COLDEX

Collaborative Learning and Distributed Experimentation

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Learning Activity Design

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1 Introduction

The learning requirements deliverable (see deliverable D.2.2.1) was written to give the theoretical foundations for the design of the different learning activities and tools in the COLDEX project. The collaborative scenarios deliverable (see deliverable D.2.2.2) served as a contextual framework for describing a wide range of educational activities related to COLDEX. This deliverable, namely, the Learning Activity Design will provide the ideas that function as the bridge between the first two deliverables. Thus, we will formulate some generic activities and design patterns in relation to the COLDEX scenarios. Moreover, these design ideas also support the learning requirements.

1.1 Designing for Pedagogical Change and Innovation

The COLDEX project aims at designing innovative learning environments in order to support a wide range of open learning activities within a number of scientific domains. This goal is achieved by combining innovative pedagogical approaches (e.g. Challenge Based Learning, CBL) together with the support of a variety of modeling tools and experimental scenarios. The collaborative approach together with coaching will facilitate initiative and exploration in the learning process. The architectural principles for the "learning workflow" of the different activities integrate remote as well as local experiments, simulations, revision of complementary learning material, discussions to support collaborative knowledge building and sharing of completed result. The educational principles include the notion of *authentic activities*, which in the context of COLDEX are defined as authentic tasks that help students to conceptualize the phenomena under investigation (rather than providing only) abstract information. Another important feature of these authentic activities is to provide real-world, case-based contexts, rather than pre-determined instructional sequences. We argue that learning activities must be anchored in real uses, or it is likely that the result will be knowledge that remains inert. This will especially be made clear when a learning activity is evaluated and the students assessed on how well they transfer the learning to other contexts and tasks (Bransford et al, 1999).

Anderson, Reder and Simon (1996) claim, that the students maybe not do appreciate real world problems in a school setting. When educational researchers used problems connected to real world situations, the students still tended to solve the task with tables and graphs and used relatively little time relating the problem to the real world context. Anderson et al., (1996) argue that it is better to use concrete examples and to combine them with abstract instruction, and that both together are better than one of them alone. This argumentation shows the difficulties that may occur when implementing new ideas in an old context or a traditional educational culture. We therefore suggest that a learning activity that is anchored in real world situations also should be anchored and implemented in the real world. This could include to solve for instance, a challenge related to an industrial problem and to see the result being used later in the production process; or to participate in an astronomy project with access to a remote telescope where the project result could be of true scientific value that will add knowledge to a scientific community.

The traditional paradigm in education, with its positivistic influences, stresses the role of the teacher as the instructor, and as the knowledge provider that reproduces and tests the knowledge transferred to the student, which is a top-down approach. The student is expected to acquire something from outside by the means of a learning activity (Tholander, 2003). New paradigms move the teacher from the pulpit and closer to the group of learners to facilitate, using a bottom-up approach. The focus is on the student's learning process and the meaning making between the participants in the learning situation, through e.g. self-directed learning, active collaboration, open-ended problem-solving and scientific inquiry. Although learning is ultimately an individual process, it can be enhanced, enriched, and better motivated by collaborative activities, especially if it brings learners with different cultural backgrounds together.

The specialty of the COLDEX project in CSCL terms is that it aims at developing methodologies to create and maintain large learner communities around complex experiential phenomena rather than focusing on small highly controlled laboratory situations. Basic learning communities will exchange their ideas, results and problems in an international network. We expect teachers to take an active roll in creating, filling with content and structuring this network.

1.2 Learning Environment and Activity Framework

Based on the learning requirements we have presented in deliverable D.2.2.1, COLDEX suggests that the design of an interactive environment for challenge-based, collaborative learning and distributed experimentation should be guided by:

- *Authentic activities:* presenting authentic tasks that conceptualize rather then abstract information, and provide real-world case-based contexts rather than pre-determined instructional sequences. Learning activities must be anchored in real uses, or it is likely that the result will be knowledge that remains inert.
- *Construction:* learners should be constructing artifacts and sharing them with their community.
- *Collaboration:* to support collaborative construction of knowledge through social negotiation, as opposed to competition among learners for recognition.
- *Reflection:* fostering reflective practice.
- *Situating the context:* enable context and content dependent knowledge construction.
- *Multi-modal interaction:* providing multiple representations of reality, representing the natural complexity of the real world.

It is also important to be *Learner-centered:* to take into consideration learner aspects, e.g. cultural practices and prior experiences and understandings, and *Knowledge-centered:* to help students become knowledgeable, and focusing on helping students in their knowledge acquisition. The students should be provided with support or scaffolding in the beginning of the process.

The different learning activities which we are designing in the different learning environments require learners to identify research questions and variables, set hypotheses, build and construct experiments, test results, analyze observations and then refine hypotheses and casual variables accordingly (see deliverable D.2.2.1, in particularly the section referred as 'The Learning Environment'). The framework should:

- *Provide support for the collaborative construction of knowledge objects, for the collaboration construction and analysis of challenge solutions;*
- *Provide tools to support negotiation of alternatives;*
- *Provide both public and private feedback support mechanisms;*
- *Provide mechanisms to share and exchange information, objects, views, etc.;*
- *Facilitate a meaningful division of labor;*
- *Support joint, online thinking, commentary, etc.;*
- *Include meaningful learning scenarios;*
- *Design authentic problems and legitimate cases as the basis for learning activities;*
- *Take into account the entire learning environment;*
- *Support mediation among all the participants;*
- *Foster a sense of collaborative learning community.*
- *Integration of online and offline, individual and collaborative, in-class and distributed activities.*

- *Flexibility to adapt the environment to the local conditions (students' background and capabilities and/or teacher's preferred teaching style).*

COLDEX aims at providing an open-ended learning environment that stimulates learners to identify and solve a challenge according to the educational premises of Challenge Based Learning. The different components of the framework for COLDEX are rooted in situated cognition, which emphasizes the importance of situating thinking within complex contexts. Learners are expected to identify/generate problems to be solved and then, learn, develop and apply relevant knowledge and skills through progressive problem generation, framing and solving. The different learning activities require learners to identify research questions and variables, set hypotheses, build and construct experiments, test results, analyze observations and then refine hypotheses and casual variables accordingly.

The educational ideas we are suggesting in COLDEX, could be used in several different ways. One is to enable novel activities for students approaching a subject, another is to support and scaffold ongoing activities, e.g. illustrate some construction aspects (Tholander, 2003). In order to stimulate transfer of knowledge from the learning environment, the training should include several different examples and encourage reflection (Bransford et al 1999).

The learning environment recommended by COLDEX is using a common platform or technological system. The system could be described as 'a complex educational environment where a variety of learning communities could undertake collaborative activities involving local and remote experimentation' (deliverable 6.1.1, ver 2, p 6). 'The rational for this is to employ open standards and open source software as long as they do not restrict flexibility or render the use of previously developed tools impossible' (D.3.2.1 and D.3.2.2, ver 0,8, p 5).

