Scaling up a learning technology strategy: supporting student/faculty teams in learner-centred design

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Many post-secondary institutions are experiencing the challenge of scaling up their learning technology initiatives without a matching increase in staff resources. This mismatch is particularly acute at the design stage of projects, where both domain knowledge and instructional design expertise are needed. To address this, we are developing structures and tools for a small cadre of instructional design experts to support a growing number of learning technology projects developed by student/faculty teams. One of these tools, the Learner-Centred Design Idea Kit, is an interactive WWW-based resource now in a fourth iteration of use in an undergraduate course, Designing Learning Activities with Interactive Multimedia. The course and the LCD Idea Kit which supports it are part of a larger institutional strategy to introduce technology-enabled change in the learning process, working 'bottom-up' with individual faculty and using the LCD Idea Kit to scale up the course across multiple university departments. In this paper, we describe the course and the Kit in detail and provide and overview of our current status and lessons learned.

Introduction

The need for post-secondary institutions to think strategically about the application of learning technologies has been well documented. The strategy must plan to effect change in faculty approaches to teaching and learning, not just to 'add technology and stir'. An effective strategy will also address both content – the particular applications with the most leverage for institutional goals – and the process of obtaining commitment and moving forward (Daniel, 1996).

In this paper we describe one component of a 'strategy in progress.' On the content side, this component addresses the development of nicheware, focused learning environments which are selected by:

> . . . considering a piece of teaching, a teaching problem; identifying what is the main problem with it at present: the bottleneck limiting its quality (effectiveness) at present; designing a way (using a computer in these cases) to tackle that bottleneck. (Draper, 1998, p. 7)

The niche systems developed in our process follow a constructivist approach to provide interactive learning experiences for students (Harper and Hedberg, 1997), and most use a cognitive apprenticeship model to structure their interactions (Collins, Brown and Newman, 1989).

On the process side, the key issue is the need to plan for widespread dissemination while beginning with small projects to build momentum. With instructional design and professional development staff expertise in short supply, we needed to create a process which would engage mainstream faculty and scale up across the university without requiring a proportional addition to the professional staff. The key element in our process is an interdisciplinary course[1] (more details about the course are available at http://tlc.uwaterloo.ca/is301a/) in which student/faculty teams design and prototype educational multimedia projects. In the course, students from across the university work in teams with faculty members to address specific instructional bottlenecks, by designing, prototyping and testing one–two hour educational multimedia applications.

The Learner-Centred Design (LCD) Idea Kit supports the instructional design process with information and structure for creating:

- learner profiles which bring to life the target audience,
- scenario narratives for the current learning process and the target process, and
- a design visualization of high-level design issues.

The learner profiles are detailed characterizations which include such things as information on their learning preferences, motivation and background knowledge. The scenario narratives are included to allow the design teams to create a description of what people do and what they experience as they take this course. The design visualization adapts Diana Laurillard's conversational model to provide a Gestalt view of the proposed learning process (Laurillard, 1993).

The course was originally created and offered from a central Teaching Resource Office, under the auspices of the university's Independent Studies programme. The course is now being adopted by regular academic departments as a special offering. One of the key factors in making this possible was the construction of the LCD Idea Kit, a performance support tool which provides just-in-time information for the project teams and structures the development process to focus their attention on instructional issues rather than technology.

In the next section, we describe the course and its place in our strategic process. Then we demonstrate the features of the support system, the LCD Idea Kit, which enables high productivity for both teachers and students. The final section reports on lessons learned, and the status and continuing plans for the LCD Idea Kit.

The course and its context

We have three milestones in our ideal development process for nicheware:

1. In the course, the instructional problem is specified, a prototype solution is designed and

evaluated with a prototype complete enough to test the learning activity but not expected to be complete in content. Faculty are involved in problem specification and content definition, professional staff are involved as design advisers.

