A Human Approach to Electronic Performance and Learning Support Systems: Hybrid EPSSs

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Introduction: Is a New Category of Educational Software Emerging?

Looking back to the range of possibilities for electronic learning-related resources a decade or two ago, when we categorized software as being "drill and practice," "tutorial," or "simulation," and we worried about how to categorize applications such as word processors and programming languages (Were these "educational software" or not?), we seem now to have moved from a time of comparative simplicity to one of a bewildering range of developments and terminology. We read about new types of electronic environments that seem by their names to be made for educational purposes, but which are hard to classify according to our familiar categories of educational software. Examples of this include "ELIEs" (Enriched Learning and Information Environments; Schwen, Goodrum, & Dorsey, 1993); CSILEs (computer supported interactive learning environments; Scardamalia & Bereiter, 1991); REALS ("rich environments for active learning"); and ISLEs ("Intensely Supportive Learning Environments") (see McAleese, 1994, for a discussion of both REALs and ISLEs); "Performance/Learning Support Systems" (Arnett, 1993a,b); and Teacher and Learner Toolkits (Hoebel & Mussio, 1990).

What is going on here? Are we seeing a new category of software for the support of learning and thinking, or many diverse and dissimilar sorts of software environments?

And, to compound the complexity, the literature is swelling with examples of software categories with their original application areas outside of education, which are now increasingly being applied to educational situations. Some of these, such as the categories of expert systems and AI, have for quite a while been familiar in educational settings. But newer examples of this sort of trans-domain migration include:

- Various types of products to support group functioning now being used in educational contexts, such as GCSSs (group communication support systems; see, for example, Pinsonneault & Kraemer, 1987); "collaborative performance support" systems (Brush, Knapczyk, & Hubbard, 1993); "electronic meeting systems" (EMSs; Grohowski, McGoff, Vogel, Martz, & Nunamaker, 1990); groupware (Collis & Heeren, 1993); telecooperation support tools (Heeren & Collis, 1993); and conferencing software.

- Various types of products to support information retrieval and handling, such as hypertext browsing systems (see Nowaczyk & Snyder, 1993, for a typical educational application); "Intelligent Assistants" (Robinson, 1991); "Intelligent Agents" (Barker, Richards, & Banerji, 1993); intelligent help systems (see Winkels, 1992, for typical educational applications); and information-finding tools such as Gopher, WAIS, and WWW, for the Internet (see, for example, Harris, 1993, for school- and teacher-oriented uses).

- And products offering guidance and information support in ways that are integrated into the regular workplace of an individual, such as EPSSs (electronic performance support systems; see Reeves & Burg, 1991, for an example made for teachers); performance support tools (see Barker & Banerji, 1993, for an example of applications for on-the-job training); and many other different sorts of systems and tools for handling different combinations of information, communication, and collaboration.

Is there some unifying category applicable here that relates these many sorts of examples, both those originating in educational contexts and those originating in other contexts but which are now being applied to the support of learning and thinking? If so, what is a useful way to describe it? What are important design guidelines for such a category?

In this discussion, we address these questions. We begin by first giving more details about some exemplars of this proposed category, to help better explain the range of environment types in which we are interested. Then we suggest two different approaches—one we call the "systems" approach and the other the "human" approach—for conceptualizing and categorizing this

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type of software environment; and we conclude with a suggestion for naming and visualizing the category that we extend to a preliminary set of design guidelines.

A Starting Point: EPSSs

As a result of our preliminary analysis of many of the types of environments listed above, we came to a first hypothesis, that the category "EPSSs" (electronic performance support systems) might be a good candidate for a generic category including many of the other exemplars. At face value, all the words are relevant: the products are electronic systems, they are meant to support people in various types of (intellectual) performance. We thought this also, however, because of the fact that the software category called "EPSSs" already has a certain recognition in practice. Gery, one of the best known authors on EPSSs, defines them by saying that they are systems whose goal is to:

> ...provide integrated information, tools, and methodology, electronically, on demand, at the moment of need. (adapted from Gery, 1991, p. 34)

Barker, by himself and with various colleagues, also has worked extensively with EPSSs. He defines them as being:

