COLDEX

Collaborative Learning and Distributed Experimentation

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Evaluation Plan II: Specialised Evaluation and Test Plan

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1. Introduction

The aim of this deliverable is to present the COLDEX evaluation plan based on the action plan outlined in work package 2 (D.2.3.2). The main target for the evaluation activities are the different learning scenarios, activities and tools developed during the course of this project. The learning scenarios are approached according to the following:

- First, the setting with subjects and objects are identified in an overall activity description. The nodes, in an activity triangle from *Activity Theory* are used to identify the collaborative settings and the educational activities.
- Second, the instruments used for the evaluation and the variables used as objectives for the evaluation are specified.
- Thirdly, the details on how and when to conduct the evaluation are specified in a time line.

The purpose of this plan is to promote the evaluation of the ongoing activities of the project. Moreover, another objective with the evaluation plan is to use it as a tool for dialogue and discussion to promote reflection and, if needed, reengineering or redesign of the different components of the COLDEX platform. This plan may be adjusted during the actual evaluation activities. In the coming sections a detailed evaluation plan for each one of the chosen scenarios is presented.

2. Evaluation Plan / Astronomy Scenario

2.1 Overall activity description

One variety of the astronomy scenario is the lunar height investigation. The idea is very simple: take a picture of the moon which has to show the terminator – the border between sun lighted and shadowed moon – somewhere, load the image within a modelling environment, build a calculation net representing a rule of thumb formula and feed the measures by clicking on the loaded picture and connect this to an input node of the calculation net. The result will be an approximate value for the crater height.

Activities in the astronomy workshops – lunar heights – are defined through the problem space, the challenge to take pictures with scientific equipment, i.e. telescopes, and the students' interest. Participants develop activities by taking pictures, measure different distances and feed them into a calculation net. The task is limited only by the tools (e.g. Cool Modes) available and the given objects (e.g. find a picture which has an appropriate moon phase which shows the appropriate shadow which is essential for the measuring). The frame which is determined throughout the workshop, guide the activity process.

- Planning, running, calculating, assessing scientific approach
- Investigation of a challenge

Subject

Groups with 5 to 25 students from different schools in Germany (Ruhr Area) are involved in experimentation activities. The goal of these experiments is to learn the scientific approaches of collaboration, combination of different data (picture, calculation formula) within the astronomy scenario. It is assumed that students' participation in these activities is based on a strong personal interest in technologies and / or science, especially against the background of the space theme. Additionally to the participation in the workshop, they need to fulfil all responsibilities in school such as homework.

The COLDEX project aims at students ranging from higher secondary education to academic beginners. A refinement of this group for the astronomy scenario is the following: learners of the average age of about 14-17 years.

Tools

Tools in the astronomy scenario workshops enable participants to increase the quantity of actions (for example re-calculating the lunar height by re-measuring the distances) since they can simulate a real world context. Collaboration features within tools support communication actions within an activity.

- Learning strategies: e.g. scientific method "collecting data”
- Software: e.g. Cool Modes
- Hardware: telescope

Object

- The space theme, e.g. Apollo missions, serves as an overall problem space within problems are set
- Selection of appropriate input data (e.g. pictures)
- Elaborate the given rule of thumb formula
- Relation between changes to the formula or distance of the crater to the terminator, distance to the edge of the edge of the moon shown in the picture
- Application of mathematical theories (e.g. plane geometry and similarity of triangles)
- Students are encouraged to ask for peer help

Workshop rules

Workshop rules as they are listed below have an impact on the workshop participants as a community and the division of labour:

- Different roles: picture selectors, calculator (who model the calculation net as a different representation of the formula), measurer (who combine the selected pictures and the calculation net and measure the needed distances); the roles should change to give every student the insight in the whole experiment
- Different groups: competition in precision of the results
- Scientific method as a guidance for workshop participants
- Solving introductory tasks should support to get to learn quickly the features of the scenario
- Timeframe / schedule of the workshop (mostly 90 minutes workshop)
- Are the students allowed to eat and drink during the workshop
- Collaborative regulations: two – four students form a group on one computer resp. with the physical maze equipment

Community

Students participating in the workshop are supported by members of the University of Duisburg-Essen. Some of the workshops will be held without a teacher of the students' school. In this case the students do not know each other, except smaller groups which are combined within the whole workshop group. That make the collaboration start slower than it would if they knew each other. Students are encouraged to ask for peer help, but also to compete with others.

On the other hand, lessons in school are hold with the help of a member of the University of Duisburg-Essen, but also with the help of the teacher of this class who prepares the theory before the experiment. In this context the students have known each other from the school community. That's why in this case there is a strong support and collaboration from the beginning of the workshop.

Division of labour

The students share responsibilities in small groups, as well as a whole group. They are allowed to switch the tasks if they solved their previous one already. Small groups have to report their findings back to the whole group and can comment other groups' results.

Desired / expected outcomes of the workshops

The value of activities (e.g. planning, running, calculating, assessing scientific approach) has a more or less immediate impact on how objects (e.g. optimisation of the formula) are transformed into outcomes

- Acquisition and application of learning strategies specifically scientific method
- Raised interest regarding scientific experiments using technology
- Raised interest towards computers and technology in general
- Raised interest in applying (mathematical) theory and therefore raised interest in the theory itself
- Acquisition of a basic scientific language (mathematical and lunar terms)
- Students' artefacts that can be stored in the LOR.