2. After prototype evaluation, selected designs are revised and further developed to a working version by students on co-operative work terms and are tested again. The roles for faculty and professional staff continue; in addition, professional help is often required to finish off the final product and test it in the delivery environment.
3. After use in the target instructional setting, one more round of revision is undertaken by professional staff. If a system is particularly promising for long-term use and dissemination to others, it may be re-engineered and rebuilt.

These milestones ensure that the professional staff's time is highly leveraged – initially to select or suggest promising directions, and later to fine-tune projects whose success has been established.

The course itself is a regular academic offering taken by students from across the university. The application form for the course requests that students identify various skills which they could bring to the class and their design team. Teams are organized to include three to four students with a mix of interests in technology, pedagogy, aesthetics and discipline knowledge. The major focus is on the team project, and the course overall includes the following activities in a thirteen-week teaching term:

- group instruction, covering the fundamentals of learning theories, instructional design and multimedia development (three weeks);
- faculty members, as clients for the teams, describe the learners, learning outcomes and instructional bottlenecks in their current situation (one week);
- the student teams document this information in the LCD Idea Kit, and then design new learning scenarios and the required computer-based activities (four weeks);
- the teams construct prototypes to test critical portions of their designs, and each member conducts a walkthrough session with one student from the target user audience (four weeks);
- students recommend changes in their designs as a result of the evaluation, and document their reflections on the overall learning experience in the course (one week).

After the initial three-week period, the staff directing the course provide guidance to the student teams at tactical points. The faculty clients commit to meet with the teams one hour per week for guidance on content, and much of the staff involvement is through the interaction facilities of the LCD Idea Kit – critiquing student designs and suggesting alternatives (each student must also critique the work of another team at three critical stages). This limited staffing, especially when there are only three weeks of introductory material, relies on the just-in-time knowledge available in the LCD Idea Kit – both explicit information on learning and design issues, and the implicit knowledge embedded as process structure.

LCD Idea Kit

The biggest challenge in the course is to get the teams focused on design issues: otherwise teams tend to think in terms of psychological studies of the learning problem or focus on

implementation details, depending on the background of the students in the team. We address this issue by using the LCD Idea Kit to guide the teams through important design issues. Three of the most notable features of the Idea Kit are: extensive learner profiling, use of narrative scenarios and use of a design visualization.

Learner profiling

Most projects will have three or four different learner profiles to represent the diverse learner groups who will be taking the course. The design teams create a characterization for each learner profile, including information on their learning preferences, motivation and background knowledge. Table 1 shows the content from one representative screen in the learner profile section. On this screen there are four characteristics regarding the learner's learning preferences. (The What/Why/How information presented in Table 1 would be seen by the student/designer only if the What/Why/How button was selected.)

Jack prefers to learn by having information presented as...

Abstract Explanations	O O O O O	Concrete Demonstrations
Theories and Interpretations	O O O O O	Facts and Data
Visual Representations	O O O O O	Written or Spoken Words
The "Big Picture" First	O O O O O	Step-by-Step Instructions

WHAT: "Learning styles... can be thought of as learning 'habits' that allow a learner to benefit more from some experiences than from others" Valley (1997).

WHY: Each preference has strengths and weaknesses in different situations. Choices made here will help you think about the needs of learners who would prefer to have information presented in alternative ways, or who would prefer to engage in alternative kinds of learning tasks (Goodyear, 1991; Gregorc, 1986; Honey & Mumford, 1992; Kolb, 1984; Solomon, 1992; Valley 1997). You will want to create learning opportunities which play to a student's strengths, and provide particularly strong support when the content and objectives require them to engage in non-preferred ways of learning.

HOW: The goal is to create a clear enough picture so that the learner "comes alive" for you. Select the presentation style and activities which this leaner would likely show a preference for.

Table 1: Contents from one screen of the Learner Profile section of the LCD Idea Kit.

To give a more complete overview of the learner profile section of the Kit, Table 2 shows the content from two screens and lists the headings for eight more. With the guidance of the faculty member, the design teams are asked to select the relevant profile elements which affect the specific instructional bottleneck they are targeting; these selections are reviewed by the instructional design staff, but the faculty member remains the key resource about the nature of the learning in the target activity.