> ...a custom-built interactive guidance and information support facility that is integrated into a normal working environment,...with a range of different performance support tools each one of which will have been selected in order to aid a particular job function. (Barker & Banerji, 1993, p. 2)

In turn, "performance support tools" are software products that:

> ...supply access to integrated information, learning opportunities, and expert consultation—with a scope and sequence that is controlled by the user, that is on-the-job and available when necessary. (Barker & Banerji, 1993, p. 2)

Functionalities of EPSSs

Prior to giving her definition of EPSSs, Gery identifies various questions or needs that a person could have when facing new or complex tasks, and associates with these various responses that an "electronic performance support system" could offer to the person in reaction to the need. Some of these pairings are as follows:

"Why do this?"	–Give explanations, provide examples and consequences.
"What is this?"	–Provide access to definitions and illustrations.
"What is related to this?"	–Show links to other information.
"Why does this work as it does?"	–Show examples and explanations.
"How do I do this?"	–Make available interactive advisers, job aids.
"Let me try..."	–Provide practice activities, simulations.
"Evaluate me..."	–Give feedback on assessments or tests.
"Predict for me..."	–Give descriptions of demonstrations of consequences.
"Where am I?"	–Provide monitoring and navigation systems.
"What next?"	–Offer directions, prompts, coaching, lists of options.

(from Gery, 1991, p. 33)

We refer to these and other "need-response" pairings from Gery's work throughout the following analysis.

Applications to Education

Many different systems meeting at least some of Gery's need- and support-response combinations are appearing in the education literature, although they are not always given the label "EPSS." For example, Leshin, Harper-Marinick, and Story (1993) describe an environment called "The Research Mentor" in which the 15 different sorts of integrated resource categories could be seen as comprising an EPSS. Reeves and Burg (1991) describe "The Instructional Framework: A Multimedia Resource to Promote Effective Instruction" as a resource for teachers in their lesson-development activities, with functionalities similar to many in Gery's list (1991); it could also be called an EPSS. Many products calling themselves "toolkits" could also be called EPSSs, at least according to the functionalities listed above. We describe one "toolkit" in more detail, as an example of the type.

"The Teacher Tool Kit": An Example of an EPSS for Educational Purposes. The "Teacher, Learner and Administrator Toolkits" developed at the Educational Technology Centre of British Columbia (Hoebel & Mussio, 1990) as an example offers integrated resources to help teachers, learners, and administrators in a way that addresses many of the user needs on Gery's list (Table 1). Instead of orienting itself around

