ECP-2008-EDU-428037

LiLa – Library of Labs

D3.2 – Pedagogical report

Deliverable number/name	*D-3.2 – Pedagogical report – new version*
Dissemination level	*Confidential*
Delivery date	*December 1, 2010*
Status	*Final*
Author(s)	*Jerry Andriessen, Thieme Hennis, Wim Veen, Pieter de Vries*

e*Content*plus

This project is funded under the *e*Content*plus* programme[1],
a multiannual Community programme to make digital content in Europe more accessible, usable and exploitable.

1 OJ L 79, 24.3.2005, p. 1.

Table of contents

1 Introduction

In this report we present the theoretical pedagogical framework underpinning the LiLa Project. The objective of the report is to describe and illustrate the strategy of the LiLa project with regard to pedagogy and following from that: functionality. In other words, how people can learn and teach using LiLa is described in this report.

The strategy is based on literature analysis, interviews among LiLa partners, the development of scenarios. It forms the basis for pedagogical design principles for the Lila Portal. These principles will guide the definition of some of the functionalities and tools to be implemented in the LiLa Portal. The chosen pedagogical concept will also help defining learning and teaching processes both for students and teachers for using the simulations and remote experiments in the LiLa portal. In addition, the pedagogical concept can guide in defining learning support and desired learning outcomes, focusing on issues concerning learning materials, learning activities, tutoring, assessment, technological environments, and cultural differences.

In a larger sense, the pedagogical strategy is closely related to the evaluation of the Lila portal. In the final chapter of this document, we will link the general pedagogical goals to the design and evaluation of the LiLa portal, including the design of an experiment in the final period of the project. Concrete evaluation criteria are formulated to assess the pedagogical success of our approach. This activity carries an educational evaluation of the pedagogical approach, learning processes and learning effects, including measurements of student activities and satisfaction.

This document describes the various investigative steps taken.

- First, we conducted interviews with LiLa partners, who are providers or teachers of remote experiments. This is Milestone 3.1, and forms the first part of this deliverable. The result of this investigation is a set of principles for the development of experiments and agreed upon by the partners. These principles are active, authentic, and collaborative learning.
- Secondly, we have researched other similar initiatives to draw some preliminary conclusions and generate ideas on the various approaches.
- Thirdly, we have conducted a literature analysis about learning theories. The most influential and important approaches are discussed: behaviourism, cognitivism, constructivism, and connectivism. Connectivism is an important theory that relates to the influence of ICT on learning processes. The goal of this section is to relate the current practices with the learning theories. The results will be used to make a carefully considered pedagogical and functional design for the Library of Labs portal. This chapter concludes with characteristics of an effective learning environment, and principles for effective learning.
- Based on the literature analysis and the interviews amongst partners, we have written a pedagogical strategy, some design principles, and a

pedagogical developers guide aimed at teachers creating or using the remote experiments.

- Following from the previous steps, we conducted several case-based studies among partner institutes. Based on the existing practices and the literature analysis, meanwhile acknowledging the variety in learning and teaching practices across universities in Europe, we developed a number of scenarios for these approaches. These scenarios have resulted in storyboards, which have been consulted with and commented on by the partners.
- In conclusion, we developed a functional design of the LiLa portal, emphasizing the part on learning and learning tools. Because we came to the conclusion that the LiLa portal should not be only a place where people can download and execute experiments, but in addition should offer the tools and support to interact and discuss, we have added a literature analysis on motivation and engagement in online communities to guide the design of the portal. Based all of the previous steps we developed a complete functional design that rooted in literature and evaluated by partners. The design supports a variety of traditional and modern learning scenarios, and intends to provide sufficient motivation for end-users to engage in self-organizing processes to maintain quality on the portal. There is no obligation of a user (student as well as teacher) to conform to a specific pedagogical scenario. The portal design hosts a number of instruments that allows users to do teaching and learning according to their own standards and pedagogical approaches. Even though the design offers substantial levels of freedom, it structures and supports different processes with tips, micro trainings, and support pages. There is (embedded) support for contributing content, structuring content in lessons, and learning from experiments. The latter is in the form of peer-support by means of comment, rating, and peer-assessment tools.

2 Summary of task analysis (M3.1)

The document entitled “task analysis” originally aimed at documenting the typical workflow for remote experiments and virtual labs at the various sites that offered them. Because there were hardly any uses of these experiments and labs, we focused also on the department and its support. A number of recommendations were listed at the end of the report to draw attention to the current weaknesses and their effect on the goal setting of the project. For convenience we repeat them here, and briefly link them to pedagogical concerns. This is retrieved from the previous version, so it might seem outdated.

1: A small team of LiLa members develop local implementation plans.

Our main conclusion was that embedding in local user contexts is a main problem and should be addressed by all of the partners. We want to stress that lack of managerial support is one of the main obstacles for lack of use, but also, the lack of an explicit pedagogical vision could be a related obstacle. Therefore, we propose to implement (and contextualize) our pedagogical approach in local implementation plans, dealing with the local educational models.

ACTION: This recommendations has been taken further in the Delft Meeting, October 2009. Cambridge will lead the activities in this matter and is currently organizing virtual meetings every fortnight in order to drive dissemination activities at each of the partner institutions.

2: Work package 5 (Evaluation) should propose a plan for analysing effectiveness of the experiments

One of the challenges of the LiLa project is to find out how simulations and remote experiments qualify as educational material from a teacher or domain expert point of view and how to evaluate this. Understanding of the concept of effectiveness or usefulness is related to the pedagogical view one has.

ACTION: This concern is being taken care of in a collaborative action of Thessaloniki and Delft. It will be part of the Evaluation Plan that these partners are currently writing. The issue will be raised again in the next meeting in Munich January 2010

3: New experiments should be self directed, authentic, collaborative.

ACTION: Chapter 6.3 contains a working guide on how to design a pedagogically valid simulation or experiment for the LiLa portal, dealing with the authenticity, collaboration and student autonomy constraints.

4: It is suggested that the Virtual Portal should classify experiments

ACTION: Metadata discussions are currently taking place in virtual meetings.

5: A working model needs to be developed for a small set of experiments and simulations, showing all steps for teachers and students (probably different steps) to undertake from the moment they have reached the LiLa portal, finding the appropriate experiment, doing the experiment, and getting the results out of that experience. This could be done using different didactical approaches, for us to see what the consequences of various choices in this respect are for our project.

ACTION: The Pedagogical Strategy Document will suggest to create awareness and skills in the field of pedagogical approaches by creating 'show case' experiments with all content providing partners of the consortium. Chapter 5 provides the plan.

6: We should develop a shared view on learning

ACTION: The Design workshop and the following discussion on the LiLa Portal at the Delft Meeting has given way to clear tasks and actions related to the Portal Architecture and its functional design. Current partners involved are Madrid, leading the creation of the Portal, Stuttgart and Delft. The LiLa Portal has been created, runs on Stuttgart servers, is currently built, Delft has been asked by coordinator to do the interface design.

7: We should investigate other portals and similar initiatives.

We have done an inventory of existing portals, see chapter 4.

ACTION: Further work on the business model is needed. By choosing for a networked learning approach, we involve users in the use and sustainability of the portal.

8: A generic model for collaboration between sites will be developed.

ACTION: The partners will start working in small local teams, each team also commenting on the work of another team, to develop the first set of showcases.

9: We will develop show cases of experiments

ACTION: This has been decided during the Delft meeting and realised before the next meeting in Munich.

3 Current Practices among the Lila Partners

WP3 serves to define the pedagogical goals of the LiLa project, which relates to successful implementation in educational practice as well as making the highest possible impact on stakeholders.

In this work package didactical models are developed, use cases of the virtual portal and the experiments are analysed, and online courses and design guides for the user interfaces are developed. Further we foresee the implementation of a system that integrates experiments and remote labs into an online course, dealing with user needs. A suitable learning approach (theory and practice) needs to be developed, with future learning arrangements in mind. This approach should encourage universities to participate in Europe-wide communities of teachers and students using the LiLa portal.

The first phase of this challenging task is to document the current situation concerning the typical workflow of using experiments and virtual labs in university courses. We addressed the suppliers of educational material with detailed interviews concerning the available experiments, the courses in which these were embedded, including the didactical set-up, the attitudes and evaluations of teachers and students regarding the use of experiments and virtual labs in their courses, and the visions and support from educational management in the institutions.

The results of these interviews would provide us with the baseline view from which to design the pedagogical vision of the LiLa project. Furthermore, we also investigated the ideas about the LiLa portal and the success criteria held for the project by each participant.

3.1 Outline of this chapter

This chapter contains in the first place summaries of each of the interviews held at the partner's premises. These summaries end in a section with short conclusions relevant for the site concerned. These conclusions sometimes have the form of recommendations or suggestions for actions to undertake.
In the third section, we provide some overarching conclusions, which have been used in the project meeting in Delft, September 2009 and for the functional design of the portal.

3.2 The interviews

3.2.1 Linköping (june 26th 2009)

Dept. of Computer and Information Science
Present: Peter Fritzson, Kristian Sandahl, Mohsen Torabzadeh-Tari, Adrian Pop, Kirstin Johansson, Christoph Kessler, Peter Dalineus, Peter Aronsson (Linkoping University); Wim Veen, Jerry Andriessen (TUDelft)

We would like to thank Mohsen Torabzadeh-Tari for organizing this event, and the other participants for their time and their willingness to answer our questions, in particular those that returned from their holiday resorts especially for this occasion.

Summary of the Linköping experience

Overview of the current situation
The main contribution of the XX-Lab to LiLa is Modelica, a language developed for object oriented modeling and simulation. The language allows the construction of experiments, and comes with a manual and hundreds of models and examples. Modelica has been compiled as a software package called MathModelica, has a large living user community, and a free library of examples, which is growing by the day. There are no LiLa partners member of this community. The other LiLa partners mainly use preprogrammed simulations. Will contact Stuttgart for using MathModelica in a Wonderland context.

Modelica is currently applied in one course, but there are other teachers interested in using it in their own courses, even if this asks for modifications of their teaching and the course organization. These teachers stressed the need for more project-based work, with assignments focusing on professional practice rather than on understanding rules and procedures. Relevant courses were Production technology, Process Product Engineering, Business Development for SME (Dept. of Management and Engineering) and software development.

Analysis of tasks
Because of the availability of Modelica, in principle there is an endless possibility of creating experiments and tasks for the LiLa project. However, creating these experiments requires some expertise in using Modelica, and there is no index or metadata available to classify the library of examples.
What is already there is classified within standard libraries (e.g. translation, rotation, spring, etc). There seems to be a need for widely accepted classifications, for teaching purposes, and the fine criteria for how to apply this.

Pedagogy and didactics

Currently, the course Modeling and Simulation (Ba-level) uses a small part of the possibilities of the library of experiments. The format of this course is a lecture with additional exercises that the students can do with their laptops during the meeting.

A need is expressed for more use in teaching, which requires development of more exercises, and using electronic book technology. Modelica is currently better used in industry and research then in teaching.

What would it take for Greek teachers to use the language? Simple typing in of equations directly from the book. So that you would see math and not programming language. Lila could create demonstrators, examples, should help with the first tutorial steps.

Teacher’s interest

We spoke with three teachers, two were very favorable towards using Modelica in their teaching, and also had experience working for companies, one was quite skeptical.

The need for university education to better prepare their students for later professional work was recognized: need for more project-based learning, with cases derived from professional practice, develop on-line interactive experiments, simulate a CAD production line, use it in a course on medium size enterprises. In the domain of software engineering ideas were there to develop materials to be used in a course about simulations of the software design process, New ways of evaluation were discussed. Currently most exams are written, but attention is also needed to the way work is organized in groups in a project context, how to coordinate people, maybe in a phase model of a project.
Both teachers underline the importance of real tasks from real customers, with realistic constraints, such as time and limitations of available expertise.

The LiLa team is ambitious with respect to the rest of the university, but does not have a clear strategy how to foster dissemination. It was suggested to develop showcases for course leaders and students in order to raise awareness of the possibilities using Modelica.

The skeptical teacher very clearly formulated his concerns. His concerns relate to pedagogical issues, and organizational issues in the department. What would be the requirements to use a portal for virtual experiments? Students should be able to work on their own, and he does not want to give much support. Online experiments could only be offered as an additional exercise, not disturbing the lectures and content of the current course. But he realized that in that case students will not use the online experiments; they do not do additional work. Other pedagogical issues he mentioned were: How could teachers verify that someone has done the experiment by himself? How would an examination be dealt with? How can we avoid cheating?

Undergraduate courses are very compact, there also are practical assignments, lab assignments, and what a student is doing in a course should not compete with this practical work, which aims for something different. A teacher could make the lectures more interactive, but this will take more time, we do not want to cut down on content or increase the number of hours for students. This teacher would not be interested in reading collaborative discussions accompanying students' experiments in an online environment. He would not mind collaboration between students as long as examination will be individual.

In addition to the above mentioned pedagogical concerns, changing anything in the curriculum would take 2 years due to departmental regulations. After 2 years it is discussible to use if it is technically perfect and content wise useful. He suggested to try the experiments in a PhD course.

Support from management

The coordinator we spoke was in favor of clear useful packages of experiments to be applied in courses. Reusability of materials is an important issue. Packages need to have clear inputs and outputs, for teachers to understand. It could start as a new offer for students. But: structuring and packaging takes a lot of time. Establishing a consortium of universities would be needed.

The coordinator had his concerns about the possibilities of dissemination of the uses of experiments within the department. Each teacher has his teaching duties and is in charge of his content. The department does not have a clear education policy where teaching is on the agenda.

There used to be an annual teaching day where staff met to discuss at high level about teaching in an academic environment. But he considers it hard to spread out ideas, education is hardly discussed. There is no educational policy to save Peter F. from vanishing in splendid isolation. Teachers want to reinvent the wheel, use material in their own way, but this takes time which they do not have. We discussed some ideas: have a vice-chancellor for education; showcase good examples; have teacher workshops (idea for LiLa); use students to coach teachers;

Our students are changing, they want to be more in charge, control and steer their own earning processes, and they want to choose, decide and create..

Succes criteria

- to have courses supported with experiments in 7 courses in Linkoping
- to have teachers in the department adopting the experiments in their teaching
- make other teachers interested in contributing experiments

Conclusions from Linköping

Content of the experiments

There is a powerful language available for building all sorts of experiments and simulations, using it requires some expertise and willingness to work with Modelica. The current experiments available are now being used in teaching setting that cannot be extended in a virtual environment for many. This will demand an adaptation of the experiments in order to get them easy to access and to use. It seems when using Modelica many experiments can be developed by a community of teachers European wide for many courses of different levels. Indeed, the impression is that such precise development of experiments for particular courses, even within the department, still has to be developed. In addition, a mature meta language for classifying possible uses of existing experiments needs further development.

Local expertise

There is a lot of expertise in the team that could contribute to the success of the LiLa project. It is committed and has many experiments on offer, all based on the Modelica language.

However, there is no pedagogic expertise in the team, necessary for implementing advanced web-technology for learning, and also no expertise on advanced pedagogy such as project-based learning or collaborative problem based learning.

We spoke to two ambitious teachers that had well developed reasons for employing the technology, also for modifying the didactics of their courses according to developments in professional contexts: problem-based, collaborative team-work. It would be a good idea to consult these teachers and make use of their knowledge for the LiLa project.

Project goals

Only local project goals were expressed in the first place. The main goal of the project was described in terms of internal dissemination, however there was no concrete plan for realising that ambition yet. The overarching goals of the LiLa project do not seem to be at top level priority. More general LiLa objectives such as sharing experiments and supporting external users is still to be considered by the team.

Support from Management

Although the educational manager was in favour of supporting the dissemination of using Modelica in the department he also indicated the lack of instruments to realize this. Apparently the department does not have a clear educational policy and therefore it was considered a challenge to get teachers from the department involved in the LiLa project. It was expected that the LiLa project would furnish that plan. Management does not have the ambition nor the capacity to move into that direction.

Technical infrastructure

Because there is a strong project-oriented development team, at this moment there is no lack of support. However, at the departmental level, support seems to be non-existent yet. When professor Fritzson would move to another place, all will be lost at this site.

Suggestions

1. Develop a strategy how to make the current experiments available for students in the LiLa consortium. Describe the steps that should be taken to make the experiments accessible and usable for all, and as a consequence, define the functionalities needed in the online environment, c.q. virtual portal.
2. Formulate an implementation plan, both for the offering of services to the LiLa project, and for implementing LiLa services into the own educational practice.
3. Contact and negotiate with the project coordinator, both on using Modelica, as well as on linking Mathmodelica to Wonderland.

3.2.2 Basel (june 30, 2009)

Biocenter University of Basel, Klingelbergstrasse 50

Participants: Tibor Gyalog (host & organiser, thanks!), Helmar Burkhart, Sven Rizzotti (Basel); Yvonne Tetour (Stuttgart); Pieter de Vries, Jerry Andriessen (Delft).

Summary of Basel experience

Overview of the current situation

The university of Basel has expensive equipment for doing experiments in nano-technology, with too many students to use it in one course. It participates in the network EUCOR (http://www.eucor-uni.org/site/Accueil-4.html), together with the universities Freiburg, Karlsruhe, Strasbourg, and Mulhouse and worked on a Virtual Campus. It appeared that much work this Virtual Campus platform was relatively unsuccessful for the physics domain because these universities were relatively close to each other and it was easier to travel than to set up a system for sharing resources. Advancing on this requires more fundamental changes in educational views. The nano-experiments would benefit from that.

More clients for the experiments are needed, this partner understands that this requires development of new collaboration models, e.g. with Thessaloniki. Industry is not very interested in developing advanced teaching to suit their needs, so far only in the technical innovations that are developed in this lab.
Analysis of tasks

The laboratory has a very powerful position in nanotechnology, and the expensive equipment (several nano-microscopes linked to software controls) for remote experiments as well as construct simulations in this domain. The experimental possibilities in this very complex domain allow tasks that are open and experimental, and in combination with simulations afford crossing the borders between the real and the virtual, often with the consequence that students do not understand the fundamental differences between doing simulations or working with the expensive real stuff. Nano-domain has aspects relevant for physics, biology, chemistry.

The simulation is based on a java-framework, is open-source and can be downloaded at sourceforge. The vision so far has been to allow teachers to build their own experiments using the framework, but perhaps due to the complexity of the domain, or to didactic issues, has not been very successful.

Pedagogics and didactics

The courses in which the equipment is used are more advanced than traditional teaching and additional experiments. The format is more that of a research lab, work in teams with interest for working practices in addition to inquiry based learning. There is no universal solution for providing fixed progress in learning. Students have to work together and organize their own progress. Examination usually involves writing reports. Groups are supported by more experienced tutors (PhD-students). There is a pilot (thesis) about the use of mobile phone equipment for supporting a research project.

Collaboration between EUCOR institutions was not very successful. There was a productive collaboration with Madrid, but this concerned remote use of the equipment, not the form of the (collaborative) learning process itself.

At this stage, a new approach for effective distance learning can be developed, technical issues have been solved. Support is desired.

Teachers interest

It seems that in this group teachers have a well developed experience in teaching project based learning. It was not implemented as orders from higher management, but is the result of gradual changes over time based on growing insight.

Students should be active, work on practical issues and solutions, this will motivate them more than just learning for understanding concepts and principles. Ideally, students should be involved in developing the LiLa site, extending the database of LiLa experiments. Use a wiki, to get their ideas.

Involving students in higher goals will motivate them even more.
New technology, mashups, were discussed, allowing a high level of personalized web, using parts of web-pages, inserting existing content into one's own environment.

Support from Management

We did not have enough time to discuss with management. Like in Linköping, they seem to be favorable to new teaching approaches, but they do not explicitly support continuation of innovation.

Ideas for the portal

There is a need for a web 2.0 environment to make LiLa work. The Wonderland metaphor could work, it should be visually state of the art, allowing 3D projection, hot spots, calendar, reservation, tags, proximity, user profiling. Maybe the 'airport metaphor' could work to explain the approach. The portal is crucial for showing what there is to find and how to find it. It should be aware of the way users are motivated to make use of it.

Teacher needs are: getting easy reports of use, not having to spend much time on preparation, scripts for good practices, how to employ an experiment in real practice, a way to organize feedback, ways to easily evaluate what users did, how to estimate (also internationally) the level of results, feedback to improve the experiments. Above all, it should be clear for teachers why they should invest in this: for whom are they saving money and what are the educational (and other) benefits?

Example: JOVI, a channel of virtual experiments in medicine where one can develop your own scenario, with a ranking system and other 'bites' that attracts users, stakeholders, etc.

We have to develop a generic model for collaboration between sites, not only involving the LiLa partners. Only a community driven portal can survive after the end of the project. Basel has some experience with new formats that died after the main originator left.

Some links

- Sven Rizzotti phd: www.rizzotti.ch/syndicate
- www.p2.unibas.ch fort he ViLabs and ViDi (pharmasquare)
- Courses.cs.unibas.ch/moodle → /werkzeuge the Computer Science Stuff
- www.ethz.ch – coreitem (Comprehensive Mathematics…)
- Physica pro medicis (Swiss virtual campus (ppm.unibas.ch)

Success Criteria

Basel's interest in the project is to further develop their innovation in (e-) learning by working together with other universities. It is a success when the user community extends beyond the LiLa partners.

Conclusions from Basel

Content of the experiments

There is a powerful nano-technological experimental situation available, which allows for both remote experimentation and for simulations in this domain. It has been used on various occasions, even with remote users (Madrid) but is not officially implemented in any course.

