CIEL: Integrating Approaches for Inquiry Learning

Wouter van Joolingen, University of Twente, on behalf of the CIEL ERT.[1]

Introduction

The world is changing and changing fast. Contemporary students live in a world full of impressions, fast changing viewpoints, ubiquitous information, zapping behaviour, play and joy etc. They use facilities such as MSN, on-line gaming, and SMS. They expect a seamless access to information, mostly in a social context. At the same time we see drastic changes in learning environments, moving them to rich, multi-media, collaborative, experiential, and individualised environments. Though starting from different angles, these two developments seem to come together. Modern learning environments such as WISE (Slotta, 2004) or BioLogica (Hickey, Kindfield, Horwitz, & Christie, 2003) combine all kinds of opportunities to learn and communicate in a facilitative setting.

In these learning environments, often called powerful learning environments (de Jong & Pieters, in press), specific design measures are taken to foster learning. In summary these design measures a) increase the engagement of learners, b) leverage the situatedness of learning, c) improve the quality of collaboration in learning, d) facilitate students in expressing their knowledge, e) scaffold students in employing key learning processes. Also, within the Kaleidoscope context, and more specifically the labs participating in this ERT proposal, a number of these encompassive learning environments that include one or more of the above mentioned design guidelines on different domains have been created. Examples are: CoolModes (Hoppe, 1999), SimQuest (van Joolingen & de Jong, 2003), Co-Lab (van Joolingen, de Jong, Lazonder, Savelsbergh, & Manlove, 2005), FLE (Leinonen, 2004; Mørch, Dolonen, & Omdahl, 2003), JEMUE (Baggetun & Dragsnes, 2003), ARI-LAB (Bottino & Chiappini, 2002) and Tangibles (Cerulli, Chioccariello, Fernaeus, Lemut, & Tholander, 2005).

The CIEL project aims to achieve a level of integration between these diverse learning environments for inquiry and experiential learning. The two main reasons for this are:

- *Combining specializations.* Each tool has its merits of supporting specific parts of the collaborative inquiry learning process, including support for collecting data, modeling and specific means of collaboration. Instead of trying to create a single tool that can do it all CIEL strives to enable interoperability between tools.
- *Support of longer term learning scenarios*. Most learning environments support a specific type of activity, such as doing research on the greenhouse effect, or create a model of volcanic activity. This means that the typical duration of use will be limited. CIEL strives to design scenarios that extend over longer time periods, involving multiple activities and tools.

In a typical inquiry learning scenario that takes more than a few lesson periods, learners will perform diverse activities. Each of these activities will represent steps in the process of scientific knowledge building, and the whole scenario may therefore be supported by a variety of tools. CIEL aims to create an architecture in which many tools can interoperate to construct many different inquiry learning scenarios.

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[1] Persons who contributed to this demo are: Jakob Sikken, Andre Berloth (University of Twente), Lars Bollen, Björn Hassing, Ulrich Hoppe (University of Duisburg-Essen), Muriel Ney, Cedric d'Ham (MeTAH), Aleksander Krzywinski (University of Bergen), Augusto Chioccariello (CNR) and Jeremy Toussaint (University of Oslo).

Figure 1 presents a possible example of such a scenario for inquiry learning, in which the learners collect data in a lab using a mobile device, and use the data to construct a model of the domain they are investigating using a modeling tool. In the mean time they can debate and construct an argument, using a dedicated argumentation builder such as Belvedere (Suthers, Weiner, Connelly, & Paolucci, 1995). The whole learning process is integrated around a common repository through which the different tools exchange information (e.g., data or models). On the one hand such a scenario should be *semantically integrated* (Koedinger, Suthers, & Forbus, 1999), meaning that the learning process as a whole, including the transitions from tool to tool take place in a smooth and meaningful way. On the other hand integration should also take place at a *technical level*, ensuring smooth data exchange between tools.

