# Integrating Design, Evaluation, and Dissemination

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Through the Institute for Learning Technologies, Columbia University seeks to develop an integrated set of design, evaluation, and dissemination services that will make the processes of curriculum development significantly more efficient and effective. We hypothesize that networked multimedia technologies can shift key limitations that traditionally complicate design, evaluation, and dissemination efforts. We describe the problem in each of these three areas. We then introduce prototyping work that we are currently conducting that will show how networked multimedia resources can enable educators to develop and test an integrated solution to the problems. Then we outline an expansion of these initial efforts designed to advance the design, evaluation, and dissemination activities of the Communicating Chemistry Project. We believe that these design, evaluation, and dissemination strategies will not only perform these functions well for the project, but will further provide the project leaders with useful management resource, helping them give unity, direction, and continuity to a complex effort spread over numerous, diverse institutions.

## Traditional limits on design, evaluation, and dissemination

In curriculum development, the difficulty in achieving good design, evaluation, and dissemination has been a difficulty in execution, not in direction. What developers should accomplish has been clear; how they can best accomplish it has not. This difficulty of execution has arisen because all three efforts, although necessary for the success of the development project, are extrinsic to the curriculum itself, and to the teaching and the study of it. For design, evaluation, and dissemination to be strong, they should closely interact with the educational work of the program and curriculum, but the more they do that, the more they set up interference patterns, deflecting the attention of teachers and students from the educational tasks at hand.

### *Design*

In recent years, methods of participatory design have received significant attention.(Ehn, 1988; Bodker, 1991; Schuler and Namioka, 1993) The idea of participatory design is to include end-users as integral members of the design team and to situate the design work as fully as possible in the setting of its prospective use. This does not mean turning design over to end-users, somehow expecting them to make the product. It is, rather, to have them work in continuous, close interaction with designers, making suggestions, explaining needs, and criticizing possibilities. Development through participatory design keeps everyone in touch with the authentic use of a system and results in software that will enter more fully and quickly into use because it meets its users needs and interests. Participatory design methods are especially useful in developing educational software. It makes sense to design tools for new educational settings with extensive participation by teachers and students, who can provide a flow of suggestions about how the technologies can help and hinder their actual work. It is difficult, however, to set up good conditions for participatory design in normal classrooms. The frequent presence of software developers in the classroom distracts students and teachers from their educational work.

### *Evaluation*

In developing software for education, the importance of formative evaluation is increasingly evident. In practice, one can move along a continuum from participatory design to formative evaluation. Through formative evaluation, developers of a program or curriculum will test features under development to see how well they work educationally, grounding the choice between alternative treatments on empirical experience. Formative evaluation attends to the educational effects of numerous elements in a working

whole, not just the summative effects of the entire program after it has been fixed and fully implemented. Ideally, a program will undergo numerous iterations of formative evaluation — testing, adjusting, and reconfiguring — and before releasing a program, its developers should have a very clear idea of how each of its specific features will work under normal conditions of use. In reality, formative evaluation is awkward to conduct and costly. As arrangements for it are usually highly obtrusive, they generally require rather elaborate controls to ensure that the processes of evaluation do not skew the apparent results. Generally the successive iterations of formative evaluation do not take place as rapidly as would be desirable, coming often only after designs have been set, making it difficult to incorporate changes when the need for these has become evident.

***Dissemination***

In higher education, academics traditionally pay little attention to problems of systematic dissemination of curricular innovations. In K-12 schooling, the primary means for disseminating new techniques and curricula have involved pre-service and in-service teacher education. These forms of dissemination are not useful for technology-based innovations. Pre-service teacher education addresses a fifteen to forty year replacement cycle that is not suitable as the primary dissemination means for fast-paced technical innovations. In-service teacher education can happen on more regular, short intervals, but it generally involves teachers leaving their schools and classrooms, and going to some other place where the in-service work will occur. This creates a problem of transfer as the resources at the in-service training center may differ from those in many teachers' schools and the training stiffens as a teacher, alone in her classroom, tries to remember the pat counsel of the expert six months before. Dissemination would be facilitated if the training requisite to sustain it could be available continuously at the many locations where the new curricula were to be implemented. But the centers of innovation are few and the sites of dissemination very numerous, putting a tremendous strain on groups that provide on-site training services.

**Design, evaluation, and dissemination through background conferencing**

It is now becoming feasible to alter the logistics of conducting good participatory design, formative evaluation, and dissemination through field services where an infrastructure of networked multimedia communications is in place. With these technologies, simple multi-point video conferencing can link complex teams of teachers, students, designers, evaluators, and field-service providers in manageable, unobtrusive workgroups. As part of the Columbia University Workshop for Undergraduates to Create Hypermedia Modules, slated to run during the summer of 1994, the Institute for Learning Technologies will pilot such arrangements and show their feasibility for participatory design, formative evaluation, and dissemination through on-line field services.

Very simple video conferencing programs have become available for microcomputers, such as CU-SeeMe, and for workstations, such as Mbone.(Macadonia and Brutzman, 1994) CU-SeeMe both displays what is happening in the ambient of a workstation, recorded through a small, unobtrusive video camera, and sharing it at very low quality (128x128 resolution, 4+/- frames per second) with other workstations, along with phone-quality sound. The program will run in the background, if one wishes, with some other program on his system being active, allowing others to see him while he works on something else. While CU-SeeMe shows audio and video of the activity around a workstation, Timbuktu, or other remote-control software, permits one workstation to show what is happening on another workstation remotely, even permitting someone at the remote computer to control the other, sending mouse and keyboard input to the distant CPU and seeing the results on screen. By combining simple conferencing with remote control, we expect to create an inexpensive, very flexible, unobtrusive way of creating conversations about design options, curriculum performance, and educational practices in educational settings adapted to networked multimedia.