Local expertise

There is local expertise both on the domain knowledge and about e-learning. Many examples were shown by a teacher, who was keen on sharing his ideas with us about promoting student activity by presenting them with problems that would consist a challenge to them and not simply filling in the blanks. Also the need for evaluation of student understanding was considered, for example by the careful design of small assignments or questions.

Project goals

Although a main goal clearly is to get new, and many users, for the nanotechnology experiments and simulations, there is a genuine and advanced insight into using European-wide networks to share technology and employing advanced educational ideas.

Support from Management

We have not spoken to the educational coordinator, but at the bureaucratic level contacts are not advanced, and support is only to be expected when some results and good examples can be shown. In this sense, there is the same situation as in Sweden.

Technical infrastructure

There is no real issue here, as the needed maintenance of the apparatus is being done anyway. It should be noted that local support of these remote experiments is time consuming.

We had interesting discussions about using web 2.0 technologies to provide access to the LiLa site in terms of teacher needs (profiles, feelings, courses, contents). LiLa could become a Google for remote experiments and virtual simulations.

Suggestions

During the meeting it was already suggested and agreed that Basel would contact the Greek partner to discuss their needs and possible ways of cooperation.

Basel should definitely be consulted for their ideas about the portal. Within the LiLa context, energy should be spent on developing advanced educational concepts for use of remote experiments in open project contexts, or in more closed problem-solving assignments. Crucially, Basel should join the team developing a longer term working model for the LiLa project, about how different sites would collaborate, and make this collaboration survive the project.

3.2.3 Berlin (july 2-3, 2009)

Technische Universität Berlin (TUD), Institut für Festkörperphysik

Participants in Berlin: Christian Thomsen, Sevak Khachadorian, Harald Scheel, Lars Knipping, Sebastian Gede (didactical tutor), Andreas Moschini (technical tutor); Thomas Richter, Yvonne Tetour (Stuttgart); Spiros Kassavetis (Thessaloniki); Pieter de Vries, Jerry Andriessen (Delft).

Summary of Berlin experience

Overview of the current situation

Berlin has a site (Remote farm: http://remote.physik.tu-berlin.de/farm/index.php) with free access to a set of remote experiments, available on a 24/7 basis. Users come from everywhere, they have to subscribe and can use it (browser plugin). If users are too many, reservation may be needed. It seems some companies use the remote experiments, but no information from there. The experiments are fully educational, that is, they simulate ideal conditions. The LiLa participation would require more realistic, but also more scientific, research oriented experiments. Is highly interested in international cooperation.

Analysis of tasks

The focus is on remote experiments. There is a set of rather basic experiments, focused on engineers from other faculties. Experiments are set up by the students, all together about 20 set ups. The team has started developing simulations from the experiments. Recorded data can be stored for further analyses.

Figure 1 - Berlin remote experiment

Pedagogics and didactics

Each experiment comes with basic information and an assignment structure online, as a script, including a Wiki. Students work in small groups, but the manner is left up to them. Courses are organized using Moodle, which is generally used by the faculty (https://www.isis.tu-berlin.de/). Moodle is mainly used for organizing the course, less for interactive and community purposes. Forums are used for basic questions, which are answered by tutors (advanced students). Each tutor is responsible for 1 or 2 experiments, there are technical tutors and educational tutors. The last are also coaching the students to write a suitable report. Outcomes of experiments are not automatically linked to evaluation. Reports are evaluated by the teacher. An evaluation of the course, filled in by 8 students, is available. It is generally positive.

Of the 800 available students, only 23 do the online course. The online course is not enough positioned as an alternative. Marketing the course is an issue.

Teachers interest

There is a lot of administrative burden involved in serving different courses for various departments. Teachers differ in their evaluation of various tasks in terms of ects. The university is rather late in harmonizing the system in this respect. Most teachers are just putting material online (in Moodle) without reflecting on the educational aspects. There is no fixed model, but the conviction that more communication and learning by doing is needed to replace traditional lectures. Maybe development of a new bachelor is a way out to come up with new teaching methods: students developing new materials for students abroad.

Support from Management
The current experiments need little maintenance, the team can handle building and maintenance themselves. Sometimes materials wear out. In the longer run there are no funds for extending the set of experiments.

Technical infrastructure
With the existing experiments many more students can be served. Simulations are built with LabView.

Success Criteria
An accessible platform, to be able to serve the international community on a routine basis.

Conclusions from Berlin

Content of the experiments
The current set of experiments are rather simple, more complex materials are needed to serve more advanced students. It is unclear if these can come from other partners in LiLa. This should be checked. The system with tutoring by experienced students seems to work very well. In general, the idea of using students for constructing experiments, technical assistance as well as coaches of small student groups is an excellent idea, for other partners to investigate. This seems to be an affordable model which serves many goals at the same time.

Local expertise
There are teachers that have experience with Moodle, mainly as a course organizer, which seems a good base to work with. The way the experiments are embedded in the course, using Moodle, may be a basis to work from by the other partners as well. Sites may differ in the use of various features, of course.

Project goals
Like with all other partners, there are not enough users for the experiments. The international aspect of LiLa is highly favored and may be exploited to increase the use as well as the motivation of users. It would be a good idea to work with some partners on a plan for more international participation.

Support from Management
Like with all other partners, there is not enough awareness of the advantages of remote experiments and virtual simulations. Because there seems to be some movement in management thinking and structuring at the management level, LiLa should become part of this, at some point.

Technical infrastructure
This partner is the one who is most advanced with integrating features of e-learning in their curriculum. Students should know where to go, access control works in Berlin.

Suggestions
The LiLa team should reflect on the possibilities of a Moodle portal at course level, in terms of functionalities, eventually as an alternative for Wonderland.

3.2.4 Stuttgart (july 2 and 7, 2009)

Rechenzentrum University of Stuttgart

We interviewed this partner during our visit in Berlin, and later during a virtual conference where experiments in combination with the ITS were shown.
Participants in Berlin: Lars Knipping (Berlin); Thomas Richter, Yvonne Tetour (Stuttgart); Spiros Kassavetis (Thessaloniki); Pieter de Vries, Jerry Andriessen (Delft).
Participants virtual meeting: Thomas Richter, Yvonne Tetour, Tilmann Robbe (Stuttgart); Jerry Andriessen (Delft).

Summary of Stuttgart experience

Overview of the current situation

There is a large set (90) of experiments available, all simulations, created by a basic development engine with java applets that can be used for experimentation. Simulations can be saved and analysed by others. There are no users, that is, the simulations are not yet part of any course. This is one of the main goals: to find users from education.

Analysis of tasks

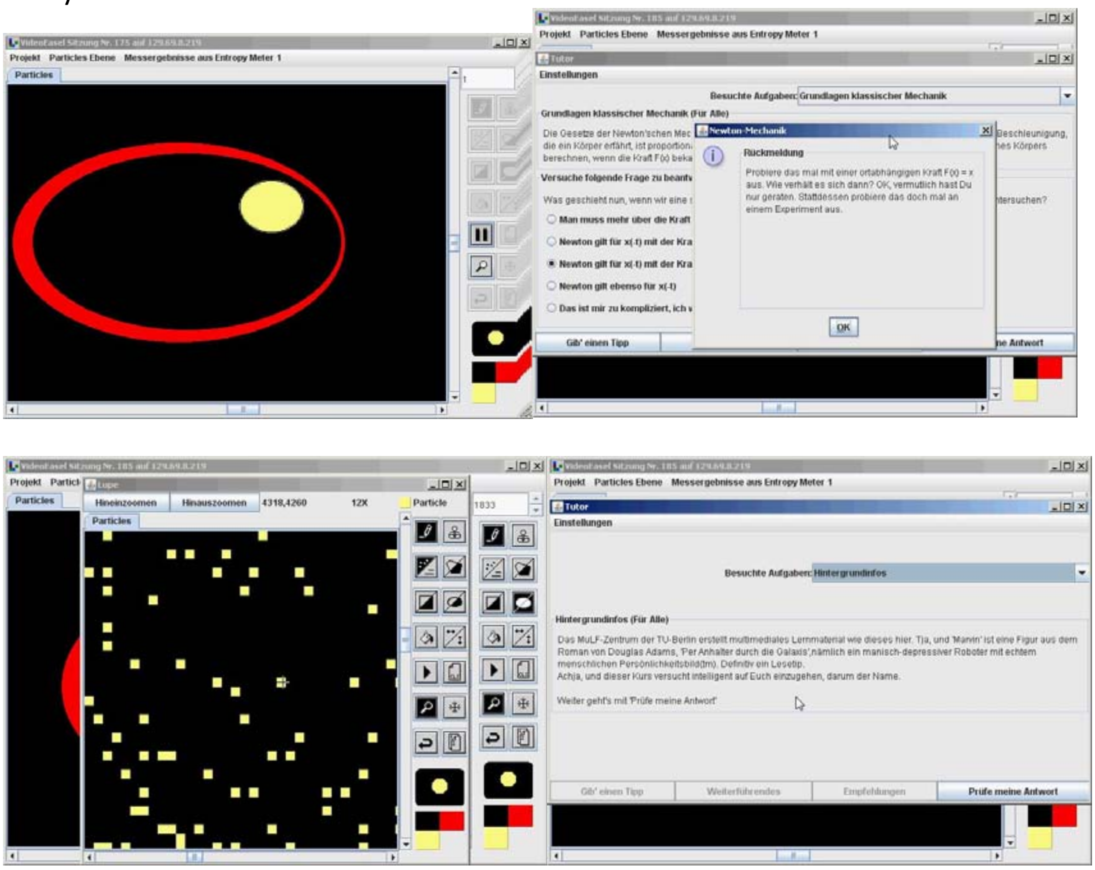


Figure 2 - Stuttgart simulation

The simulations have been developed as an addendum to the lecture, suitable for multiple audiences. The users can work with and manipulate applets which correspond to various problem states at the micro-level. Many simulations work with a tutoring system which guides the users through understanding the complex issues. Feedback is based on what users are currently doing. The simulation can be shared by two users, but no additional communication features are afforded. There is no metadata available, simulations can be found by their general title.

Pedagogics and didactics
Experiments can be described as problem oriented, students have to experience the simulation and discover what is there. The support system in which some of the experiments are embedded provides structure to the experience and users can monitor their progress by feedback to the answers they provide to test questions. The system 'knows' where the student is and can adapt its questions and feedback to that knowledge.

Success Criteria
It is clear that the main goal is to find a useful audience for the experiments and to extend the set of experiments. LiLa would become a supermarket for all kinds of experiments. Stuttgart is ready for collaboration with all partners to develop a strong user community. Educational innovation is not the main goal, although we need a good concept.

Conclusions from Stuttgart

Content of the experiments
The set of experiments offers a rich and various start for the LiLa database. However, more reflection is needed on who is supposed to use them and for what reason. The issues are not only didactical, but also a matter of precise content: what courses or what teacher needs can be served here?

The simulations and the combination with the tutoring system have a clear view on learning as guided discovery, with an emphasis on structured guidance, by a teacher, or by a tutoring system. While this is one form of learning that is widespread in academics, its use is rather basic and development of tutoring for other simulations (also for other sites) is not an easy task. We do not recommend focusing on this development for the project. However, further reflection at the project level on support of independent student learning is highly recommended. In addition, developing some way of estimating usability of the experiments at the project level is needed. A standard may have to be developed to guarantee usefulness for large groups of students.

Local expertise
It is clear that the team has a lot of expertise with development of simulations, and is willing to adapt existing ones, or develop new ones. The didactics still need to be shown to have a desired effect, and with this kind of strict tutoring, details matter.

Project goals
The challenge for LiLa is to find an innovative view on using experiments in education that is technologically sound, and that is resistant to the future. It may be that setting up a user community is important. One option could be using existing Facebook (or studivz) community-software.

Suggestions
Because Stuttgart is the project-coordinator, and originator of the LiLa proposal, we should look closely into the original conception of the proposal, as it seems that not all authors of that text still are member of the project team. The current focus seems to be on making content available, but without the clear didactical perspective, chances for success are not very high. We would like to challenge this team to develop a working case of a course, or package within a course, to be used and tested by students in actual education.

3.2.5 Cambridge (july 8, 2009)

Department of Chemical Engineering and Biotechnology
Participants: Markus Kraft, Andreas Braumann, Amit Bhave, Studentassistant, Sebastian, Wim Veen

Summary of Cambridge experience

Overview of the Current Situation
The Cambridge team has in its laboratory one piece of equipment, the Process Control System SIMATIC PCS7, which has been installed within the framework of a project and has been sponsored by Siemens (como.cheng.cam.ac.uk/weblabs/reactors.html). It is currently used by all Cambridge students (around 60) taking a course in their 3rd year of study. The course is on Reaction Engineering and Process Dynamics, given by Markus' group. The equipment consists of a reduced model of a real-life situation controlled by three Siemens computers. The equipment is used online, students working from home, being able to monitor the system visually through a webcam installed in the lab. Students do the experiments as an integrated exercise within the course. In total students have to do five experiments on a yearly basis two of which using the WebLab.

The Cambridge Weblab as used in two 3rd year courses

Analysis of Tasks
Students work in teams of three students and report individually on the results of the experiment. An experiment takes 2 hours on an average. Students are supported by instructional materials available online. Students should be able to work independently from teaching staff, however, a student-assistant is available for questions and support. The student assistant is also responsible for maintaining the system, both for the chemicals and for the computer systems to

run. The student assistant reports that many questions of students relate to issues they might have solved on their own, indicating that a student assistant fosters pampering students, rather than making them self-steering learners. All together the SIMATCI PCS7 is in use for about 3 weeks a year.

Due to the amount of time the system is out of use, the Cambridge team has invited universities to use it the equipment. Imperial College, Loughborough University, New Castle University, MIT, Birmingham University and some other institutions have been using the system for their students. As a consequence, the Cambridge team has experience in providing access to the system by other target groups than the Cambridge students. Still, there is no system of authentication for 'foreign' students nor a platform where they can work together, exchange experiences or create a community. The Cambridge staff expects the LiLa Project to provide these functionalities in the Virtual Portal.

Pedagogics and Didactics

Two pedagogical strongholds underpin the experiment:
a. simulation of a real-life situation, and
b. a collaborative working approach.

The pedagogy used is a form of collaborative learning, students working in groups of three. Groups of four students have been trialed, giving negative effects such as free-riding and lack of clarity of tasks among the group members. Students discuss using a chat facility or also face-to-face, but always outside the lab. As they report individually on their work there is no collaborative result in the form of a group report. As a consequence, the assessment of the students is to be measured individually, although the learning process is organized on a collaborative basis. The learning process and the learning product are separated, and emphasis is on product rather than on process. The two experiments running on the system simulate a real-life situation for chemical engineering, the system representing a reduced model of reality.

The remote experiments are integrated in the standard curriculum, they are exercises each student has to go through within a well-defined timeline. They are not an add-on or optional learning activity. Students use customized online materials for carrying out the experiments. They may ask for additional help through the chat facility, a student assistant helping them out.

The student assistant has been supporting the students by filling the tanks in the system, checking the power in critical parts of the system, and by giving answers on questions from students. Before being a student assistant he has been a regular student taking the course and the experiments.

The student assistant is explicit in his view on the motivational value of the experiments: *'This is different from other experiments, as you have all information real time at hand, you can see both the control panel of the system through the webcam and the control screen of the system, giving you all the details of what is going on. It works as if your were there and you are working on something real. It* *is not a paper and pen exercise, this is real.'* The student assistant considers the two existing experiments as sufficient.

Evaluations of the uses of the equipment have been done, as part of a strict Cambridge regime of evaluating teaching activities. Students are pleased with the experiments similar in similar terms as the student assistant mentioned above.

Teachers Interest

As the equipment is very specific in its own chemical engineering field, there is no drive to engage other teachers in the department to use it. As a consequence, Markus does not intend to involve other teachers as they are not teaching the same subject he is teaching.

Support from Management

Unfortunately, at the time of visit the managing staff was not available for interviews.

Success Criteria

Having asked if more experiments such as the existing ones are being planned for, Andreas said this was not the case. The system covers a specific area in the courses involved and there are no plans for more equipment to install.

There is another idea on developing new stuff linking another project to the LiLa Project. In this project the Cambridge team has developed a simulation that still needs to be elaborated for teaching purposes, in particular, teaching materials going along this simulation. Having discussed the pedagogical approach of these materials, we agreed that micro-learning would be an appropriate pedagogical approach, providing students with materials for short learning sequences of 10 to 20 minutes. The learning sequences could be used 'just-in-time', and could be organized in a Web 2.0 approach enabling users to contribute new learning content, hence, creating learning communities making the LiLa Project a sustainable community of practice. Cambridge does not have any experience in this field and would appreciate to collaborate with Delft in creating such materials as showcases for the LiLa Project. This idea would lead to more content delivered by the Cambridge team, and it would enhance the expertise of the whole LiLa consortium in creating innovative learning opportunities online.

Conclusions from Cambridge

Content of the Experiments

The content of the current experiments are well defined and ready to use. Limited adjustments in the accompanying materials are to be made for use in the Virtual Portal of the LiLa Project. Depending on the pedagogical approach to be chosen, these experiments can function within various learning cultures across Europe. For group assessment procedures, however, new materials should be developed. Existing experience with student groups from beyond Cambridge University have shown the experiments are doable at a distance. Maintaining the system does not demand intensive staff support from Cambridge.

Other strong points of the equipment is that it provides authentic and hands-on exercises, without any risks or safety issues.

The amount of experiments, however, is limited to two only and are not generic in the sense that other disciplines than chemical engineering might profit from them.

Local Expertise

The team has a clear and technically stable equipment that has proven to function within and beyond the faculty of Chemical Engineering. Ideas for further development of equipment related to the SIMATIC PCS7 are not at stake as the equipment has been built for very focused and specific experiments.
The Cambridge team is currently developing simulations that could be used as virtual experiments in the LiLa project.

Project Goals

Andreas said he would consider the LiLa Project a success if other partner institutions would use the available equipment at Cambridge in their courses. Markus cherish plans for further development of experiments using the simulations that are currently under development for the automotive industry. He considers this a chance for the LiLa Project to develop new content based on innovate learning approaches, in collaboration with LiLa partners.

Support from Management

Without any educational manager available, there is no evidence that the faculty is supporting the LiLa Project and its goals. It seems that no further dissemination of the experiments within the faculty or university is envisaged, and developing business models for making the equipment available for many, is a matter of the group in which it is currently used. However, it is wise to involve and commit the faculty's management in further activities and make them aware of the opportunities for participating in European wide initiatives such as LiLa as this project implies managerial decisions if it is to become a sustainable project.

Technical Infrastructure

There is an issue at the level of the programming language that has been used for the experiments. As the equipment and the computer systems has been sponsored by Siemens, the language might be a problem for the integration of the experiments into the Virtual Portal of LiLa. This issue is already under consideration by the Madrid team.

Suggestions

1. The current equipment is running fine and is available for users from beyond the Cambridge University. Experiments could be provided as they are within the Virtual Portal, using the existing pedagogical approach. Other ways of using the system could be considered however, in the framework of international cooperation introducing 'peer learning' as a pedagogical concept where students help each other in online environments. The purpose of such new approaches is to tackle the problem of dealing with large number of students without any additional demand on staff support. From experiences in online environments it is well-known that a community is

very supportive for their members seeking help. Using these social processes can help to make it feasible to provide content to many thousands of students, without creating a huge problem of support from any teacher. The Cambridge team might consider to develop such peer learning approaches together with pedagogical experts and the technical staff of Madrid.
2. As new content will become available from other LiLa partners, the Cambridge team might well consider how to integrate some of this content into their own courses, and define the conditions for integrating them and negotiate these with the LiLa partners.
3. The Cambridge team is willing to develop new content using a simulation that is under construction for the automotive industry. This initiative is strongly supported as it creates opportunities to provide innovative authentic learning opportunities for students. It will also help the LiLa Project creating show cases that can inspire partners for further development of online content.

3.3 Conclusions and Recommendations

3.3.1 The Current Content

When we speak about experiments, we mean remote experiments as well as virtual simulations. When the distinction between the two applies, it will be mentioned explicitly.

Although the Delft team lacks the expertise in physical sciences to be able to precisely judge the merits of the experiments we have seen, we assume that the below mentioned lack of use is not a consequence of the lack of quality. On the other hand, we cannot estimate how the experiments that are offered by our LiLa partners fare when compared to international standards in the area. We propose to have this at least examined by one or two independent experts. The questions that we have, as a project could be:

1. Quality: are the experiments that are offered by the LiLa partners of sufficient, or even excellent, quality with respect to the standards in the field?, and
2. Coverage: is the offer of experiments by the LiLa partners such that we can claim to cover the most important areas in the field of physics, and if not, how can we describe the areas that we cover, and where are the gaps that could be filled at some later stage?

In what follows, we assume the answers to these two questions are positive.

3.3.2 Embedding in Educational Practice

The weakest aspect of the project, paradoxically, is that the current use of experiments in the learning process of students is limited even at the sites of the partners we visited. Both the frequency of use and the number of teachers involved is limited. It is unclear if there is a lack of urgency or need for using them among teachers and students. Do teachers and students think they can do without? Or is it ignorance, not knowing what is available. Whatever the reason might be, there seems to be no apparent need for experiments in the teaching practice using technology. We cannot expect this situation to automatically improve with the availability of more experiments. More online experiments will not convince teachers to use them. Communication and dissemination activities at the faculty's and teachers' level would be critical in order to stimulate colleagues and others to use the content. The LiLa Project should carefully plan for actions to strive at a sustainable development of the portal. It should be noticed we visited the sites of the partners who offer experiments, not those of partners (or still unknown other sites) that explicitly need experiments. Nevertheless, the level of middle management (faculty, directors of education) is crucially unaware of the possibilities and implications of using shared experiments and combining educational expertise between different sites. Within the LiLa Project we should develop explicit strategies for addressing this managerial level, and probably the level above.