1) Jack prefers to learn by engaging in tasks which involve...

Learner Control	O O O O O	Instructor Control
Lots of structure	O O O O O	A minimum of structure
Active experimentation	O O O O O	Reflective observation
Writen reports	O O O O O	Visual design

2) Jack is likely to approach this subject by trying to...

Get things done quickly	O O O O O	Get things done accurately
Take risks	O O O O O	Avoid risks
Seek meaning	O O O O O	Use rote memorization
Process top-down	O O O O O	Process bottom up

3) What Jack can already do

Prerequisite knowledge
Relevant misconceptions
Related knowledge (mental models)

4) Jack expects the content of this unit to be...

5) Resource limitations and logistics make it difficult for students to...

6) Description of the learning scenario

7) Some things that make Jack who he is include...

8) Other important preferences not already mentioned...

9) The most important learning goals for this unit that challenge Jack are...

10) Based on the learning content Jack is like to have difficulty...

Table 2: An overview of various sections in the Learner Profile section of the LCD Idea Kit

Scenario-based design

Learner-centred design focuses on the learners' experience with the content, rather than the structure of the content presentations. We use a scenario-based design method to achieve this, in which the design teams create a scenario of the current problem in the learning situation and the target learning scenario they want to achieve (for the various learner profiles):

> For designers of interactive software, a usage scenario is a narrative description of what people do and what they experience. Scenarios force designers to consider the range of users who will use the system and the range of activities for which they will use it. Usage scenarios are developed early in the design process and employed to drive later stages. Usage

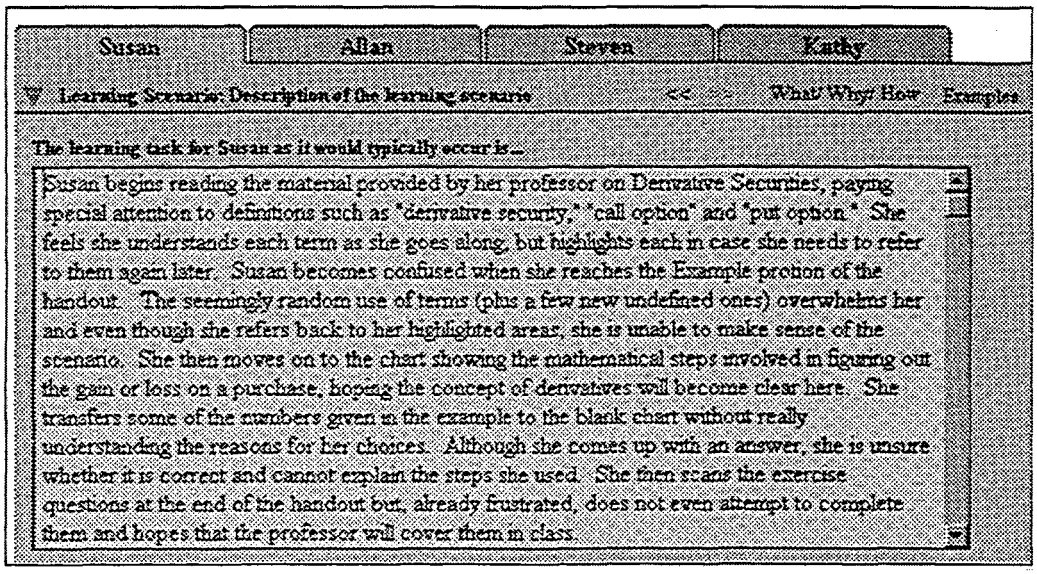

Figure 1

> scenarios complement prototypes as vehicles for exploring, refining and communicating interaction designs . . . (Carey and Minstrell, 1996, p. 84).

Figure 1 is a screen image of an example current learning scenario for one learner profile.