Motives and activities

- Specific interest (motive) the student gains when planning, running, calculating and assessing his or her results
- Goal orientation (motive) when investigating a problem

Actions and immediate goals

- Select data (pictures)
- Transfer formula to another representation
- Feed distances as input by measuring with mouse clicks (immediate goal)
- Comparing their own results with others and discussing the different groups' results to deepen the understanding and understand better the meaning of the scenario

Operations in response to conditions

- Hand out scribbling paper if students want to make sketches or need to visualise with a different medium
- Raising hand if something is unclear

Overall Computer-Simulated Experimentation Goal

- Learners will be able to find connections between theoretical formula and practical effect (e.g. selecting a different location of a crater has an effect on precision of the results).

Objectives

- Apply principles of scientific approach in the context of computer simulation and modelling
- Demonstrate their understanding of the relation between the distance of a crater to the terminator resp. to the moon edge within the picture on the one hand and on the other hand the precision of the given formula.
- Make guesses about how a result will differ if the input error increases, e.g. by taking no zoomed picture.

Educational aspects

The activities in the astronomy workshops are characterised by applying scientific methods on the challenge to combine several input data (pictures, formula) to a calculated result (approximate height of a moon crater).

2.2 Instruments and Variables

The table below (table 1) gives an overview of how the astronomy scenario evaluation will use COLDEX relevant variables using appropriate instruments.

Table 1. Variables and instruments table.

Variables→ Instruments ↓	Knowledge and comprehension	Attitudes and motivation	Collaboration	Science Skills	Usability	Language issues
Questionnaire	*	*	*	*		
Scale ratings		*	*	*		
Observation			*			*
Heuristic evaluation					*	
Standardized tests /performance assessment	*					
Interview, Focus Groups			*			*
Logfiles			*		*	*
Learning diary		*				

Knowledge, comprehension and Science Skills
In order to assess comprehension and learning outcomes, contextualized content specific test items will be used. Because of the extracurricular character of the astronomy scenario, standard test items are not useful; the non-standard (school) activities demand COLDEX specific items, which will be used in a pre post assessment.

Attitudes and Motivation
Motivation will be assessed using Deci and Ryan's (1994) intrinsic motivation questionnaire (IMI) and with additional specific items regarding the astronomy scenario. Since students do not only work hands on but also in a computer-based environment, an attitude test will be applied that assesses attitudinal behaviour towards technology. These technology-related items will be adapted and enhanced with specific questions regarding hands-on learning.

Collaboration

To assess the types of collaboration supported within the astronomy scenario, we will use rubric that distinguishes between different types of interaction that can be supported within a reciprocal learning situation. As a validation of this assessment log files can be used to backup the rating scale outcomes. The rubric will be used as an instrument to guide a heuristic observation done by an expert.

Usability
CoolModes: A usability evaluation will be carried out to test the effectiveness of the used software CoolModes. The user evaluation template System Usability Scale (SUS) developed by Brooke (1996) will be adapted to serve as a guide to carry out a usability evaluation.

Remote control of a telescope via a web interface: The interface evaluation will be carried out doing a one-to- one user trial evaluation (a heuristic expert evaluation as well as a general user evaluation using the System Usability Scale (SUS). The One-to-One Trial will give insight on how easy the interface can be used by a non expert user with no prior experience with this interface.

2.3 Logistics /Timeline

The table below (table 2) gives an overview of how the Astronomy scenario evaluation will use COLDEX relevant variables using appropriate instruments.

Table 2. Logistics and timeline.

What	When	Who	Time Frame
Knowledge assessment	pre post (email) 19. Nov 2004 Univ. UDE	Maria Oelinger	Lesson: 90 minutes Whole workshop: 3 hours
Motivation and Attitude assessment	18. Nov Univ. UDE	Maria Oelinger	
Collaboration assessment	18. Nov. observation using Rating scales	Maria Oelinger, Markus Kuhn	
Usability assessment	Kay -> Schüler auftreiben datum (bis Feb 2005)	Kay Hoeksema	

3. Evaluation Plan / Maze Scenario

3.1 Overall activity description

Activities in maze workshops are defined through the problem space, the challenge to construct mazes and to give rules for escaping mazes and the students' interest. Participants develop activities by generating mazes and classifications of mazes, rules and rule sets. The task is limited only by the tools (e.g. Cool Modes, Lego Mindstorms) available and the given objects (e.g. find a rule set for solving every maze without an island). The frame, which is determined throughout the workshop, guides the activity process.

- Planning, running, assessing scientific approach
- Investigation of a challenge

Subject

Groups with 5 to 25 students from different schools in Germany (Ruhr Area) are involved in escaping strategy experimentation activities. The goal of these experiments is to learn the scientific approaches of abstraction, finding classes of mazes or rule sets, which can be minimized concerning the number of rules using wildcards within the maze scenario. It is assumed that students' participation in these activities is based on a strong personal interest in technologies and / or science, especially within the background of the space theme (mars mission as motivational real-world event). Additionally to the participation in the workshop they need to fulfil all responsibilities in school such as homework.

Tools

Tools in maze scenario workshops enable participants to increase the quantity of actions (for example running a virtual robot through a maze) since they can simulate a real world context. Collaboration features within tools support communication actions within an activity.