1. It is suggested that a small team of LiLa members (with representatives of each site) develop local implementation plans.

Another crucial point related to the content not being used intensively is that we do not have clear information about the presumed effects on learning. We may be selling experiments and simulations that do not work for learning. How can we tell new users that the LiLa content is of excellent quality? We need to set up some way of 'proving' that these experiments, when actually used in some educational practice, are effective tools for learning, not in general, but with respect to each specific case. Only then, LiLa can claim to be able to make a difference, when appropriately applied, of course.

2. It is suggested that Workpackage 5: Evaluation should come forward with a system how to provide evidence on effectiveness of the experiments for future users. This could be part of the Evaluation Plan

3.3.3 Pedagogical Issues

We have seen different educational approaches, different levels of expertise addressed by the materials, different levels of abstraction and reality of the situations addressed, and also different degrees of visualization of the interfaces for the remote experiments and virtual simulations. Therefore, we conclude it would be unwise to advocate a unified didactical approach. This would force partners to deviate from their usual working procedures.

However, most materials we saw were based on individual learning, as an addition to existing courses, addressing deeper understanding of abstract rules and principles of physical science. In contrast, we observed a lack of realistic and/or multidisciplinary materials addressing complex problem solving and collaborative learning, such as, for constructing a car engine or a ski lift, or building a bridge or a robot that serves tea. In other words, we missed approaches involving authentic applications of abstract concepts and knowledge. (The Cambridge experiments being an exception to this observation.) This kind of knowledge is needed for students to understand the meaning of the abstractions and apply them in the real world in professional contexts as well as in daily life. Also, we assume that such realistic, collaborative, and constructive problems would attract more students for the natural sciences, because it is currently well acknowledged that this format is better suited to prepare students for the future in professional contexts, and even for research.

3. It is suggested that new experiments should be problem oriented, have a high degree of authenticity and/or should include, where possible, different disciplines enabling students to collaborate in teams.

We think the implication of this is that already constructed experiments should not be changed, but that we have to be clear about what purpose they serve, and about their didactical approach at the level of the portal. One option could be to present experiments in packages that would belong to certain problem areas (e.g. building software applications), would be especially suitable for collaborative projects which allow students to construct (new) material objects (e.g. a ski lift or water-cooker), or which bundled together allow understanding basic concepts of a sub domain (e.g. the second law of thermodynamics).

4. It is suggested that the Virtual Portal should classify experiments in terms of pedagogical application, content domain, authenticity, and format of working (alone, together, or as a team). It should also provide insight in effectiveness and users should be enabled to rate and comment on the experiments.
5. A working model needs to be developed for a small set of experiments and simulations, showing all steps for teachers and students (probably different steps) to undertake from the moment they have reached the LiLa portal, finding the appropriate experiment, doing the experiment, and getting the results out of that experience. This could be done using different didactical approaches, for us to see what the consequences of various choices in this respect are for our project.

3.3.4 The Portal

There is some consensus for making the portal a didactic entrance to the LiLa world. We might adopt a shared view on experimental learning (learning by doing experiments using strategies such as trial and error) in modern online environments (creating learning communities providing opportunities to contribute and co-create). Powerful concepts to be used in this shared view might be:

self-directed, authentic, and collaborative.

Learning being an active process of learners trying to construct meaningful knowledge communicating with others. This definition of learning is called the constructivist pedagogy, currently the mainstream pedagogical view on learning. In this pedagogy, learning mostly is problem oriented inviting students to construct new solutions to preferably authentic problems, albeit simple to more complex problems.

6. The issue of a shared view on learning was discussed during the Delft meeting on October 1st and 2nd, 2009. The results include design requirements for the portal, such the presence of discussion facilities, and functionality that supports the creation of new learning materials with *or* based on the available content. This process of creating new materials must be embedded in the portal and guided with useful suggestions on how to do that.

The above-mentioned comment about the quality and coverage of the set of existing experiments also applies to the virtual portal. What other virtual portals have been developed in this and other relevant domains? What happened to these and what were the reasons for success or failure? Do we have expertise in the project to provide us with this crucial information?

7. It is suggested that a small inventory-team should be established to report on this by the end of September 2009. Initiatives such as Connexions and MIT iLabs should be included in this review. The following chapter will include an overview of existing, similar projects.

3.3.5 Collaboration between LiLa Partners

8. It is suggested that a generic model for collaboration between sites will be developed, not only involving the LiLa partners. We invite partners to get together in small teams, setting this up for their mutual cases.

3.3.6 The Development of Showcases

A substantial amount of materials is available at partner sites, however, practice is limited as number of users are. It would be important to develop a package (a course, a coherent set of exercises, a problem with associated experiments or simulations), which we can show to potential stakeholders. These show cases would work from a consistent didactic perspective (based on actual needs on one of our sites), would display the best of our abilities in experiments and simulations, and is of course based on sound technical infrastructure.

9. It is suggested that LiLa partners will work with the Delft team to develop show cases of experiments that may stimulate our expertise within the LiLa Project and may use as examples of best practice for future members to contribute to the Virtual Portal. The cases described in this document may be right for this.

4 Examples of relevant portals

Remote labs extend access to laboratory experiments, making them available 24/7 whenever students wish to use them. They also enable faculty to bring experiments into lecture to explore real scenarios, without the need for laboratory equipment in the classroom. Remote labs can provide laboratory experiments with devices that otherwise would be impossible for students to manipulate. Sharing expensive laboratory devices can provide students with more opportunities to interact with experiments and confront the messiness of real data. This is a crucial step if the intent is to give students the opportunity to experience the difference between modelling the world versus understanding how the real world actually works. Yet, with all this potential, the wider adoption of remote labs has been limited, whenever it has been attempted. Why is this so? A paper by Long & Ehrmann, from Carnegie-Mellon, a site of another failed attempt, gives us some clues (Iiyoshi & Kumar, 2008).

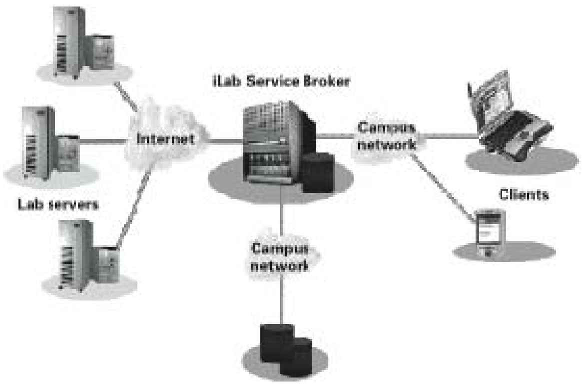


Figure 3 - iLabs architecture

One reason why iLab at Carnegie Mellon failed was the following. Typical for academe, each lab was built by a team, with a lead faculty member (the domain expert), developers and technical experts (usually students). They used the approach most familiar to them, without regard to the other teams developing remote experiments. They created useful and functional labs, but each with their own (reasonable) mechanisms for authenticating users, authorizing access, and managing resulting data sets. This way of working makes the next experiment no cheaper than the previous one. Support depends on the lead faculty member, because documentation is poor, and each software product is unique. Sharing this with colleagues requires a lot of additional work: manage external accounts, paying attention to course schedules, different languages, managing data created and stored on servers. This is not attractive at all, because instructors are on tight schedules. In addition Instructors are rarely prepared, supported, or rewarded for finding and adopting innovations.

For making decisions about the sustainability of our attempts, some other examples were investigated. The following list may be seen as representative. Not all examples are 'good' examples.

- PEMCWebLab (www.PEMCWebLab.com) offers a set of remotely controlled real and virtual experiments from fields of electrical engineering mainly from Power Electronics, Electrical Drives and Motion Control at Delft University. It is constructed hierarchically in content fields and modules within fields. Each module is presented with its learning objectives, a short description of the experiment, and a number of assignments. Also, there is a picture of each experiment showing the apparatus. Its clarity makes this an interesting example to follow for our showcases.
- The oercommons (www.oercommons.org) database provides a "referatory" of lessons, experiments and media for all grades and all domains. It is a repository, which is alive because members can add their materials. There is no indication of pedagogical goals, in order to find something to your taste you have to check out individual items. Subject area, grade level, media type, are the most important metadata for users. It is open for everyone to add links and metadata. Users can tag, rate and review lessons.
- LOREnet (www.LOREnet.org) is an instrument for teachers to share knowledge within and between educational institutes. Teaching materials are published and made available for reuse. The initiative, despite having

received quite some funding and news, did not gain enough traction, and is now more or less abandoned. We cannot find any evaluation on the project explaining the failure, but it is clear that both contribution and reuse of educational materials on the site has stopped.

- Open Courseware (www.opencourseware.org) is an international initiative of many schools and institutes to share educational materials. The common approach is to assist and support the publication of educational materials by teachers in a top-down, centralized manner. These resources are then collected and reused through websites as www.oercommons.org and others. Some of the initiatives (such as at Utah State University), because of cost savings, have stopped publishing and updating materials. These processes are quite costly, both from a financial point of view, and from the teacher point of view.
- Merlot (www.merlot.org) is a multimedia educational resource database. The approach toward quality in this initiative is through peer reviewing. Anyone can publish materials, but there are editors/reviewers who look at (as much as possible) resources and write a qualitative review using a standard format. These resources can be found as peer reviewed materials. Another strong point is formed by the communities in which materials are added, aggregated, peer reviewed and discussed.
- Connexions (www.cnx.org) is another initiative that allows anyone to contribute content. Their approach to sustaining quality is also distributed: persons and organizations can start one or more lenses. The owner of the lens (an organization or person) can then allow persons (for example to add content to the lenses. In that way, the lens owner endorses content. Lenses typically focus on quality or on topic (or both) and can have their own interface. For example, travellers in the Middle East have a list of about 40 texts in their lens. A tag cloud shows the contents of these materials, making it easy to find relevant materials about the tagged concepts.
- Nixty (www.nixty.com) is a community-based site for people that want to learn. Members can start new communities about anything. There is an authority index for every contribution. Existing online content can be organized by anyone using an intuitive lesson and course authoring environment.
- OpenStudy (http://openstudy.com/) is another community-based initiative supported by the OCW consortium in providing a social layer on top of the OCW courses and other content. Students and teachers can interact with each other, create and manage so-called 'studypads', and follow what is happening and being said. Answering questions and supporting each other is the core of this community.

4.1 Conclusions about existing portals

The above portals were reviewed before and during the Delft meeting. The shared view can be summarised as follows. Top-down structures, relying on a number of key persons, have a small basis that may be too small. In a decentralised structure anyone can be a contributor, and the end-users are empowered with tools and tutorials to sustain the environment. individuals are able to contribute, review, comment on, rate, and add metadata to resources themselves. On these sites, such as LabSpace, Connexions, OER Commons and

MERLOT end-users are given tools and explanation on how to do this, but no or little centralized support. PEMCWebLab provides a simple and clear solution to the presentation of the experiments, but it is not a community model. A networked learning model, explained in the next chapter, meets most of the constraints put forward in the current chapter and may have the best sustainability.

5 Short overview of learning theories

This literature review introduces several traditional and recent views on learning. Based on this overview, it describes an approach to learning that is most applicable to the project and takes into account the most recent developments in the field of learning and education. The results of the analysis are used in the development of functional requirements for the design and implementation of the LiLa portal.

In specific, this literature review connects learning theories and opportunities enabled by the Web. LiLa, being a web-based online environment, should be designed according to these latest views on learning and pedagogy. This chapter will show how the current practices align with these views, and what the role of LiLa can or must be.

5.1 Introduction

The Internet and the numerous online communities of practice and professional networks provide opportunities for informal, self-regulated and networked learning. Above all, the open character offers relatively cheap access for individual learners worldwide to connect with people and find relevant content. The Internet is an environment in which skills can be developed that are needed in a technology driven, and rapidly changing society (J. S. Brown & Adler, 2008). The skills that learners develop in regular education systems are different from those developed in peer-based communities (Soekijad, Huis in 't Veld, & Enserink, 2004; G Stahl, 2003; Etienne Wenger, 2000). The first part of this chapter will focus on learning theories and the relevance of the Internet for learning.

The second part of this chapter follows from the first part, where we conclude and propose a specific pedagogical approach for LiLa. Based on this approach, we focus on online communities as a place for learners and teachers to advance their knowledge and connect. The coming decades, we will see the emergence of institutions and systems that sustain high-quality learning in online communities (D. A. Wiley & Edwards, 2002). In order to create sustainable online environments for learners to engage in peer-based learning, we must recognize and address both the opportunities and challenges facing us. Quality management, assessment and recognition, and motivation to collaborate or to share information are just a few of the challenges (Caswell, Henson, Jensen, & D. Wiley, 2008; Davidson & Goldberg, 2009; Hylén, 2007; Hylén, 2006; Iiyoshi & Kumar, 2008; Klotz, 1999; Pascual et al., 2006; Veen, Staalduinen, & Hennis, 2010).

The final part of this chapter draws conclusions from literature on engagement and motivation to determine design requirements describes the role of social mechanisms.

5.2 Developments in learning theories

Below, a brief overview of the development of learning theories is given, based on Bransford et al. (Bransford, A. Brown, & Cocking, 1999).

Drawing on the empiricist tradition, behaviorists conceptualized learning as a process of forming connections between stimuli and responses. Motivation to learn was assumed to be driven primarily by internal drives, such as hunger, and the availability of external forces, such as rewards and punishments (e.g., (Skinner, 1950; Thorndike, 1913)). A limitation of early behaviorism stemmed from its focus on observable stimulus conditions and the behaviors associated with those conditions. This orientation made it difficult to study such phenomena as understanding, reasoning, and thinking—phenomena that are of paramount importance for education. Over time, radical behaviorism gave way to a more moderate form of behaviorism that preserved the scientific rigor of using behavior as data, but also allowed hypotheses about internal "mental" states when these became necessary to explain various phenomena. In the late 1950s, the complexity of understanding humans and their environments became increasingly apparent, and a new field emerged—cognitive science. From its inception, cognitive science approached learning from a multidisciplinary perspective that included anthropology, linguistics, philosophy, developmental psychology, computer science, neuroscience, and several branches of psychology (Newell & Simon, 1972; Norman, 1980). New experimental tools, methodologies, and ways of postulating theories made it possible for scientists to begin serious study of mental functioning: to test their theories rather than simply speculate about thinking and learning (see, e.g., (Anderson, 1982; Ericsson & Charness, 1994; de Groot, 1965; Newell & Simon, 1972), and, in recent years, to develop insights into the importance of the social and cultural contexts of learning (e.g., (B. R. Cole, 1996; Lave, 1988; Lave & E. Wenger, 1991; Rogoff, 1990; Tudge & Rogoff, 1999).

5.2.1 The social nature of learning

Constructivism is the psychological theory, which argues that humans construct knowledge and meaning from their experiences (Bruner, 1991; Piaget & Cook, 1952; Vygotsky & M. Cole, 1978). Constructivist educational theory focuses on concept development and deep understanding, rather than behaviors or skills, as the goals of instruction(Amory & Seagram, n d). Personal development and deep understanding happens through the construction of meaning by the learner self, not through transmission from one person (the teacher) to another (the learner). The fundamental principle of constructivism is that learners actively construct knowledge through interactions with their environment (Hout-Wolters, Simons, & Volet, 2000)(Rieber, 1996). Therefore learners are viewed as constructing their own knowledge of the world.

For effective learning, knowledge should be uniquely constructed by people through play, exploration and social discourse with others. Learning objectives *presented in constructivist learning environments should be firmly embedded in context, and should, at least in some way, represent every day life situations. Learners should also accept responsibility for their own learning and be self-motivated to explore different knowledge domains. (Amory & Seagram, n d)*

The central point of social-constructivism is an individual's making meaning of knowledge within a social context (Vygotsky & M. Cole, 1978). Learning as a social practice is well established and dialogue is one of the corner stones of social constructivism. This makes online communities such potentially effective places for learning. The interactions in online communities is being maintained through a sense of community and social capital through information flow, altruism, reciprocity, collective action, identities, and solidarity to support the development of democracy(Ackerman et al., 2004; Bouman et al., 2007; Kollock, 1999; McLure-Wasko & Faraj, 2005a). These are central elements that need attention in an online social learning context.

The illustration below shows development of learning theories in the 20th century. These three approaches are acknowledged as the three traditional strands in pedagogy. The following paragraphs will elaborate on more recent developments.

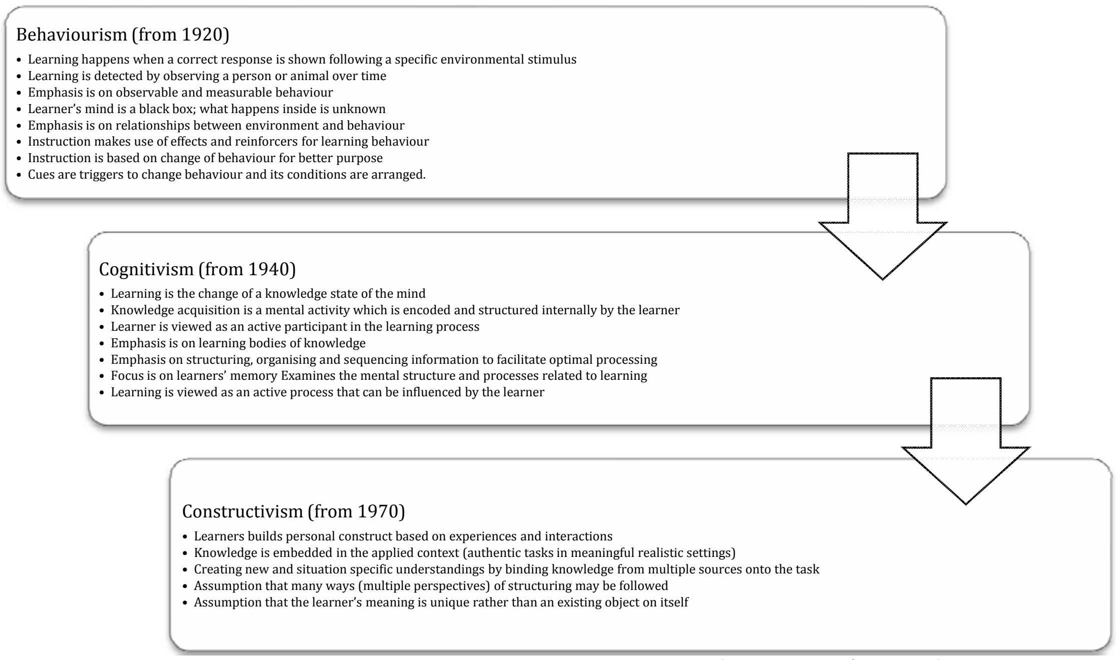


Figure 4 - Traditional strands in learning and pedagogy (van Der Zanden, 2009)

5.2.2 Learning in communities

The term 'situated learning' locates learning in the process of co-participation and in the field of social interaction, not in the head of individuals to get an inter-subjective understanding and meaning of something(Lave & E. Wenger, 1991). In communities, learning means moving from the peripheral (lurking, being introduced into processes, people, etc) into the center (sharing expertise, making decisions). Peripheral participants do not accumulate knowledge and skills but are introduced in processes, routines, networks, relevant issues, and approaches within the community. *"The individual learner is not gaining a discrete body of abstract knowledge which (s)he will then transport and reapply in later contexts. (…) There is no necessary implication that a learner acquires mental representations that remain fixed thereafter, not that the 'lesson' taught consists itself in a set of abstract representations"* (Allert, 2004).

Learning as knowledge creation is seen as the epistemological foundation of CSCL, Computer Supported Collaborative Learning. Paavola, Lipponen and Hakkarainen explain the "knowledge-creation" metaphor of learning as follows; *"Learning is seen as analogous to processes of inquiry, especially to innovative processes of inquiry where something new is created and the initial knowledge is either substantially enriched or significantly transformed during the process"* (Paavola, Lipponen, & Hakkarainen, 2004). Hence, learning goes beyond the information given.

Since traditional models of distance learning have not inspired researchers and teachers to develop innovative pedagogical practices, current research and development work in the field has turned towards creating multi-faceted pedagogical practices, utilizing ICT, that can support learners in their efforts to engage in deeper-level learning and interaction (G Stahl, 2003). Allert writes that in modern knowledge societies, there is a need for scenarios that focus on collaborative processes of creating innovative knowledge (Allert, 2004). This type of learning comprises of open, ill-structured problem solving processes, focuses on communication and collaboration.

Stahl emphasizes that meaning is collaboratively produced in a cultural context, embodied in a physical or semantic artefact, and is situationally interpreted within a community or social system (G Stahl, 2003). He refers to learning as shared meaning making, which is not understood as a psychological process which takes place in individuals' minds but as an *"essentially social activity that is conducted jointly - collaboratively -- by a community, rather than by individuals who happen to be co-located"*. Meaning is not transferred from one thinker to another, but is constructed.

Processes of knowledge construction and shared meaning making happen increasingly in virtual environments, such as games, online communities and forums. CSCL aims at supporting this type of learning through the design of powerful learning and communication environments integrating collaborative learning and the use of ICT (Gerry Stahl, Koschmann, & Suthers, 1999).

Social mechanisms that address internal cohesion and sense of community are important for learning and overall sustainability of a social learning environment, but so are mechanisms that impact interaction with the external environment (Hennis & Kolfschoten, 2010), including reputation and recognition.