Visualization of design issues

The design visualization used in the Kit adapts an existing model for teaching/learning interactions, the Conversational Framework (Laurillard, 1993), to highlight Mediated Conversations for Cognitive Apprenticeship in an MCCA diagram (Carey, Harrigan and Palmer, 1998). The roots of cognitive apprenticeship lie in the traditional methods by which apprentices acquire skill and knowledge from experts, and its key features are modelling, coaching, fading and reflection.

The mix of these activities undertaken by a computer-mediated expert and a computer-assisted learner was originally illustrated with a visual aid showing expert/novice activities and building/applying concepts as a matrix (Laurillard, 1993, p. 103), of which an adapted version is shown in Figure 2.

This is a visualization of mediated learning processes and the ways they are related: by representing planned learning activities on the diagram, a design team can record the kinds of activities undertaken by learners and the balance amongst them. The boxes represent operational processes in computer-mediated learning, which involve operations on either an application problem or on representations of the concepts which need to be applied. In the cognitive apprenticeship approach, these processes could be performed by the learner or by an expert acting as model. An ideal design would contain a balanced set of learner tasks using these processes, for example drawing concept maps and refining concept descriptions (which would appear in the top right box of Figure 2), or engaging with an expert describing the

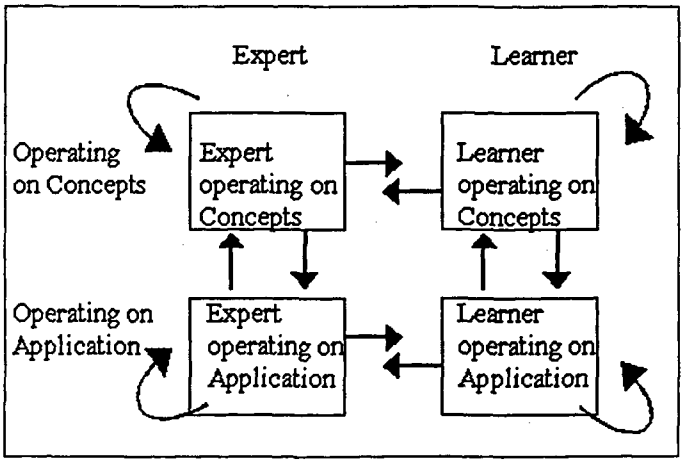

Figure 2

concepts (which would appear in the top left box). The processes in the lower row, applying concepts, could be instantiated with tasks like measuring liquids in a virtual laboratory or assembling component pieces on a simulated workbench.

Using such a diagram in the design toolkit requires designers to focus on high-level issues like the balance between expert and novice activities and between building and applying concepts.[2]