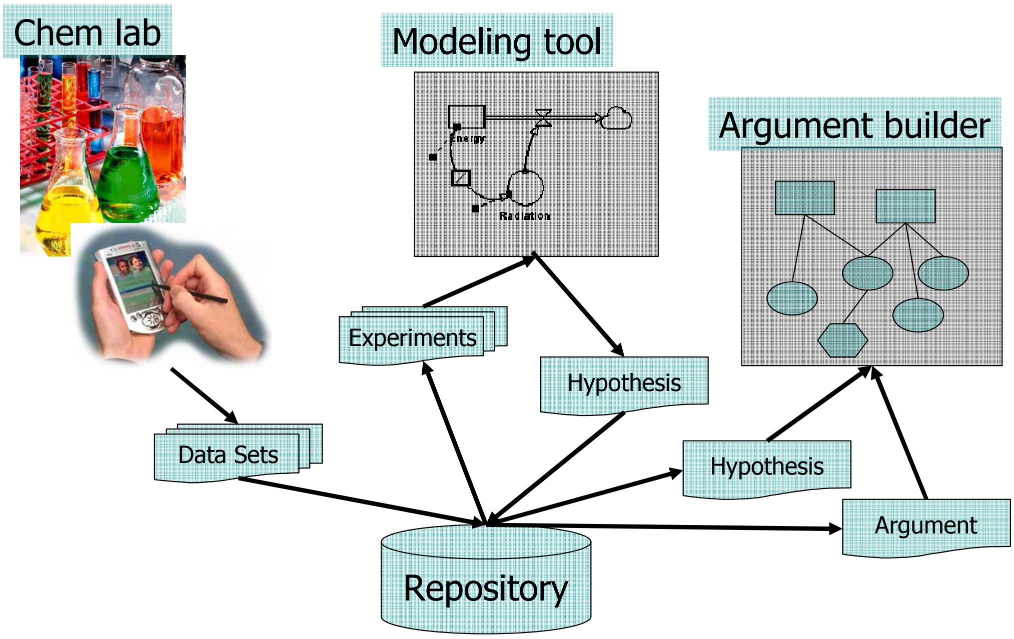


Figure 1 A multi-tool scenario to be supported by CIEL.

On the semantic level, it is important to support the flow of information and activity in the task context. This can be facilitated and implemented in different ways. One possibility is to map data onto specific objects that can be physically transferred (e.g., data can be captured on a PDA and thus be transferred). Another possibility is to transfer information between places and different environments by real time synchronization. In (Milrad, Hoppe, Gottdenker, & Jansen, 2004), several of such interoperability patterns are discussed from both an engineering and an educational design view.

Here the environments can possibly be heterogeneous. This second option requires a tight coupling in terms of processing and time constraints. A loose coupling which implies much less restrictions is often facilitated through a common repository, although a real time synchronization is not supported in a loose coupling model. It needs a common data format which can be 'understood' and generated by the different tools. In CIEL, we have first adopted the loosely coupled model for our technical approach.

CIEL aims to support both levels of integration by bringing together several systems that support collaborative inquiry learning and make them interoperate at the two indicated levels. At the semantic level CIEL works on integration of concepts such as learning processes, learning objects and learning tools. For each of these shared definitions are created that provide meaning to data that are stored. Examples of these definitions include “data set”, “experimental setup”, “phenomenon”, “experiment”, and “model”. Such definitions allow consistent support of learning processes across learning environment. If two systems treat the same object, for instance an “experiment” in a semantically consistent way, continuity of the learning scenario can be reached. The shared definitions in CIEL are created within a CIEL ontology.

The CIEL ontology also provides a context to the technical level of integration. In order to exchange data between tools, XML definitions are given of the terms in the ontology. This leads to a common data format shared by a set of tools that each can play a part in scenarios for collaborative inquiry and experiential learning. This approach is depicted in Figure 2.

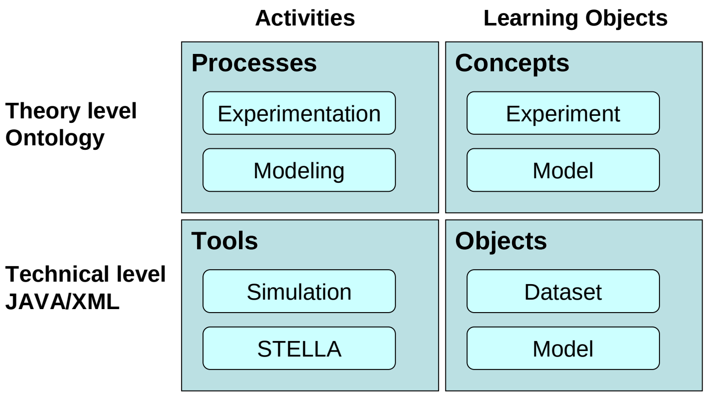
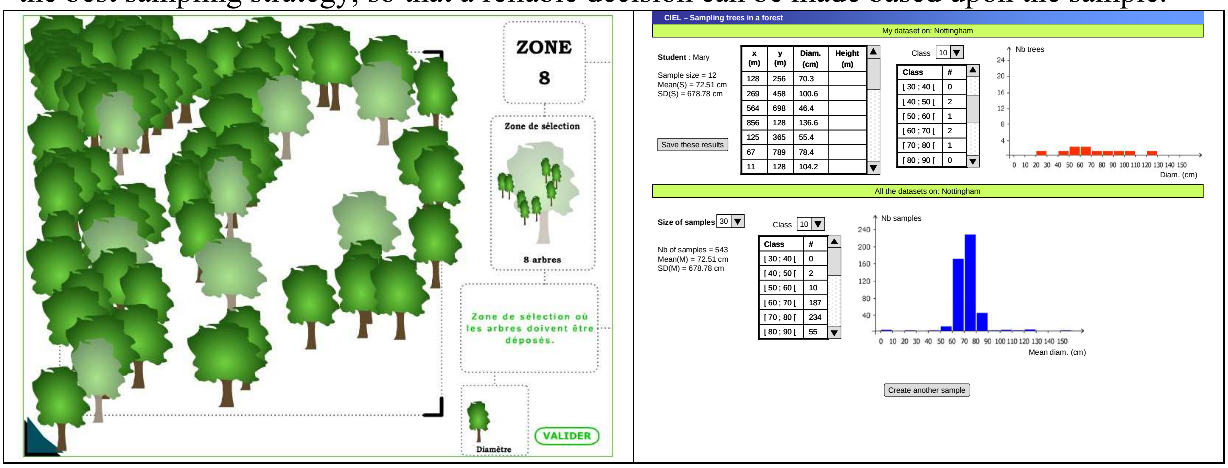


Figure 2 Structure of the CIEL work, depicted as two layers: theoretical and technical. The contents of the four cells are examples of a wider range of possible content.