5.2.3 Learning with understanding

Historically, education has focused more on memory than understanding. An emphasis on understanding leads to one of the primary characteristics of current theories of learning: its focus on the processes of knowing (Piaget & Cook, 1952; Vygotsky & M. Cole, 1978). Humans are viewed as goal-directed agents who actively seek information. They enter a learning process with a range of prior knowledge, skills, beliefs, and concepts that significantly influence what they notice about the environment and how they organize and interpret it (Lave, 1988; Lave & E. Wenger, 1991). This, clearly, can have both positive and negative consequences for the learning process and their abilities to remember, reason, solve problems, and acquire new knowledge. Effective learning environments, effective support systems for learning, and effective teachers therefore take into account the background of a learner.

5.2.4 Control over learning

New developments in the science of learning also emphasize the importance of helping people take control of their own learning. Since understanding is viewed as important, people must learn to recognize when they understand and when they need more information. Effective learning environment therefore focus on sense-making, self-assessment, and reflection on what worked and what needs improving (Paris & Winograd, 2003; Siemens, 2005; G Stahl, 2003; Gerry Stahl, Koschmann, & Suthers, 1999).

5.2.5 Networked learning

Learning is becoming a lifelong, self-directed and collaborative effort, in which one engages with people and finds resources online. Learning institutions should focus on supporting this process, and guide students in assessing and evaluating knowledge they encounter online. Leaders at learning institutions need to adopt a more inductive, collective pedagogy that takes advantage of the collaborative and participative spirit of our era and the potential of the internet to connect people, link information sources, and support creativity. Rather than individual learning based on competition and hierarchy, is a more networked model of learning preferred, because it allows learning from peers, and stimulates cooperation, partnering, and mediation(Davidson & Goldberg, 2009).

Networked learning focuses on interconnectedness between people and between people and resources (M. D. E. Laat & Lally, 2003; M. D. Laat, 2006; Veldhuis-Diermanse, Biemans, Mulder, & Mahdizadeh, 2006; Vries, 2008). Technology is used to integrate delivery of knowledge with interaction, communication and application (Jones & Steeples, 2001). The earlier mentioned concept of Communities of Practice (Etienne Wenger, 2000) is integrated in Networked Learning, because learning practices and social practices are interconnected, the learning practices emerge from participants rather than be imposed by facilitators, learners are involved in concrete practical actions together, learning is not designed, rather designed for, variation in levels of expertise can expand the group's learning, networked learning needs to support visits to "otherness" (Paavola, Lipponen, & Hakkarainen, 2004).

5.2.6 Connectivism

Widely adopted learning theories behaviorism, cognitivism, and constructivism, and combinations of them, do not sufficiently explain the effect of technology in our lives and learning activities. George Siemens and Stephen Downes have attempted to explain learning in a digital age by combining and enhancing different learning views, and developed Connectivism (Downes, 2005; Siemens, 2005; 2006). An important distinction from social constructivism is the emphasis on the fact that knowledge does not need to be internalized and emphasizes that learning also happens outside a person's mind. Siemens argues that in the Information Age the learning process concerns activities such as synthesizing and recognizing patterns, meaning making, and forming connections between specialized communities. Know-how and know-what is supplemented with *know-where* as the understanding of where to find the knowledge needed. Connectivism addresses learning outside the person, knowledge stored in databases or other electronic information holders accessible throughs the Internet. It describes a form of knowledge and a pedagogy based on the idea that knowledge is distributed across a network of connections and that learning consists of the ability to construct and traverse those networks. This implies a pedagogy that seeks to describe 'successful' networks, as identified by their properties, such as diversity, autonomy, openness, and connectivity; and seeks to describe the practices that lead to such networks, both in the individual and in society (Downes, 2005). Connectivism extends the notion of learning as a personal, internal change (Illeris, 2003) to a network change: Non-human elements act as actors in the network and the medium itself is part of wider networks.

5.3 Characteristics of effective learning environments

Four perspectives on the design of learning environments—the degree to which they are student centred, knowledge centred, assessment centred, and community centred—are important for the development of these environments.

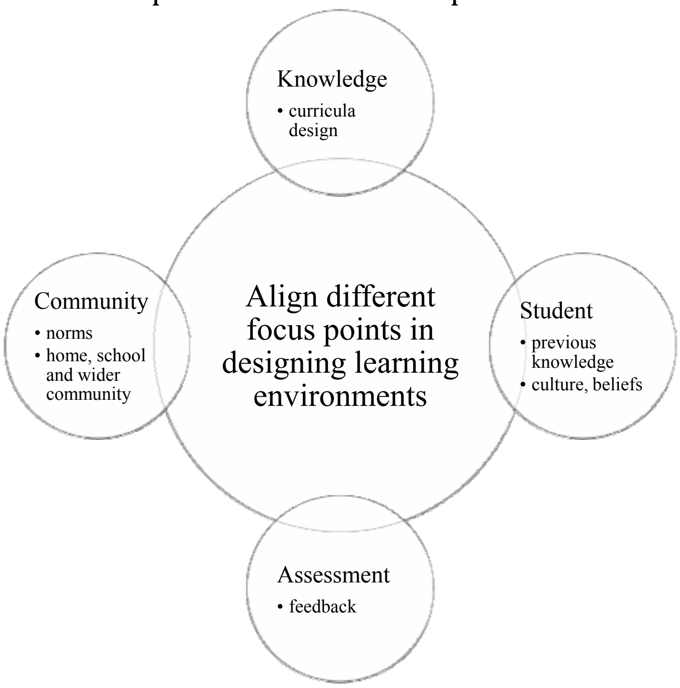


Figure 5 - Design of learning environments

A focus on the degree to which environments are learner centred is consistent with the strong body of evidence suggesting that learners' use their current knowledge to construct new knowledge and that what they know and believe at the moment affects how they interpret new information. Sometimes learners' current knowledge supports new learning, sometimes it hampers learning: effective instruction begins with what learners bring to the setting; this includes cultural practices and beliefs as well as knowledge of academic content.

Learner-centred environments attempt to help students make connections between their previous knowledge and their current academic tasks. Parents are especially good at helping their children make connections. Teachers have a harder time because they do not share the life experiences of each of their students. Nevertheless, there are ways to systematically become familiar with each student's special interests and strengths.

Effective environments must also be knowledge centred. It is not sufficient only to attempt to teach general problem solving and thinking skills; the ability to think and solve problems requires well-organized knowledge that is accessible in appropriate contexts. An emphasis on being knowledge centred raises a number of questions, such as the degree to which instruction begins with students' current knowledge and skills, rather than simply presents new facts about the subject matter. While young students are capable of grasping more complex concepts than was believed previously, those concepts must be presented in ways that are developmentally appropriate. A knowledge-centred perspective on learning environments also highlights the importance of thinking about designs for curricula. To what extent do they help students learn with understanding versus promote the acquisition of disconnected sets of facts and skills? Curricula that emphasize an excessively broad range of subjects run the risk of developing disconnected rather than connected knowledge; they fit well with the idea of a curriculum as being a well-worn path in a road. An alternative metaphor for curriculum is to help students develop interconnected pathways within a discipline so that they "learn their away around in it" and not lose sight of where they are. Issues of assessment also represent an important perspective for viewing the design of learning environments. Feedback is fundamental to learning, but opportunities to receive it are often scarce in classrooms. Students may receive grades on tests and essays, but these are summative assessments that occur at the end of projects; also needed are formative assessments that provide students opportunities to revise and hence improve the quality of their thinking and learning. Assessments must reflect the learning goals that define various environments. If the goal is to enhance understanding, it is not sufficient to provide assessments that focus primarily on memory for facts and formulas. Many instructors have changed their approach to teaching after seeing how their students failed to understand seemingly obvious (to the expert) ideas.
The fourth perspective on learning environments involves the degree to which they promote a sense of community. Ideally, students, teachers, and other interested participants share norms that value learning and high standards. Norms such as these increase people's opportunities to interact, receive feedback, and learn. There are several aspects of community, including the community of the classroom, the school, and the connections between the school and the larger community, including the home. The importance of connected communities becomes clear when one examines the relatively small amount of time spent in school compared to other settings. Activities in homes, community

centres, and after-school clubs can have important effects on students' academic achievement.

Finally, there needs to be alignment among the four perspectives of learning environments. They all have the potential to overlap and mutually influence one another. Issues of alignment appear to be very important for accelerating learning both within and outside of schools.

Good teachers are learner centred in the sense that teachers build on the knowledge students bring to the learning situation. They are knowledge centred in the sense that the teachers attempt to help students develop an organized understanding of important concepts in each discipline. They are assessment centred in the sense that the teachers attempt to make students' thinking visible so that ideas can be discussed and clarified, such as having students (1) present their arguments in debates, (2) discuss their solutions to problems at a qualitative level, and (3) make predictions about various phenomena. They are community centred in the sense that the teachers establish classroom norms that learning with understanding is valued and students feel free to explore what they do not understand.

5.4 Principles for effective learning

The previous sections describe the developments in learning theories and more recent pedagogical approaches. When teachers or students make use of the LiLa portal or the content hosted on it, they must not be forced into any of the described pedagogical approaches. Even when research points out that some approaches can be more effective than others, the aim of the project is not to change pedagogical practices around the world. Rather, it hopes to facilitate as much learning as possible in any educational or pedagogical context. Based on the previous sections, we propose some principles for effective learning. People's abilities to transfer (e.g. apply or relate) what they have learned depends upon a number of factors:

1. People must achieve a threshold of initial learning that is sufficient to support transfer. This obvious point is often overlooked and can lead to erroneous conclusions about the effectiveness of various instructional approaches. It takes time to learn complex subject matter, and assessments of transfer must take into account the degree to which original learning with understanding was accomplished.
2. Spending a lot of time ("time on task") in and of itself is not sufficient to ensure effective learning. Practice and getting familiar with subject matter take time, but most important is how people use their time while learning. Concepts such as "deliberate practice" emphasize the importance of helping students monitor their learning so that they seek feedback and actively evaluate their strategies and current levels of understanding. Such activities are very different from simply reading and rereading a text.
3. Learning with understanding is more likely to promote transfer than simply memorizing information from a text or a lecture. Many classroom activities stress the importance of memorization over learning with understanding. Many, as well, focus on facts and details rather than larger themes of causes and consequences of events. The shortfalls of these approaches are not

apparent if the only test of learning involves tests of memory, but when the transfer of learning is measured, the advantages of learning with understanding are likely to be revealed.

4. Knowledge that is taught in a variety of contexts is more likely to support flexible transfer than knowledge that is taught in a single context. Information can become "context-bound" when taught with context-specific examples. When material is taught in multiple contexts, people are more likely to extract the relevant features of the concepts and develop a more flexible representation of knowledge that can be used more generally.
5. Students develop flexible understanding of when, where, why, and how to use their knowledge to solve new problems if they learn how to extract underlying themes and principles from their learning exercises. Understanding how and when to put knowledge to use—known as conditions of applicability—is an important characteristic of expertise. Learning in multiple contexts most likely affects this aspect of transfer.
6. Transfer of learning is an active process. Learning and transfer should not be evaluated by "one-shot" tests of transfer. An alternative assessment approach is to consider how learning affects subsequent learning, such as increased speed of learning in a new domain. Often, evidence for positive transfer does not appear until people have had a chance to learn about the new domain—and then transfer occurs and is evident in the learner's ability to grasp the new information more quickly.
7. All learning involves transfer from previous experiences. Even initial learning involves transfer that is based on previous experiences and prior knowledge. Transfer is not simply something that may or may not appear after initial learning has occurred. For example, knowledge relevant to a particular task may not automatically be activated by learners and may not serve as a source of positive transfer for learning new information. Effective teachers attempt to support positive transfer by actively identifying the strengths that students bring to a learning situation and building on them, thereby building bridges between students' knowledge and the learning objectives set out by the teacher.
8. Sometimes the knowledge that people bring to a new situation impedes subsequent learning because it guides thinking in wrong directions. For example, young children's knowledge of everyday counting-based arithmetic can make it difficult for them to deal with rational numbers (a larger number in the numerator of a fraction does not mean the same thing as a larger number in the denominator); assumptions based on everyday physical experiences can make it difficult for students to understand physics concepts (they think a rock falls faster than a leaf because everyday experiences include other variables, such as resistance, that are not present in the vacuum conditions that physicists study), and so forth. In these kinds of situations, teachers must help students change their original conceptions rather than simply use the misconceptions as a basis for further understanding or leaving new material unconnected to current understanding. The idea that all learning involves transfer from previous experiences must include more than an analysis of the individual concepts and beliefs that students bring with them; it must include an analysis of cultural practices. Many aspects of school failure can be explained as a mismatch between what students have learned

in their home cultures and what is required of them in the school culture. Issues of cultural practice are extremely important for understanding the multiple ways that students learn and for helping them achieve learning fluency.

The above analysis is still too generic to come to a detailed pedagogical strategy. We therefore developed a number of scenarios and related storyboards in order to make the above more specific for the LiLa project. These storyboards have been created in close collaboration with the partners.

6 Pedagogical Strategy

On the one hand, learning has to be designed, on the other hand, learning outcomes depend on the actions of the learner. Learning needs to focus on understanding rather than memorization, and preferably should be applicable in multiple areas in practice. Learning is always contextualised and what is learned depends on previous experiences. Students must be stimulated to link the learning materials to what they already know, as well as to what is important in the discipline and in the community of professionals in which they want to function. Assessment must be in line with the learning goals a learner has when doing an assignment or series of tasks.

The characteristics of effective learning environments and the principles for effective learning as discussed in the current chapter are the main frame of reference for the selection of the components that are used for the development of the pedagogical model for the Lila portal. This model is called 'Networked Learning' and a business version has been developed and put in practice in 2008. The model will now be re-engineered for the Lila setting and is explained below.

6.1 Networked Learning Model for LiLa

The LiLa portal needs to be designed according to the latest insights in learning and technology for science education. This starts with the design of the homepage, and also concerns the design of the environment, tagging of the contents (conceptual as well as pedagogical), the search engine, ratings and usage information.

In the current section, we describe a pedagogical approach for presenting the content of the LiLa portal, whereby we as much as possible respect what is going on at the sites of the participating partners. The approach is called the Networked Learning model, proposed in papers from Delft University (Veen, Lukosch, & Vries, 2008), see Figure 6. We will first explain the model and the implications for the pedagogical design of the LiLa experiments and simulations. In the chapter that follows after that, we present a concrete scenario for developing the pedagogical embedding of a simulation or remote experiment for the portal, employing the recommendations from the Networked Learning model.

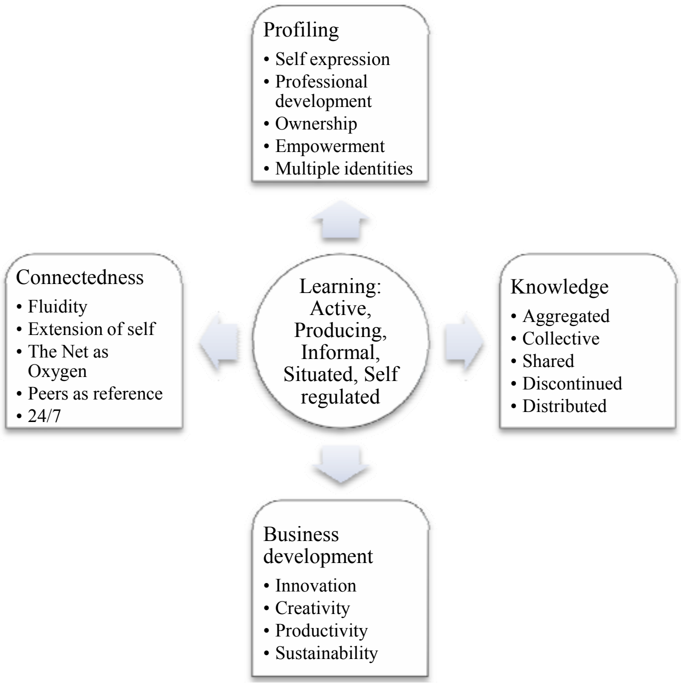


Figure 6 - Components of the Networked Learning model (Veen)

Networked Learning refers to a context in which internet-based information and communication technologies are used to promote connections: between participants; between participants and external experts; between a learning community and its learning resources, so that participants can extend and develop their understanding and capabilities in ways that are important to them, and over which they have significant control. We can see the LiLa portal as facilitating the learning of a community of users. We speak about a community of users because we think that in the networked society users must share some responsibility for the well-being of the portal. Users are students as well as teachers. Teachers use resources, support learners, develop and adapt learning materials (simulations and remote experiments), and may be available as experts to consult by students. Students use resources, support other users, evaluate the use of learning materials and can act as peer tutors for other students.

The ingredients components of the Networked Learning model (figure 2) are organized into four complementary areas that play an important role in knowledge development. Each of the components elements that are connected to these areas is relevant for this development process in which the technology is a major facilitator for the processes of communication, for information retrieval and information sharing. The areas are: Profiling, Connectedness, Knowledge and Business Development.

- ‘Profiling’ is the area describing a collection of social and organizational aspects of how users in their own context, and in the context of the LiLa portal. It states that individual users should take ownership of their professional development, ICT enabling them to do this through social software tools. One of the aspects of the effect of using LiLa tools should be found in the area of profiling. A way for teachers of profiling is act as a tutor (individual online support, for example in forums), coach (general support on

specific areas), or scaffold (provides handhelds for students to bring them further), and instructor (writes instructions and manuals). Students can also profile their presence as helper and peer-tutor, or as a critical but presently evaluator of learning materials.
- 'Connectedness' stands for the connection between people and people and resources. It relates to social networks and the way interaction and human relations are relevant for people to perform in communities. These communities are fluent; you can take part for some time depending on the purpose of the community and leave when the need is gone. Communities are based on peer references and are not limited to office hours.
- 'Knowledge' is the area that defines content and information in the Network Learning Model. This content is distributed and discontinuous, stored in databases. Learners have to aggregate bits and pieces (modules) into a meaningful whole. They do this collaboratively, sharing their expertise with others.
- 'Business Development' is the area that describes the major companies' business goals, what they offer and for what purpose. These goals are the reference framework within which learning takes place, it provides the organizational context (e.g. Dept. of Physics, Univ. of Thessaloniki). Business models in LiLa are the local curriculum or faculty making use of some or all of the affordances of the LiLa portal, and collaborating with other to develop standards and credits that transfer the boundaries of individual partners.

6.2 Pedagogical and design principles

The Networked learning model and the chapter on learning lead us to propose the following pedagogical requirements for the LiLa portal and embedded content, as a networked learning model:

1. Any user entering the LiLa portal is entering **a world of knowledge**, in which other users are present. Other users can be other students, but also experts and teachers, from various nationalities. Knowledge is embedded in simulations, remote labs and other educational resources (instructions, links, media). All this should be immediately clear when entering the portal, and when entering the area for a simulation or remote lab.
2. Users that participate in the community should **register and have a profile**, both as teacher (expertise, availability, specific ownership of simulations and experiments) and as students (expertise, experiments and simulations visited, available as tutor for…, has evaluated…).
3. Every experiment and simulation is **linked to a community** of users of that particular experiment or simulation. The author or authoring institution is indicated, as well as the courses in which it had a function, and profiles of the previous users. When finished, users have to leave some evaluation or comment about the use.
4. Experiments and simulations each have explicit **learning objectives**, adapted for various learner groups, authenticity, individual or collaborative use, and instructions allowing independent use or whom to address in case of problems, and other resources, if available.
5. Materials developed for collaborative, and/or authentic assignments with the simulations/remote labs have to promote **sharing expertise** with others, and have to be embed the simulation or remote lab in a **realistic practical**

context. Learning activity produces some **knowledge artefact** that can be used and evaluated.

6. Materials developed for individual use of the simulations/remote labs have to promote **active learning** (student learns through exploration and self-regulation), not needing too much guidance and predefined answers. Learning activity produces some knowledge artefact that be evaluated.
7. Teachers that use experiments and simulations in a new way, developing their own learning materials, are invited to **share instructional materials** with the community, so that the amount of assignments around each simulations and remote labs will continue to grow.
8. Participant organisations **commit to the sustainability** of the portal, and are invited to propose their goals on using and further development of the LiLa portal.
9. New organisations can join the LiLa portal, under the condition that they contribute with one or more simulations or remote labs. These organisations are also invited to formulate goals on use and development of the portal.

6.3 Pedagogical developers guide

In this section we further develop the pedagogical principles for the design of the pedagogical layer of simulations and remote experiments. For this guide, we have the development of showcases in mind, meaning that we suppose that the simulations and remote experiments already exist at the partners site, and need embedding in the Lila pedagogical model. Also, we do not discuss technical requirements, although they are an obvious collateral to what we propose. Hence, we propose a next version of this guide with amendments from technical experts and other developers (portal, evaluation), when available.

Figure 7 below sketches the pedagogical elements for a showcase in the LiLa portal. It is based on the Delft Pemcweblab portal, and in no way represents the actual LiLa portal. We briefly discuss the elements.