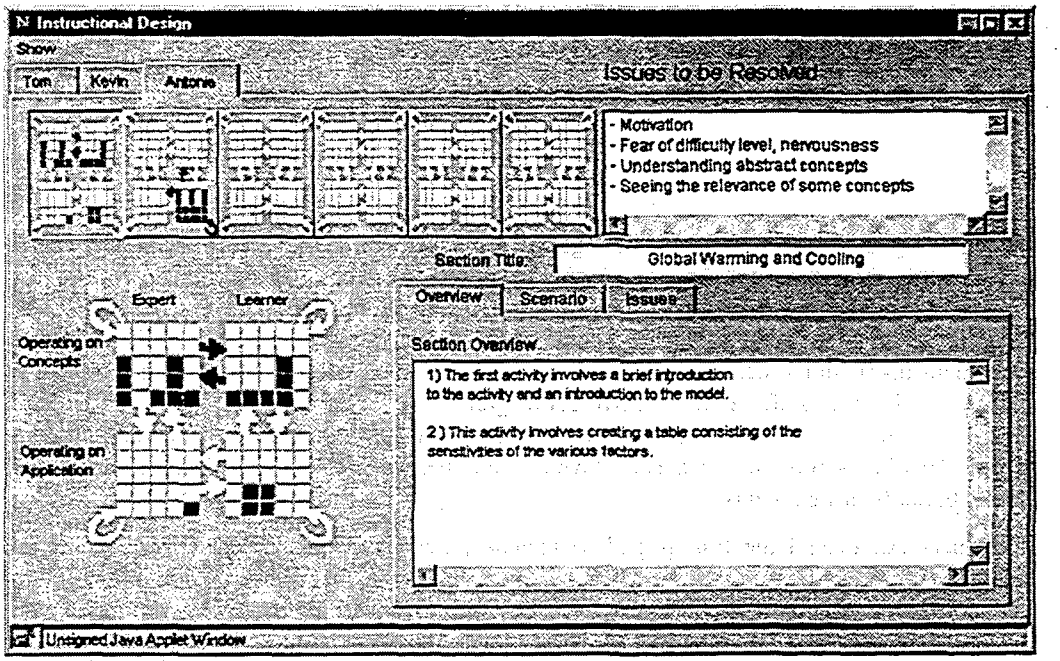

Figure 3

To represent more fully the tasks in a learning activity, a temporal dimension is needed. Figure 3 shows a sample learning activity, represented as an MCCA diagram with its time dimension represented as columns. Anything in the four column 1s happens first, then everything in the four column 2s happens next, and so on. A grid square represents one unit of time that the learner engages in that activity – typically five minutes although some designs require a different timescale. Figure 3 shows this temporal dimension for the following learning scenario:[3]

> The learner, a physiology student, begins the learning activity by meeting with a couple seeking counseling. The couple isn't sure what risks they face in having a second child, given that their first child did not have Sickle Cell problems . . . after spending some time engaged with the couple, the learner realizes that her conceptual background allows her to address only a few of the couple's concerns, and poses a question about the likelihood of a cure to a computer-mediated medical expert. The expert reconstructs current understanding of Sickle Cell disease . . .

The MCCA diagram highlights critical elements in the design scenarios as shown in Table 3:

Column [learning task] in MCCA Diagram	Related Scenario Excerpt
1. 5 minutes of Learner Operating on Application	Learner meets couple in cover story
2. 5 minutes of Learner Operating on Concepts	Learner begins to construct explanation for couple and recognizes her lack of understanding
3. 5 minutes of Expert Operating on Concepts	Expert reconstructs additional knowledge of Sickle Cell
4. 10 minutes of Learner Operating on Application	Learner returns to the couple and offers advice

Table 3: Critical elements in a design scenario.

MCCA diagrams provide a focus for high-level instructional design decisions. They do not represent the important details which logically follow from such decisions, such as how the learner is oriented or motivated. Novice and expert instructional designers have found MCCA diagrams useful to convey the different conversations which they could build into their designs, document instructional design decisions, and act as a resource for team communication. The instructional design staff can use the MCCA diagrams to infer domain-independent patterns of instruction, and to quickly identify aspects of the design which they need to examine in more detail. This helps provide the needed leverage for their time to be spread across numerous student/faculty design teams.

Designers can extend the timing grid to include longer activities, or create a sequence of activities. A screen image from the MCCA implementation in the current version of the design toolkit is shown in Figure 4. It represents the design of two learning activities for a module on global climate change. The first MCCA diagram on the screen represents a well-balanced set of learner tasks with each of the four process boxes containing at least one task. The toolkit also provides an alternate view that allows comparison of the learning processes expected for different learner profiles.