As part of the work with identifying the functionalities of the COLDEX system a use case study was developed using the Unified Modeling Language (UML). As a result of this process, a number of user diagrams and use cases were produced (see Appendix A for more detailed information). The purpose of this kind of diagrams is primarily to look at a system from a user perspective, and to capture high-level functional requirements of the system. The diagrams are a static description of what a system will do; they will not cover all the requirements of the system or how the system will function. The activities covered above are to some extent the same activities that will be defined through Active Document (see deliverable D.3.2.1 and D.3.2.2).

The activity design framework should outline a generic methodology (guiding scaffold) for the development of each specific collaborative scenario. Each scenario description needs to articulate the methods and activities that will be implemented in order to fulfill the relevant learning requirements. The specific learning requirements that are addressed in each scenario should fit into the more generic framework of learning requirements.

2 Learning Activity Design

The activity design framework presented in this chapter has been conceived as a tool to guide and facilitate the process of articulating a specific collaborative scenario. This could be useful both for the design and for the evaluation of a learning activity. A primary means for providing this facilitation is to ask questions that will require the activity designer to consider the general learning requirements of the initiative that they are working within. For each activity, the following questions should be considered and addressed:

1. What are the specific concepts and skills that this activity will develop?
   a. How will this activity advance understanding of these concepts and/or competency in these skills?
2. What are the key areas of complexity within these concepts?
   a. How will the learners' interest in this complexity be stimulated by the activity?
   b. How will the learners' be supported to avoid being overwhelmed by the complexity of the phenomenon they are investigating?
3. What are the different levels of challenges that fit the target audience?
   a. What is the range of skill levels of the target learners?
   b. What is the range of complexity that exists within the phenomenon of interest?
4. What are the discrete problems that the learners should identify within the challenges?
   a. What are the subtasks that can be distinguished within the problem interpretations?
5. What tools can be used to support the pursuit of problem solving and challenge confrontation/tackling?
   a. How can the usage of tools become more transparent within the process?
6. What aspects/subtasks of the activity are better augmented with hands-on experiments? Virtual experiments? A combination of both?
7. Where are the most logical opportunities for collaboration within each activity and task?
   a. Which scale of collaboration makes most sense? (Individual, Group, Class, Global)
      i. Synchronous vs. Asynchronous
   b. Which mode of collaborative learning strategies makes most sense? (Refine, compose, asses, compete, negotiate, sum up, divide& merge)
   c. Which media and tools can be used to support the collaboration process?

Each learning activity to be conducted within the framework of a COLDEX project should be clearly tied to the already mentioned general learning requirements. Another main point mentioned above is the use of technology to support and facilitate the collaborative learning process, e.g. modeling, simulation and visualization. These two aspects will both have to be considered in the learning activity design process.

2.1 The Learning Activity scenario

During the COLDEX project meeting in Lisbon, Portugal (February 2003), a discussion about the ontology for the Learning Activity Design took place. In the following sections we will present a diagram for a learning activity in a scenario, based on the results of that discussion. Due to limitations of space, the diagram is split into separate parts although it was originally only one big tree diagram.

In a COLDEX Scenario both, the (A) Educational Aspects and (B) Technical Aspects (figure 1) should be taken into consideration. These two issues that form the top of the diagram will separately be further described in the two preceding sections (section 2.1.1 and section 2.1.2 respectively).

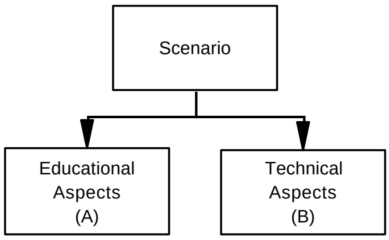

Figure 1. A Scenario

2.1.1 (A) Educational Aspects

The Educational Aspects in a scenario (figure 2) can be divided into three parts: (A:1) Activity, the actual operation in the scenario; (A:2) Community, the people involved in the learning scenario; and (A:3) Type of Learning, the objective for the activity, problem definition and learning space.

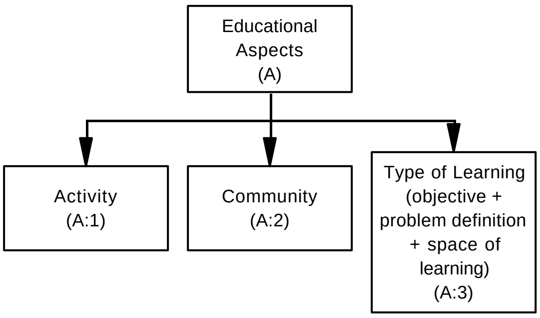

Figure 2. Educational Aspects

(A:1)Activity

From a more general perspective, an Activity (figure 3) usually results in an outcome, that is for example an exhibition, or a written report; containing an Experiment Model with the educational aspects of the experiments ontology (cp. below under section (B:2) Resources); has a Deadline, when the activity should be finished; and an Organizational model, how the activity is organized (figure 4).

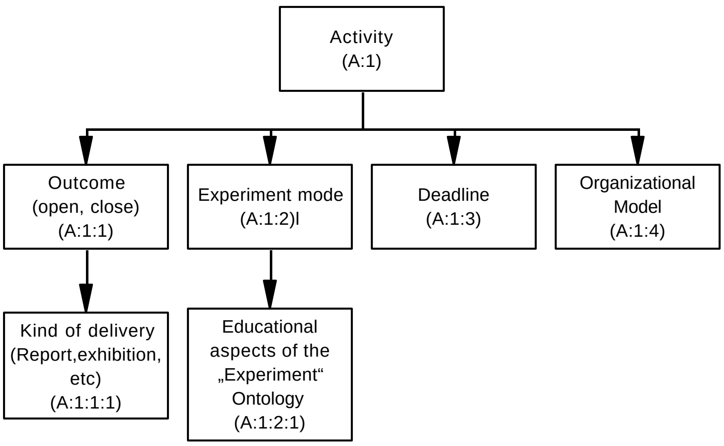

Figure 3. The Activity

The Activity parts Outcome and Deadline do not need any further explanation. The part the Experiment Model could for example be the educational objective for the experiment. The part the Organizational Model (also in figure 4) refers to the organization of the activity, which here means the Collaboration Model and the Task structure with Degree of freedom.