- Software: e.g. Cool Modes, ETMC ("escape the maze control software" to control the physical Lego Mindstorms robot)
- Hardware: Lego Mindstorms (robots), wooden maze pieces

Object

- The object of the activity is the construction of mazes by competing with other students' rule sets and vice versa
- The space theme, e.g. mars mission, serves as an overall problem space within problems are set
- Classify mazes
- Distinguish different kinds of rule sets (e.g. wall-following left or right)
- Use rule sets for the physical maze also for the simulated mazes and vice versa.
- Relation between situations and rules, dependent on the bigger context (e.g. wall-following around an island makes no sense in escaping the maze)
- Optimisation of the rule sets (minimising number of rules by using wildcards)
- Students are encouraged to ask for peer help

Workshop rules

Workshop rules as they are listed below have an impact on the workshop participants as a community and the division of labour:

- Different teams: maze constructors vs. rule setters
- Scientific method as a guidance for workshop participants
- Solving introductory tasks should support to get to learn quickly the features of the scenario
- Timeframe / schedule of the workshop (e.g. project week vs. 90 minutes workshop)
- Are the students allowed to eat and drink during the workshop
- Collaborative regulations: two – four students form a group on one computer resp. with the physical maze equipment

Community

Students participating in the workshop are supported by members of the University Duisburg-Essen. Most of the workshops will be held without a teacher of the students' school. The students do not know each other, except smaller groups which are combined within the whole workshop group. That make the collaboration start slower than it would if they knew each other. Students are encouraged to ask for peer help, but also to compete with others.

Division of labour

The students share responsibilities in small groups as well as in the whole group. They are allowed to switch the tasks if they solved their previous one already. Small groups have to report their findings back to the whole group and can comment other groups' results.

Desired / expected outcomes of the workshops

The value of activities (e.g. planning, running, assessing scientific approach) has a more or less immediate impact on how objects (e.g. rule sets) are transformed into outcomes

- Acquisition and application of learning strategies specifically scientific method
- Raised interest regarding scientific experiments using technology
- Raised interest towards computers and technology in general
- Acquisition of a very basic scientific language (mainly represented in the rule sets)
- Students artefacts that can be stored in the LOR

Motives and activities

- Specific interest (motive) the student gains when planning, running and assessing his or her results
- Goal orientation (motive) when investigating a problem

Actions and immediate goals

- Classify mazes or minimise rule sets
- Planning rule sets for general situations, not only the concrete ones

- Running the robot to check the predicted behaviour for a rule set
- Formulating rules / maze class characteristics to be able to accurate robot behaviour
- Comparing their own results with others and discussing the different groups' results to deepen the understanding and understand better the meaning of the scenario

Operations in response to conditions

- Hand out scribbling paper if students want to make sketches or need to visualise with a different medium
- Raising hand if something is unclear
- Switching (viewing) from physical to virtual part if the student needs another input channel

Learning objectives – Overall Computer-Simulated Experimentation Goal

Learner Will Be Able To (LWBAT) classify and generalise and abstract from concrete to general situations and rules.

Learning objectives – Objectives

- Apply principles of scientific approach in the context of computer simulation and modelling
- Demonstrate their understanding of the relation between maze class and rule set class within the discussion phase.
- Make guesses about how a robot will act for a given maze and rule set and how given rule sets can be minimised in the number of rules or how a maze can be re-built to break a given rule set

Educational aspects

The activities in maze workshops are characterised by applying scientific methods on the challenge to find a way out of a maze – or not.

3.2 Instruments and variables

The table below gives an overview of how the maze scenario evaluation will use COLDEX relevant variables using appropriate instruments.

Table 3. Variables and instruments table.

Variables→ Instruments ↓	Knowledge and comprehension	Attitudes and motivation	Collaboration	Science Skills	Usability	Language issues
Questionnaire	*	*	*	*		
Scale ratings		*	*	*		
Observation			*			*
Heuristic evaluation					*	
Standardized tests /performance assessment	*					
Interview, Focus Groups			*			*
Logfiles			*		*	*
Learning diary		*				

Knowledge, comprehension and Science Skills
In order to assess comprehension and learning outcomes, contextualized content specific test items will be used. Because of the extracurricular character of the maze scenario, standard test items are not useful; the non-standard (school) activities demand COLDEX specific items, which will be used in a pre post assessment.

Attitudes and Motivation
Motivation will be assessed using Deci and Ryan's (1994) intrinsic motivation questionnaire (IMI) and with additional specific items regarding the MAZE.
Since students do not only work hands on but also in a computer-based environment, an attitude test will be applied that assesses attitudinal behaviour towards technology. These technology-related items will be adapted and enhanced with specific questions regarding hands-on learning.

Collaboration
To assess the types of collaboration supported within the maze scenario, we will use a rubrik that distinguishes between different types of interaction that can be supported within a reciprocal learning situation. As a validation of this assessment, log files can be used to backup the rubrik outcomes. The rating scales will be used as an instrument to guide a heuristic observation done by two observers.

Usability
A usability evaluation will be carried out to test the effectiveness of the used software CoolModes. The user evaluation template System Usability Scale (SUS) developed by Brooke (1996) will be adapted to serve as a guide to carry out a user one to one evaluation. SUS view of usability is reflected in the current draft international standard ISO 9241-11 and in the European Community. Additionally focus groups are planned to ask specific questions regarding usability. Within the workshops and project week, the users are asked to give their feedback concerning usability (self formulated).

3.3 Logistics /Timeline

The table below (table 4) shows the details of the evaluation.

Table 4. Logistics and timeline.