Module 3.3: DC Motor (developed by the partner P12 - Technical University, Trencin, Slovak Republic)

Learning Objectives		**Assignments of DC Motor**
• Verify the basic principles of DC machinery • Show the principles of DC motor with shunt excitation • Demonstrate the influence of applied mechanical load on values of current supply • Understood the possibilities, advantages and disadvantages of DC Machinery with shunt excitation		• Control the DC motor speed • Control and check the excitation current and armature current • Control the mechanical load on motors shaft • Measure the output voltage and current • Control of output voltage • Calculation and evaluation of secondary parameters as input and output power, efficiency

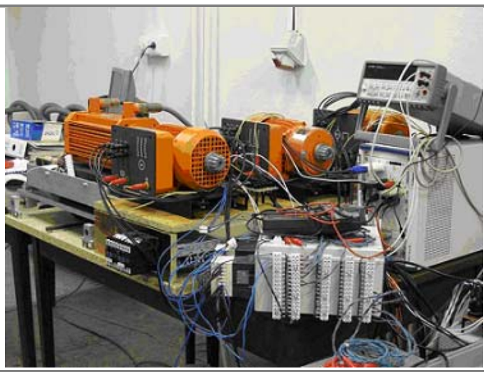
Experiment Description		Community
User is able to set the speed of shunt excited DC motor. After reaching the obtained value the mechanical torque can be applied on motors shaft and the response of DC motor (change of supply current) can be obtained.		comments from teachers comments from students related experiments

Figure 7 - Example of pedagogical elements in the LiLa portal

As can be seen we propose (in addition to a **title**, and an **owner**) four different pedagogical elements and a picture for **each** simulation or experiment:

1. Learning objectives: what are users supposed to learn when they do this experiment or work with this simulation? Learning objectives can cover knowledge, understanding and use of concepts, and/or processes, but also acquiring certain skills. Specifying learning objectives is not easy to do out of context of a course or project. Therefore, objectives are usually linked to assignments and courses in which they are embedded. Nevertheless, try and formulate objectives that serve the experiment or simulation as stand-alone. Objectives within context are part of the assignments/tasks section.
2. Description of the experiment/simulation: a factual description of what happens, or is supposed to happen in case of successful use, so that the potential user can realistically estimate and understand what he/she is up to. If something (an artefact) is produced, it should be clear what it is. We can imagine a link to a short movie here.
3. Assignments/tasks: the material does not run by itself, but has a purpose, and especially, a context. This context can be a course in which it is embedded, or a series of experiments, a project, a manual, etc. So, here we could have descriptions of the course, the series, the project, or links to the corresponding web-site, or Moodle pages. For any user, before the click it should be clear what the assignments will be like. If isolated experiments can be done, this is the place to find the manual, and where to store the results. It should be clear if the user is a teacher or a student, as instructional material for each may be quite different. The material for teachers should contain information on the contextual constraints of the assignment or simulation, the level of required experience, and the kind of support that is needed or available. At this level also, we should know if the assignment is individual or collaborative.
4. Community: users are supposed to leave traces of their use, and here they can find the links to the forum, user group, evaluation wiki, or mail address in order to share their ideas. Also, relevant experiences by former users can be found here. Both students and teachers need to be served here. This 'community-based' part is explained in more detail in the final chapter of this report, because it is embedded in the functional design of the portal.

All this is still the front matter. When the user has entered the experiment, through the assignment portal, it should also be clear what happens with the results of the activity, where to send the score or the knowledge artefact that is produced. So, probably, some entry form is needed. The assessment is a crucial element for reaching the pedagogical goals, but it is particular for each user context. We suppose here that some data of use are being recorded, and sometimes an artefact is being created that can be evaluated in some way, and all this needs to be specified for **each** simulation or experiment.

Steps to take: answer or develop the following questions

1. Make a picture representing the simulation or experiment for the LiLa portal
2. Make a short movie in which (work of) the simulation or experiment is shown
3. Describe the experiment/simulation in words.
4. In what course is the simulation or remote lab being used?
5. Describe the assignment for the simulation or experiment.
6. What are the learning objectives?
7. Is it individual or collaborative?
8. What is the level of required experience?
9. What kind of support is needed or available?
10. How are the learning objectives of the simulation/remote lab assessed? Is there a product that can be evaluated (e.g., report, paper), or a fixed outcome or end score to achieve? Think also of ways to assess the process: what user-data are recorded?
11. What other courses/area's could benefit from using the simulation/ experiment?
12. What are practicalities that need to be considered when using the simulation or remote lab?
13. In what way can a user or teacher make use of the other practitioners and students connected online through the experiment?

The last point relates with the community-related, web-based part of doing an experiment. We have developed a functional design for the LiLa portal based on the literature analysis, the results of the interviews and a design workshop with LiLa participants (October 2009). This is discussed after the next chapter.

7 From scenarios towards storyboards

The "Library of Labs" is a unique access to virtual laboratories, remote experiments, transfer services, know-how transfer and opportunities for cooperation open to all European countries. This is especially of benefit to those countries and institutions that don't have the financial capacities to develop virtual laboratories or to set up remote experiments themselves.

The embedding of the experiments in the curricula ensures a very sustainable use of the eLearning content. The universities of the consortium (and as we suppose others as well) will have great interest in the new infrastructure since it will on the one hand improve the quality of the physics and engineering education and on the other hand reduce the costs of the experiments for every single partner.

Thus, partners have an intrinsic interest in using and supporting the LiLa infrastructure beyond the termination of Community funding.

Within WP3 we have developed a contemporary pedagogical philosophy for the project, to substantiate the aim of the LiLa infrastructure to continue after project termination. This infrastructure should on the one hand be flexible enough to accommodate existing educational scenarios, but also, offer opportunities for collaborative knowledge creation in a community framework.

At the same time, given the time and budget limitations of this project, we have to be pragmatic and not making everything possible. Therefore, WP3 has developed a limited number of five educational scenarios on the basis of current uses of online experiments within the different partner institutions. The scenarios has been worked out in 'to do' activities for teachers and students, called storyboards. During the Munich meeting these storyboards have been discussed and it was agreed that LiLa partners would further concretize the storyboards according to their existing teaching practices.

With this partners' input detailed functionalities and requirements for the LiLa systems can be defined, meta- vocabulary can be extended, and partners will be able to work on the first showcases to be ready within a few months.

This chapter summarizes the partners' input to the suggested storyboards and provides an overview for all partners of the current teaching practices and the need for looking ahead once the LiLa Portal will be implemented.

The first section presents the assignment sent to all partners. Then, briefly, the partners' input is discussed, including the consequences for the design of the LiLa Portal. It also shows several pedagogically sound scenarios in line with the feedback from partner institutes. Finally, you will find a reflection and recommendations for the design of the portal.

7.1 The assignment sent to the LiLa Partners

Below the letter to partners;

Dear All,
It was a very fruitful meeting in Germany! All Delft members enjoyed the enthusiasm of all of you and we have been working towards tangible tasks. One of which we would like to follow up on now. As time is flying, we would like to help you meeting the deadlines!

We have been discussing the Storyboard document ((SURFgroepen, shared documents, WP3, Storyboards 3a). In this document there are five different scenario templates, each covering a pedagogical perspective. For each scenario template, there is a storyboard, in which user actions (and system requirements) can be listed. As a first approximation there is a storyboard filled in for each scenario. It is not meant to be final and complete, but needs to be worked out and adapted by you, relative to your situation i.c. the use of the simulation/experiment that you want to offer as a showcase.

We have agreed that each of the content providing partners takes one (most fitting) scenario and consequent storyboard, adapts it to foreseen needs in a concrete context and makes concrete what users of the simulation or experiment, given the selected pedagogical scenario, would do (and therefore need) when using the LiLa portal.
For understanding the learning effects of users working with a simulation/remote experiment, the actions of the user when actually doing the simulation/experiment, need to be specified, or at least written down as detailed as we can. The important thing to realize is that at least the most important actions of learners with the simulations/experiments need to be easy to do, and maybe in some way supported by instructions, interactive tools, or feedback options.

The assignment is as follows:

Choose a scenario and fill in a detailed storyboard, describing in detail the actions of the teacher and students, as you might see teachers and students to work for your case. Your assignment here is: what should the teacher do and what should the student do when using an experiment within a chosen scenario? Use the first 2 columns as provided by the Storyboard document. By doing this you will complement, adapt or redesign the storyboard for your showcase.

Choose a specific experiment you have on offer for LiLa, and take your storyboard a step further by executing the actions you have designed in step 1. E.g. you will write the accompanying text with the experiment, the learning objectives, the assignments going with the experiment, the powerpoint or videoclip that students can watch before starting the experiment, etc.

Upload your storyboard (step 1) AND the materials coming from step 2 in the SURF groepen environment **at the latest on February 5th.**

The purpose of the whole exercise is twofold:
To link the pedagogy to the work packages on metadata, the design of the interface, and the affordances of the portal in general. With completed storyboards, we have an overview on further requirements for the interface and portal. Because work on the interface is expected to lead to a first version by half February, our assignments should be available by the end of next week.
To prepare your first showcase for the first version of the LiLa portal. This will give us insight in how we can make the system an easy-to-use environment for teachers and students alike. It might be great fun to have some of the experiments already uploaded in the portal during our Madrid meeting.

If you need help with the assignment, please mail the Delft team, we can arrange Adobe Connect meetings on your request.

Looking forward to your storyboards!

Cheers

Wim Veen
Alexander Verbraeck
Pieter de Vries
Jerry Andriessen
Thieme Hennis
Boris Shishkov

7.2 Summaries, comments and conclusions about received Storyboards

We received storyboards from Stuttgart, Berlin, and Linkoping. Basel & Cambridge have collaborated on a quite interesting version in Munich. For each of the partners we have been harvesting suggestions for functionalities of the LiLa Portal. It should be mentioned here that some of the homework seems to have been written from the perspective of the current situation where the LiLa Portal is still unavailable. The authors have interpreted the partners' input from the future situation where the Portal could enhance the possibilities of working and collaborating of students and teachers in a European wide system.

7.2.1 Stuttgart

The concrete example is an optional set of exercises (virtual simulations) for students to improve their understanding, but are not graded, nor evaluated. The focus of the storyboard is the work done by the teacher *outside* the LiLa infrastructure. Most of the instructional materials are being prepared and presented in the learning management system, from which hyperlinks to LiLa are leading to the virtual labs. The teacher has selected the simulations beforehand. Simulations are downloaded on the student's personal computer, not run from within the portal. This is the current situation where the LiLa Portal is still unavailable. Once the LiLa Portal is available teachers should be able to do the above-mentioned activities within the Portal.

Funtionalities for the LiLa Portal:

- Tool for uploading and downloading instructional materials that belong to an specific experiment by users (teachers and students alike)
- Tool for selection of experiments from the LiLa Portal
- System recording selections of experiments
- Tool for students to upload notes and comments related to a specific experiment.
- Tool for students to rate the experiment (thumb up – thumb down or a 5 star rating system)

7.2.2 Berlin

The concrete example Berlin has been working out is an existing exercise to be run on the Remote Farm about an oscillatory circuit. Here also, the main platform for the course is currently a learning management system, where the teacher has prepared materials and links. Berlin has remote experiments, which require the use of a booking system, and as a consequence, the use of these experiments would run in the LiLa Portal. Students log into LiLa to read or download instructions, book a timeslot, perform the experiment, discusses with others, makes notes, searches feedback, and produces a solution (report) on LiLa.

Functionalities for the LiLa Portal:

- Tool recording experiments selected by teachers
- Tool recording the number of students selecting experiment X
- Tool to upload and download instructional material belonging to an experiment
- Booking system of timeslots for remote experiments
- Tool for students to upload notes, comments, reports (final solution), and download instructional material belonging to an experiment
- Tool for students to locate other users, or coaches to discuss (synchronous or asynchronous)
- Tool for communication between student & teacher for making appointments and link to relevant materials
- System records # and content of interactions with other users and coaches, working time spent on case, #uploading and #downloading
- System records time lag between question and answer (asynchronous)
- System records #teachers # students using instructional materials from teacher X
- System records # students # teachers logging in
- Relation between student data (of use of functionalities) and grade is computed
- System records # of loads and # usage of cases (per hour)

7.2.3 Linkoping

Linkoping has worked out three different options, none of which require intensive use of the LiLa infrastructure. This situation relates to the fact that the Swedish partners are working with the Modelica platform for which the added value of the LiLa Portal remains to be decided. Materials from this partner require using OpenModelica as a software platform. In the first option, only download of the platform from the existing DrModelica site is needed and cases can be performed locally. In a second option, a web browser is used to run simple experiments. In a third option an OpenModelica plugin can be used, supporting the HTML format.

7.2.4 Basel/Cambridge

This was the result of the workshop in Munich, where a case of collaborative learning was developed. In this case, teachers do not develop or select concrete exercises, but a more general, relevant problem for the students to solve. This is classroom work, in the first place. As a result, no fixed assignments can be prepared, but we need a flexible environment allowing students to search and select. Of course, technically, this may imply no different requirements, but there should be options for students that in the other cases were only available for teachers.

Functionalities for the LiLa Portal:

- Tool for students to upload and download instructional material belonging to an experiment
- Tool for students to search and select, and link to community forum
- Tool to open a case in joint window (on different computers)
- Communication tool for communication and interactive problem solving

7.3 General conclusions on the storyboards

Most of storyboards that were sent by the partners seem to assume that teachers will continue to work with their current learning management system (Moodle, ISIS, Blackboard…) in which teaching content (instructions, explanations, assignments…) is provided and the interaction between students and teachers is taking place. If this way of working will become common practice once the LiLa Portal will be available, the authors think the LiLa project is going to miss out a tremendous opportunity to become a partner among many other initiatives trying to share online experiments. The Phet initiative of the Colorado University is such an example. The LiLa Portal should definitely not become a mere database for teachers to download an experiment as this view is already surpassed by far through other existing projects. What makes the Phet initiative challenging is that teachers can easily step into the system, upload their materials and share experiences with others. Popular experiments are being translated for free by users into many languages and search options for users are simple and clear. Phet supports the exchange of different approaches of experiments by other teachers or students, and provides an ever-growing environment where teaching staff find ideas and new perspectives. There are many arguments for making LiLa an even better environment:

- Experiments require online access which can only be managed remotely from the LiLa portal. This cannot be handled by a learning management system. The solutions presented only work for virtual simulations.
- Teaching guides, teaching ideas, special assignments should find their place in LiLa. These educational materials should inspire others to add new ones or give feedback to the original authors.
- It cannot be expected that all our material is perfect all the way. On the contrary, we expect that in a living environment, improvements and updates, or additions for new scenarios will increase sustainability.
- And for collaboration: how is a collaborative session setup, who is taking care of synchronous activities on a case? Do we expect teachers or students to manage all of this themselves?
- Who does the tagging (metadata)? Do we really assume that one experiment fits only one type of scenario? Or that simulations can always be tied to one specific type of educational scenario? And if not, what metadata should be used?
- For evaluation: LiLa should provide tracing information on activities of students in order to know what the actual uses are. LiLa should provide the information which experiments are evaluated positively, which ones do teach best, what the relevant learning episodes for the simulations are. This information is crucial for teachers who want to ensure the quality and reputation of their teaching.

- At the community level: How is usage shared and updated? On what basis are simulations and remote experiments offered and revised? How will LiLa be sustained if it does not look alive and developing?

7.4 Scripts and scenarios for pedagogically sound cases in the LiLa portal

The above conclusions have been merged into a small set of pedagogically sound (example) cases for the LiLa portal. This section is an extension to and further concretization of the previously produced 'pedagogical developers guide' (D3.2) and the previous sections. It aims to provide concrete tips for the functional design of the LiLa portal. It extends the pedagogical strategy because we try and explain more concretely the pedagogical options for a proper integration of a case in the LiLa system. It is an extension to the first draft of the LiLa portal as we try and explain more concretely what is behind the options for users and how a case can make clear what it is about and what not, in terms of pedagogy.

It might at this point become necessary to describe, or at least constrain, the concept *pedagogic*. Pedagogic comprises all activity which, in principle, involves, supports, or lead to learning. *In principle* can be interpreted as a loosely structured sequence with an explicit learning goal in mind. Activity comprises teacher and learner actions, as well as activity embedded in the design of the environment and the learning task. Such activity is pedagogic as it does not merely concern correct execution of procedures or application of knowledge, but gaining new understanding from that activity as much as possible.

Pedagogic activity comes in various kinds. First, it is the activity of teachers, traditionally the main source of information, instruction, feedback and evaluation in a learning process. Teachers explain, instruct, direct, coach, and sometimes even understand their students. In the LiLa pedagogical vision, teachers are important and we have to clear about what teacher activities we imagine for each case in the portal. Of course, we cannot tell teachers what to do, but we can suggest and recommend, offering solutions for various types of teacher activity. An example of teacher centered use of LiLa experiments, and especially simulations, is as demonstrations during a course, or as small exercises to deepen understanding during a course, as is the case in the Modelica course in Linkoping.

Second, we have learner activities, that is, those actions (actions are micro-level activities, activities as we use the term refer to established practices in a learning session, such as a lesson comprising various actions) by learners (students) that are part of their learning process. In our vision, learner activities (and not teacher activities) define the learning process. In that vision, certain activities are considered more important than others: listening is less active than answering questions, finding a solution is more active than reading what the solution is, creating a knowledge artefact is more active than creating a solution, and learning in realistic situations would be more complete than learning to solve an isolated problem. More active, more complete, more constructive refer to positive connotations of a learning outcome.

We distinguish a third kind of pedagogic activity which is also by learners, and that is *group activity*, learning by groups that collaborate on solving problems, creating knowledge, preferably in authentic situations. Simulations and experiments can figure in such activities in various ways, either under the control of a teacher, or as part of activities under student responsibility. In our vision, group activities can be most constructive, and more constructive than individual learner activities, when embedded in an appropriate pedagogical setting. A community-based setting, where education is part of a larger sphere of living and working, extending to future goals and collective interests, would be the most fertile ground for any learning environment to survive its initial stages. In the following sections, we develop prototype scenarios of use of LiLa material available in the portal. This should serve as a guide for types of LiLa cases in the portal. The LiLa pedagogic strategy favors the collaborative and community-based scenarios.

7.4.1 Scenario 1: Teacher-led problem solving

For example: teacher from Cambridge working with Linkoping materials.

General description	In this ‘classic’ teacher led learning method the teacher verbally explains a subject to a group of students. He uses the blackboard/whiteboard to illustrate his story. The LiLa simulations are used as tool to help explore the problem or principle at hand, during class time. Besides the classically performed simulations, the teacher can use the LiLa portal to create a lab of experiments and exercises for the students to solve similar problems on their own or to prepare for the next class.	
Objective type **Content type**	List of course objectives Conceptual knowledge, rules & procedures	
Materials	Modelica tutorial and software; teacher selected lab of experiments	
Activities	Teacher ✪✪✪	Students ✪✪✪
1. Orientation	Talk & illustrate	Listen
2. Execution	Propose exercises Answer & ask questions	Solve exercises Ask & answer questions
3. Review	Examination	Answer questions
Guidelines for Lila	**Set of exercises:** LiLa should afford individual teachers to create a *group* of simulations/experiments belonging to the same course/session, and to be graded together. These exercises should closely match the desired objectives for the teacher. A frame for report of results should be developed. For this activity probably the following classes should apply: *success, part-success, unfinished, failure*.	
Issues:	Because exercises closely follow an existing textbook, it remains to be seen whether they would serve in isolation or with other methods. The pedagogical ontology should be quite specific here. This activity can be made more interactive with on-line (part-time) peer tutors available. An option to record teacher lectures and power points in the LiLa portal would enhance this scenario. Our pedagogical strategy would also recommend use of feedback features of the materials: evaluations, classifications, and discussions.	

7.4.2 Scenario 2.1: Independent student learning

For example: student from Greece working with Berlin remote experiment

General description	As part of a course in classical physics a teacher recommends his students to visit the LiLa portal to do experiments with [topic X].	
Example	http://remote.physik.tu-berlin.de/farm/index.php?id=160&L=1	
Objective type **Content type**	Understanding of topic X, which is a part of a larger course with multiple topics. Conceptual information, rules and procedures, level bachelor 2	
Materials	Course manual and literature, including topic X. Preferably the teacher has prepared a set of exercises for each topic, corresponding to entries in the LiLa portal.	
Activities	Teacher ✪	Students ✪✪✪✪
1. Orientation	Set of exercises	Read
2. Execution		Student visits the LiLa portal, studies the experiment, tries the exercises and produces a report
3. Review	Examination questions	Answer questions
Guidelines for Lila	The topic should be easily located from the portal, and the teacher has prepared by identifying the experiment as suitable for this particular objective. If properly prepared by the teacher, (s)he could verify the quality of the report of the experiment, and/or verify the answers to relevant examination questions. It should be quite easy for students to find an appropriate exercise	
Issues	This scenario means more preparation activity for the teacher than in the previous scenario, where a course and manual, and the appropriate exercises are already developed. The teacher could also leave it up to the students to deepen their understanding of a particular topic. In that case, the reporting (from the system) of student activity, and the level of that activity must be clear and obvious. Scrutiny of the exercise by the teacher is advisable, including reporting his/her estimations and evaluations. An option to record teacher lectures and power points in the LiLa portal would enhance this scenario. Our pedagogical strategy would also recommend use of feedback features of the materials: evaluations, classifications, discussions, communities. This version is not very interactive. The next activity (1.2) is an example with peer tutoring, as currently happens in Berlin.	

7.4.3 Scenario 2.2: Independent student learning with (peer) coaching

For example: student from Greece working with Berlin remote experiment.

General description	As part of a course in classical physics a teacher recommends his students to visit the LiLa portal to do experiments with [topic X].	
Example	http://remote.physik.tu-berlin.de/farm/index.php?id=160&L=1	
Objective type **Content type**	Understanding of topic X, which is a part of a larger course with multiple topics. Maybe also asking questions and argumentation could be among the objectives. Conceptual information, rules and procedures, level bachelor 2	
Materials	Course manual and literature, including topic X. Preferably the teacher has prepared a set of exercises for each topic, corresponding to entries in the LiLa portal.	
Activities	Teacher ✪✪	Students ✪✪✪
1. Orientation	Set of exercises	Read

2. Execution	Teacher can monitor progress on the forum. The teacher can answer questions, but answering can also be done by experienced students.	Student visits the LiLa portal, studies the experiment, tries the exercises and produces a report; questions can be asked on an electronic forum, some are answered by the teacher, some are commented on or solved by other students from the course. Ideally, questions are dealt with within a day
3. Review	Examination questions, or evaluate report	Answer questions or produce report
Guidelines for Lila	The topic should be easily located from the portal, and the teacher has prepared by identifying the experiment as suitable for this particular objective. If properly prepared by the teacher, he could verify the quality of the answers to relevant examination questions, to be corroborated by discussing student performance with the peer coaches. Indeed, the nature of student activities may matter here.	
Issues	The step to collaborative learning is not very big when students are asked to solve exercises as a group. Of course, in that case equal contributions and complexity of exercises must be somehow monitored. Our pedagogical strategy would also recommend use of feedback features of the materials: evaluations, classifications, discussions, communities.	