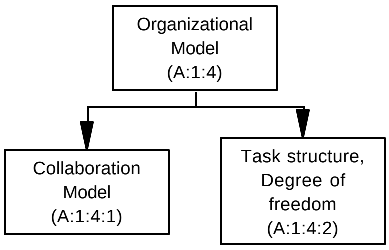

Figure 4. The Organizational model

The Collaboration model (figure 5) is then in turn divided into Mode, e.g. refine, compose, sum up, and assess; the Communication Type, synchronous or asynchronous; and members' mode of Presence, that is on site or remote. The Task structure (figure 5) is taking into consideration the degree of freedom in the activity. The least degree of freedom can be found in the task that is completely predefined, and the highest degree of freedom can be found in an Open task. Between these two there are Workflow and Self-organized/emergent. As we are proposing to use CBL as a learning method, the Workflow and Self-organized/emergent way of structuring a task will most likely be the freedom degrees that will be used.

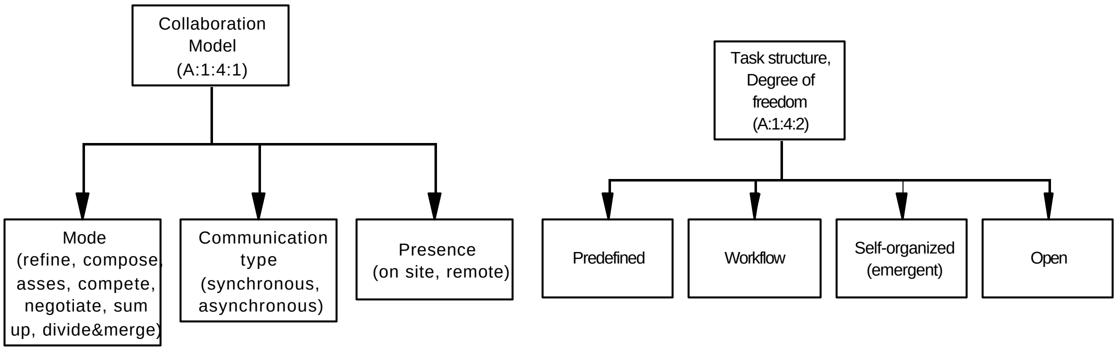

Figure 5. The Collaboration Model and the Task structure.

(A:2) Community

The second component of the *Educational Aspects diagram* (Figure 2) is *Community*. A community can be either local or global, and may already exist or will be emerging under the time a learning activity is taking place. A community can be defined and include roles and rules for the members (Figure 6).

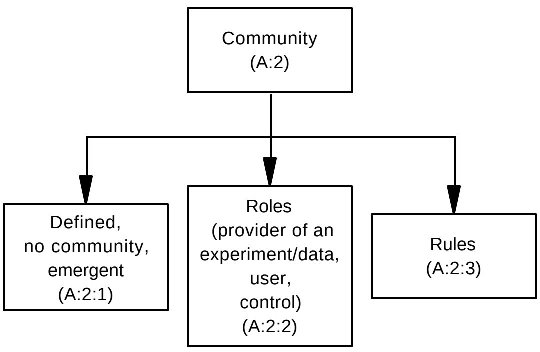

Figure 6. The Community

(A:3) Type of Learning
The third component of *Educational Aspects diagram* is *Type of Learning*. The person responsible for the learning activity to be completed will determine the Type of Learning method that will be used (figure 7). Preferably COLDEX advocates the use of CBL as the method for learning. But there could also be used other methods, e.g. PBL (Problem Based Learning), or Guided discovery.

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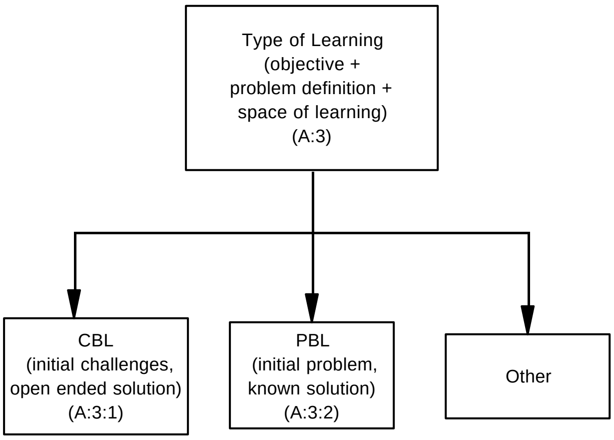


Figure 7. Type of Learning

2.1.2 (B) Technical Aspects
The previous section described those issues related to the Educational Aspects of a scenario. This section addresses the Technical Aspects. The two major components of Technical Aspects of the scenario are (B:1) the Workspace and (B:2) all Resources (figure 8).

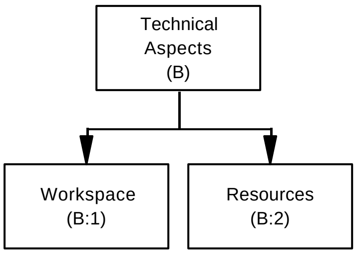


Figure 8. Technical Aspects

(B:1) Workspace
The Workspace consists of one private part and one shared (figure 9). The private part is meant for the individual student, while the shared part is the common workspace for a community. It is important that the students have a possibility to reflect in their own private space. When they find it appropriate they can transfer their material to the community group's workspace. The private space also gives the students a chance to communicate as an individual with the teacher or with other students in the COLDEX network.

The content from both workspace types can be stored in the COLDEX's Learning Object Repository (LOR) and thereby become public and retrieved by anyone connected to COLDEX's network. It is of course also possible to import learning objects from the repository into the private or shared workspace. This could be useful if students want to get access to contributions coming from other students' or if they want to compare/share their own result with those of others.

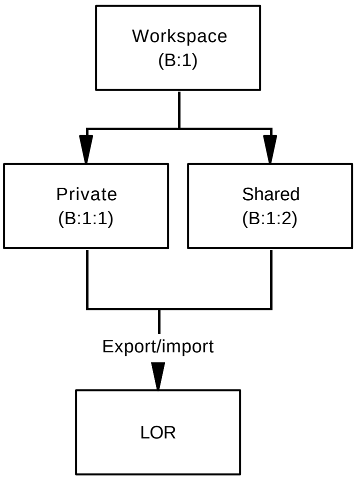


Figure 9. The Workspace

(B:2) Resources
The second component of *Technical Aspects* is Resources, which includes Tools, Digital Experimentation Tool Kits or DExTs and other material (figure 10). The Tools and DExTs that can be seen both as separate parts and as intertwined, represent the Technical Aspects of the Experiments Ontology (cp. above under section (A:1) Activity). Examples of Tools are a Telescope, CoolModes, a LEGO RCX, and Active Document. A DExT can be seen as a package of resources which includes:

- *Experimental instructions,*
- *Scientific background*
- *Modeling and simulation tools*
- *Access to real data*
- *Visualization and collaboration tools*
- *Initial challenges*

The ideas behind a DExT are to present a particular experiment with instructions, ideas and challenges for expanding the *physical experimentation* with the aid of computational tools as those mentioned above.

