It shows a set of metrics on parallel axes. A student is represented as a polyline with the vertices on every axis. The metrics are: the average and total time spent on the course, the number of documents used and the average time of the day that a student works. By visualizing these metrics next to each other one can grasp another view on the course activity and discover trends.

The widget is developed in Adobe Flex. To monitor user activities, we use CAM [17]. In order to test the tools, we used course data provided by U&I Learning [21]. Together with our partners at FIT, we experimented with the data to op pose possible communication and collaboration on a Web service providing methods to retrieve and calculate: a list of all courses, a list of recommended documents for a course, general statistics for a course, statistics of a student of a course and the student’s attention metadata for a course. The widget can be easily deployed on top of another Web service that uses different attention metadata to provide the same statistics.

In a teacher modus, the student names may need to be anonymized. Privacy is an important issue when monitoring this kind of data. For the Christmas project, we want to simply anonymize the names of the students in the teacher view. This is not implemented yet, because the data from U&I was already anonymized.

Another design idea, not yet implemented, is a graph-based community visualization widget. This tool could allow students to find fellow students how have the same language proficiency as their friends. The widget would communicate with the chat module of RWTH to provide chat functionality. We are currently implementing this widget.

E. XMPP Chat Widget

The contribution of RWTH Aachen University is a Chat Widget providing a simple Instant Messaging (IM) client (cf. Figure 7) based on the XMPP [12][13] protocol. The widget offers interface elements for 1-on-1 conversations, the management of buddy lists and user presence information. In its default configuration, the widget connects to the ROLE XMPP Server. However, connections to arbitrary XMPP Servers are possible. Regarding the ROLE Christmas Project’s language learning scenario, the XMPP Chat Widget contributes to synchronous communication between learners integrated in a PLE. The widget is as a rich source for communication events, e.g. updated presence information, incoming/outgoing messages, etc. The integration of event publishing into the Open Application approach to be captured by CAM is planned for the near future.

Besides the added value of XMPP chats between learners and basic communication statistics, these two widgets demonstrate how inter-widget communication could be realized between remote widgets (via sending messages over XMPP) and between local widgets (e.g. via a gadget push). There already exist specifications on XMPP Extension Protocols (XEPs) for Publish/Subscribe [14] or Personal Eventing Protocol [15] mechanisms, which will be considered for a seamless integration of remote/local inter-widget communication for future developments.

F. Language Learning Widgets

In order to fulfill the requirements of the language learning scenario, imec AG developed the English learning widgets: The Language resource browser widget allows students to find fellow students who are working on the same task. These widgets demonstrate a reasonable use of the Inter-widget communication by sending a nd receiving term items described by their context and source.

Figure 7. ROLE XMPP Chat Widget
I) Language Resource Browser Widget

The Language Resource Browser widget (cf. Figure 8) allows users to consume media and send terms to other widgets processing the information. Examples of such widgets are the Translator Widget where the term will be translated or the Vocabulary Trainer where the user can add this term to a vocabulary list. At the moment the widget offers three different tabs. The "Text" tab works like a web browser. It displays a page to a given URL where the user can select the term and context. The source of such a term item will be the URL from the page.

In the second tab "Own Text" the user can add her own text taken from an online or offline resource. The third tab provides support to browse for different media such as video and audio. While watching or listening to the media, the user can enter a term in a field. The source of such a term item will be the URL from the media and the context will be defined as "Media Context".

2) Translator Widget

The Translator widget allows a user to translate terms or sentences. It translates either a term which was entered from the user or a received term item. We combined different Web services (i.e. Wikipedia, Google Dictionary, DICT.ORG, Google Translate) for the translation process. At the moment only English to German is supported, but the language pool could be extended to all languages supported by the services above.

3) Vocabulary Trainer widget

The Vocabulary Trainer (cf. Figure 9) widget is implementing a slightly modified Leitner system [23]. A vocabulary list consists of five different buckets. If an item is added it will be put in the first bucket. If the user is training a list and knows the right translation the item will be moved to the next bucket and else it will be moved to the previous bucket.

The information is stored on a central server and accessed using REST Web services. Each user has a unique login and authentication is done by basic access authentication over REST. For translation the same Web services are used as in Translator widget, and Flickr is used to suggest pictures for term items. Vocabulary items are stored in a list which can be managed by the user.

The widget has four functionalities represented by four tabs: "Add", "List", "Train" and "Stats".

The "Add" tab allows users to manually insert a new term/sentence, the context of that term and its source. In combination with the Language Resource Browser the term item appears automatically in the Vocabulary Trainer widget.

The "List" tab provides an overview of the stored lists and vocabulary items. The user can create/delete lists and inspect the content of the different buckets.

The "Train" tab gives the learner the possibility to practice her stored vocabulary. After choosing a bucket that she wants to train a term from this bucket and its context will be displayed. The user can get help by viewing the source of that item or viewing the image to that item (if there exists one). The fourth tab "Stats" shows statistics of the training. It displays a global score and a score for each list.

G. Federated Search & Language Processing

In traditional educational scenarios, teachers typically provide appropriate learning materials and give feedback on student essays. Vienna University of Economics & Business contributed two widgets which are useful for these purposes and indicate their application for language learning.

ObjectSpot, a widget for federated search of academic papers in different digital libraries, has its origins in the iCamp project (http://www.icamp.eu). This search client allows plugging in different digital repositories, whereby the documents are retrieved via the Simple Query Interface (SQI) [24] standard. The central core of this widget is the ranking algorithm which has been developed over several iterations and mixes in the search results from the repositories on the fly [25]. In practice, this widget is useful for both learners and teachers to retrieve the most appropriate literature for a specific knowledge domain. By default, the most important digital library is containing...
academic papers, e.g. ACM, IEEE, Google Scholar, CiteSeer, EBSCO, etc., are included.