7.4.4 Scenario 3.1: Collaborative student learning

General description	Assignments that need to be solved in a small group.	
Objective type **Content type**	Collaborative understanding of domain knowledge, collaboration Conceptual, procedural, strategic, collaborative	
Materials	Collaborative exercises within a course manual	
Activities	Teacher ✪	Students ✪✪✪✪✪
1. Orientation	Set of exercises	Read
2. Execution	Teacher can monitor progress on the forum. The teacher can discuss with students, but this can also be done by experienced students.	Students visit the LiLa portal, study the experiment, try the exercises and produce a report; questions can be asked on an electronic forum, some are answered by the teacher, some are commented on or solved by other students from the course. Ideally, questions are dealt with within a day
3. Review	Examination questions, or evaluate report	Answer questions or produce report
Guidelines for Lila	A group with individual members should be identifiable (common space) Teachers (and group members) should get an overview of activities in the portal by other members Experiments and simulations that are more frequently used in previous group activities should be clearly identifiable.	
Issues	For an activity to be truly collaborative, some added value of collaboration must be obvious: distributed knowledge and information, joint construction, and, ultimately, joint goals superseding individual objectives. This requires open exercises of sufficient complexity.	

	An option would be to have small communities formed around complex actual questions, linked to relevant simulations and experiments. These independent groups try and solve or move ahead in the context of these problems. Scientists could also be part of the problem solving group.

7.4.5 Scenario 3.2: Collaborative student learning by knowledge creation

General description	Students receive a commission to (collaboratively) construct or create some knowledge object (apparatus, machine, tool, etc), preferably to be actually used in the real world. The assignment comes as a project during which (by the coach or by the students themselves) several subtasks are carried out. These subtasks may also concern knowledge objects created by other teams.	
Objective type **Content type**	Knowledge creation Conceptual, rules, procedural, application, collaboration, regulation	
Materials	Various An expert team (teacher, domain experts)	
Activities	Teacher ✪	Students ✪✪✪✪✪
1. Orientation	Discussion about commission and planning	Discussion about commission and planning
2. Execution	Coaching and monitoring	Various experiments, produce knowledge object
3. Review	Evaluation of report and product	Construction of report (joint or individual) and product
Guidelines for Lila	A group with individual members should be identifiable Teachers (and group members) should get an overview of activities in the portal by other members Experiments and simulations that are more frequently used in previous group activities should be clearly identifiable Reports and knowledge objects should be available for further use	
Issues	For knowledge creation, members should have a joint objective of constructing something (new). A (virtual) space for discussing and storing intermediate results should be available. A community site would be prerequisite, as well as links to other relevant communities.	

7.5 Suggestions for the functional design

How can we make the LiLa Portal an attractive environment that is up to date with the current trends and developments, within the time framework of the project?

7.5.1 Simplicity

We think that simplicity should be at the basis of the Portal. Users should be able to explore the environment easily, and the procedure for teachers to upload content should be cristal clear and not overloaded by choices of possible pedagogical approaches.

7.5.2 The Content Upload Tool

We recommend to implement a *4 steps procedure* to upload content to the Portal.
Step 1: Uploading the *learning objectives* of the experiment.
Step 2: Upload the *experiment,* including check boxes
- indicating if it is a single player or multiplayer experiment
- indicating if it is meant for self directed learning or teacher led learning
Step 3: Upload the *assignments* for the students

Step 4: Upload the *accompanying materials*, including tests.

7.5.3 The Evaluation Tool
Teachers and students alike should be able to add evaluations to specific experiments. This tool should enable users to write short comments.

7.5.4 The Experience Sharing Tool
This tool enables teachers to upload their experiences, approaches, teaching materials for sharing with others.

7.5.5 The You Need Help Tool
This tool should do two things: it should enable students to offer support for a specific experiment and it should enable students to ask for this support. This tool should contribute to one of the envisaged cash flows of the system, using micropayments. The latter payment tool can be designed later.

7.5.6 The Rating Tool
This tool gives the possibility for users to rate an experiment, and should provide the average scores to users.

We suggest this list of tools to be implemented for the first series of showcases. The next part will describe the functional design process and results, including screenshots of the actual Interface Design of the portal.

8 The functional design of LiLa
The functional design of the LiLa portal is based on the pedagogical strategy, the scenarios and storyboards, a workshop held in Delft (October 2009), and another literature review that focused on engagement and participation in online learning communities. The first two pillars of the functional design have been discussed in the previous chapters. Below, we will first describe the setup and results of the workshop.

8.1 Design workshop LiLa
This section summarizes the workshop held in Delft on 1 October. In the workshop, the participants (consisting of the major part of the project members) collaboratively designed and discussed several pages of the LiLa portal. Doing that, we developed a shared view on how the portal should look like, what functionality it needs to contain.

8.1.1 Workshop setup
The workshop was structured in two activities of one hour, explained below.

Hour 1: Introduction of workshop and group discussions about personas.
Personas are fictitious characters created to represent the different user types within a targeted demographic that might use a site or product. Personas are useful in considering the goals, desires, and limitations of the users in order to help to guide decisions about a product, such as features, interactions, and visual design. Personas are most often used as part of a user-centered design process for designing software and are also considered a part of interaction design (IxD),

however they are also used in industrial design.

A user persona is a representation of the goals and behavior of a real group of users. In most cases, personas are synthesized from data collected from interviews with users. They are captured in 1–2 page descriptions that include behavior patterns, goals, skills, attitudes, and environment, with a few fictional personal details to make the persona a realistic character. For each product, more than one persona is usually created, but one persona should always be the primary focus for the design.
(Source: http://en.wikipedia.org/wiki/Personae)

Because of time constraints, 5 personas were pre-formulated, and the participants had to build on the descriptions given and define the personas in more detail and congruent with their own opinions and ideas. After an hour, the participants came back and we discussed the different personas. Appendix A shows the description handed out, and reactions of the discussion.

The most important issues emerging from the discussion are;
- Support for teachers on how to implement or use experiments in their own teaching (including pedagogical support);
- Support for teachers on how share their own lab resources;
- Access control and statistics to see who has done certain experiments and controlling the information;
- Finding peers or a community of practice to share experiences and get to know colleagues who may help you;
- Clear *how-to pages* or manuals help teachers and students using the online content;
- Communication tools so students can communicate about experiments and discuss results;
- Translation is a very difficult and challenging issue.

Hour 2: Using the personas in designing one or two LiLa web pages
The second hour the same groups made a sketch of one or two web pages. By discussing the resulting designs, all in the appendix, we have been able to construct a shared vision of the functionality and vision of the LiLa portal.

8.1.2 Results of the workshop
Below you can find preliminary designs based on the outcomes of the workshop. Later on (in the following sections), a more elaborate functional design will be presented in a LiLa functional design report.

Bumper page; message, slogan
The bumper page is nothing less than the first impression of the LiLa site. It contains the most important message, and for whom the portal is.

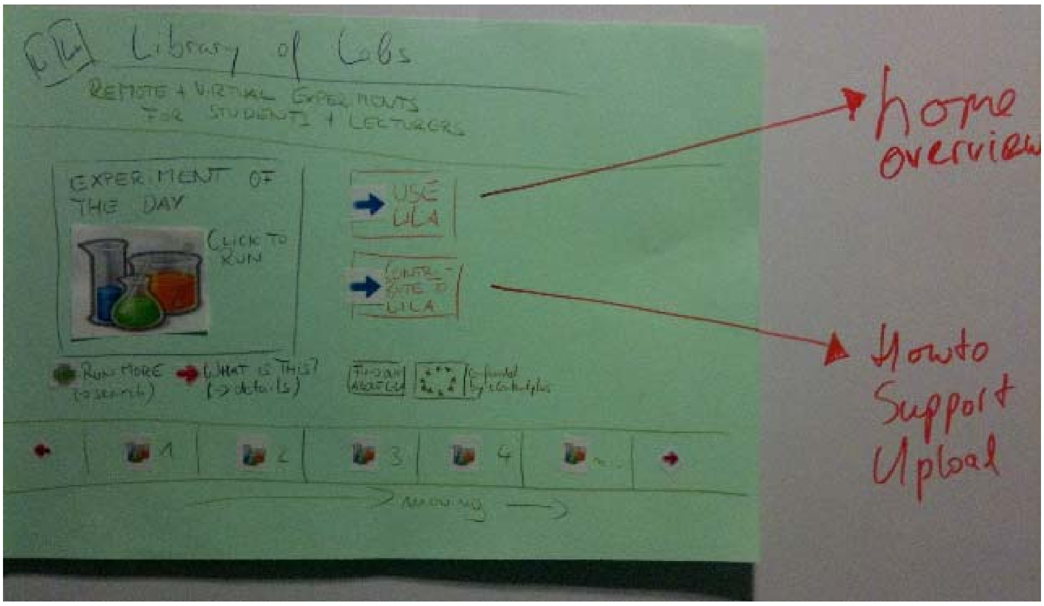


Figure 8 - Design by LiLa partners

Two most important aspects of LiLa are *to use the content* available on the site, or *to contribute new content*. The large image/video and slogan show that the site is about doing experiments; *"Remote and virtual experiments for students and lecturers"*. In the picture, a list of experiments is shown in a moving banner. You can run the example experiment directly from the bumper page. The links *"Use Lila"* and *"Contribute to LiLa"* go to the *"Homepage"* and *"How-to/Support"* page.

Homepage

The homepage is a starting point to start discover interesting content and people, or finding the answer to a question. It is also a place where news about LiLa and its users is shown, through activity streams and Pick of the Week videos. It gives an overview of what's going on, not only in the activity streams, but also in the tag cloud, which represents keywords of the content on the site. Preferably, the homepage is personalized, such that the links it contains link to relevant experiments or groups (with personalized links or through tagging), and the activity stream contains messages about the experiments one is doing, or group in of one is member.

Some of the elements that we saw in the designs were;

- Sign up / login for users: teachers or students
- News / broadcasting
- Activity stream
- Tag cloud
- Forum; specific (per experiment) and general (support/about LiLa)
- Search (in categories) plus link to different Categories
- New on LiLa (people/experiments)
- Top 10 experiments / Experiment of the day
- MyLab; containing lab pages on LiLa you are working on
- Experiment (video) plus information
- Success stories (on YouTube)
- Webcam to a live setup of a lab
- RSS feed to follow what is happening on the site

In the picture below, you can find a structured overview of these functionalities and requirements integrated into one design. This was created directly after the workshop using the software package Omnigraffle. It must be clear that it does not represent the eventual interface.

Figure 9 - Mockup 1 based on the design workshop

Experiment page

When a user is logged in, he/she has more options for interacting with and using experiments. The web page on which the experiment is shown, therefore is different for users who are not logged in, than for users who are. Differences may be in storing an experiment for later, reserving a timeslot, or doing a simulation or experiment. We discussed the following elements,

- Support for technical issues
- Wiki for editing content about the experiment
- List of teachers and students who do or did the experiment

- Discussion/Forum on the experiment

And more, to be seen in the design below

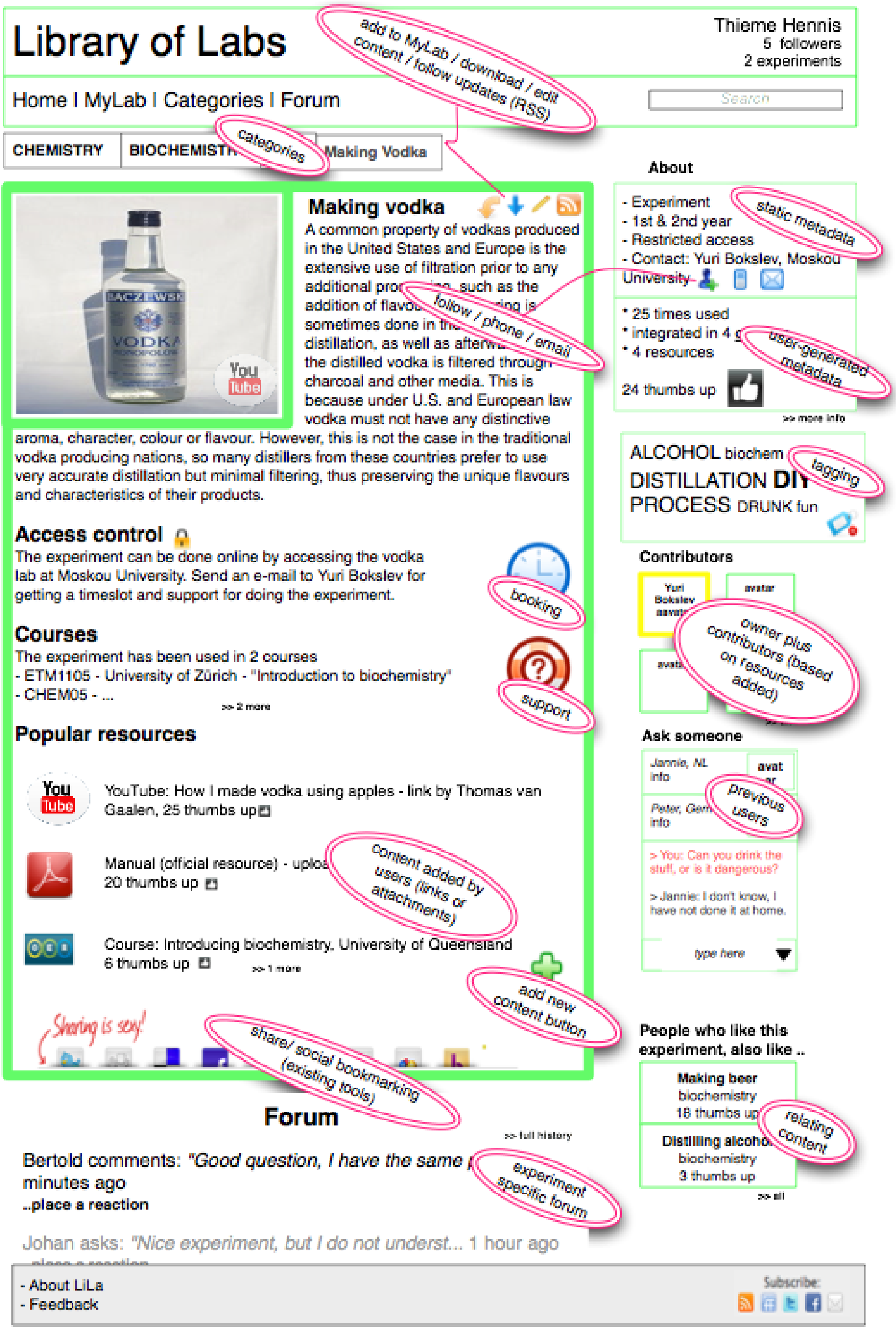


Figure 10 - Mockup 2 based on design workshop

Search; metadata, filters, results, interface

How people search is much influenced by the way how they are allowed to search. Which metadata fields are searchable, and how the search page presents different options to search the whole system, or only partially. It is a very difficult matter to define the most important search fields, and the filters that should apply. We talked about different options, and the following was said. The 2 search pages that were developed, show the following result.

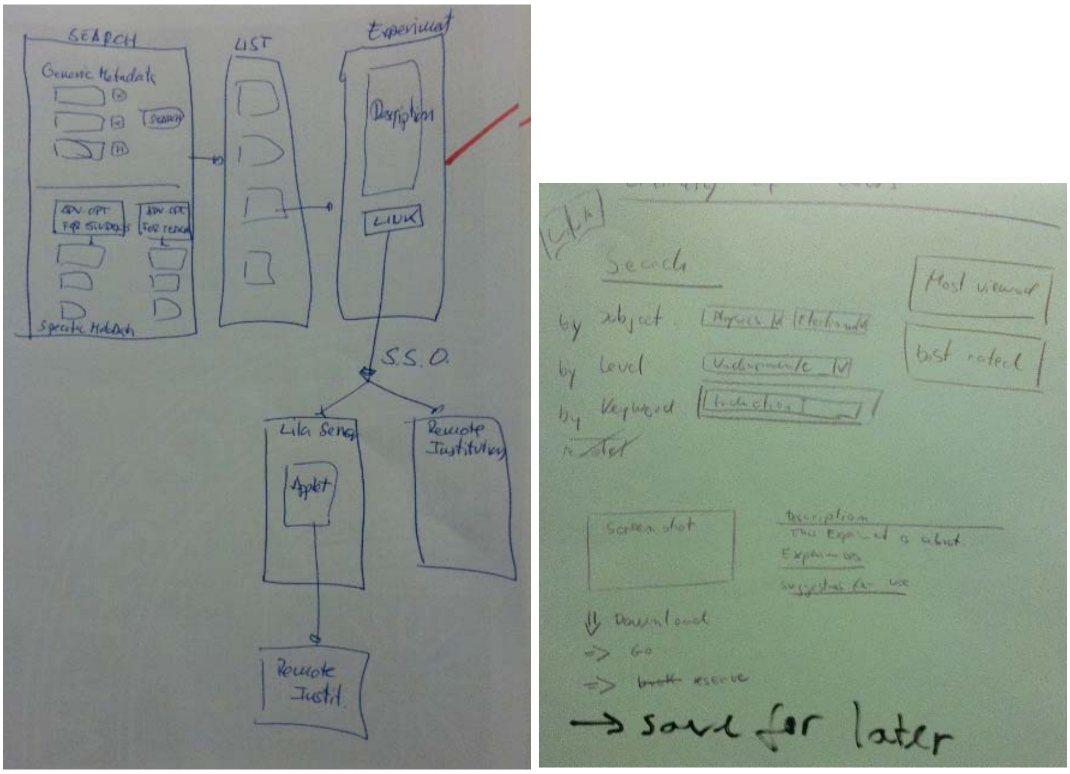


Figure 11 - Designs by LiLa partners

As can be seen in the above designs, users must be able to search on **subject**, **level**, and **keyword/tag**, and filter the results based on popularity and rating. Additionally, we see in both designs a preview of the first or selected result, already showing a screenshot, description, etc. and some options (visit page, download experiment, make reservation, save for later). Results can include;

- Simulations and experiments
- Experiences by others
- Groups/Communities (such as described in the personas)

The following sections will focus on creating a more complete functional design, including literature research on motivation & participation in online communities, sustainability of these initiatives, and links to other work packages, such as evaluation and metadata. This final literature analysis, in addition to all the previous steps and actions, we think we have grounded the design of the LiLa portal sufficiently in literature as well as the desires and expectations of partners and end-users.

8.2 Social mechanisms and design choices

As we have seen in all of the previous sections, we acknowledge the importance of social interaction between learners on the portal in order to foster effective learning. Online interaction is key to some of the pedagogical scenarios we have described, but this is easier said than done. The following texts are based on a paper written for the CAL conference 2011, UK (Hennis & Lukosch, 2011) and shows how certain design choices are made based on literature on engagement and motivation. It also shows where we can improve with the project from a technological or process perspective.

We will show some of the designs we have developed in order to give a better idea of how the portal will look like. It must be said that these are NOT screenshots of the portal. The designs are in the final phase of developments, so the final interface and layout will not differ much from what is represented here.

8.2.1 Motivation in online learning processes

Self-organization and peer-based learning in online communities can become an important and effective mode for learning. Supporting people to create new communities has the potential to improve communication and support sharing of critical information and knowledge. It also aligns with newer organizational views: moving from command and control to more competency-based virtual communities (Koh, Kim, B. Butler, & Bock, 2007). Despite the popularity of online social networking sites, most initiatives fail to reach momentum and fade away shortly after inception, because individuals lack the motivation to be active (B. S. Butler, 1999; Hennis, 2009a; 2009b). In many online communities and websites that rely on community participation, the majority of the contributions are done by a very small percentage of members (Ortega, Gonzalez-Barahona, & Robles, 2008).

According to Bonk and Reynolds (1997), online learning should create challenging activities for learners to connect new information to old. Learning in online environments is thus heavily influenced by social interaction. Motivation plays an important role in online learning environments, understood as behavior referring to the choices people make and the degree of effort learners are willing to exert. Thus, the concept of motivation is defined as the organized pattern of a person's goals, beliefs, and emotions that the person is striving for (Ford, 1992). In online learning environments, motivation is a force to arouse, give direction to, continue, and choose a particular behavior (Wlodkowski, 1985). Course design, available interaction and the role of the facilitator seem to be factors influencing learner's motivation (Bonk & Reynolds 1997). Furthermore, rewards such as grades and feedback seem to be important in matters of motivation (Rotter, 1990; Lepper & Malone, 1987).

In summary, overall understanding of the factors that influence motivation of individuals in online knowledge environments can be used to increase willingness to invest time and share knowledge. The following section summarizes mechanisms that influence motivation of individuals in online knowledge environments, and their willingness to invest time and share knowledge, based on (Hennis & Kolfschoten 2010).

