# ReCoIL Project and Co-Lab Modelling Tool

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**Abstract.** *In this communication the European ReCoIL project will be presented together with an introduction to the system dynamics like modelling editor used in Co-Lab, a previous European project included as part of ReCoIL.*

*ReCoIL project aims to facilitate teachers the adoption of a collaborative inquiry learning approach. In ReCoIL three former projects have participated: Co-Lab, ModellingSpace and Viten. Support to the teachers comes in the form of a web based Access Point including some ready to use material configured as CoILs (collaborative inquiry learning stuff) oriented to allow the students to act as scientists, making empirical research, expressing and communicating their knowledge and working together.*

*The model editor, developed for Co-Lab and used in the Co-Lab like CoILs of ReCoIL, is in the line of the system dynamics modelling tool used by STELLA, allowing not only quantitative modelling but also qualitative one, somewhat similar to Model-It. It has been written in Java as an open source tool.*

**Keywords.** Computers in Education, Inquiry Learning, System Dynamics.

## 1. Introduction

ReCoIL [13] is a European Project in which three former projects have collaborated: Viten [16], ModellingSpace [11] (in which the University of Lisbon was one of the partners) and Co-Lab [4], [7]. In this last project we have collaborated in the development of the Model Editor that will be considered below. The main topic in ReCoIL has been Collaborative Inquiry Learning (CIL), and the main product an Access Point (AP), a web portal including organized material to give support to teachers who want to use an Inquiry Learning approach in their classrooms.

## 2. ReCoIL

CIL involves a broadly accepted methodology that is not easy to implement [1], [2]. Probably *Inquiry Learning* is a term with different meanings for different people, like *Hands-on learning*, the subject of the present HSci06 Meeting. But both, Inquiry and Hands-on learning share the same key point: an activity based learning in which the student is actively involved in her/his learning process. In collaborative inquiry learning, students work like scientists, meaning that they perform empirical research, express and communicate their knowledge, and work together. In ReCoIL CIL involves a phase of empirical research or data collection followed by a stage where the learner have to express the new knowledge, and all this with a set of activities that promotes collaboration with other learners. The different ingredients, empirical research, knowledge expression and collaboration could participate in different degrees depending on the specific subject under investigation. One of the main difficulties associated to the CIL approach is the lack of enough resources in the hands of the teachers and the preparation that the learners should have to efficiently take part in a CIL process. ReCoIL has been designed trying to give support to the teachers who want to implement CIL at their classrooms, with a set of didactic units that can be used to improve the preparation of the learners.

To perform empirical research, ReCoIL offers computer simulations and animations, remote laboratories, and on-line databases. Students can use these resources to collect data and background information on phenomena in various science domains i.e. physics, chemistry, biology and general science.

Simulations play a central role in ReCoIL. Simulations are not only very often used in the empirical research phase but also as a mean for the learners' expression of her/his new knowledge. To express knowledge, ReCoIL resources include tools for building static and dynamic models that can visualize students' understanding. You'll also find assignments which stimulate and support students in writing research reports, articles, and expressions in other media.

To support collaboration, students are provided with group assignments. Technical means such as a chat and shared workspaces are a part of some of the ReCoIL resources.

ReCoIL initially aimed to integrate the pedagogies and materials that were developed in three aforementioned predecessor EC-projects: Viten, Co-Lab and ModellingSpace into one all-embracing learning environment. However, interviews with teachers across Europe made us shift focus from developing one large, monolithic environment to creating a series of small-scale learning packages. The main reason for this shift was that teachers indicated that large systems are hard to implement, requiring a too great innovation at once.

These findings resulted in the concept of CoILs (Collaborative Inquiry Learning stuff), as well as in the design of a "stepping stone approach" to support teachers in choosing and using CoILs. A CoIL is a small-scale unit spanning a maximum of four lessons. Most CoILs involve *empirical data collection*, *collaboration*, and *knowledge expression*. The collection of empirical data may vary from obtaining them from an on-line simulation to laboratory work, collaboration can range from synchronously face to face to asynchronous on-line settings, and, finally, the expression of knowledge may range from creating an executable model to preparing a television debate on the topic. A typical CoIL example is one for the domain of electricity in which the learner is confronted with the problem of capacitor charging in the electronic flash of a speed control camera. Based on a cover story, students explore a simulation and build a model that can then be used to propose an improvement of the situation. In their process they are supported by a modelling tool, as well as worksheets.