The screenshot shows the results for the query term 'open responsive learning environments'. At the top, the search term and the state of the repositories are displayed. At the bottom, the user can navigate through the pages. On the left hand side, a user can lock appropriate results, thus giving explicit relevance feedback and recommendations for others. This mechanism can also be used to export search results through a feed-based API if another tool is attached to ObjectSpot. Pressing the option button, a user can configure SQI-enabled digital repositories for her search client, visualize the location of the repositories on a map, get statistics on the quality of the repositories, export the results as RSS-feed, get recommendations for a query term, or plug another tool to ObjectSpot.

Conceptalyzer comprises a language processing widget which builds upon a LSA-based Web services developed within the LTfLL project (http://www.ltfll-project.org).

This widget analyzes online resources (e.g. Wikipedia articles or RSS feeds) in terms of the concepts behind the text and visualizes them according to their relevance. Application areas of this widget comprise learner positioning, monitoring one's conceptual development. It can also be helpful for teachers in preparing learning materials or grading students [26].

The screenshot shows the result of the analysis of a Wikipedia article, whereby the relevant terms are visualized in the form of a 'concept cloud'. The size of a term indicates its relevance for the article while the color links to the text corpora used to train the LSA function.

V. DISCUSSION OF WIDGET TECHNOLOGIES

During the development process of the ROLE Christmas Prototype PLE, we collected a set of valuable however negative experiences to be shared with other developers working with the technologies we attempted to combine. These experiences will be discussed in this section.

One of the most surprising experiences from the developer perspective was the immature state of many widget technologies, especially with regard to inter-widget communication, one of our main requirements for the language learning PLE. During the development process we tested the following three OpenSocial compliant Gadget development environments:

1. Apache Shindig
2. SocialSite (based on Shindig within Glassfish)
3. OSDE (Eclipse Plugin with integrated Shindig)

With all of these synctstems we encountered at least one of the following problems:

- Lack of Forward Incompatibility
- Client Browser Dependence
- Server Platform Dependence
- Inaccessible Bugs in Generated Code
- Incompatibility with External Libraries
- Lack of Developer Support

The first problem was related to the installation of a gadget container, in particular with SocialSite. First, the current SocialSite distribution is restricted to specific, already outdated versions of Glassfish and Shindig, and thus is not forward compatible - an essential property, when working with experimental systems. Given the diversity of devices and platforms available to the developers, we quickly had to find out that platform and browser independence was not given at all. Container-side or browser-side errors were the result. The most essential problem was the inaccessibility of bugs in JavaScript code. In many cases, problems occurred outside the source code under developer control. The reason was a malfunction in the code produced by the container itself. Furthermore, error messages were cryptic and incomprehensible and thus did not provide any hint to the original location of an error. Furthermore, we lost a lot of time communicating possible alternatives. An excursion to the usage of Apache Shindig instead of SocialSite was also not successful for all of us. Further problems were related to the incompatibility of external JavaScript libraries with the Gadget container, which again resulted in strange code rewriting affects. Especially with regard to JavaScript library support for XMPP, we had to experience that libraries were not far enough for the realization of our goals and definitely need improvement. Finally, we had to experience that the developer support by SocialSite was not available at all. At the time of writing this document, it seems quite obvious, that SocialSite is dead.

We finally managed to deploy our prototype in Graasp in a rather stable version, but still with a lot of open issues...
to be tackled in later development stages of the ROLE project.

Drawing the conclusions from our experiences, we can state that the technologies we experimented with were insufficiently mature for the deployment of a stable integrated prototype assembled from a set of innovative tools realized using different technologies. For further collaborative distributed development experiments we agreed on a short, but regular biweekly meetings in order to get aware of occurring problems earlier. The agenda will be inspired by action items of W3C meetings.

VI. CONCLUSION & OUTLOOK

In this paper we provided a report of the collaborative distributed development of the ROLE Christmas Project resulting in a prototype of a Widget-based PLE for language learning. We first described the development process conducted among different partners from both academia and industry, with varying technical backgrounds, m2tivations and interests regarding the hole project. We pointed out that at regular communication and the clear definition of goals and a schedule was inevitable during the whole process. Furthermore, we listed useful technical means of collaboration such as communication media, shared document entertainment, shared code repositories, etc. Furthermore, we drew the conclusion that our approach did not work as expected, rising the necessity for an improved approach better suited for collaborative distributed development of Widget-based PLEs. In a section on requirements we presented our use case scenario in which we gave an insight into the psycho-educational model behind. In that context we pointed out that in conceptual and technical work must happen together. We elicited technical requirements to a basic framework for distributed PLE development and presented a selction of technologies for its realization as a foundation for our experiments. We then provided an overview of the innovations resulting from individual personal and collective ributions, ranging from integration technologies to scenario-dependent and independent learning environments. Finally, we critically discussed the outcome of the ROLE Christmas project and reported a set of technical issues hindering the conclusion that Widget technology is not mature and stable enough to enable distributed collaborative PLE development without hassle at this point in time. However, we worked out the requirements and associated problems for distributed implementation of Widget-based PLEs and collected a lot of valuable experience that will shape future endeavors. In an upcoming conclusion we need to have developer teams engaged in the stabilization of core reusable libraries, improve and address the development process and then continue work towards a number of bundles for the implementation of the ROLE test bed scenarios.

ACKNOWLEDGMENT

The research leading to the results has received funding from the European Community’s Seventh Framework Programme (FP7 2007-2013) under grant agreement no 231396 (ROLE project).

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This article was modified from a presentation at the International Conference of Interactive Computer Aided Learning ICL2009, September 2009 in Villach, Austria. Submitted 11 September 2009. Published as resubmitted by the authors on 17 January 2010.