Co-Lab, design considerations for a collaborative discovery
learning environment

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1. Introduction

In the Co-Lab project, we develop a computer-based environment for collaborative
inquiry learning. Collaborative inquiry learning is a potentially fruitful but complex
undertaking. Potentially fruitful, firstly, because knowledge constructed in this manner
is expected to be deeply rooted, and structured such that it can be applied in new
situations (e.g., Penner, 2001). Secondly, we take collaborative inquiry not just as a
way to learn about a domain, but as an integral part of science itself. Following the
definition of the AAAS (1994), we regard science as the process of building and
justifying knowledge, and we would like to convey an understanding of these
processes as part of science education. Collaboration and negotiation are essential
processes both in knowledge building and in justification (Dunbar, in press).
Therefore, we believe that collaborative inquiry learning in Co-Lab is a promising way
to get acquainted with some basics of scientific inquiry.

However, collaborative inquiry learning is also complex because it requires strong
cognitive and regulative abilities. Learners encounter substantial difficulties when
they engage in inquiry (or discovery) learning (de Jong & van Joolingen, 1998),
modelling (e.g., Clement, 1989; Feurzeig & Roberts, 1999), collaboration (e.g., Baker
& Lund, 1997), and reflection (e.g. Bell, 2002). Thus, it will strongly depend on the
design of the learning environment whether learners will be able to attain the
intended learning aims. In this paper we will discuss the requirements posed to
different aspects of the learning environment, our design solutions and the way we
used empirical research to influence our design solutions.

2. Argumentation

In order to realise a fruitful collaborative inquiry learning process, requirements at
different levels must be fulfilled:

a) The learning tasks must provide an opportunity for authentic inquiry, i.e. they must
pose motivating and challenging, yet feasible problems and allow a certain freedom
(both approaches and possible answers ).

b) The software learning environment must provide a forum for learners to create a
common ground and coordinate their learning processes.

c) The learning environment must provide sufficient guidance and scaffolding.

d) Collaborative discovery learning can only be successful in a supportive classroom
atmosphere.

In order to develop more specific design guidelines on these aspects, we have
conducted user and usability studies, and we have organised consultation meetings
with teacher panels and domain experts. The formative process is still going on; a
time line can be seen from table 1.

<table>
<thead>
<tr>
<th>Period</th>
<th>Study / Implementation</th>
<th>population (country)</th>
<th>type / methods</th>
<th>outcomes / aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr 2001 – end of project</td>
<td>consultations of experts</td>
<td>about 20 experts (D, NL, E, I)</td>
<td>consulting process (interviews)</td>
<td>design of modelling tool, demonstrator materials and model solutions</td>
</tr>
<tr>
<td>June 2001</td>
<td>modelling study 1</td>
<td>39 students (NL)</td>
<td>Model construction by students</td>
<td>model representations (“system dynamics”)</td>
</tr>
<tr>
<td>October 2001</td>
<td>mock-up studies</td>
<td>experts (I)</td>
<td>Observation and interview</td>
<td>structure of the environment (“city metaphor”)</td>
</tr>
<tr>
<td>October 2001</td>
<td>collaboration study 3</td>
<td>36 students (NL)</td>
<td>Peter Gardner task</td>
<td>coordination of learning process</td>
</tr>
<tr>
<td>Autumn 2001</td>
<td>teacher study 1</td>
<td>189 teachers (D)</td>
<td>questionnaire</td>
<td>teacher types regarding software use</td>
</tr>
<tr>
<td>Since Feb 2002</td>
<td>curriculum studies</td>
<td>- (D, NL, E, I)</td>
<td>Theoretical analysis with teacher support</td>
<td>adaptation of materials to the curriculum</td>
</tr>
<tr>
<td>Sep 2002</td>
<td>teacher study 2</td>
<td>20 teachers (D)</td>
<td>Questionnaire</td>
<td>teachers’ experience with collaboration, inquiry learning and modelling</td>
</tr>
<tr>
<td>Sep 2002 – end of project</td>
<td>Teacher involvement</td>
<td>20 teachers (D)</td>
<td>consulting and training process (workshops, interviews, co-authorship)</td>
<td>hints for software development, development of teacher and student materials</td>
</tr>
<tr>
<td>Dec 2002</td>
<td>user study 1a</td>
<td>educational experts (NL)</td>
<td>guided walkthrough through the Co-Lab environment</td>
<td>usability of interface and tools</td>
</tr>
<tr>
<td>Jan 2003</td>
<td>user study 1b</td>
<td>9 students (NL)</td>
<td>guided walkthrough</td>
<td>usability of interface and tools</td>
</tr>
<tr>
<td>April 2003</td>
<td>user study 2</td>
<td>36 students</td>
<td>unguided Co-Lab activity</td>
<td>intuitiveness, spontaneous activities, motivation</td>
</tr>
<tr>
<td>June 2003</td>
<td>user study 3</td>
<td>classroom courses (NL)</td>
<td>unguided Co-Lab activity, multiple lessons</td>
<td>learning processes, process coordinator versions</td>
</tr>
<tr>
<td>Apr – Jun 2003</td>
<td>classroom study 1</td>
<td>12 courses (D)</td>
<td>realistic lessons + video-recording, questionnaire, interviews</td>
<td>explorative: students’ inquiry, collaboration and modelling</td>
</tr>
<tr>
<td>Sep – Dec 2003</td>
<td>summative classroom evaluation</td>
<td>20 courses (D, NL, I)</td>
<td>realistic lessons + video-recording, questionnaire, interviews</td>
<td>summative evaluation of Co-Lab</td>
</tr>
</tbody>
</table>

Table 1: Overview of studies conducted and planned within the Co-Lab project.

3. Conclusion and implications

In the following, some of the findings and decisions are listed that contributed to the process of the development of the collaborative working space Co-Lab:

- Based on studies with a mock-up of the system, we chose a ‘city metaphor’ to structure a student project in modules (buildings, cf. Fig. 2), submodules (floors), and activities (rooms, cf. Fig. 1). This provides a way to control the balance between guidance and freedom, as students can be given complete freedom to organise their working processes at a small scale (e.g., move between rooms on a floor), while at a larger scale (e.g., move to a next floor) decisions can be subject to teacher or system control.

- In studies with a partial prototype of the system (e.g. “collaboration study 3”), we saw a need to help students structure their inquiry process. To this purpose, we included a process coordinator tool, which helps students identify phases in the inquiry process and keep track of their progress.
A study on the effects of different model representations ("modelling study 1") led to choosing a graphical ‘system dynamics’ model representation.

The outcomes of the expert and user studies were included in the first implementation of the system (Figure 1).

Outcomes of the expert, teacher and curriculum studies led to a further specification of the contents that could be addressed, with which teachers and students. As a result learning materials have been developed for two domain areas: “water management” and “greenhouse effect” (for details, see Bosler et al. 2002). In order to satisfy the requirements about guidance and freedom, and in order to connect to the curriculum, a modular structure was developed (Figure 2), which matches the ‘city metaphor’ described earlier. The studies also resulted in a teacher training/teacher involvement program, which is still underway.

Figure 1. The first implementation of Co-Lab.

Figure 2. Modular structure of the demonstrator „Greenhouse effect“. 
The paper will provide a more detailed account of how the design decisions made in the development of Co-Lab contribute to the realisation of a powerful learning environment for collaborative inquiry learning.

4. Bibliography