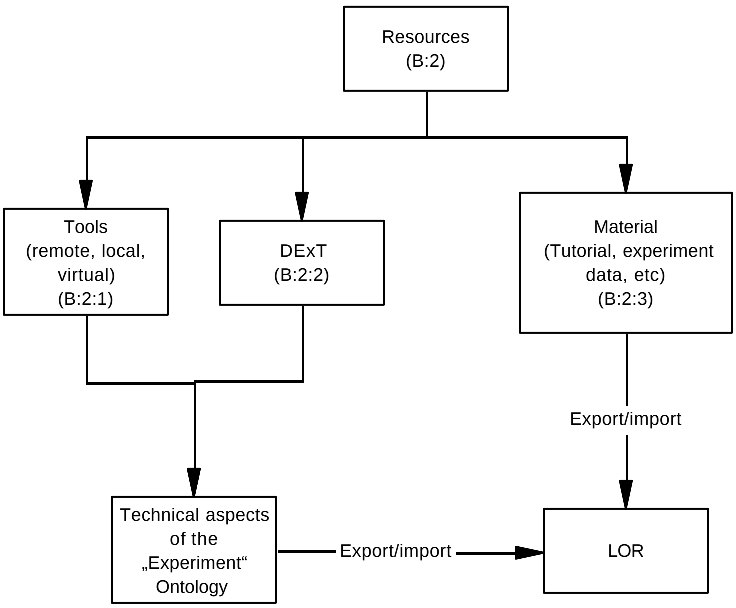


Figure 10. Resources

2.2 The Learning Activity experiment

Sharda et al., (2001) propose a framework to explain the technological and behavioral requirements in a laboratory environment. They suggest that learning technologies should be categorized according to three dimensions: *temporal* (asynchronous/synchronous), spatial (co-located/distributed) and *level of presence* (classroom/laboratory). They visualize this typology in the shape of a cube. This cube coincides with taxonomy for experiments envisioned by COLDEX (figure 11). In the taxonomy of COLDEX the three axes are *location* (local/remote), *temporal* (real time/batch) and *nature of experiment* (real world/hybrid/virtual). For example, an experiment performed at the science center in Växjö involving manipulating the different inputs for a Biosphere to maximize the harvest of a certain plant, would be placed in the upper, left, front corner since it is local, real world, and real time. Another experiment, for example a local community ordering pictures of a certain galaxy at a certain time through remote access to a telescope in Chile, would be placed in the bottom, left, back corner, since it is remote, real world, and batch.

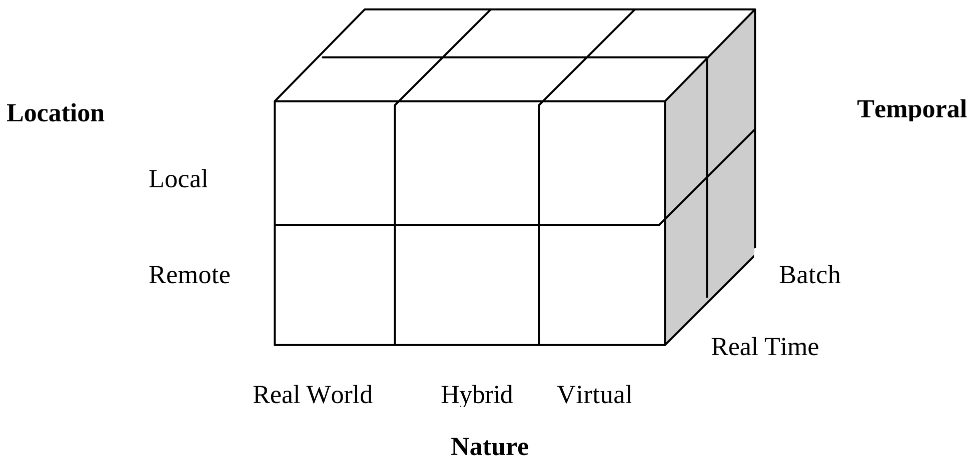


Figure 11. The taxonomy of experiments.

2.3 The Learning Activity and Collaboration in the Different Scenarios

Scenarios in COLDEX are defined as follows: “A collection of educational activities which are inspired by the ideas behind CBL. The COLDEX project aims at facilitating learning scenarios of various types, which include different sizes and types of learning groups. These activities are designed for well-specified domains and are supported by an educational workflow and a number of tool kits” (from deliverable D.2.2.12). Following Dillenbourg (2003, personal communication), we will use the following scale for levels of collaboration:

1. *Level of individual learning*
   Here, tools should support rich representations with high interactivity, particularly also responsive environments which stimulate the learner’s activity. It is important that tools are inter-operable between learning phases to facilitate the transfer and reuse of results. Individual learners should have full access to group and community archives on all levels.

2. *Small group level*
   Small groups may be formed during classroom, but also in between, e.g. as ad hoc working groups to solve exercises. Small groups may use synchronous and asynchronous means of collaboration support. Again, reusability, interoperability and access to group resources are important. Small group work needs a light-weight support infrastructure (e.g., ad hoc networking).

3. *Large group level:*
   Examples of large groups are classrooms or courses. Individual exercises in the classroom would be level 1, whereas a plenary discussion or presentation would be level 3. Beyond the use of potentially shareable modeling and annotation tools, the classroom also needs a special "session handler". In our case, this is the CiC tool (Computer-Integrated Classroom). Also, group documents are typically defined on this level. Both the session manager as well as group documents should reflect tasks and roles. Level 3 support could be embedded in a learning platform (not of primary interest in CoLDEx).

4. *Community level*
   The CoLDEx learning community is trans-continental and initiated by the Open User Scheme. It is technically supported by a community archive, which serves as a collective memory and provides primarily asynchronous cooperation mechanisms. Problem-oriented indexing using metadata allows for exchange and reuse of learning objects (models, reports) between different learning groups.