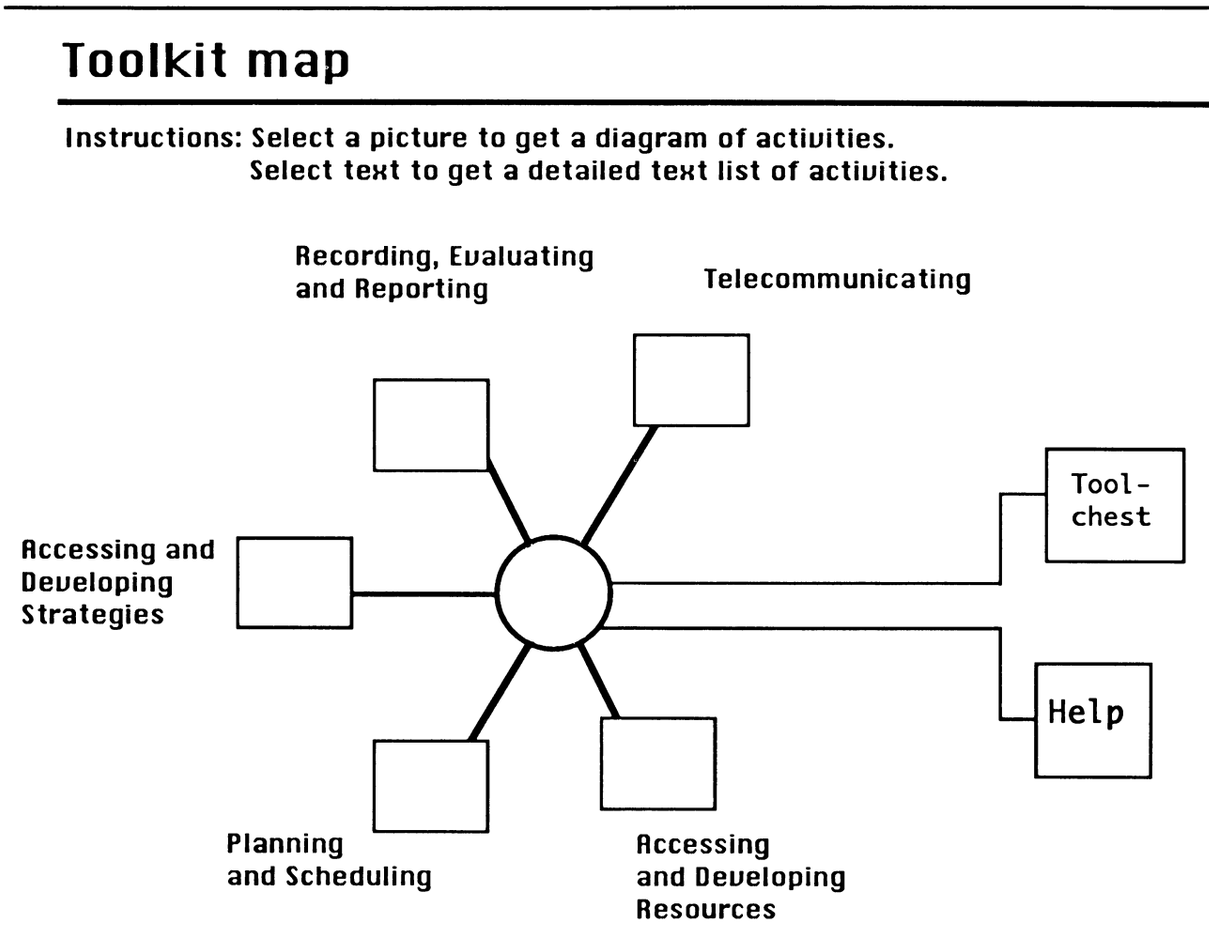

Figure 1. Entry to the "Teacher's Toolkit" environment (from Hoebel & Mussio, 1990, p. 20).

questions, however, the "Teacher Toolkit" is oriented around five types of activities in which teachers typically engage, with an associated "tool chest" that can be utilized in any of the activities. Figure 1 shows the front-end organization of the overall "Teacher Toolkit Map."

From each of the activity icons, a further range of options is available. For example, after choosing the icon for "Assessing and Developing Strategies," the following range of choices becomes available:

–View All Resources
–Tag Resources
–Get Computer Resources
–Get Print Resources
–Get Other Media Resources
–Create Computer Resource
–Create Print Resource
–Create Other Media Resource

Those that involve "viewing" or "getting" in turn rely on access to either collections of resources available directly from storage locally available to the user's personal computer, or to distributed resources requiring a telecommunications linkage.

As another example of the functionality of the "Teacher Toolkit," Figure 2 shows a resource available from within the "Recording, Evaluating, and Reporting" option. Here, the teacher is presented with a template to support him or her in the systematic collection of observations about a student and the subsequent generation of those observations into a report on the student's progress. Figure 2 shows such a template.

From each area of the Teacher Toolkit, a common set of "tools" can be selected to carry out work within the area. These tools include a word processor, a paint program, databases of text and print materials, other resources, and a database of student information.