Integrating these technologies together can significantly change the logistics of participatory design, formative evaluation, and on-line field services. Designers can closely and unobtrusively observe what users do while working with curriculum materials, entering into teleconferencing exchanges with them when necessary to clarify some point and to get further insight into a problem of use. Evaluators should be able to refine their observations of work with a system, forming a more precise understanding of particular effects and specific difficulties, than they can when their observations intrude on the dynamics of learning. Evaluators should get closer to observing directly the processes of a program's use and not need to rely on inferring back to those dynamics from sampling the consequences of its use. Dissemination through field services should be greatly facilitate by enabling the dissemination team to be in many places at once and by overcoming the traditional isolation of the classroom. With simple video conferencing a teacher can consult with an expert while a problem is fresh and pressing, and new users in many locations can congregate at a distance to pool their insights, concerns, and experience.

During the coming summer, we will pilot use of CU-SeeMe and Timbuktu as a powerful means for interacting at a distance, permitting unobtrusive monitoring and collaboration without co-optation. We will begin linking Macintosh workstations in Columbia's Chemistry Department development lab and in a science classroom at the Dalton School, through a "reflector" at the Institute for Learning Technologies design studio. We will explore how to use these arrangements to facilitate participatory design discussions, formative evaluation procedures, and dissemination through on-line field services. Professor Robert McClintock, director of the Institute for Learning Technologies, will oversee this work. The Institute's design staff will track work on the curriculum modules that undergraduate fellows are developing and interact with the developers on issues of pedagogical strategy and human-computer interface design and other systems issues. The Institute will cooperate with the Workshop evaluators, Professor Art Markman and his students of the Columbia Psychology Department, to develop ways to use the background conferencing resources in their evaluation arrangements. The goal will be to discover how early the evaluation effort can identify confusing or difficult features of a program implementation and how finely resolved these identifications can be. The Institute group will also work to pilot field services in cooperation with teachers at the Dalton School as they prepare to test the modules in courses there. We will seek to prototype in-service workshops delivered on location at multiple sites and follow-up consultation services that can respond immediately to the specific needs that teachers may encounter as they put new resources into operation. These initial efforts will provide a basis for further work through the Communicating Chemistry Project.

**Integrating design, evaluation, and dissemination in the Communicating Chemistry project**

As part of the Communicating Chemistry project, the Institute for Learning Technologies will expand and develop its design, evaluation, and dissemination services based on background conferencing. In doing this, we will explore the degree to which they can facilitate the management of a complex curriculum development project that has numerous collaborating groups spread over diverse schools and campuses. We believe these services will help unify distributed design resources, establish coordinated formative evaluation procedures, and achieve a consistent implementation through on-line field services to user-groups across the nation. If these expectations prove sound, we will make an important advance in the capacity to develop and disseminate curricular changes conducive to the systemic transformation of education.

As the project develops, the base of users who can actively participate in the design work of the project through background conferencing will increase significantly. These will be located, not only on the Columbia campus, but at the many other campuses cooperating in the project. We will be able to explore a variety of facilitating factors as a result of this widening base of participation. For instance, different campuses will have different speed linkages, ranging from under T1, which is probably the threshold for useful background conferencing, to ATM testbed speeds in the case of schools linked by NYNET. As a

result of these differences, we will be able to explore the value of different levels of resolution as a variable determining the usefulness of the background conferencing system for participatory design activities. In addition, as the full project develops, we will include a wider range of development platforms in our basic arrangements, using Mbone as a background conferencing resource for UNIX workstations. This will enable us to test the use of participatory design arrangements in more advanced components of the curriculum.

One of the advantages of having a diverse coalition participate in a curriculum development project such as Communicating Chemistry is that on-going formative evaluation of the curriculum can take place in diverse educational settings, informing development with a more representative span of experience. This advantage is easily dissipated, however, by the logistical difficulty of conducting coordinated evaluation efforts on multiple sites widely dispersed around the nation.(National Science Foundation, 1993) It will be a major advantage to have one evaluation team able to conduct simultaneous yet continuous evaluation efforts at multiple sites via unobtrusive conferencing. Through these arrangements, we should be able to collect and use a rich stream of experiential data about the performance of software and curricular strategies, providing developers with a stream of timely results indicating which features work well and which need significant redesign.

A diverse coalition also gives the opportunity to develop strategies of dissemination. The temptation in a coalition is for each part to go its own way, and to maintain the coherence of the whole project, the coalition needs to cope internally with the problem of dissemination, making sure that curricular resources developed in one location are quickly and effectively disseminated to all the participants. Good on-line field services, through which developers of one or another resource can help colleagues elsewhere put it into normal use, will be essential to make the coalition function as a whole. Traditionally, such efforts often undermine the productivity of the most creative development groups in a coalition, for they find key members leave development work to travel all about helping other sites implement their programs. Being able to do this at a distance, without leaving the design studio, will greatly improve the chances of good internal dissemination while maintaining the pace of development.

Traditionally, design , evaluation, and dissemination have been separated functionally in the developmental sequence of a project. Design takes place at the outset and when relatively complete its fruits are then subject to evaluation, which may inform one or two iterations of revision, with the results then readied for wider dissemination. The extensive overlapping of these functions is natural and desirable. their clear separation in practice has arisen, we think, largely from the logistical difficulty of combining them. The arrangements for participatory design, formative evaluation, and dissemination through field services that we propose for Communicating Chemistry permit us to diminish the separation between these three functions and to treat them continuously and decisively all as one. If this strategy proves effective, it will provide a powerful tool for systemic educational reform across all levels and subject matters.


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