The following table summarizes the characterization of the collaboration levels, and categorizes them using the categories setting, knowledge building strategies and cooperation mechanisms.

	individual	*small group*	*large group*	*community*
setting(s)	- homework - individual studies (e.g. in self-learning centre)	- group work (in school) - afternoon grps - museum user groups	- classes (f-t-f) - courses (also online) - bigger museum visitor groups	- trans-continental network of learners and institutions
knowledge building strategies	- indiv. inquiry and problem solving - reading - browsing	- group problem solving - smaller discussions - design meetings	- aggregation / comparison of small grp. and indiv. results - discussions - teacher presentation	- retrieval of others' learning objects - online SIGs - FAQs
Collaboration mechanisms	no (instead: access to archives at all levels)	- workspace sharing - group archives	- result sharing using big screen - classroom archives	- indirect exchange of learning objects through archives

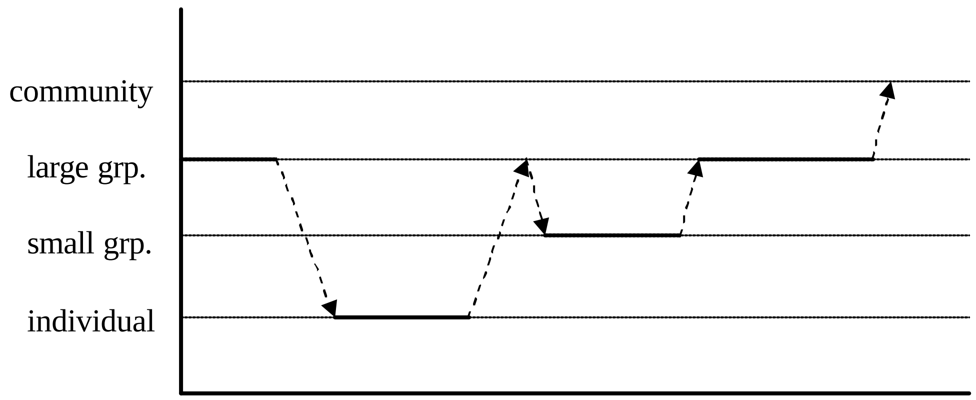
2.4 Example scenario (in narrative form):

A school class (11th grade) has visited the science museum in the capital city. They saw demonstrations of water rockets and chemical rockets and these gained considerable interests. Back to the classroom, the physics teacher takes this experience up by assigning the task of developing a system dynamics model of an ideal rocket (with constant exhaust velocity and mass loss during a certain time) using the Cool Modes tool. As a starting point, the teacher explains the basic rocket equation and leaves the modeling task as homework.

Thomas is a student in this class. When back home, he looks for relevant material on the web. He finds a number of graphical simulations, but the underlying models are not inspectable. He tries to set up the model in Cool Modes, but he does not get very far.

*In the next physics lesson (2 x 45 min.), it turns out that only about one third of the class has been able to complete the task. The teacher forms working groups and lets the students exchange their results using the shared workspace facilities. In the second half of the lesson, the teacher transfers two different solutions to the big interactive screen, discusses and annotates them. Based on the second solution, he discusses refinements for water rockets, which would reflect the continuous loss of pressure in the water reservoir. Finally, he asks the work groups to store their results in the CoLDEx community archive. The classroom session manager generates metadata entries for this example based on the teacher's description of the original problem (*grade, course, content area, problem theme*) and on the Cool Modes parameters (*authors/users, modeling language*).*

This example illustrates how integrated learning activities can involve different levels of collaboration over time. The following trajectory corresponds to the example:



The example episode does not comprise a concrete learning activity on the community level, yet in the end it produces learning objects, which are exported to the community archive. From the point of view of collaboration support, it is important that access to group archives and repositories is available on and between all levels. Tools and data formats used on different levels should be inter-operable. The necessary group infrastructure should be provided by session handlers, particularly on levels 2 (ad hoc session management for small non-permanent user groups) and 3 (CiC). Session handlers together with tools should generate and maintain metadata, which can be used to automatically index learning objects when they are put into an archive.

3 Summary

This deliverable provides some ideas that are conceived as a bridge between the learning requirements and the collaborative scenarios in the learning activity design process. COLDEX aims at providing an open-ended learning environment that stimulates learners to identify and solve a challenge according to the educational premises of Challenge Based Learning. An interactive learning environment should therefore be guided by:

- Authentic activities
- Construction
- Collaboration
- Reflection
- Situating the context
- Multi-modal interaction.
- Multicultural Perspective

The learning activities should be designed having in mind the following aspects: the objectives of the learning activity; the complexity of the topic under investigation; the challenges that could fit the student's group and its knowledge and skills; the possible tools to support the process; and the collaboration mechanisms. All these aspects are closely connected to those presented in the previous section.

The specialty of the COLDEX project is focused on the development of methodologies to create and maintain large learner communities around complex experiential phenomena rather than focusing on small highly controlled laboratory situations. This implies that a high degree of freedom should be assigned to the learning activity environment. This freedom of action will of course be different from school to school and from country to country, since aspects like culture and view on learning and teaching will vary. There will also be different degrees of possibilities for the students since some of the schools that will be involved in the project will have limited access to ICT, and/or face a lack of other resources and of money. Most of the tools that are accessible through the project will be offered free of charge.

The learner-centered approach we are suggesting does not exclude the teacher as having a leading role; on the contrary the intention of the project is to include teachers into the design and evaluation process as pedagogical and content experts. It is therefore important that the learning activity design is conducted by or at least in close collaboration with teachers at different levels. It is also important that teachers can see the advantages with regard to collaboration with global networks. We expect teachers to take an active roll in creating, filling with content and structuring this network.

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Appendix A: Use case diagrams

Introduction

During the initial fase of the COLDEX project a modeling was made using the language UML, the Unified Modeling Language. Due to the early stage of the project and the type of work done so far, the modeling was concentrated to the behavior of the system. This was done by using use case diagrams.

The purpose of this kind of diagram is primarily to look at a system from a user perspective, and to capture high-level functional requirements of the system. The diagram is a static description of what a system will do, it will not cover all the requriements of the system or how the system will function (Booch et al, 1999).

The COLDEX system is understood as all systems and applications, including LOR, webb server, application server and remote experimentation data providers. The modeling process for the COLDEX system is made in four steps, namely:

- The context
- The actors
- The functionalities
- Specific use case scenarios

The first two steps are explained below, though not all actors or use cases in detail. Concerning The functionalities and Specific use case scenarios, only the scenario that will be implemented in Växjö will be used in the description below and the possible functionalities this scenario will require. This is because all partners are responsible for the design of their own scenario and so far we have only seen our own. We believe though that this modeling more or less covers most of the functionalities needed.