As CoILs are small, self-contained units that run in an Internet browser, they can easily be tried out in class. Although each CoIL stands on its own, CoILs can be sequenced to cover a specific domain or to introduce specific issues in inquiry learning to students. These sequences are developed such that teachers can step in at any point, and can use each CoIL as an upbeat for another one. For each CoIL, the level of expertise needed by learners on empirical data collection, collaboration, and knowledge expression are indicated on a four-point scale. These ratings help teachers in selecting the right CoIL for their purpose.

## 2.1. ReCoIL Access Point

An *access point* (AP) [13] was created to assist teachers in finding appropriate CoILs. It organizes CoILs into a searchable collection, in which each CoIL is tagged with metadata based on IMS-LOM [5] [6], complemented with specific rating indicating required levels of student experience.

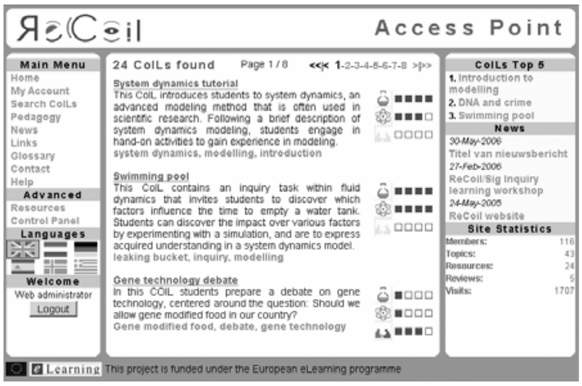


**Figure 1. Recoil Access Point**

The ReCoIL access point, as well as the CoILs it contains, were evaluated in a number of teacher workshops. Teachers were introduced to the access point and could browse and work with the CoILs. They indicated a positive attitude towards the approach, especially the fact that CoILs were complete units and the rating system were seen as features that distinguishes the access point from other collections of on-line science teaching material.

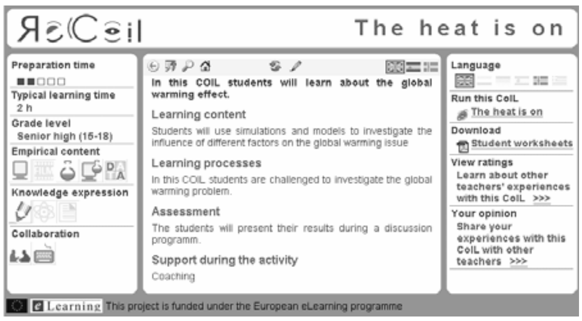


**Figure 2. Information about a CoIL**

From the technical point of view, the AP was designed as a web portal based on PHP and MySQL. It runs without changes on Windows and Linux. It has been built from scratch, with no use of other commercial software, in such a way that it has been easily adapted to the specifications of the ReCoIL project and with no problems for its maintenance or for its adaptation to new developments if required. The AP includes a control panel for the remote system administration with facilities like user administration, access statistics, users' folders, etc. The following are screenshots of some of these facilities.