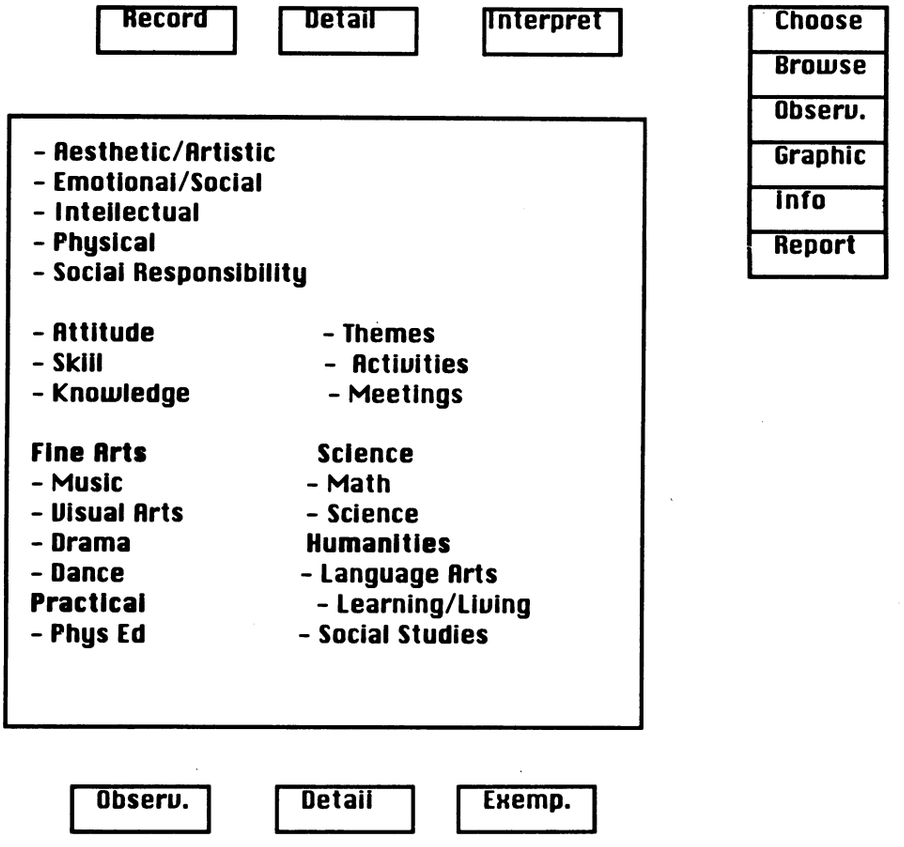

Figure 2. Specialized template available as a tool within the "Recording, Evaluating, and Reporting" area of the "Teacher's Toolkit" (from Hoebel & Mussio, 1990, p. 28).

The emphasis in the Teacher Toolkit from British Columbia is on supporting the teacher as he or she works, alone, on typical jobs which are part of the teacher's day. There is no explicit mention made of the teacher as a learner. The just-in-time aspect of EPSSs, however, is probably not so much viable for the Teacher Toolkit, in that generally teachers will have to make special efforts outside the normal locale of their teaching, to get to the computer system on which the Toolkit is installed. In addition, teachers will have to allot special time to use such a system because of its physical removal from their classrooms (where they teach) or homes (where they prepare). Also, the aspect of custom-built interactive guidance that Barker and Banerji (1993) stress and that is needed as a response to many of Gery's questions ("Evaluate me...") is not apparently present in the Toolkit example.

Thus, the EPSS category could seem to, in many but not all ways, describe "toolkits" such as Teacher Toolkit from British Columbia. But is the EPSS label a good choice for other types of exemplars? We next briefly describe examples from four additional categories of electronic support environments, and note for each how the fit with the definition of an EPSS is not even as adequate as it was in the Toolkit example.

Other Examples: EPSSs or Something Extra?

"The Teacher Toolkit" seemed to fit many aspects of Gery's and Barker and Banerji's descriptions of an EPSS, but not all. As another variant, some systems are explicitly based on the "immediate, on-the-job access" idea of EPSSs, but stress the idea of choosing a tailored learning experience as part of the performance-support repertoire. The following is an example of this variant.