What	When	Who	Time frame
Knowledge assessment	pre post (email) 19. Nov 2004 Univ. UDE	Maria Oelinger	90 minutes resp. 3 hours
Motivation and Attitude assessment	18. Nov Univ. UDE	Maria Oelinger	
Collaboration assessment	18. Nov. observation using Rating scales	Maria Oelinger, Markus Kuhn	

4. Evaluation Plan / System Dynamics

4.1 Overall activity description

Activities in System Dynamics workshops are defined through the problem space, the challenge to model and simulate the flight of a (water) rocket. Participants develop activities by learning to use the System Dynamics modelling language in Cool Modes and to construct an operational model of a rocket. The task is limited only by the tools (e.g. Cool Modes, System Dynamics) available and the given objects (e.g. find a model for solving the "rocket problem"). The frame, which determined throughout the workshop, guides the activity process.

- Planning, running, assessing scientific approach
- Investigation of a challenge

Subject

A group of about 8 students from different schools in Germany (Ruhr Area) are involved in System Dynamics experimentation activities. The goal of these experiments is to learn the scientific approaches of abstraction, getting used to the System Dynamics modelling language and constructing a simulation for flying rocket (keywords: momentum, gravity, acceleration, decrease of fuel, etc.). It is assumed that students' participation in these activities is based on a strong personal interest in technologies and / or science, especially within the background of the space theme (hands-on toy is available at any toy shop or can be re-build by students with little effort).

Tools

Tools in System Dynamics scenario workshops enable participants to increase the quantity of actions (for example constructing and operating a simulation) since they can simulate a real world context. Collaboration features within tools support communication actions within an activity.

- Software: e.g. Cool Modes, System Dynamics

Object

- The object of the activity is the construction of a System Dynamics model to simulation the flight of a rocket
- The space theme, e.g. mars mission, serves as an overall problem space within problems are set
- Learn about System Dynamics: General features, possibilities, limitations
- See relations between momentum, acceleration, velocity
- Students are encouraged to ask for peer help

Workshop rules

Workshop rules as they are listed below have an impact on the workshop participants as a community and the division of labour:

- Several team for having different solution / discussion about these solutions

- Scientific method as a guidance for workshop participants
- Solving introductory tasks should support to get to learn quickly the features of the scenario
- Timeframe / schedule of the workshop (e.g. project week vs. 90 minute workshop)
- Are the students allowed to eat and drink during the workshop
- Collaborative regulations: two – four students form a group on one computer resp. with the physical maze equipment

Community
Students participating in the workshop are supported by members of the University Duisburg-Essen. Most of the workshops will be held without a teacher of the students' school. The students do not know each other, except smaller groups which are combined within the whole workshop group. That make the collaboration start slower than it would if they knew each other. Students are encouraged to ask for peer help, but also to compete with others.

Division of labour
The students share responsibilities in the small groups as well as a whole group. But they are allowed to switch the tasks if they solved their previous one already. Small groups have to report their findings back to the whole group and can comment other groups' results.

Desired / expected outcomes of the workshops
The value of activities (e.g. planning, running, assessing scientific approach) has a more or less immediate impact on how objects (e.g. System Dynamics models) are transformed into outcomes

- Acquisition and application of learning strategies specifically scientific method
- Raised interest regarding scientific experiments using technology
- Raised interest towards computers and technology in general
- Acquisition of a scientific language (System Dynamics)
- Students artefacts that can be stored in the LOR

Motives and activities

- Specific interest (motive) the student gains when planning, running and assessing his or her results
- Goal orientation (motive) when investigating a problem

Actions and immediate goals

- Solve small problems, introducing System Dynamics
- Find relevant variables, relations concerning the “rocket problem”
- Constructing a System Dynamics model to solve the “rocket problem”
- Find suitable values for simulations
- Find limitations of the model, “Which attributes of a real flying rocket are not / cannot be modelled?”

- Comparing their own results with others and discussing the different groups' results to deepen the understanding and understand better the meaning of the scenario

Operations in response to conditions

- Hand out scribbling paper if students want to make sketches or need to visualize with a different medium
- Raising hand if something is unclear

Learning objectives – Overall Computer-Simulated Experimentation Goal

Learner will know basic features of the System Dynamics modelling language and can apply them to real world phenomena / problems.

Learning objectives – Objectives

- Apply principles of scientific approach in the context of computer simulation and modelling
- Demonstrate their understanding of the relation between physical objects / terms / procedures.
- Demonstrate their understanding of System Dynamics.

Educational aspects

The activities in System Dynamics workshops are characterized by applying scientific methods (e.g. System Dynamics) on different challenges, especially on how to simulate a flying rocket.

4.2 Instruments and variables

The table below (table 5) gives an overview of how the System Dynamics scenario evaluation will use COLDEX relevant variables using appropriate instruments.

Table 5. Variables and instruments table.

Variables→ Instruments ↓	Knowledge and comprehension	Attitudes and motivation	Collaboration	Science Skills	Usability	Language issues
Questionnaire	*	*	*	*		
Scale ratings		*	*	*		
Observation			*			*
Heuristic evaluation					*	
Standardized tests /performance assessment	*					
Interview, Focus Groups			*			*
Logfiles			*		*	*
Learning diary		*				

Knowledge, comprehension and Science Skills
In order to assess comprehension and learning outcomes, contextualized content specific test items will be used. Because of the extracurricular character of the System Dynamics scenario, standard test items are not useful; the non-standard (school) activities demand COLDEX specific items, which will be used in a pre post assessment.

Attitudes and Motivation
Motivation will be assessed using Deci and Ryans (1994) intrinsic motivation questionnaire (IMI) and with additional specific items regarding this scenario. Scale rating: Motivation.

Since students do not only work hands on but also in a computer-based environment, a attitude test will be applied that assesses attitudinal behaviour towards technology. These technology-related items will be adapted and enhanced with specific questions regarding hands-on learning.