8.2.2 Social Mechanisms of the LiLa portal to foster motivation

In the following, we describe social mechanisms that can be addressed in order to increase motivation to participate in Open Educational Resources (OER) projects. We have applied this framework into the design of processes and technology of the EU-funded project called LiLa, Library of Labs. The portal disseminates and aggregates remote experiments, learning resources (including assignments), and lessons. A lesson is a set of learning activities that contain LiLa content, such as experiments and learning resources.

Objectives, relevancy and fit: Who are the users?
One of the most important things in the design of an online community is its alignment with the interests of the intended participants, and the collective characteristics of the community (Preece & Maloney-Krichmar, 2003; 2005). A person only contributes when this effort helps to satisfy a need (i.e. psychological needs) (Kollock, 1999). If a person perceives as if a technology brings personal benefit, participation will be more likely (Garfield, 2006; Pearson, 2007; Rashid et al., 2006). It is therefore required to know the problems and objectives of (future) users. When potential users and contributors can relate this to their own needs, there is higher probability of participation (Preece & Maloney-Krichmar, 2003). For example, a clear statement of the site's purpose is a common way to communicate its objectives and relevancy. Other possibilities include regular reminders, feedback messages, supportive and explanatory notifications, online statistics and email newsletters. In addition, it is important that the online environment and functionalities support practice, like learning processes, identity building, and networking (Bouman et al., 2007). It should also be easy for people to start participating and make use of the offered technology. The technology should fit in both the mental mindset of an organization or a person, as well as the physical workflow and organizational processes. The norms, values, language, technology and interface must correspond with the worldview of future users and problems must solve real-world problems, such as inability to find relevant people and learning resources. Existing structures must be integrated.

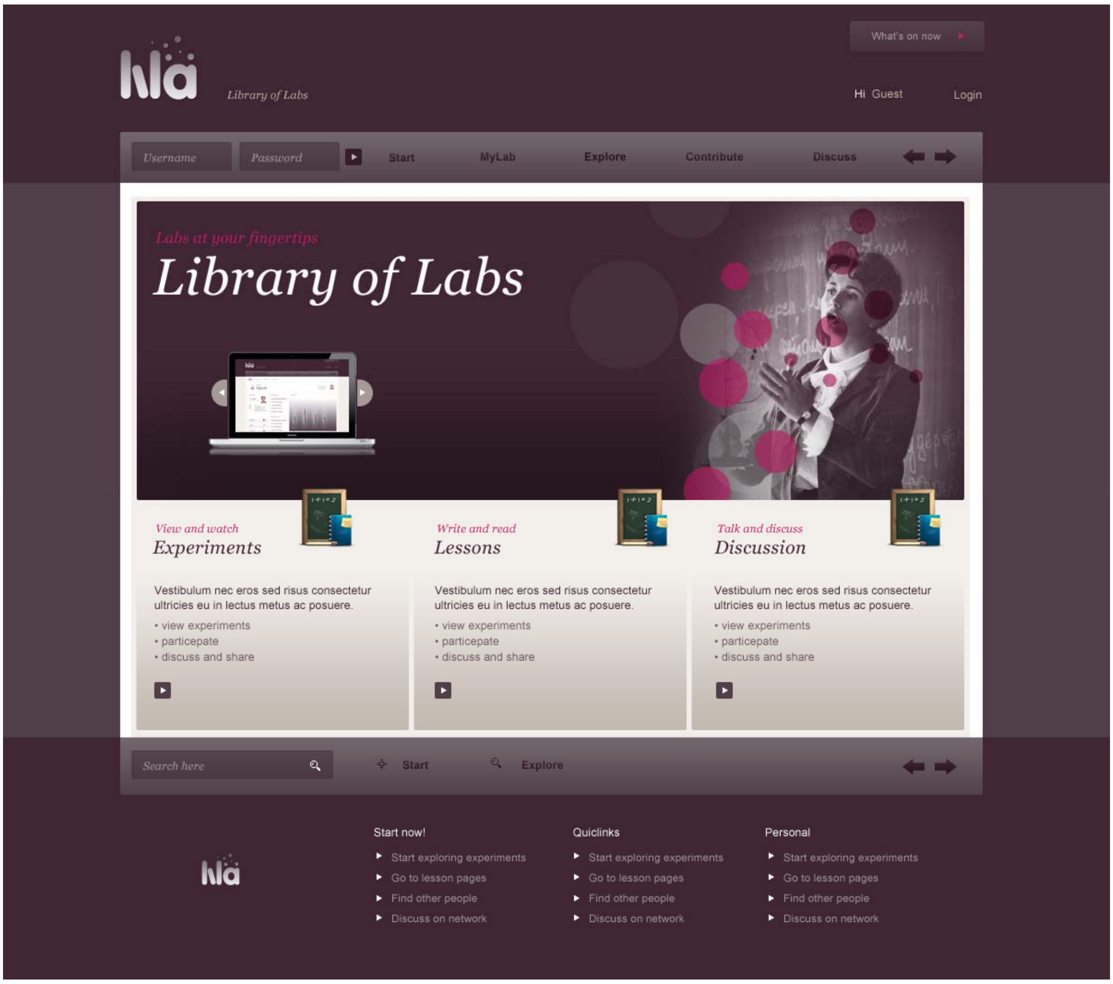


Figure 12 - Homepage of the LiLa portal

The homepage of the portal shows directly what we can expect from it. There are experiments, Lessons, and Discussions.

The primary audience of LiLa consists of university teachers and students. Because it is an “open resource”, anyone could make use of it, but preferential treatment regarding the use of scarce resources (popular or expensive remote experiments) is given to partnering institutes. The use of experiments in education ranges from teacher-centered education to student-led education. A whole range of learning scenarios can be thought of within the two ends of the spectrum. The strategy we chose to accommodate the different learning scenarios is by offering tools that support both teacher- and student-led learning. Two examples are given below:

1. 1. SCORM compliancy. Remote experiments, and other LiLa materials are packaged as LLO-files (LiLa Learning Objects) that are SCORM-compliant. SCORM is the most widely used educational metadata standard. LLOs can therefore easily be integrated into popular learning management systems, such as Blackboard and Moodle.
2. 2. Active learning and peer assessment. Students can personalize their learning in embedded forums. Each lesson allows for users to ask questions and give answers. In addition, we designed a peer-assessment tool to support students to assess each other.

Next to “consumers” of LiLa content, we have the content providers, who are the institutes and individual experiment owners (teachers etc.) who potentially want to share their remote experiments online. The same motivations for people to share OER (Hylén, 2006) seem to apply to remote experiments. Potential content providers have reacted enthusiastically on the possibility of sharing their remote experiments, which they have been developing over the years, with a global audience. With sufficient support, and high quality feedback, and the ability to make use of other LiLa resources, contribution is likely to occur. Currently, a widespread survey is being done in order to find out more about potential content providers and their willingness to contribute.

Leadership & Roles

Leaders in online communities can be important for the success of the community. In addition, leadership is an enabler for knowledge sharing (Ardichvili, 2008). Leaders support and engage people, form connections, discuss strategies, choose content and technology, and show exemplary behaviour (Koh, Kim, B. Butler, & Bock, 2007; E Wenger, McDermott, & Snyder, 2002). Online communities typically provide roles such as an administrator. Oftentimes, communities do adopt specific names to assign to community-specific roles. For example, a discussion leader in a forum on boats could be called “Captain”. A typical role is the technology steward, who is someone with enough experience of the workings of a community to understand its technology needs, and enough experience with technology to take leadership in addressing those needs. Stewardship typically includes selecting and configuring technology, as well as supporting its use in the practice of the community (Etienne Wenger, White, & Smith, 2009).

LiLa members have a personal page where they can add their field of expertise. In addition, users can indicate their role as a student or teacher. Role definition and processes are an important issue that remains to be addressed. In addition, we have a functionality called “Ask-an-expert”, which makes use of this indicated domain of expertise. Students (or teachers) who have a question about a specific topic, can ask that and users who have indicated this topic in their profile will be notified of the question.

Organization

With regards to organization, sustainable online communities should offer services along four dimensions: self-management (facilitation of creation and management of presence and resources), self-organization (facilitate interaction and knowledge construction), self-categorization (support classification and evaluation of contributions), and self-regulation (offer tools to manage privacy and spam) (Berlanga, Rusman, Bitter-Rijpkema, & Sloep, 2009).

There is much debate about the sustainability of the project from the organizational perspective. Reliance on a central organization seems costly and less feasible. Therefore, the design of LiLa focuses on the decentralization of adding, managing, and learning from LiLa content. One example of decentralization is given below. Teachers and students are able to guide themselves through the site, and are recommended other, possibly relevant experiments, based on the location and interests. Information about the use and users of experiments is shown, to support the decision process of an individual about whether or not he/she should do the experiment. In addition, teachers and students are able to rate and comment on resources, aggregate them into unique lessons, add keywords, and even contribute materials.

Figure 13 - Self-organization through rating and recommending technologies

Heterogeneity

Uniqueness and social comparison can encourage participation and sharing of information (Chen, Harper, Konstan, & Li, 2009; Ludford, Cosley, Frankowski, & Terveen, 2004). Generally speaking, heterogeneity is an important factor for knowledge creation in online communities. In order to bring together different perspectives, there has to be an open dialogue, and different levels of participation must be accepted. Large and small contributions (such as comments) are needed to sustain and create new interaction. Because true membership grows over time and with interactions, passive members may over time become active and engaged (Berlanga, Rusman, Bitter-Rijpkema, & Sloep, 2009; E Wenger, McDermott, & Snyder, 2002). It also means that different people must be addressed in different ways (Kollock, 1999).

LiLa is a European project, which means that different partners have different cultures and backgrounds. The future users of LiLa will have different educational and cultural backgrounds, and are learning or are experts in different scientific domains. As we wrote in an earlier chapter, we wrote that this heterogeneity should be utilized in the learning process. For example, collaborative assignments can be designed that require input from different disciplines. Also, heterogeneity is accommodated in the metadata, which allows for translation of content.

Learning & Networking

We mentioned relevancy as requirements for an online community to become successful. One important incentive for people to join and participate in learning communities, is of course, their ability to help you learn something (Bouman et al., 2007). Learning can relate with heterogeneity in expertise, support for questions, and getting useful recommendations (automatic and social). Another essential motivation for people to join online communities is networking. Networking leads to new trust relationships and collaboration. It is especially effective when online and offline interactions reinforce each other (Koh, Kim, B. Butler, & Bock, 2007; E Wenger, McDermott, & Snyder, 2002). Relationships are established through social presence, empathy, and trust, possibly by means of community managers or moderators (Preece & Maloney-Krichmar, 2003). Learning is the core of LiLa. As we mentioned before, we accommodate different learning scenarios, from traditional classroom teaching to active and networked learning. In the design, we focused on supporting the download process, the reservation process, and providing templates for teachers on how to use the materials in their own teaching. Additionally, to support online learning, we have developed a number of tools, including recommending technologies, rating and peer-support through forums and a specialized tutoring system to support learners during learning activities. Also, automatic emails are sent that contain interesting contributions and comments on content one follows. The picture below shows a 'lesson', one of our suggested tools.

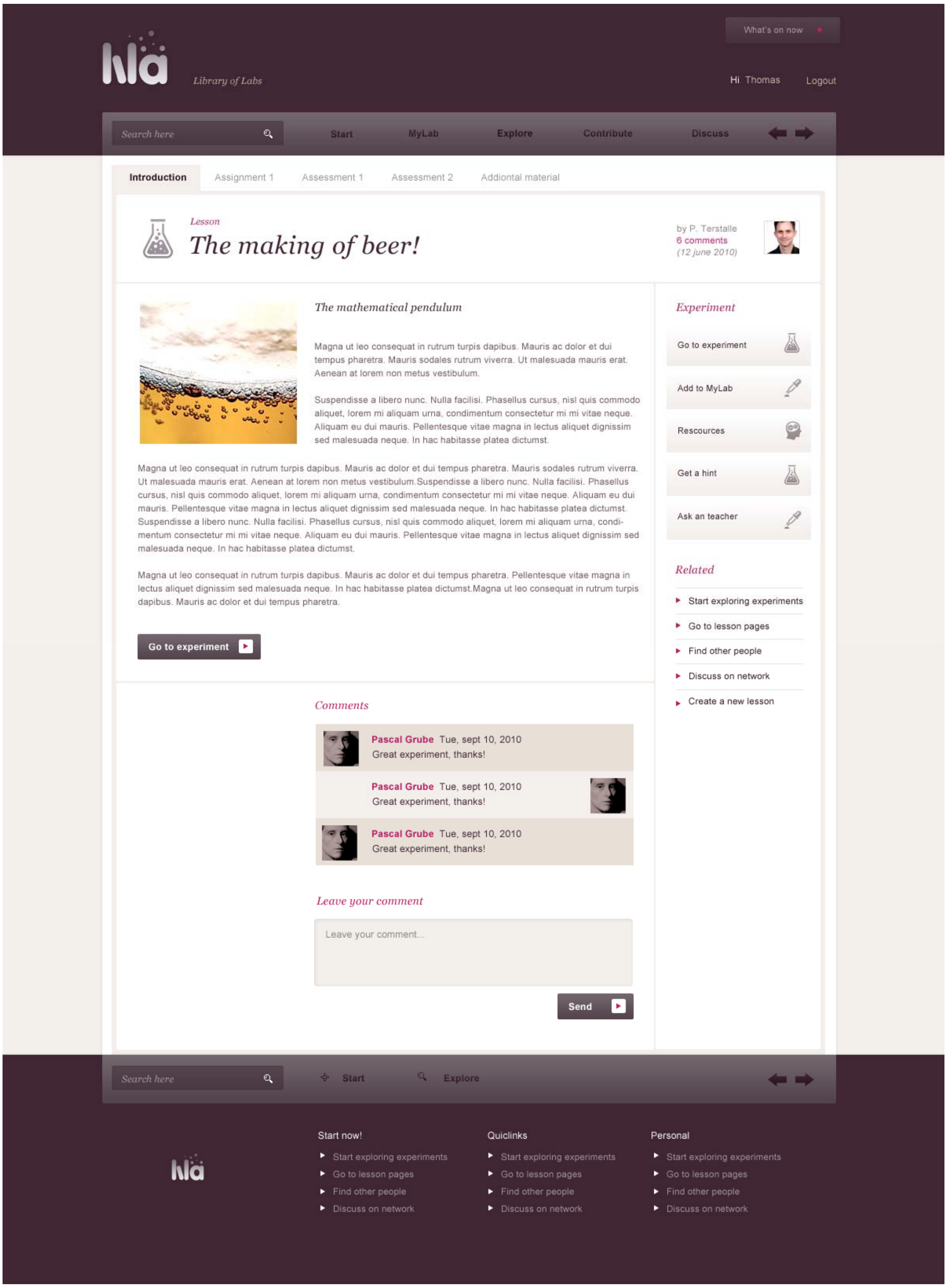


Figure 14 - Example lesson page

The lesson page offers any registered user to create an aggregation or set of activities. These activities can comprise an Introduction, Assignment, Assessment/Test, Group discussion, and Resources. These rather generic elements can be combined into a lesson by anyone in an intuitive authoring interface. Users can then make use of the lesson, rate it, and recommend it to others, and this information is being used in order to In order to maintain the quality

Students and teachers will only keep on visiting LiLa, if they benefit from it. The benefits may relate with learning, but an important incentive for OER providers is also the ability to connect with peers and get feedback. Online, you are able to follow persons, so if someone you find interesting adds a new resource, you will be notified. Offline, we organize several meetings and visit conferences to increase and improve the LiLa network.

Reputation & Identity
Reputation relates to the concept of online identity and trust and is a primary research focus in Web science2. Overview of past actions and participant identification helps to create and sustain trust relationships in communities (Moore & Serva, 2007).

Trust forms the basis of a relationship and is one of the most important enablers of community participation (Ardichvili, 2008) and sharing knowledge (Choi, Kang, & Lee, 2008). Reputation is used as virtual currency (World of Warcraft), can be a conduit for trust (eBay), and the information stored in reputation profiles is used for recommendations of people and content. Howard Rheingold describes status, recognition or prestige as a key motivation of individuals' contributions to the group (Rheingold, 1993). This is especially true in knowledge-sharing communities, and forms an important motivation for people to contribute (Lampel & Bhalla, 2007; Pearson, 2007). Recognition satisfies a person's need for self-esteem, as depicted in Maslow's hierarchy of needs (Kollock, 1999). People tend to contribute knowledge when it enhances their professional reputations (McLure-Wasko & Faraj, 2005a; McLure-Wasko, Teigland, & Faraj, 2009). Increased recognition also supports identity building and belonging (Bouman et al., 2007). Visibility of contributions is similarly important: if people see their contributions being used and re-shared, they are more inclined to share more information, especially when there is some recognition or praise or encouragement (M. L. Endres, S. P. Endres, Chowdhury, & Alam, 2007). Many communities have therefore features that show the level of contribution of individuals in ranking or increased visibility.

In Open Source communities, programmers are motivated not only by intrinsic aspects, i.e. engaging in an activity out of pure pleasure, but also have in mind the signaling knowledge to potential employers of profit-oriented companies (Von Hippel, 2005). The motivation of managers in OSS projects, as well as of programmers can be traced back to career plans, which makes the reputation one has within a community so essential (Lattemann & Stieglitz, 2005).

We suggest a reputation architecture that motivates individuals to be engaged in processes that ultimately contribute to the sustainability of the portal. For LiLa, we argue that these include organizational processes of quality management, contribution and aggregation of content, creation of knowledge, and managing discussions. Also, helping out people with questions and providing feedback on requests are attributed. The reputation architecture monitors the interactions and contributions, and creates human readable profiles of someone's online activity on the portal. The interpretation of this activity can be done by teachers, students, or others, and will depend on the objectives for interpretation.

Reciprocity & Feedback

In addition to reputation, there is reciprocity, the social norm that describes the expectation of people to respond to each other in kind, both in a positive and negative sense. People expect something to get in return from others. Even though reciprocity is not always an essential element (McLure-Wasko & Faraj, 2005b), many online communities and social network sites encourage reciprocity with rewards and acknowledge helpful responses (Preece & Maloney-Krichmar, 2003).

We have suggested a feedback tool for teachers to share their experiences on experiments and pedagogy. Teachers, as consumers of remote experiments, are asked to review the usefulness and quality of the downloaded materials. The management of quality of online resources is embedded in the download process: the teacher is asked to give some information about course and how he/she can be contacted. Through feedback by teachers, good resources are more easily found than the bad ones.

Students can ask questions and engage in discussions about theoretical or practical issues. Registered LiLa members are notified of changes and new discussions, responses, and added content. If someone posts a question, he or she expects to get a response in time. Hence, each person has a personal Watchlist, and is notified through e-mail with a weekly digest of what happened on LiLa.

Depending on the results of the survey amongst potential content providers, we will develop standardized contracts for content providers. These contracts will include rules for preferential treatment with regard to the use of other remote experiments

Common ground

Common ground theory provides a framework for understanding how two people or a small group develop shared understanding in a conversation (Clark and Brennan, 1991). Grounding is the process of acquiring common understanding, which is important for creating trust and establishing effective communication. Co-presence, visibility, audibility, co-temporality, simultaneity, sequentiality, reviewability, and revisability are factors that influence the grounding process (Preece & Maloney-Krichmar, 2003). It is therefore influenced by both the communication task and the medium. For instance, in a chat program it can be difficult to take turns, which is clearer in a more static discussion board. Organizing offline meetings is an important instrument to establish common ground and increase participation, social cohesion and belonging. Each community has to find its own rhythm of offline events, online meetings, new information, and find its appropriate pace over time (P. Johnson-Lenz & T. Johnson-Lenz, 1991).

Creating a common ground is a difficult issue for an international endeavour as LiLa. Grounding occurs at typical “common grounds”, such as during traditional education at universities. The LiLa portal should offer the possibility to create groups with communication tools in order to have private conversations.

Privacy

Community spaces and social networking sites typically allow users to manage their online presence. They can establish private or semi-public groups to discuss in a restricted setting, start private discussions, and are able to hide specific data from non-members or specified users (E Wenger, McDermott, & Snyder, 2002). Grounding and the exploration of each other’s interests, and discovery of similarities is supported by private spaces and the mentioning of people’s expertise on the personal profile page.

Sense of community & Accountability

A “sense of community” has different dimensions, including feelings of membership, feelings of influence, integration and fulfilment of needs, and shared emotional connection (McMillan & Chavis, 1986). The popularity of social networking sites show that people are likely to connect with people they know or feel affiliated with through a shared interest. On the technical level, this requires networking possibilities, and people to disclose their personal information. Because not everyone is happy with personal information being available on the Internet, privacy issues are very important. Many sites offer the possibilities to indicate contact preferences and the visibility of personal information. Having a personal profile also means that misbehaviour can be traced back, and the culprits removed from the environment.

Obviously, in order to engage in conversations on LiLa and to contribute, one has to register. Personal profiling facilitates both networking and accountability. With sufficient high-quality content in a domain, a sense of community will emerge that will set standards on quality and behaviour.

Newcomers

In many online communities, most activity comes from of a small core group of experienced people. It can be difficult for newcomers to participate and to have enough confidence to contribute (self-efficacy, see next paragraph). Newcomers, therefore, should be treated carefully and given considerable attention. Administrators or technology should be focused on supporting early interactions (Burke, Marlow, & Lento, 2009). Newcomers who witness friends or relatives contributing, become accustomed to sharing content (in a social and technical sense) and continue to contribute themselves.

When people signup, in LiLa we ask for some information, including background and affiliation. Using the affiliation of a person, we can connect newcomers with active members and other newcomers, making newcomers more comfortable. Also, we developed a static information pages containing the relevant information to be able to contribute or make use of LiLa.