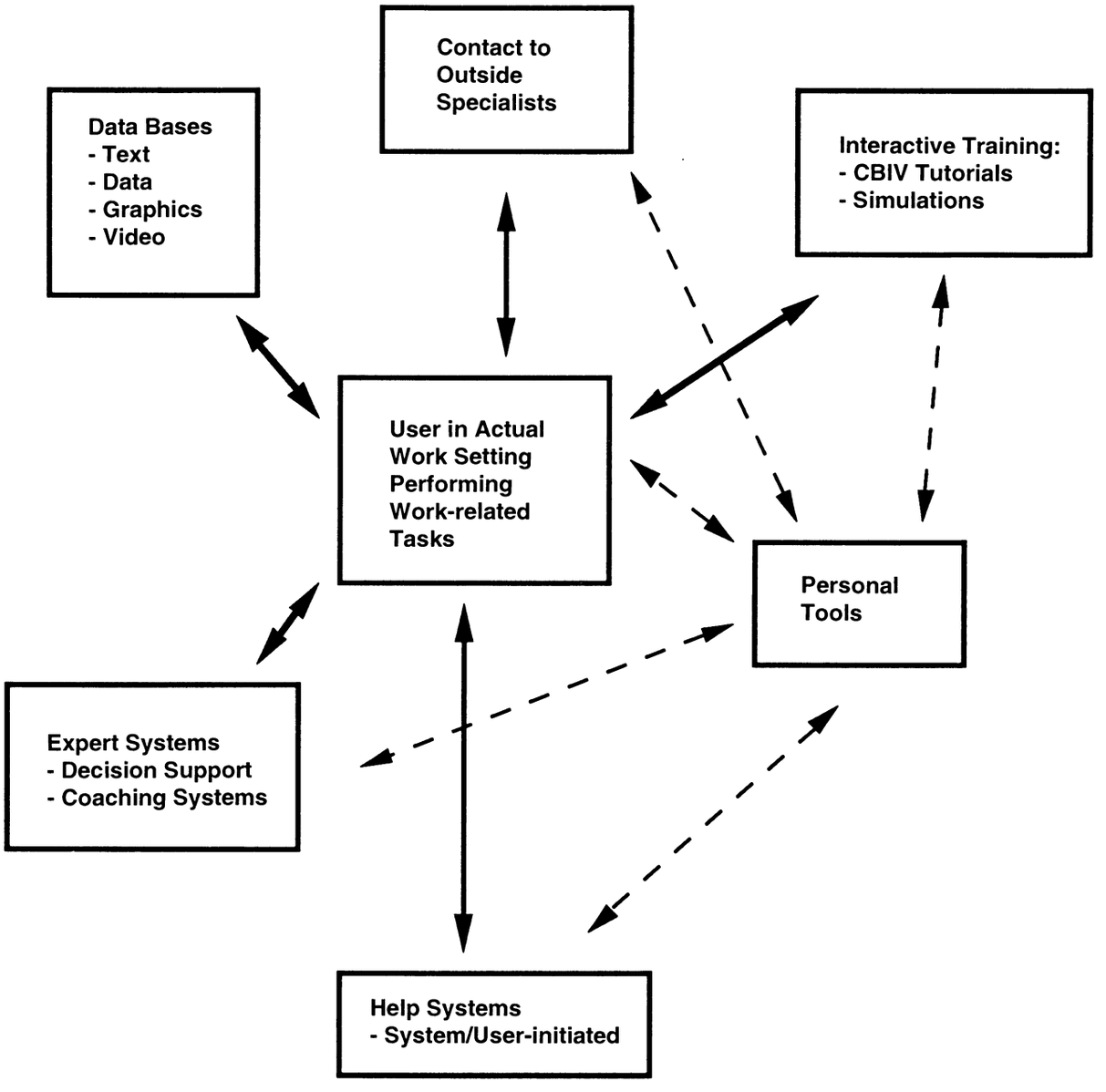

Figure 3. Adaptation of a "performance/learning support" system as a variant of an EPSS (adapted from Arnett, 1993b, p. 44).

"Performance/Learning Support Systems": An Example of Support for Integrated Working and Learning. From the business world, the idea of learning while performing one's job is becoming a powerful alternate approach to traditional concepts of how "training" and professional development should be conceptualized (Barker & Banerji, 1993). Arnett, for example (1993a,b), describes a "paradigm shift" for training and performance in a major corporation (IBM) by the year 2000. Arnett sees that the "workforce will need new levels of support tools to manage and filter all the data, information, and knowledge available in making decisions" (Arnett, 1993b, p. 46), and that this will require in turn a "Performance/Learning Support System" (P/LSS) integrated into the employee's work environment and offering, among other components,

integrated training, databases, expert systems, help facilities, and application and productivity software. Thus, learning and performing intermingle. Support is available for either or both through the same integrated environment. Figure 3 shows these ideas.