Collaboration
To assess the types of collaboration supported within this scenario, we will use a rubric that distinguishes between different types of interaction that can be supported within a

reciprocal learning situation. As a validation of this assessment log files can be used to backup the rating scale outcomes.

Usability
A usability evaluation will be carried out to test the effectiveness of the used software CoolModes. The user evaluation template System Usability Scale (SUS) developed by Brooke (1996) will be adapted to serve as a guide to carry out a usability evaluation. Additionally focus groups are planned to ask specific questions regarding usability. Within the workshops and project week, the users are asked to give their feedback concerning usability (self formulated).

4.3 Logistics /Timeline

The table below (table 6) shows the details of the evaluation.

Table 6. Logistics and timeline.

What	When	Who	Time frame
Knowledge assessment	pre post (email) 19. Nov 2004 Univ. UDE	Maria Oelinger	3 hours
Motivation and Attitude assessment	18. Nov Univ. UDE	Maria Oelinger	
Collaboration assessment	18. Nov. observation using Rating scales	Maria Oelinger,	

5. Evaluation plan / Chemistry

5.1 Overall activity description

UNED, a Spanish Distance Learning University, with students all over Spain and also (a few number) in other countries. Central Headquarters are in Madrid, and there are about 70 study centres in different towns. Chemistry is one of the basic subjects, and it is studied in the first two years. Chemistry I (Introduction, 1rst year) and Chemistry II (2nd year). Chemistry I involves many students and the lab work is geographically distributed among the Study Centres, organized in intensive mode. Students have to come to their nearest Centre for 2 days, to work in a lab; the usual period is in March.

Subjects
Students are organized in groups of two, with maximum 10 groups per turn. The practical work is mandatory, and has to be carried out only once. There are different tutors for the different turns. The professor in the Engineering School establishes the guidelines, but it is up to tutors the concrete deployment and organization of the experimental work in each centre. On the contrary for Chemist II, all students have to come to the lab facilities in Madrid UNED central headquarters, where professors organise, monitor and control directly the experimental work.

Objects
The goal is to identify the elements in an organic sample. Practical work involves activities organized in three stages: some preparatory work before coming to the lab, the lab period, and some work after the lab sessions. A brief description for each stage follows:

- Pre-lab: Teaching staff prepares a document in paper (guidelines and instructions) and send it by ordinary mail to students
    - Students receive documentation at home and have to read it (usually they don't)

- Lab: 3 sessions, to carry out three experiments, and one video session in a classroom. This intensive mode is a constraint that can not be removed, due to financial and organizational reasons.

- Post-lab: report preparation (deadline 1 month), one report by pair of students, at home. The document is delivered by ordinary mail. This Report is corrected by the assistants and sent back to the students.

The lab phase is carried out in Las Rozas Study Center. A wireless network is installed in the chemistry lab, and students can connect to the server, to work in their scenario environment, using PDAs with wireless cards.

Tools
Students are informed about two approaches: using spectroscopy, which is the "modern" way to proceed, (shown by a video) and the traditional analytic one, by physical and chemical manipulation, the one they will do in the lab called elemental analysis and functional organic group.

In the lab phase, the students work together in small groups using an interactive on-line environment built with the system: The lab activity consists of the analysis of a chemical compound in order to identify its main components. Adequate experimental procedures and tools have to be selected, reflection has to be undertaken on the results obtained, and finally, a conclusion based upon the evidence obtained has to be elaborated. Due to the nature of a chemistry laboratory, where the presence of standard desktop PCs among the chemicals is somewhat impractical, the student's use PDAs running specially developed client software, connected to the platform via a real time synchronous wireless link. The environment accepts a variety of inputs, for instance, photos taken by the students, and offers different types of functionality, such the annotation of the results obtained in the lab. In this phase tutors are available at the lab for assisting students.

Once the experiment has finished, and the students leave the laboratory, the post-lab phase begins: a reporting activity, undertaken at a distance, using any desktop PC, using a standard Web browser to connect to the platform. The results generated during the laboratory can be integrated into a final document which is submitted to the teacher for correction on-line.

For the postlab phase, the main tool used is a collaborative reporting tool. The tool uses a private space, and a shared space between the users. Students can import the entire outcome they have produced in the other phases by using the "import" button. They can move objects from the private space to the shared space by drag and drop operations.

5.2 Instruments and variables

In our case the instruments are logfiles- we have registered data of the activity of the students-, performance assessment (from the teacher), as well we can interview the teacher in a more formal way, for aspects of knowledge, attitudes, motivation, etc.

To evaluate the theoretical knowledge related to the experiment, the professor has designed a set of questions, in form of multiple-choice questionnaire. These questionnaires are processed with a tool.

6. Evaluation Plan / Biodiversity

6.1 Overall activity description - FoodinSpace Workshop

Activities in the FoodinSpace workshops are defined through the problem space, the parameters of plant growth and the students' interest. Participants develop activities by generating research questions that are limited by the tools (e.g. BioBlast, BeLife) available and the given objects (e.g. Optimization for Plant growth). The rules, which are determined throughout the workshop, guide the activity process.

- Planning, running, evaluating scientific experiments
- investigation of a scientific problem

Subject: Group of eight students from a high school in Växjö involved in plant growth experimentation activities to optimise conditions for plant growth within an advanced life support scenario. It can be assumed that most students participate out of a strong interest in technologies and /or science because additionally to the participation in the workshop they need to fulfil all responsibilities in school such as homework.