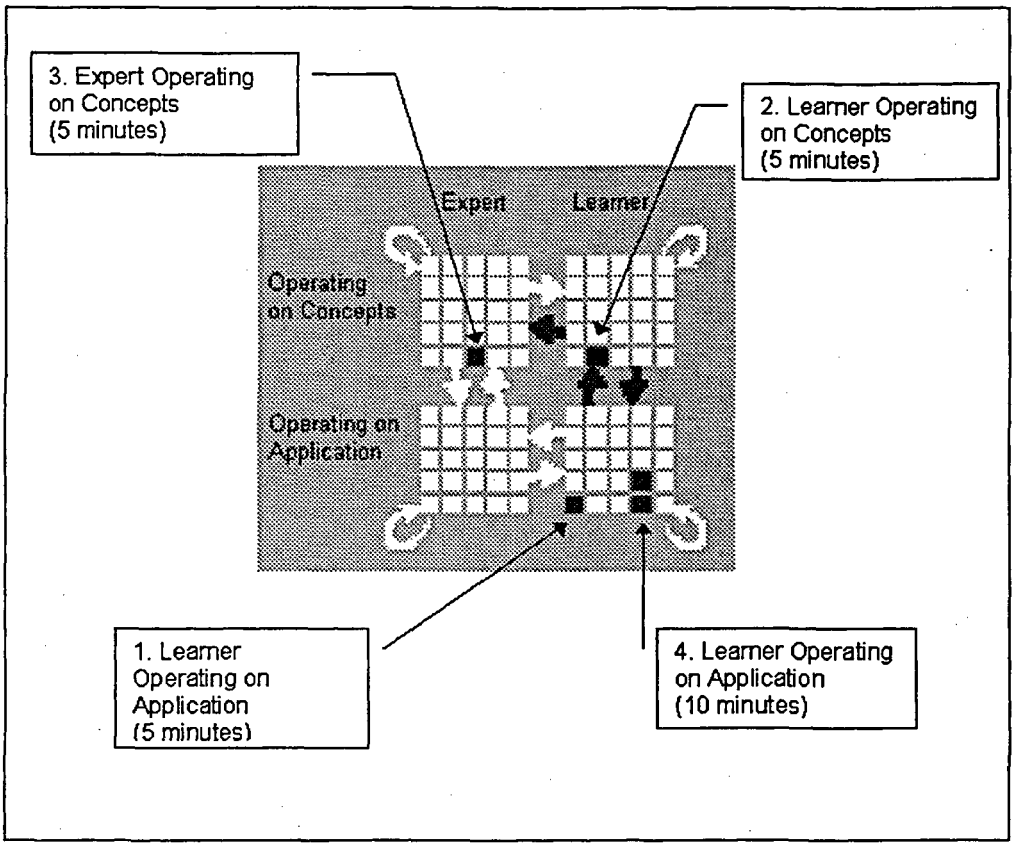

Figure 4

Just-in-time instructional design knowledge

In order for the teams to work effectively after only a few weeks' introduction to the knowledge needed for design, the LCD Idea Kit must provide a performance support environment for novice designers. The information available includes the following components:

- What/Why/How links, as shown in Table 1 and at the top of Figure 1, lead to one paragraph overviews for definitions of the relevant terms, the reason they are important in instructional design, and practical tips on making the required decisions. There are also pointers to content in the course reference list.
- A WWW-based idea space on 'Designing a Learning Activity' provides design choices like types of learning activities and the outcomes they support, different levels of challenge and feedback, and examples from past designs.

There are also facilities for interactions amongst students on their work. For example, each student must constructively critique the work of another team, which leads to an electronic discussion on the thinking underlying the designs. We are extending this facility so that these electronic discussions can be used efficiently to produce a design rationale which would aid in the reuse of the teams' ideas.

A representative success story

We are now just finishing our fourth course using the model and software described in this paper and we have several success stories including projects in Accounting, Computer Science, Kinesiology and Environmental Studies. In this section we will walk through the Environment Studies project to give the reader a feel for what actually happens in practice; in essence this is a scenario narrative of a typical product development in our course.

Four students from various backgrounds (Arts, Kinesiology, and two from Environmental Studies) and abilities choose to work with an Environmental Studies professor on a section of her course that taught how to analyse critically an Environmental Studies article. The professor felt that this part of the course was an instructional bottleneck because students do not take a formal course on critical analysis and thus do not have the skills. The students do learn and think deeply but only after a few tries, therefore the learning curve is steep.