Self-efficacy & Social comparison

The perception people have about themselves and their ability to perform a specific task is called self-efficacy. Self-efficacy is the central cognitive mediator of the motivational process (Bandura, 1997). In other words, if a person does not have a positive perception about his or her ability to do or contribute something, the (s)he will not do it. This also applies to knowledge sharing (M. L. Endres, S. P. Endres, Chowdhury, & Alam, 2007). People are more likely to share knowledge when they see peers doing it. Also, in social comparisons, self-efficacy may increase and therewith the likeliness of sharing. Next to one's perception of own skills, belief in each other's skills and expertise increases the intention to share individual knowledge (Chen, Harper, Konstan, & Li, 2009; Ludford, Cosley, Frankowski, & Terveen, 2004). The earlier mentioned recognition and praise is similarly important.

LiLa members must be able to contribute in small, easy steps. For example, adding a comment is very easy, and can give someone the confidence of starting a discussion, or reviewing a solution. Additionally, users can simply indicate that they find a resource, comment or experiment useful. When people get positive feedback, and are recognized for their contributions, they are more likely to contribute.

8.2.3 Conclusions

In the above, we use a framework of social mechanisms to give direction to the design of the LiLa portal. The framework supports designing for motivation by focusing on social and psychological factors that influence the way people behave and share information online.

In projects where Open Educational Resources must continuously be contributed, created, updated, managed, reliance on a central authority is costly and sometimes not feasible. We linked this problem with current approaches on learning, which address a more active, creative, and conversational way of learning. In addition to support for individuals to connect, discuss, assess and create learning materials, an OER project must also address their motivation to communicate, collaborate and learn. With social mechanisms, we can look for solutions and support our design choices.

In our further research on LiLa, we will focus on evaluating the effectiveness of and defining the social mechanisms. Evaluating the use of the portal and the behavior of the users will become a crucial part of the online environment itself and thus an additional functionality to foster motivation with providing feedback to the users.

8.3 The LiLa interface

In the previous sections, we have seen how the LiLa portal will eventually look like. The dark colors show tradition, which is put in a modern jacket. Science is a serious discipline, but we might as well make it fun and attractive. The placement of menus and combinations of colors is well-thought out to give the end-user a good first impression. We saw that in the previous section that that is very important.

Below we show one more page design made by the graphical user interface designer in the Delft team.

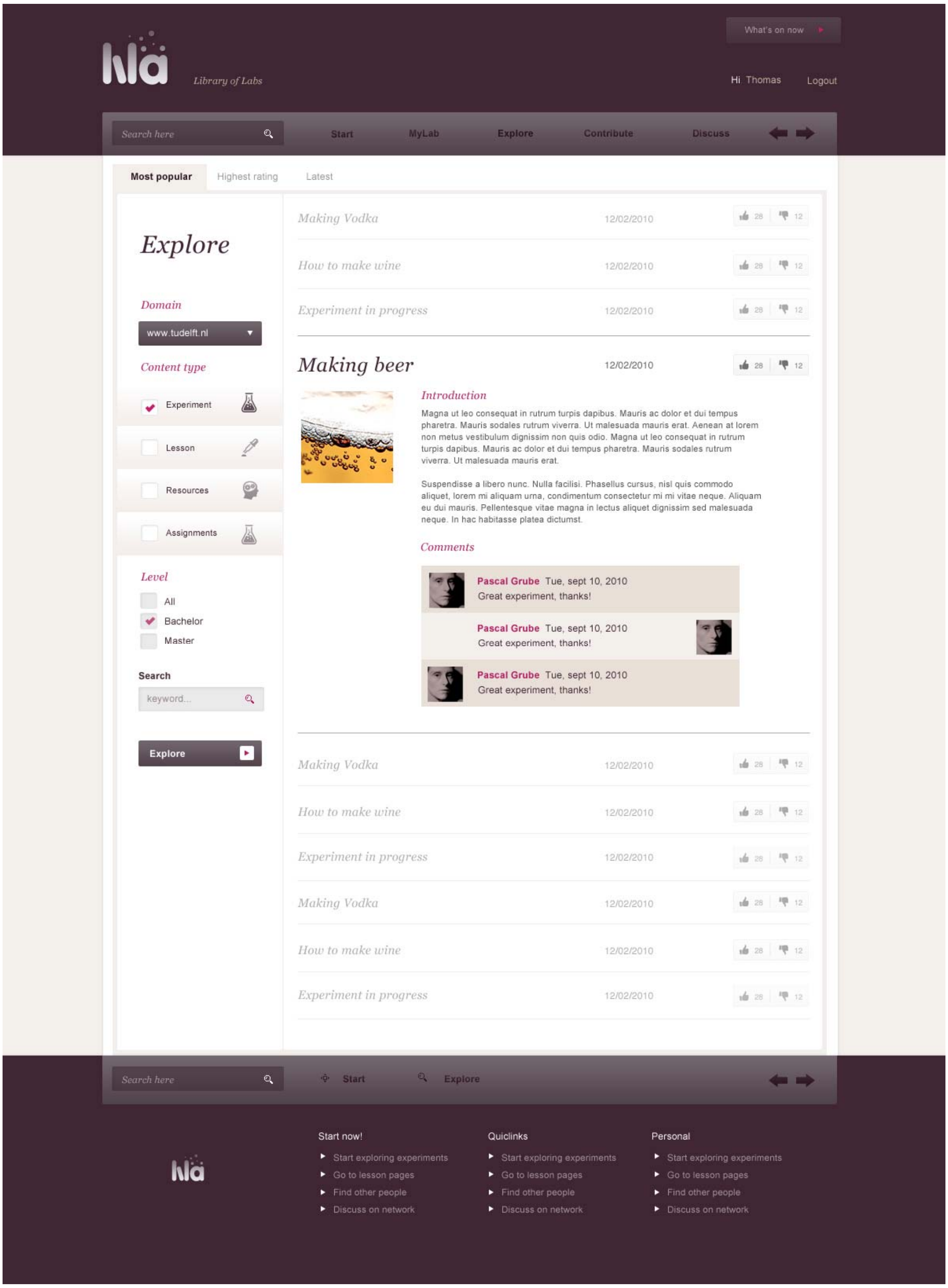


Figure 15 - Explore Lila page

9 Concluding remarks

The responsibilities of WP3 include the development of pedagogical strategies and guidelines for designing, developing and using learning activities. This includes the creation of a style guide and a uniform interface for the different elements and functionalities in the portal. Didactical guidelines are developed and models to support the creation and adaptation of learning content. We have focused on developing a design for the portal, functional as well as graphical, that supports teachers and students to create and share new materials, discuss about them, and to explore new content. We also developed a developer's guide to assist teachers and student assistants in setting up an effective learning environment or remote experiment for their students. Much of the tips will be share by means of downloadable documents as well as embedded as *micro-teaching* entities in the portal. For example, in the authoring environment where users are able to create lessons, tips can be shown to help the lesson creator from a pedagogical perspective.

We have not excluded any pedagogical approach, and developed tools that support most common traditional and more recent and collaborative learning scenarios.

In this second version of the pedagogical deliverable we have described the various steps we have undertaken to come to a pedagogically sound and accepted framework and design to implement the LiLa portal.

10 Literature

Ackerman, M., Carroll, J. M., Demichelis, G., Huysman, M., Wellman, B., & Wulf, V. (2004). Communities and Technologies: An Approach to Foster Social Capital? *CSCW04*, 406-408.

Allert, H. (2004). Coherent Social Systems for Learning: An Approach for Contextualized and Community Centred Metadata. *Journal of Interactive Media in Education*, *2*, 1-30.

Amory, A., & Seagram, R. (n.d.). Educational game models: conceptualization and evaluation. *Journal of Higher Education*, *17*(2), 206–217.

Anderson, J. R. (1982). Acquisition cognitive skills. *Psychological review*, *89*(4), 369-406. doi: 0033-295X/82/8904-0369.

Ardichvili, A. (2008). Learning and Knowledge Sharing in Virtual Communities of Practice: Motivators, Barriers, and Enablers. *Advances in Developing Human Resources*, *10*(4), 541-554. doi: 10.1177/1523422308319536.

Bandura, A. (1997). *Self-Efficacy: The Exercise of Control* (1st ed.). Worth Publishers.

Berlanga, A., Rusman, E., Bitter-Rijpkema, M., & Sloep, P. (2009). Guidelines to Foster Interaction in Online Communities. In R. Koper (Ed.), *Learning Network Services for Professional Development* (pp. 27-42). Berlin, Heidelberg: Springer. doi: 10.1007/978-3-642-00978-5_3.

Bouman, W., Hoogenboom, T., Jansen, R., Schoondorp, M., Bruin, B. de, & Huizing, A. (2007). The realm of sociality: notes on the design of social software. Amsterdam.

Bransford, J., Brown, A., & Cocking, R. (1999). *How people learn: Brain, mind, experience, and school*. Washington DC: National Academies Press.

Brown, J. S., & Adler, R. P. (2008). Minds on fire: Open education, the long tail, and learning 2.0. *Educause Review*, *43*(1), 16. Educause.

Bruner, J. (1991). The narrative construction of reality. *Critical inquiry*, *18*(1), 1–21. JSTOR.

Burke, M., Marlow, C., & Lento, T. (2009). Feed me: motivating newcomer contribution in social network sites. *Proceedings of the 27th international conference on Human factors in computing systems* (p. 945–954). ACM.

Butler, B. S. (1999, November). When is a Group Not a Group: An Empirical Examination of Metaphors for Online Social Structure. Pittsburgh. doi: 10.1111/j.1467-629X.1980.tb00220.x.

Caswell, T., Henson, S., Jensen, M., & Wiley, D. (2008). Open Educational Resources : Enabling universal education. *International Review of Research in Open and Distance Learning*, *9*(1), 1-11.

Chen, Y., Harper, F. M., Konstan, J., & Li, S. X. (2009). Social Comparisons and Contributions to Online Communities: A Field Experiment on MovieLens. *American Economic Review*, 1-51.

Choi, S. Y., Kang, Y. S., & Lee, H. (2008). The effects of socio-technical enablers on knowledge sharing: an exploratory examination. *Journal of Information Science*, *34*(5), 742-754. doi: 10.1177/0165551507087710.

Cole, B. R. (1996). Characterizing On-line Communication: A First Step.

Davidson, C. N., & Goldberg, D. T. (2009). *The future of learning institutions in a digital age*. *The MIT Press* (p. 81). Cambridge, MA: The MIT Press.

Der Zanden, P. van. (2009). *The Facilitating University*. *books.google.com* (p. 311). Delft: Eburon Uitgeverij BV.

Downes, S. (2005). E-learning 2.0. *eLearn*, *2005*(10), 1. doi: 10.1145/1104966.1104968.

Endres, M. L., Endres, S. P., Chowdhury, S. K., & Alam, I. (2007). Tacit knowledge sharing, self-efficacy theory, and application to the Open Source Community. *Journal of Knowledge Management*, *11*(3), 92-103.

Ericsson, K. A., & Charness, N. (1994). Expert performance: Its structure and acquisition. *American psychologist*, *49*(8), 725–747.

Garfield, S. (2006). Ten reasons why people don't share their knowledge. *KM Review*, *9*(2), 10-11.

Groot, A. de. (1965). Thought and Choice in Chess (rev. translation). *Mouton and Company, The Hague*.

Hennis, T. A. (2009a). Platform voor promovendi - Valkuilen op de werkplaats. *Intellektueel Kapitaal*, (3), 40-42. Rotterdam.

Hennis, T. A. (2009b). Platform voor promovendi - Lessons learned leidt tot achtstappenplan. *Intellektueel Kapitaal*, (4), 36-40. Rotterdam.

Hennis, T. A., & Kolfschoten, G. L. (2010). Understanding Social Mechanisms in Online Communities. In G. D. Vreede (Ed.), *Group Decision and Negotiation 2010* (p. 153). Delft, the Netherlands.

Hennis, T. A., & Lukosch, H. (2011). SOCIAL MECHANISMS TO MOTIVATE LEARNING WITH REMOTE EXPERIMENTS - Design choices to foster online peer-based learning (unpublished). *CSEDU 2011*.

Hout-Wolters, B. V., Simons, R., & Volet, S. (2000). Active Learning: Self-directed learning and independent work. In R.-J. Simons (Ed.), *Springer* (pp. 21-36). Kluwer Academic Publishers.

Hylén, J. (2007). Giving Knowledge for Free: The Emergence of Open Educational Resources. Paris.

Hylén, J. (2006). *Open educational resources: Opportunities and challenges*. *Open Education* (p. 11). Paris.

Iiyoshi, T., & Kumar, M. (2008). Opening up education: the collective advancement of education through open technology, open content, and open knowledge. (Toru Iiyoshi & M. S. V. Kumar, Eds.), 478. Cambridge, MA: MIT Press.

Illeris, K. (2003). Towards a contemporary and comprehensive theory of learning. *International Journal of Lifelong Education*, *22*(4), 396–406. Routledge.

Johnson-Lenz, P., & Johnson-Lenz, T. (1991). Post-mechanistic groupware primitives: rhythms, boundaries and containers. *International Journal of Man-Machine studies*, *34*(3), 395-417.

Jones, C., & Steeples, C. (2001). Perspectives and issues in networked learning. *Networked learning* (p. 14). Springer-Verlag New York, Inc.

Klotz, U. (1999). The challenges of the New Economy, 1-24.

Koh, J., Kim, Y. G., Butler, B., & Bock, G. W. (2007). Encouraging participation in virtual communities. *Communications of the ACM*, *50*(2), 68-73. ACM.

Kollock, P. (1999). The Economies of Online Cooperation: Gifts and Public Goods in Cyberspace. In M. Smith & P. Kollock (Eds.), *Communities in cyberspace*.

Laat, M. D. E., & Lally, V. I. C. (2003). Complexity, theory and praxis: Researching collaborative learning and tutoring processes in a networked learning community, 7-39.

Laat, M. D. (2006). *Networked Learning*.

Lampel, J., & Bhalla, A. (2007). The Role of Status Seeking in Online Communities: Giving the Gift of Experience. *Journal of Computer-Mediated Communication*, *12*(2), article 5.

Lattemann, C., & Stieglitz, S. (2005). Framework for Governance in Open Source Communities. *Proceedings of the 38th Annual Hawaii International Conference on System Sciences*, *00*(C), 192a-192a. Ieee. doi: 10.1109/HICSS.2005.278.

Lave, J. (1988). *Cognition in practice: Mind, mathematics, and culture in everyday life*. Cambridge Univ Pr.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge Univ Pr.

Ludford, P. J., Cosley, D., Frankowski, D., & Terveen, L. (2004). Think different: increasing online community participation using uniqueness and group dissimilarity. *Proceedings of the SIGCHI conference on Human Factors in computing systems* (pp. 631-638). New York: ACM. doi: http://doi.acm.org/10.1145/985692.985772.

McLure-Wasko, M., & Faraj, S. (2005a). Why should I share? Examining social capital and knowledge contribution in electronic networks of practice. *MIS Quarterly*, *29*(1), 35-57.

McLure-Wasko, M., & Faraj, S. (2005b). Why Should I Share? Examining Social Capital and Knowledge Contribution in Electronic Networks of Practice. *MIS Quarterly*, *29*(1).

McLure-Wasko, M., Teigland, R., & Faraj, S. (2009). The provision of online public goods: Examining social structure in an electronic network of practice.

Decision Support Systems, *47*, 254-265. Elsevier. doi: 10.1016/j.dss.2009.02.012.

McMillan, D., & Chavis, D. (1986). Sense of community: A definition and theory. *Journal of Community Psychology*, *14*(1), 6-23.

Moore, T. D., & Serva, M. A. (2007). Understanding Member Motivation for Contributing to Different Types of Virtual Communities: A Proposed Framework. *SIGMIS-CPR '07: Proceedings of the 2007 ACM SIGMIS CPR conference on 2007 computer personnel doctoral consortium and research conference* (pp. 153-158). New York: ACM. doi: http://doi.acm.org/10.1145/1235000.1235035.

Newell, A., & Simon, H. A. (1972). *Human problem solving*. Englewood Cliffs, NJ: Prentice-Hall.

Norman, D. a. (1980). Twelve Issues for Cognitive Science. *Cognitive Science*, *4*(1), 1-32. doi: 10.1207/s15516709cog0401_1.

Ortega, F., Gonzalez-Barahona, J. M., & Robles, G. (2008). On the inequality of contributions to Wikipedia. *Proceedings of the 41st Annual Hawaii International Conference on System Sciences*.

Paavola, S., Lipponen, L., & Hakkarainen, K. (2004). Models of Innovative Knowledge Communities and Three Metaphors of Learning. *Review of Educational Research*, *74*(4), 557-576. doi: 10.3102/00346543074004557.

Paris, S., & Winograd, P. (2003). The role of self-regulated learning in contextual teaching: Principles and practices for teacher preparation. *Preparing Teachers to Use Contextual Teaching and Learning Strategies to Improve Student Success in and beyond School*.

Pascual, M., Geser, G., Gruber, A., Forschungsgesellschaft, S. R., Baumgartner, P., Naust-, V., et al. (2006). The concept of open educational resources as instrument for implementing lifelong learning strategies at higher and further education institutions. *Source*, 1-8.

Pearson, E. (2007). Digital gifts: Participation and gift exchange in Livejournal communities. *First Monday*, *12*(5).

Piaget, J., & Cook, M. (1952). *The origins of intelligence in children*. International Universities Press New York.

Preece, J., & Maloney-Krichmar, D. (2003). Online communities: focusing on sociability and usability. In J. Jacko & A. Sears (Eds.), *Handbook of human-computer interaction* (p. 596–620). Mahwah, New Jersey: Lawrence Erlbaum Associates Inc. Publishers.

Preece, J., & Maloney-Krichmar, D. (2005). Online communities: Design, theory, and practice. *Journal of Computer-Mediated Communication*, *10*(4).

Rashid, A. M., Ling, K., Tassone, R. D., Resnick, P., Kraut, R., & Riedl, J. (2006). Motivating participation by displaying the value of contribution. *Proceedings of the SIGCHI conference on Human Factors in computing systems - CHI '06* (p. 955). New York, New York, USA: ACM Press. doi: 10.1145/1124772.1124915.

Rheingold, H. L. (1993). Virtual Communities and the WELL. *GNN Magazine*, (1).

Rieber, L. P. (1996). Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games. *Educational technology research and development*, *44*(2), 43–58. Springer.

Rogoff, B. (1990). Apprenticeship in thinking: Cognitive development in social context.

Siemens, G. (2005). Connectivism - A learning theory for the digital age. *International Journal of Instructional Technology and Distance Learning*, *2*(1), 3–10. Citeseer.

Siemens, G. (2006). *Knowing knowledge*. Lulu. com.

Skinner, B. (1950). Are theories of learning necessary?. *Psychological review*, *57*(4), 193–216.

Soekijad, M., Huis in 't Veld, M. a a, & Enserink, B. (2004). Learning and knowledge processes in inter-organizational communities of practice. *Knowledge and Process Management*, *11*(1), 3-12. doi: 10.1002/kpm.191.

Stahl, G. (2003). Meaning and interpretation in collaboration. In B. Wasson, S. Ludvigsen, & U. Hoppe (Eds.), *Designing for Change in Networked Learning Environments: Proceedings of the International Conference on Computer Support for Collaborative Learning (CSCL '03)* (pp. 523-532). Bergen: Kluwer Academic Publishers.

Stahl, Gerry, Koschmann, T., & Suthers, D. (1999). Computer-supported collaborative learning: An historical perspective. In S. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (Vol. 8). Cambridge, UK: Cambridge University Press.

Thorndike, E. L. (1913). *An introduction to the theory of mental and social measurements*. Teacher's College, Columbia University.

Tudge, J., & Rogoff, B. (1999). Peer influences on cognitive development: Piagetian and Vygotskian perspectives. *Lev Vygotsky: Critical assessments*.

Veen, W., Lukosch, H., & Vries, P. D. (2008). Improving organizational learning through Networked Learning. *GI2008* (pp. 22-31).

Veen, W., Staalduinen, J.-P. V., & Hennis, T. A. (2010). Informal self-regulated learning in corporate organizations (submitted). In G. Dettori & D. Persico (Eds.), *Fostering Self-regulated learning through ICTs (forthcoming)*. Genova, Italy: Institute for Educational Technologies Italy's National Research Council.

Veldhuis-Diermanse, A. E., Biemans, H. J. A., Mulder, M., & Mahdizadeh, H. (2006). Analysing Learning Processes and Quality of Knowledge Construction in Networked Learning. *The Journal of Agricultural Education and Extension*, *12*(1), 41-57. Routledge. doi: 10.1080/13892240600740894.

Von Hippel, E. (2005). *Democratizing innovation* (1st ed., p. 202). Cambridge, MA: the MIT Press.

Vries, P. D. (2008). *Networked Learning for Lifelong Learners. Journal of documentation* (p. 26). Delft.

Vygotsky, L., & Cole, M. (1978). *Mind in society: The development of higher psychological processes*.

Wenger, E, McDermott, R., & Snyder, W. (2002). *Cultivating communities of practice: A guide to managing knowledge* (p. 304). Boston, MA: HBS Press.

Wenger, Etienne. (2000). Communities of practice and social learning systems. *Organization*, *7*(2), 225-246.

Wenger, Etienne, White, N., & Smith, J. D. (2009). *Digital Habitats; Stewarding Technology for Communities* (1st ed., p. 250). Portland: CPsquare.

Wiley, D. A., & Edwards, E. K. (2002). Online self-organizing social systems: The decentralized future of online learning. *Quarterly Review of Distance Education*, *3*(1), 33.