Tools:
Tools in FoodinSpace workshops enable participants to increase the quantity of **actions** (for example running experiments) since they can simulate a real world context. Collaboration features within **tools** support communication actions within an **activity**. Also Tools used to support knowledge-building processes foster the understanding of complex **objects** (e.g. Photosynthesis) by visually representing them which otherwise would be not easy to grasp.

- learning strategies: e.g. scientific inquiry method
- Software: e.g. Coolmodes, Inquiry Tool, BioBlast, BeLife
- Concept of photosynthesis

Objects:
- The Object of this activity was the production of plants by collaboratively altering parameters to optimize conditions for humans and plants using innovative technology.
- Mars and Advanced Life Support System served as an overall problem Space within problems were investigated.
- Feeding as many people on mars most effectively
- Distinction between Edible / inedible Biomass
- Relation between parameters and their effect on plant growth
- Optimization of conditions for virtual plants

Rules:
Rules as they are listed below have a strong impact on the workshop participants as a community and the division of labour.

- Self-generated research-questions that guide the scientific investigation. These research-questions determined the scientific process of making a prediction and running an experiment. The conclusions from the experiment guided the follow up research question
- Shared responsibilities /Team expectations
- Scientific method as a guidance for workshop participants
- Timeframe / schedule of the workshop
- Numbers of cokes that students are allowed to drink :-)
- Collaborative regulations: two students work on one computer except for presentations or whole activity situations

Community: Students participating in the workshop belonged to Instructors, Evaluators, Science Centre pedagogues in the science centre Xperiment Huset, Växjö, Sweden. The students have known each other from the school community. That's why there was a strong support and collaboration from the beginning of the workshop. Students felt confident to ask for peer-help.

Division of labour: The students shared responsibilities in the small groups as well as a whole group. Most tasks were divided in subtasks, so small groups had to report their findings back to the whole group.

Desired/ Expected outcomes and goals of the Biodiversity scenario: The value of activities (e.g. planning, running, evaluating scientific experiments) has a more or less immediate impact on how objects (e.g. optimization of conditions of the plant) are transformed into outcomes

- Acquisition and Application of learning strategies specifically scientific method
- Raised interest regarding scientific experiments using technology
- Raised interest towards computers and technology in general
- Understanding the parameters that affect plant growth

(see method section to view instruments to asses these desired outcomes and goals)

Motives and activities:

- Specific interest (motive) that the student gains when running, planning and evaluating scientific experiments
- Goal Orientation (motive) when investigating a problem

Actions and immediate goals:

- Writing explanations to make predictions (immediate goal)
- Formulating research questions to investigate the problem of feeding humans in space
- Running experiments to get scientific data
- Formulating conditions to be able to accurate run experiments
- Comparing experiment results with predicted results to understand made mistakes

Operations in response to conditions:

- Writing experiment notes on paper if a students is not familiar with word
- Raising the hand something is unclear
- Opening a web browser when more information is needed to answer a research question
- On a later stage in the workshop the scientific methods was used by some of the students as an operation. The use of the scientific method collapsed (from being earlier a conscious action) into well-defined routine after 2 days of practice. However this operation can become a conscious action when the conditions of investigating a scientific problem change so significantly that the routine method needs to be adapted. Then the operation needs to become a conscious action again

Learning Objectives

Learning Objectives are needed to operationalise desired and expected outcomes from FoodinSpace Workshop activities. Additionally they can be reused later in the Assessment phase as a basis for creating rubric items.

Overall Computer-Simulated Experimentation Goal:

LWBAT (Learners Will Be Able To) generate reasons and explanations that demonstrate their knowledge about dynamics (interrelation between plant growth parameters and human needs) within a certain Advanced Lifesupport System (ALS) following the principles of scientific inquiry

Objectives:

- LWBAT apply principles of scientific inquiry in the context of computer controlled plant growth
- LWBAT demonstrate their understanding of the chemical building blocks of photosynthesis within their explanations of experimental results
- LWBAT make educated guesses about how changes of parameters will affect the photosynthesis rate.
- LWBAT generate meaningful conclusions from comparisons of data and interpretation of data results.
- LWBAT apply taught principles of photosynthesis within simulation software by balancing parameters to affect the photosynthesis rate appropriately.

6.2 Instruments and variables

The table below gives an overview of how the FoodinSpace workshops evaluation will use COLDEX relevant variables using appropriate instruments.

Table 7. Variables and instruments table.

Variables→ Instruments ↓	Knowledge and compre-hension	Attitudes and motivation	Transversal skills, specifically: Collaboration	Science Skills	Usability	Language issues
Questionnaire	*	*	*	*		
Scale ratings		*	*	*		
Observation			*			*
Heuristic evaluation					*	
Standardized tests /performance assessment	*					
Interview, Focus Groups			*			*
Logfiles			*		*	*
Learning diary		*				

Knowledge and comprehension:
We will use TIMMS items in a Pre-Post manner to assess overall comprehension of photosynthesis and some self-developed items to assess comprehension specifically for looking at ALS.

Attitudes and motivation:
We will use a self-developed questionnaire which is in alignment with the CAQ Computer attitude questionnaire (http://www.tcet.unt.edu/research/survey/caqdesc.htm) . To assess motivation we will use the intrinsic motivation questionnaire (IMI) by Deci and Ryan (2003) and self developed items assessing student's interest towards informal science.

Collaboration
We will use a rubric to evaluate the types and levels of collaboration that can take place within the Biodiversity scenario. This rubric will be used by an external evaluator to assess collaboration.