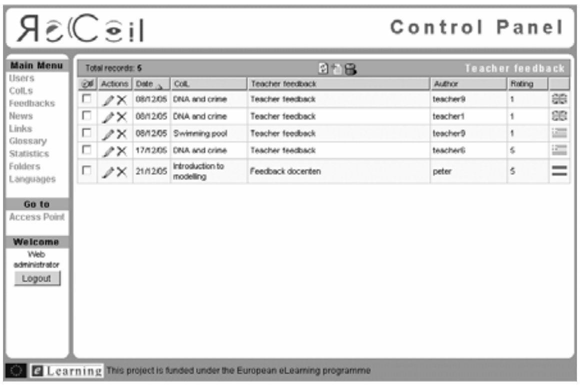


**Figure 3. Control Panel showing teacher feedback**

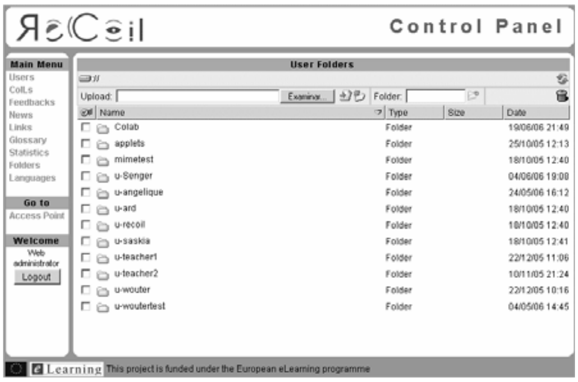


**Figure 4. Information about user folders**

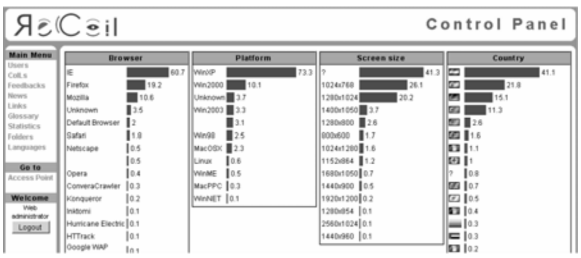


**Figure 5. Statistics**

## 3. Model Editor

As previously said, simulations and modelling is a central part of the IL process implementation used in ReCoIL. Modelling is an activity in which learners create an executable domain model of the system under investigation [3]. By comparing their models with the model underlying the simulation, learners can check their understanding of the domain. In some CoILs, learners use simulations as part of the empirical data collection activities; but, more important, model building is frequently found as a way for expressing the knowledge the learner has acquired. The models to be built by the learner should give results that can be compared with those of the simulations prepared for the empirical research stage. For both purposes, building simulations to be used by the students and as a tool for the students to build their own simulations, a Model Editor has been adapted from the one developed for Co-Lab.

The Editor is a tool that allows building simulations in the line followed by the system dynamic environments [8] [9] [14] like STELLA [15] or Powersim [12]. The Modelling Tool consists, basically, of a graphic Editor to design the model and an integration engine, the Simulator, to solve the differential equations involved in the model.

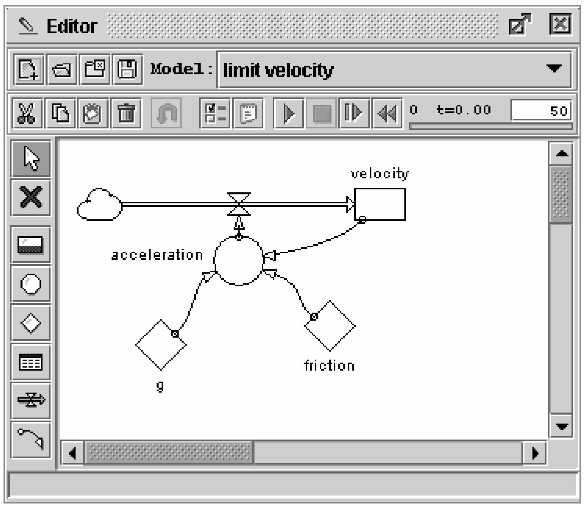


**Figure 6. Model Editor showing a model diagram**

Figure 6 shows the graphic editor with a small model. Fig. 7 shows the corresponding finite difference equation in text format. In this model, a simple example that can be used to study the sedimentation of particles in a fluid is represented.

