## **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 broadly accepted a 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 allembracing 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 online 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.

Яट⊄ि@il Access Point					
Main Menu Home Ny Account Search Colls Pedagogy News Links Glossary Contact Holp Holp Contact Holp Holp Holp Holp Holp Holp Holp Holp	24 ColLs found Page 1/0 << 1.2.3.4 Pystem dynamics tutorial This ColL, inforduces students to system dynamics, an advanced modeling method that is often used in spitcher dynamics, modeling, students engage intard- an achivets lig ain regeritorie in modeling, system dynamics, modeling, introducedon <u>Swimming ape</u> This ColL contains an inquiry task within fluid fyamics that invites students to discover which factors influence the time to empty a water tank Students Can discover the imgach derivations status bioduced understanding in a system dynamics model. leaking bucket, inquiry, modelling Gene technology debate In this COLL souters prepare a debate on gene technology certered around the question. Should we allow gene modified food in our country? Gene modified food, debate, gene technology		Colls Top 5 1. Introduction to modelling 2. DNA and crime 3. DNA and crime 2. DNA and crime 20494/2000 Recoil Sig Inquiry Isarming workshop 24409/2005 Recoil Webbits Site Statistics Members: 116 Researce: 431 Researce:		
C Learning This project is funded under the European eLearning programme					

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.

Preparation time     In this COLL students will learn about the global varing street.     Language       2 h     In this COLL students will learn about the global varing street.     Language       2 h     In this CoLL students will learn about the global varing street.     Run this CoLL       2 h     In this CoLL students and models to investigate the global varing issue     Im the students will use simulations and models to investigate the global varing issue     Im the students value simulations and models to investigate the global varing processes       Knowledge expression     Lasensment     Lasensment       In the students will present their results during a discussion     Students will present their results during a discussion       Support during the activity     Students will present their results during a discussion	Ii⊛D©ŝR	The he	eat is on
Coaching	Preparation time Typical learning time 2 h Grade tevel Senior high (15-18) Empirical content Collaboration Collaboration	P P A P A     In this COIL students will learn about the global warming effect. Learning content Students will use simulations and models to investigate the studence of different factors on the global warming issue Learning processes In this COL suberts are challenged to investigate the global warming problem. Assessment The students will present their results during a discussion programm. Support during the activity Coaching	Language Run this Coll. The heat is on Download Student worksheets View ratings Learn about other teachers' experiences with this Coll. >>> Your option Supperfances with this Coll. with ether teachers >>>

Figure 2. Information about a ColL

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.

Total reco	ords: 5		216			
Ø Actio	ns Date _	Coll.	Teacher feedback	Author	Rating	
	X 08/12/05	DNA and crime	Teacher feedback	teacher9	1	8
□ //;	X 08/12/05	DNA and crime	Teacher feedback	teacher1	1	88
	× 08/12/05	Swimming pool	Teacher feedback	teacher9	1	12
	× 17/12/05	DNA and crime	Teacher feedback	teacher6	5	12
0 23	× 21/12/05	Introduction to modelling	Feedback docenten	peter	5	=

Figure 3. Control Panel showing teacher feedback

Re	C⊇il	Cor	Control Panel		
Main Menu		User Folders			
Users	<b>a</b> 11				
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lews	Ø Name	Type	Size	Date	
inks	Colab	Folder		19/06/06 21:41	
ilossary	🗆 🗁 applets	Folder		25/10/05 12:13	
tatistics obtone	🗆 🗁 mimetest	Folder		18/10/05 12:4	
anguages	🗆 👝 u-Senger	Folder		04/06/06 19:0	
	🗆 👝 u-angelique	Folder		24/05/06 16:1	
Go to	🗆 👝 u-ard	Folder		18/10/05 12:4	
ccess Point	🗆 👝 u-recoil	Folder		10/10/05 12:4	
Nelcome	🗖 👝 u-saskia	Folder		18/10/05 12:4	
Web	C C u-teacher1	Folder		22/12/05 11:0	
dministrator	D co u-teacher2	Folder		10/11/05 21:2	
cogoor	C S u-wouter	Folder		22/12/05 10:1	
	C C u-woutertest	Folder		04/05/06 14:4	
🕽 🖻 Lea	rn ing This project is funded under t	he European eLearning programme			

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.

	Equations
÷	limit velocity
P	🎭 Config
	🎭 start: 0.0, stop: 50.0, step: 0.5, method: Runge-Kutta 45
ļΫ.	🔚 Stocks
	📍 📟 velocity
	INIT O
	🛥 +dt*(acceleration)
P	+ Flow rates
	🍳 😽 acceleration
	-friction*velocity+g
P	♦ Constants
	♥ ♦ friction
	= 0.2
	Ŷ ◇ g
	= 10
	Close

Figure 7. Model Equations in textual form

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	$\bigcirc$	It is used to take input data and manipulate or convert that input into some output signal. (converter in SD)		
Flow	<del>-X-</del> >	It is the rate of change of a stock.		
Dependency	~~~~	Relation between variables (connectors in SD).		
Cloud	0	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 8. Link between two variables



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.

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