Step 1 The context

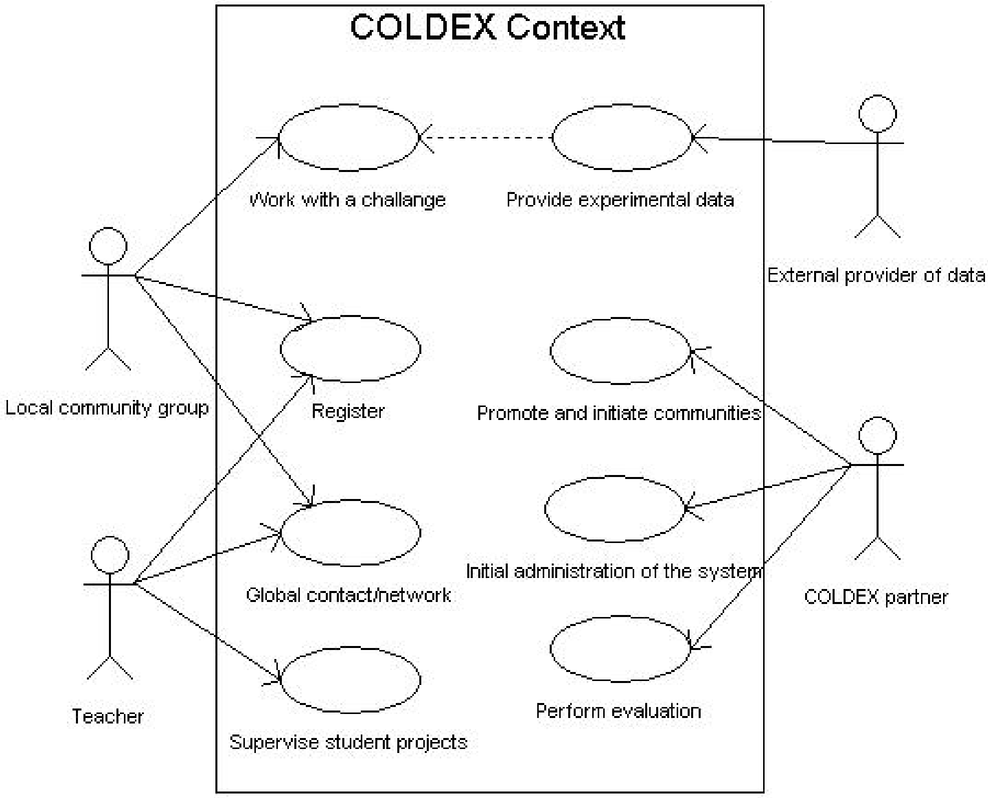
The first step is to model the context of the system. The context that surrounds the system has been limited to the following actors: a community group with its members of individual students; teachers; providers of external experimentation data, and the different COLDEX partners (see figure 1).

These actors are directly involved with the system and will require help from the system to perform their task. Below under step two follows a separate use case diagram for each one of them, except for the actor "External provider of data", and for the actor "COLDEX partner".

The system's use case for the COLDEX partners should be to provide an initial administration of the system, to initiate and promote community building and to do evaluation. The only use case for the External provider of data should be to provide experimental data on request from the local community group. The "External provider" could be a system or a human being.

The common use cases for Teacher and the Local community group are to register to get access to the system and the material, and to be involved in global sharing through the global network of COLDEX. The "Teacher" will also be able to supervise the work of the Local community group.

To clarify, the use case named Register covers the login of the teacher, the creation of a project group, the teacher's invitation to student into the project group or Local community group, and the student's registration as group member.



Figur 1. A use case diagram showing the context of the COLDEX system.

Step 2 The actors

The next step, to identify actors or roles that interact with the system, is more or less already done. In this case they are the same as those surrounding the system. The only adjustment made is to break free the individual Learner from the actor Local community group. The actors identified are therefore Teacher, Learner, Local community group, the COLDEX partner and External provider of data. The use case diagrams below cover Teacher, Local community group, and Learner.

As the user will perceive it, “The system” is here the COLDEX web accessed working space with a chosen DExT. In our (Växjö) case it is the DExT called “Biodiversity”.

Step 3 and 4 The functionalities and a specific use case scenario

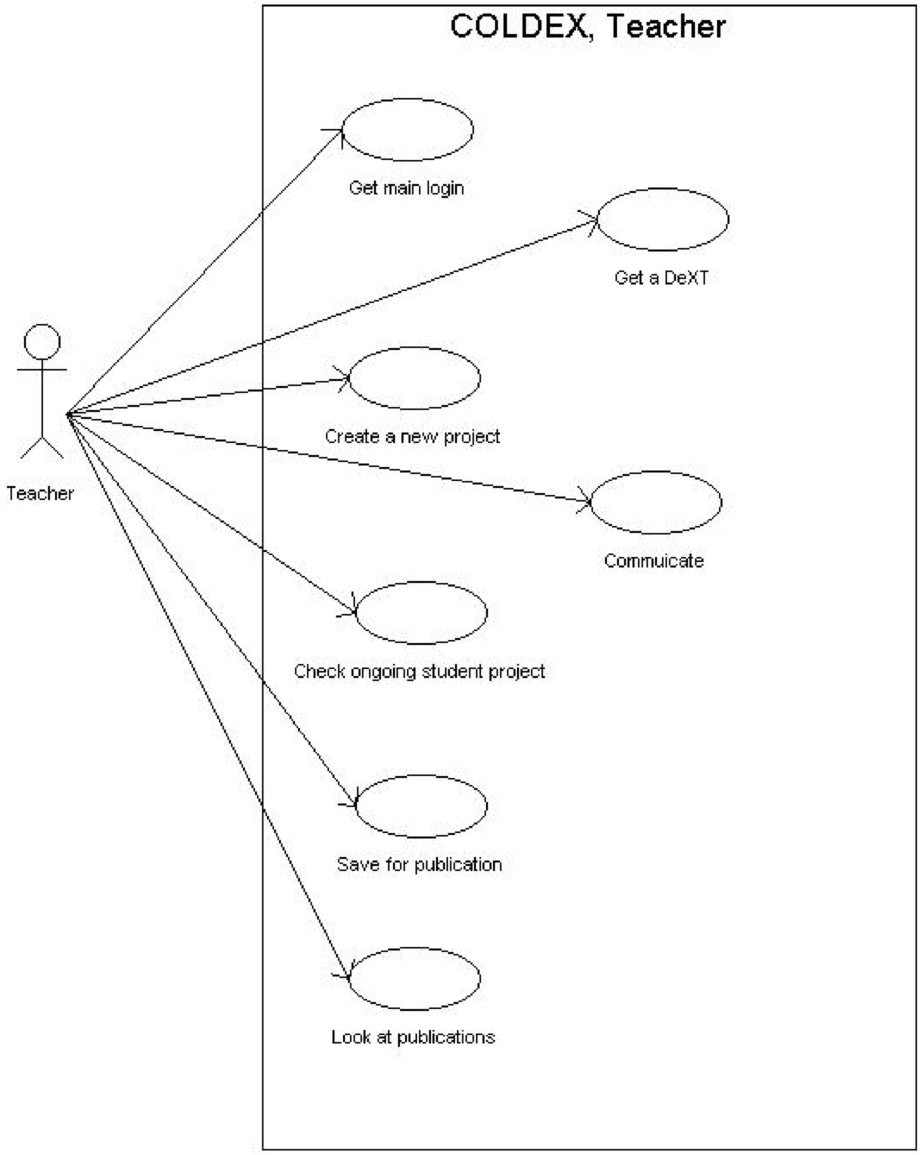
From the teacher’s perspective

We assume that a teacher has got information about COLDEX via the AV-Media portal in Växjö, or maybe through contact with the Xperiment House. The teacher applies for participation and gets a general teacher’s login. This is the entry where the teacher later may have access to all the different DExTs that the teacher buys and all the student groups that the teacher is responsible for. So far, it just gives access to the public space of COLDEX. This is to give the user a chance to be acquainted with the idea of challenge-based learning and of DExTs, to look at already finished and published material and to collect ideas.