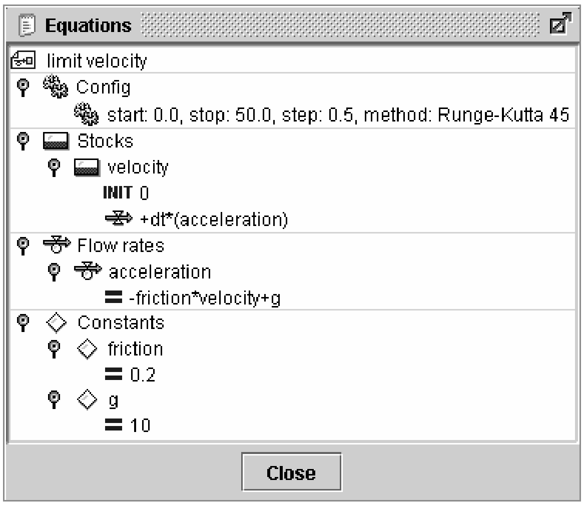


**Figure 7. Model Equations in textual form**

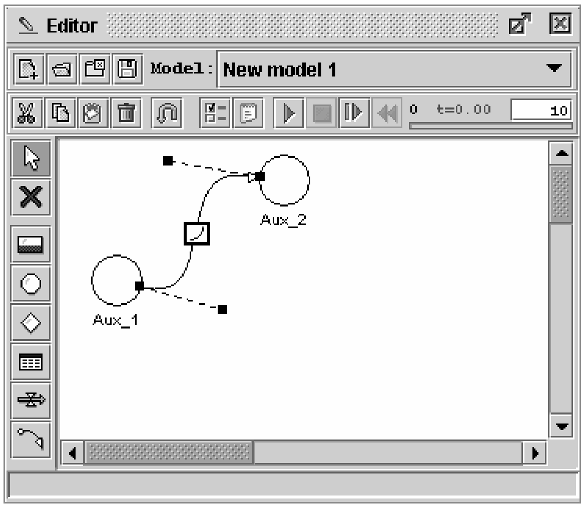


**Figure 8. Link between two variables**

The Editor uses Forrester diagrams [8] to represent the different elements of the model: *stocks*, *flows*, *auxiliary variables*, *constants* and *connectors* to be used as links between the other elements. Basic elements are shown in Table 1.

**Table 1. Model Editor elements**

| | | |
|---|---|---|
| *Stock* | | Anything that accumulates or drains. |
| *Auxiliary* | | It is used to take input data and manipulate or convert that input into some output signal. (converter in SD) |
| *Flow* | | It is the rate of change of a stock. |
| *Dependency* | | Relation between variables (connectors in SD). |
| *Cloud* | | The cloud represents an unlimited source or sink; |

The models could be designed with two different kinds of relations. Quantitative links could be used for relating several variables or, like in Model-It [10], also a quantitative relation can be used, as presented in Fig. 8 and 9. The same model can include both, quantitative and qualitative relations. These relations, the qualitative ones, can be used for simple models, especially useful for introductory modelling activities.

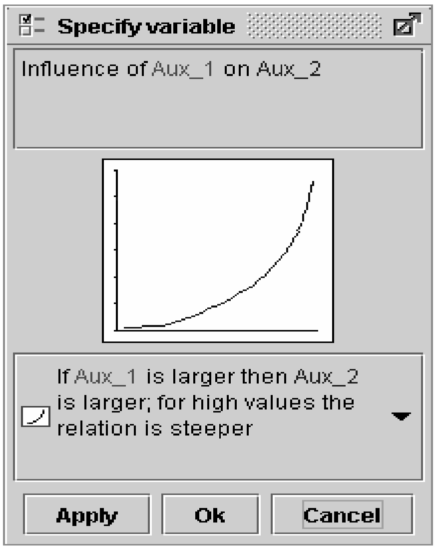


**Figure 9. Qualitative relation**

From the Co-Lab web page [7] you can download the so called *Co-Lab solo*, a stand alone applet version of the Co-Lab environment. It includes the Model Editor and Simulator and some Co-Lab tools (graph, table) and laboratories (TankLab, RCLab, BlackBody, etc.). It is single user and does not allow online collaboration, but it is lightweight and requires no installation.

The Simulator engine includes the most practical integration methods: Euler, Runge-Kutta (RK) 2, RK 4 and RK 4-5.

For those new to the SD world, ReCoIL includes a tutorial on System Dynamics and a simple user's guide to the Modelling Editor.

## 4. Acknowledgements

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