Science Skills:
A main focus within the Biodiversity scenario is to encourage students to work as scientists. We support the use of scientific method and aim to get students interested in science that goes beyond what is written in schoolbooks. To assess these goals we developed a Scientific Inquiry questionnaire. To assure convergent validity this questionnaire will be compared with log files that show how students used the scientific inquiry method to conduct scientific experiments.

To assess activities we use the rating scale template developed by Chin and Malhotra (2002) to assess cognitive processes supported within authentic inquiry tasks.

Usability

DeXT: We will assess the effectiveness of the BioDiversity DeXT using a self-developed questionnaire. Also we will have teacher focus groups to adapt the DeXT to the teacher's needs.
FoodinSpace scenario: Tools that are used within the FoodinSpace workshops in Sweden will e evaluated regarding usability using the System Usability Scale (SUS) by Brooke (1996).
BeLife: The usability testing of the system will follow a learner-centred approach. This differentiates from a user-centred perspective since it acknowledges the specificities of the learning goals and tasks. This consideration means that the usability methodologies to test a learning system should be adapted.

The plan to evaluate BeLife's usability involves three main stages that might correspond to three major design iterations. However, due to the nature of this task it is impossible to predict precisely how many actual tests and iterations will be needed since these are dependent on the problems encountered. Furthermore, the three stages correspond to different methodologies. The use of different methodologies intends to explore the complementarities of each method. In fact, sometimes, the different usability methods find distinct issues or give relevance to distinct factors (Fu, Salvendy, & Turley, 2002; John & Marks, 1997). The three stages are:

- First stage - heuristic evaluations. In this stage four computer scientists with good knowledge of HCI will act as experts following a set of evaluation heuristics based on well defined design principles. The set of heuristics will be an adaptation of Jacob Nielsen's and Reeves (Reeves, 1992) set of heuristics. The latter are already an extension and adaptation for the evaluation of interactive learning environments (refs...). The experts' evaluation might propose some design refinements that will be implemented for the second stage evaluation run.
- Second stage - user testing. At this stage we will ask a group of end users, teachers and students, to carry out a set of the basic tasks to test the functionalities of the system. The users' interactions will be recorded and their opinions about the tasks performed will be collected. The analysis of the collected data should give us insight about the use and point out possible problems. If need be, the analysis will inform the re-design of the system.
- Third stage - pilot study. Finally, we want to run a pilot study on a real school context and find out to what extend the system's functionalities are appropriate and useful. Furthermore, this pilot study will give us the opportunity to tune the methods employed in order to prepare ground for a set of experiments to test the benefits of some of the system's functionalities.

6.3 Overall activity description - Long term school project

Activities in the long term school project are defined through the problem space, the challenge to arrange a space trip: plan the space ship and the life support system and a settlement on Mars, the plant experiments, and the students' interest. Participants develop activities by generating research questions in line with the challenge and the available tools (e.g. BioTube, BioBlast, BeLife).

The frame which is determined throughout the project, guide the activity process.

- Planning, running, calculating, assessing scientific approach
- Investigation of a challenge

Subject

A compulsory school in Växjö, Sweden. All students from grade 7, totally 140 thirteen years old students, are participating as part of their compulsory school activities. From this group, some students have chosen to work more deeply with the project in something they call Science groups. The activities continue throughout one whole school year.

Tools

The students will have access to the BioTube, Lego RCX with some sensors, The Texas Instruments calculator (TI-84) with sensors, the InquiryTool and BioBlast or BeLife. They will save their learning objects produced in these activities into the LOR.

Objects

The students are working with the subject spaceship to Mars. Their task is to figure out how a spaceship or a space settlement should be planned, which crew should be aboard, what life support system they need and how to supply the crew with food.

The school activities are shaped by the teacher team especially for this school year and are to some extent affected by the expectations that we have on them to fulfil the requirements of the COLDEX project. The project has just started and the objectives are not yet fully formulated. To goal is to create activities that can be incorporated into the schools regular curriculum.

The students are encouraged to use the scientific inquiry method. The students work in groups of 5-6 persons. They get the frame from the teacher and then plan their own work. The students brainstorm, set their challenge and plan further work. Hypotheses and simulations will be run and saved to try to make better choices and a better work. The students visit the Xperiment house and use the BioTube for experiments. The BioTube is accessed both at site and remotely from the classroom. A web camera shows the progress of the plants whenever the students are curious and want to look at them. The students reflect during the work and write reports regularly and in the end they analyze and reflect upon their work and discuss with other groups. They will use writing as a tool for reflection and dissemination.

6.4 Instruments and variables

Since this is not a one-time workshop but rather a full school year activity, we will do a field study and follow the students over time. The science groups are the most interesting student groups and will be followed more closely. We will look at how they interact with each other and with the COLDEX material and tools. This will be done through observation and interviews. Some activities will be video recorded and some will be analyzed by using log files from the tools.

Table 8. Variables and instruments table.

Variables→ / Instruments ↓	Knowledge and comprehension	Attitudes and motivation	Transversal skills, specifically: Collaboration	Science Skills	Usability	Language issues
Questionnaire	*	*	*	*		
Scale ratings		*	*	*		
Observation			*			*
Heuristic evaluation					*	
Standardized tests /performance assessment	*					
Interview, Focus Groups			*			*
Logfiles			*		*	*
Learning diary		*				

The learning aspects that are most interesting to us are knowledge and comprehension, and attitudes and motivation. The students will be subject to a pre-test to find out their previous knowledge within the subject. This will be done by the teacher. The teacher will ask the students to write and draw what they know about e.g. photosynthesis. By the end of the project, the same students will be asked to do the same. During the project, we will observe the students and listen to them reflecting, and together with interviews try to find out their development of knowledge and comprehension in the subject area.