The demonstrated system

The system demo consists of a first version of an integrated scenario along the lines described above. For the topic of “sampling” in the domain of statistics, a scenario has been designed and implemented that involves multiple activities and tools. The learner is placed in the role of an employee of a forest agency that is involved in the production of wood. For a certain forest area it must be determined whether the trees are tall and wide enough to harvest the wood. In doing so a sample of trees has to be taken. The task for the learner is to determine the best sampling strategy, so that a reliable decision can be made based upon the sample.



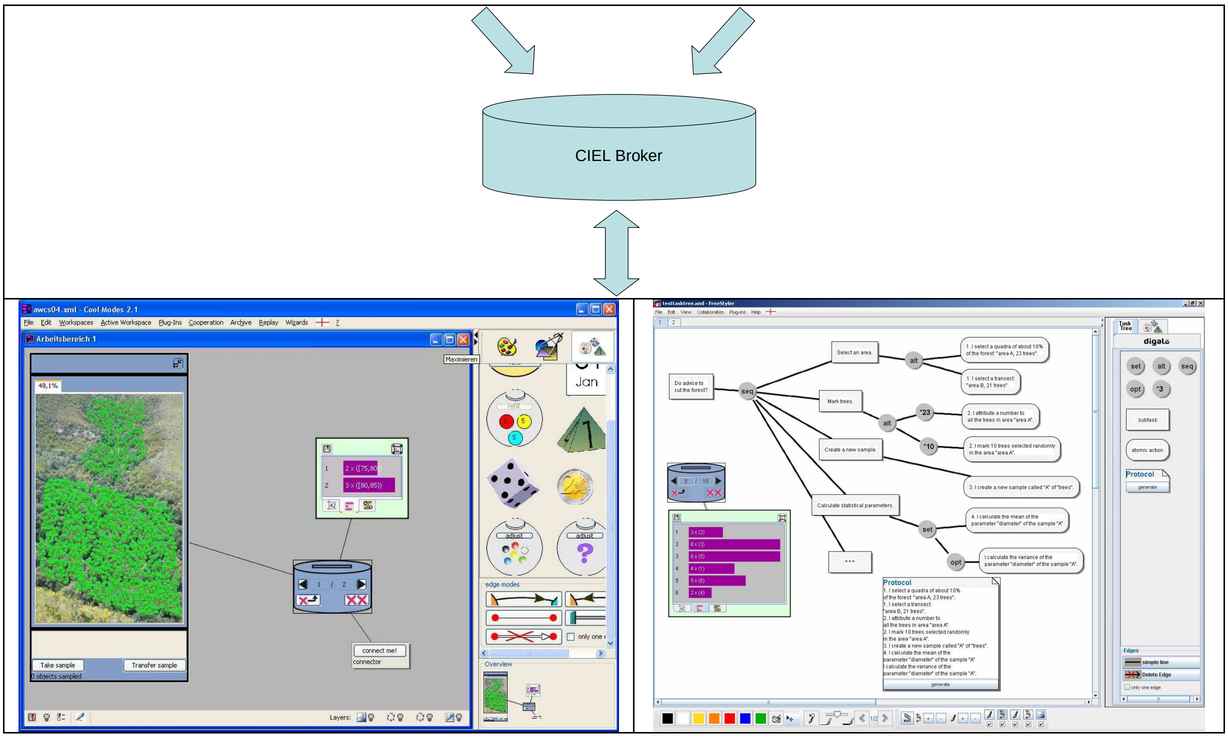


Figure 3 Overview of the demo. The two data generating tools at the top (Co-Lab and an independent flash application share their data with the broker. The data is used in FreeStyler modeling application depicted at the bottom.

The scenario is supported by two simulations, one in Flash and one made in Co-Lab. Both allow creating samples and computing parameters such as the average and standard deviations of each of the samples. The data from the samples are stored as learning objects in an XML format defined by the project and can be imported in Cool Modes and Freestyler, which are modeling tools that allow for modeling a variety of domains, including statistics. The sampling strategy can be modeled in FreeStyler.

Figure 3 provides an impression of the demo as well as the underlying architecture. Underlying the scenario are the definitions of datasets and models, as well as a working CIEL broker that allows for storage and retrieval of the objects produced by the learners. Tools can connect to the broker and store the objects, accompanied by automated generation of metadata, that helps with their retrieval.

The demonstrated scenario illustrates a step on the road that is pursued by CIEL towards a wider integration of tools, supporting different modes of collaboration and experimentation.

Demo requirements

The demo will be run from two brought-in laptops. Participants will be able to work with the applications. We will need a working internet connection from them (wired or wireless) as well as a beamer or large monitor to display the demo.

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