Through the course, the student team designed and prototyped an application. In the summer, one of the students was hired to complete the application and it is now packaged on a CD and is used by the students in the course.

The summer student won the 'Young Pioneer' award for the application at Canada's TeleLearning Network of Centres of Excellence annual conference in 1997. The professor is extremely pleased with the application and has used it with two classes of students. An informal survey of her students confirmed that the application provided positive response of the application's usability, functionality and enjoyment. Her grading of the student critical analysis assignments has convinced her that the application is valuable as the quality of the assignments is much higher with a lesser ramp-up learning period. Because of the success of this application we are now planning to make this into a more general application with applicability to many departments. Because of our original implementation, the application may have to be completely rewritten in order to facilitate this generalization.

Current status and lessons learned

Through the four offerings of the course and the ongoing development of the LCD Idea Kit, we have learned the following lessons about the link between our institutional strategy and the supporting resources and tools for the course:

- Mainstream faculty respond positively to approaches from students interested in working on learning improvements. Some innovative faculty have approached us seeking design help, others have responded to a public notice seeking participation. But to reach mainstream faculty, we need the student teams to be more proactive in recruiting an instructor to host their project, particularly from one of their own previous courses.
- In addition to providing a truly interdisciplinary learning experience, the course adds value to the students' educational experience outside the unit itself. Many of the students have reported back on their growth as 'consumers' of education, and a number have redirected their programmes of study as a result of their learning in the unit.
- Interactions amongst the faculty participants can be an additional learning activity. In addition to the informal knowledge-sharing that developed amongst the faculty on design teams, two faculty members joined student teams working with other teaching staff in order

to participate more fully in the design projects and acquire more knowledge about the process.

- In the overall process of which the course is the initial component, the use of multiple decision points during development has allowed for healthy attrition of less promising projects, without consuming undue professional staff resources.

We are continuing to develop the LCD Idea Kit, and welcome collaborations that add more information for team members and more exemplars/components for reuse. The two areas currently of most interest to us are the development of a library of reusable ideas from exemplary systems, and a way to link the LCD Idea Kit into technology components for implementation.

The design of the LCD Idea Kit was informed by our earlier study of how faculty members used a set of multimedia exemplars in designing their own courseware (Minstrell, 1997). This work demonstrated that mainstream faculty could utilize ideas from computer-mediated learning activities in other disciplines, provided there had been appropriate indexing of the exemplar cases at the level of learning tasks. We are still experimenting with the right level of granularity for such descriptions, which will provide a vocabulary for use in the LCD Idea Kit – and could then serve as an index into a library of ideas for implementing learning activities in computer-based environments.

A number of research efforts are now under way to encourage reuse of implementation components for courseware, e.g., the Elicitation Engine (Twining *et al.*, 1998). As more of these become available, the ability of instructors to implement learning technology will increase, but their contact with a university's central resources in instructional design may decrease. Viewed strategically, providing access to a rich set of components through a tool like the LCD Idea Kit strengthens the potential for good instructional design to precede implementation. Linking design and development resources is therefore another direction where we seek future collaborations.

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Notes

1 A student in a 'course' at our institution is expected to spend approximately 10 hours per week on the course for the 13-week teaching term, representing 120–50 hours of learning activity.

2 Since the computer-mediated learning is intended to be highly interactive, *conversational* processes are also included in the high-level representation. The arrow going from the upper left to the upper right boxes – from the Expert Operating on Concepts process to the Learner Operating on Concepts – represents an intervention by the expert (as mediated by the computer system) for a question or suggestion while the learner is engaged in building a concept. The arrow in the opposite direction represents a request from the learner for the expert to model or comment on part of the concept building activity. The arrows leading back into their originating box represent reflective or meta-cognitive activities (see Figure 2).

[3] An adaptation of the Sickle Cell Counselor learning activity (Bell, Bareis and Beckwith, 1993), for a cognitive apprenticeship approach and learners building a stronger conceptual base.

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