When the teacher decides to purchase one or more DExTs, s/he also gets a separate login (license?) for each DExT that s/he has bought. From now on the teacher’s general login also gives access to DExT/s and to all the tools in the system. A group space for a student group may be created and an invitation sent out to the students that have notified the teacher of their interest of participation.

During the ongoing work of the students, the only way for the teacher to follow their work in the COLDEX system, is to go to “Work in progress”, the work space where the community group publishes the material that they have chosen to show for others. This is to ensure the students some privacy and to help the teacher to see the progress of the group. Of course, the students meet the teacher face-to-face and can share their work whenever they choose to.

When the student group has finished their work and the teacher has approved their efforts, the material can be saved by the teacher for publication in the public part of the COLDEX system. This is the public space where anyone that is registered and have a login can search for and download material.



Figur 2. The use case diagram Teacher.

A proper description of each use case would be:

Use case:	**Get main login**
Actors:	Teacher
Purpose:	To be able to use the COLDEX system.
Description:	The teacher asks for permission to enter the system (a login) and after a registration procedure s/he gets a login back. This gives access to the public space of COLDEX. After purchasing a DExT this login also gives access to the DExT, project space and to all the tools available.
Cross References:	The use cases “Get a DExtT” and “Create a new project”.

Use case:	**Get a DExT**
Actors:	Teacher
Purpose:	To choose one of COLDEX´s DExTs.
Description:	The teacher opens the menu of DExTs and chooses one. The system charges somehow the teacher for the purchase of the DExT. This gives access to all the resources in COLDEX.
Cross References:	The use cases “Get main login” and “Create a new project”.

Use case:	**Create a new project**
Actors:	Teacher
Purpose:	To use a DExT offered by COLDEX
Description:	The teacher creates a new local community group workspace and registers all members. The system creates a login to every student member and makes him or her aware of it. (By this the student gets both a private space and a common space for the group).
Cross References:	“Get a DExT”, the teacher must purchase a DExT before s/he can create a new project.

Use case:	**Communicate**
Actors:	Teacher
Purpose:	To communicate
Description:	The teacher activates (mail-) chat-, discussion thread-, notice board-functions to communicate with students and other students and colleagues globally that work with COLDEX DExTs.
Cross References:	The use case “Communicate” in the diagrams “Learner” and “Community group”.

Use case:	**Supervise ongoing student project**
Actors:	Teacher
Purpose:	The teacher follows up the students’ work.
Description:	The teacher looks at the student group’s work published in “Work in progress” and gives feedback through a communication channel.
Cross References:	See related diagram “Community group”, and the use case “Save in Work in progress”. “Work in progress” is the space where the student group publishes the material that they have chosen to show for others. See related diagram “Community group” and use case “Communicate” and current diagram “Teacher” and the use case “Communicate”.

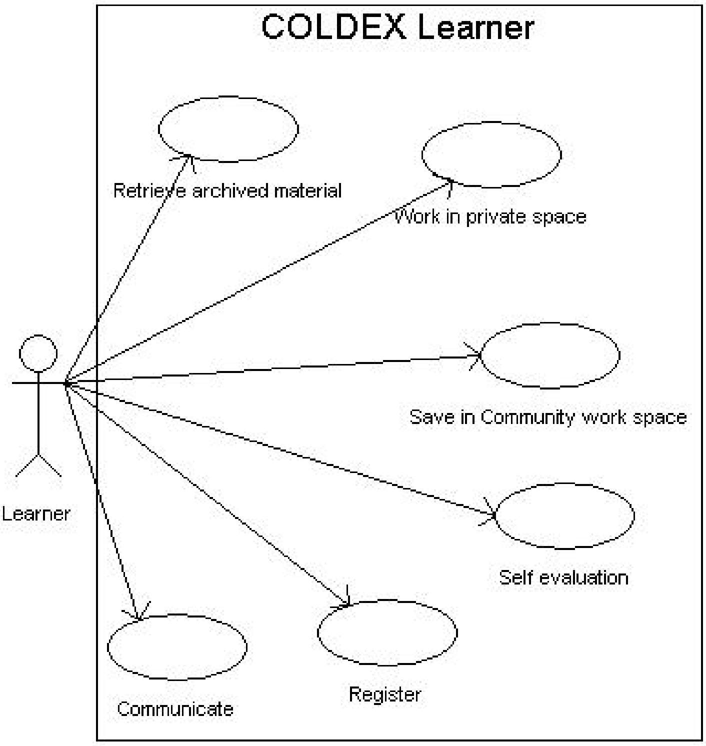
Use case:	**Save for publication**
Actors:	Teacher
Purpose:	The teacher publishes the students’ work.
Description:	The teacher looks in the “Work in progress” space and decides in cooperation with the group that the student work is finished. S/he publishes the completed project in the public space COLDEX system.
Cross References:	“Supervise ongoing student project”, “Look at publications”.

Use case:	**Look at publications**
Actors:	Teacher
Purpose:	The teacher looks at published projects.
Description:	The teacher looks and gets inspired by other projects saved in the COLDEX system.
Cross References:	See related diagram “Learner” and the use case “Retrieve archived material”.

From the student's or the learner's perspective

The same scenario as the one described above but from a student's perspective would start with that the student gets an invitation to join a community group to work with the specific DExT "Biodiversity". The student accepts the invitation, registers and becomes a member of a specific community group. Most of the student's activities are thereafter performed collaboratively in the Local community group. But the student can still have interest in doing some work on her own.

It is important that the student has a possibility to reflect in her own private space. When she finds it appropriate she can transfer her material to the community group's workspace. The private space also gives the student a chance to communicate as an individual with the teacher or with other students in the COLDEX network.



Figur 3. The use case diagram Learner.

The use cases in the diagram Learner (figure 3) would be as follows:

Use case:	**Register**
Actors:	Learner
Purpose:	The student registers herself to have access to the system.
Description:	The student registers herself as a respons to the invitation with the login sent by the system when the teacher created a group. This gives the student access to her private workspace and the Local community workspace
Cross References:	See related diagram "Teacher" and the use case "Create a new project".

Use case:	**Retrieve archived material**
Actors:	Learner
Purpose:	The learner looks at published projects and other archived material.
Description:	The learner looks at and gets inspired by the material saved by others in the COLDEX system.