The Intrinsic Motivation questionnaire (IMI) by Deci and Ryan (2003) will be used to capture the aspects of student attitude and motivation. The teachers will also be interviewed to capture their subjective thoughts about the students' performance, and about the teachers' attitudes towards the system and how they perceive that the students are should use it.

A usability evaluation will be carried out to test the effectiveness of the used software BeLife. The user evaluation template System Usability Scale (SUS) developed by Brooke (1996) will be adapted to serve as a guide to carry out a user one to one evaluation.. Additionally focus groups are planned to ask specific questions regarding usability. The users will be asked for their feedback concerning usability (self formulated) during the life time of the project.

6.5 Logistics /Timeline

The details of how and when to conduct the evaluation of the workshops and the school project, is specified in table 9.

Table 9. Schedule of evaluation.

What	When	Who
Evaluation planning and definition of a specific task	October – November 2004	Workshops: Astrid Wichmann School project: Marine Karlsson, Marianne Björn
Conduct the evaluation: Observation notes, informal and formal interviews, student reports, weekly student diary, artefacts built by students, photos, video tapes, questionnaires.	November 2004 – March 2005	School project: Marine Karlsson, Marianne Björn
	January 2005	Workshops: Astrid Wichmann
Analyze data	February – April 2005	Workshops: Astrid Wichmann School project: Marine Karlsson, Marianne Björn
Write the evaluation report	April – May 2005	Marianne Björn, Marine Karlsson, Astrid Wichmann,

7. Evaluation Plan / Open User Scheme

7.1 Overall activity description

A particular concern is that different cultures may have varying attitudes toward collaboration (Hofstede, 2001), and negotiating these differences may be difficult in distributed, technologically-mediated contexts. An analysis of a learning activity should therefore consider the influence that culture and history have.

As Littleton and Häkkinen (1999) emphasize, much of the work on collaborative learning has focused on the collaboration within groups. In order to understand these processes we need to recognize the powerful influence of the context. From this perspective, COLDEX aspects related to different languages and cultures deserve special consideration. The local communities will exchange ideas and results in a network established by the Open User Scheme (OUS) and the global learning communities that will be established have to build up a common context and a common culture.

The intercultural aspects concern both how the users interact with the system and how the system supports the users' actions and collaboration. In the assessment, this could be considered as of specific interest for COLDEX. There is an assumption that the tools are going to be approached different in the different countries.

7.2 Instruments and variables

How should one assess the intercultural aspects of COLDEX? One way is to use the log files from the LOR and to assess the cross-national relations within the COLDEX network with Social Network Analysis (SNA). SNA provides means to visually and mathematically analyze human relations. It visualizes the humans as nodes and their relationships as links between the nodes. The visualization model helps to determine the prominence of a node and the structure of the relations in the network.

Discourse Analysis is a tool that can show the interaction between community members and how they co-construct intersubjectivity. Conversation Analysis is a method used in order to analyze students' conceptual change. Both analyze methods may be used to analyze intercultural interaction and to give "insight into the content and quantity of students' networked discussions as well as interaction structures in a general level" (Häkkinen et al., 2003, p 395).

The "Learning advantages of an intercultural learning environment" will have to be assessed through investigation of the users' subjective opinions. This will be done through questionnaires to teachers and students as late as possible within the time frame of the project. Since the OUS starts rather late, there will be too little time to thoroughly experience the advantages of the intercultural learning environment.

The OUS started during the autumn semester 2004 with participation of the participants from the workshop in South-America in May the same year. Their experiences and ideas will be addressed in a summative evaluation and some of them will be shared at a workshop in the beginning of 2005.

7.3 Logistics / Timeline

The time schedule for the evaluation will be as shown in the following table (table 10).

Table 10. Logistics and timeline.

When	What has to be done?	Who will do it?	Reports to
Autumn semester 2004	Test of the working COLDEX system with the LOR	Each partner	VXU
January – April 2005	Collect and analyse log files, SNA, discourse or content analysis, questionnaires to teachers and students	VXU, UDUI?	
Spring 2005	Summative evaluation of the OUS	Responsible for the OUS workshop	OUS workshop participants

8. Summary

The evaluation plan described in this deliverable try to link together the evaluation activities to be conducted at the local communities based on the ideas presented in deliverable D.2.3.2. The main purpose of these activities is to assess these learning scenarios in order to create a solid base for future activities related to the Open User Scheme and intercultural collaboration. Our previous experiences have shown us the importance of starting with local community activities, and thereafter to proceed with new efforts in order to establish global collaboration. Cross-comparisons of results between scenarios are also planned. Questionnaires used for assessing motivational and attitudinal behaviors, as well as a questionnaire regarding usability issues have been tested in several studies (McAuley et. al, 1987) and found to be reliable, so we will use these techniques in our evaluation activities.

One of the ideas behind the COLDEX project is to build communities bottom-up, starting with local communities such as school classes or study groups. These local communities should then, establish contact through the Open User Scheme with communities in Europe or Latin America. The main connection is through the Learning Object Repository where the communities can find objects produced by other communities and share their own material.

This evaluation plan contains also evaluation activities for the Open User Scheme, but due to the distance to some of the remote communities, the evaluation has to be limited to manageable activities like log files and questionnaires.

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