Cross References:	See related diagram “Teacher” and the use case “Look at publications”; and the diagram “Community group” with the use case “Look at archived projects”.

Use case:	C**ommunicate**
Actors:	Learner
Purpose:	To communicate.
Description:	The learner activates (mail-) chat-, discussion thread-, notice board-functions to communicate with the teacher, fellow students in the local community, and other students in the global network that work with COLDEX DExTs.
Cross References:	The use case “Communicate” in the diagrams “Teacher” and “Community group”.

Use case:	**Work in private space**
Actors:	Learner
Purpose:	The learner works alone without insight from anyone.
Description:	The learner works with tools for text production, reflection and note taking.

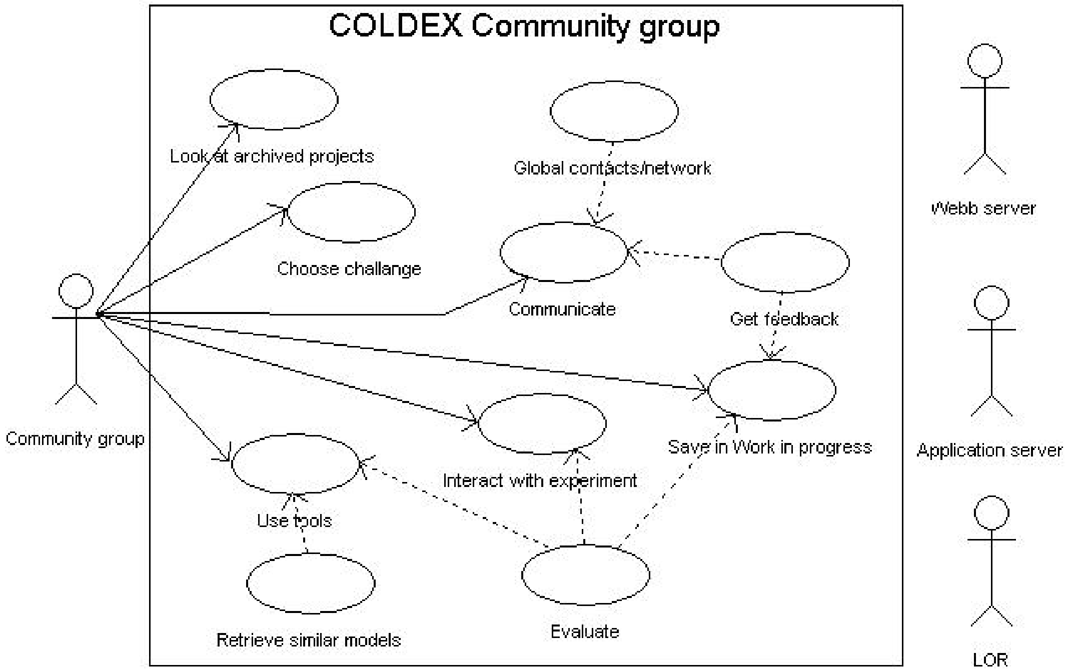
Use case:	**Save in community workspace**
Actors:	Learner
Purpose:	The learner transfers material from private space to public space.
Description:	The learner takes material produced in her own private space and transfers it to the Local communities common workspace for the other group members to see.

Use case:	**Self evaluation**
Actors:	Learner
Purpose:	The learner evaluates her own work.
Description:	The learner follows and evaluates her own work in relation to common and individual goals and tasks.
Cross References:	See related diagram “Community group”, and the use case “Evaluation”.

From the Local community group’s perspective

As soon as the individual student accepts to participate in a community, she becomes part of the actor Local community group. Here the group performs activities together, use tools and communicate (see diagram in figure 4). In figure 4 there are some actors on the right side of the diagram. We are still lacking the information needed to be able to draw the connections from the use cases to the different actors LOR, web server and application server.

The Local community group forms by the initiative of the teacher. The individual members login with their individual login, which gives them access to their private workspace and the group workspace. Most of the activities should be done in the common workspace to foster collaboration and collaborative knowledge building. The activities include communication with each other in the group, with the teacher and with other students in other communities; the use of tools which could be for modeling, simulation or concept mapping; interaction with experiment remote or local; downloading of material from the COLDEX system database; and self evaluation of the work done in relation to the chosen challenge.



Figur 4. The use case diagram Community group.

The use cases for Community group are:

Use case:	**Look at archived projects**
Actors:	Local community group
Purpose:	The community group looks at published projects.
Description:	The community group looks at and gets inspired by the material saved by others in the COLDEX system.
Cross References:	See related diagram "Teacher", and the use case "Save for publication"; and the diagram "Learner" with the use case "Retrieve archived material".

Use case:	**Choose challenge**
Actors:	Local community group
Purpose:	The group chooses a challenge to work with in the project.
Description:	The group gets a list of available challenges or makes one up by themselves, and chooses it by registering the challenge in their workspace.

Use case:	**Use tool**
Actors:	Local community group
Purpose:	The community group uses tools.
Description:	The community group uses tools for concept mapping, modeling, simulation or experimentation.
Cross References:	The use cases "Retrieve similar models" and "Evaluate".

Use case:	**Retrieve similar models**
Actors:	Local community group
Purpose:	The community group looks at published and archived models made with COLDEX tools.
Description:	The community group looks at already made models, made through the tools for e.g. concept mapping, modeling, or simulation.

Cross References: The use case “Use tool”.

Use case:	C**ommunicate**
Actors:	Local community group
Purpose:	To communicate.
Description:	The community group activates (mail-) chat-, discussion thread-, notice board-functions to communicate with the teacher, with each other, and other students in the global network that work with COLDEX DExTs.
Cross References:	The use case “Communicate” in the diagrams “Teacher” and “Learner”.

Use case:	**Save in Work in progress**
Actors:	Local community group
Purpose:	The group transfers material from the group’s workspace to the public space where the teacher can see the material.
Description:	The community group takes material produced in their workspace and transfers it to the Work in progress, the common workspace for the teacher to see. The teacher gets a notification, looks at the material and gives feedback.
Cross References:	Use case “Evaluate”. See also related diagram “Teacher” and the use case “Supervise ongoing student project”.

Use case:	**Interact with experiment**
Actors:	Local community group
Purpose:	The group interacts with an ongoing experiment.
Description:	The community group constructs, follows and manipulates an experimental setting, on place or remote through Internet.
Cross References:	See the use case “Evaluation”.

Use case:	**Evaluation**
Actors:	Local community group
Purpose:	The group evaluates its work.
Description:	The community group follows and evaluates its own work in relation to common goals and tasks.
Cross References:	See related diagram “Learner” and the use case “Self evaluation”. See also current diagram and the use cases “Use tool”, “Interact with experiment” and “Save in Work in progress”.