Many examples are appearing in the literature of environments sharing characteristics of a "P/LSS," but, as before, called by a variety of names. "Just-in-Time Knowledge Performance Support" (Dorsey, Goodrum, & Schwen, 1993) is one such example.

Are P/LSSs substantially different than EPSSs? Perhaps the major difference is the stress on "learning" and the philosophical integration of learning with doing or performing. Gery also includes the learning possibility in her list of EPSS functionalities (1991) when she cites "Teach me..." as a need that can be met by EPSSs. But she and other EPSSs authors usually do not stress the "learning" aspect as a central support role of the system.

Arnett's P/LSS seems to be based on the implicit model of a single user, and locally available resources, as are many of the EPSSs appearing in the literature. The next example emphasizes interconnectivity with local and distant resources and persons more so than the P/LSS example, the Toolkit example, or Gery's examples in her (1991) book.

"Outreach and Technical Assistance Network": An Example of Distributed and Local Support for Professional Development. Many variants of EPSSs emphasize the aspect of providing the user with integrated access to both local and distant resources and thus bring internetworked access to distributed resources more clearly into the picture. The type of resources that can be accessed can be clearly differentiated as electronic or as persons. With these sorts of emphases, support environments usually do not call themselves EPSSs or P/LSSs but instead "network services" (although Barker, Richards, and Banerji, 1993, among others, describe a "distributed EPSS").

Among the many different examples of "Network Services" (or "CISOs": communication and information systems for education; Collis, Veen, & De Vries, 1993), the California "Outreach and Technical Assistance Network" (OTAN) is a typical example. OTAN "provides training, technical assistance, information, and communication links for adult literacy staff" (US Congress OTA, 1993, p. 172) with 17 types of distributed services available through a common HyperCard-type user interface, including:

-MASTER CALENDAR, news items about activities in the field of adult education.

-WHO'S WHO, a directory with a wide range of names and addresses of persons working the field of adult education.

-CURRICULA RESOURCES, listing instructional resources in print, video, or software format.

-WANT ADS, where users can post or view ads related to job opportunities.

-LESSON PLANS and DEMO SOFTWARE, samples that can be downloaded.

-UPLOAD AREA, where users can place files that they want to share on-line.

-The ROUND TABLE, an on-line discussion area.

Literally hundreds of such "Network Services" are now in operation around the world, providing support for persons in educational practice as they go about their work (and sometimes as they explicitly set out to expand their knowledge). Typically they stress information access, communication, and idea exchange among persons, and downloading and otherwise sharing resources. Explicit learning aids for the individual user are generally not part of the repertoire. The extent to which they can provide "just-in-time" support depends on the degree of access the user has to a computer with an on-line connection.

In contrast, the next example is one of many from the distance education world, where the information-handling and communication that is supported by the system is directly related to an externally structured learning experience, i.e., the course offered by a distance education institution.

"The Study Planner": An Example of Support for Distributed Open Learning. The resource called "The Study Planner," (Baaren, Koehorst, & Wonderen, 1993), is a type of "Network Service"/EPSS specifically made for learners in open and distant learning situations, and as such shares characteristics with many such systems being described in the literature for open and distance education. The Study Planner offers various forms of information relevant to the course in which the user is involved, guidelines for self-study of learning materials, and support for communication among distant learners and the tutor, and relies heavily on the learner's own capacity to guide his or her learning and interaction with resources. Various examples and learning activities should be available for the learner through the system, as well as tools to allow him or her to save and further work with text obtained through discussions, e-mail, and conferencing. Figure 4 shows an example of a learning setting in the Study Plan environment.

Although the emphasis is on supporting a learner in a distance-education setting, generically this sort of environment is providing performance support in ways functionally similar to EPSSs more generally, to P/LSSs, and to Network Services.

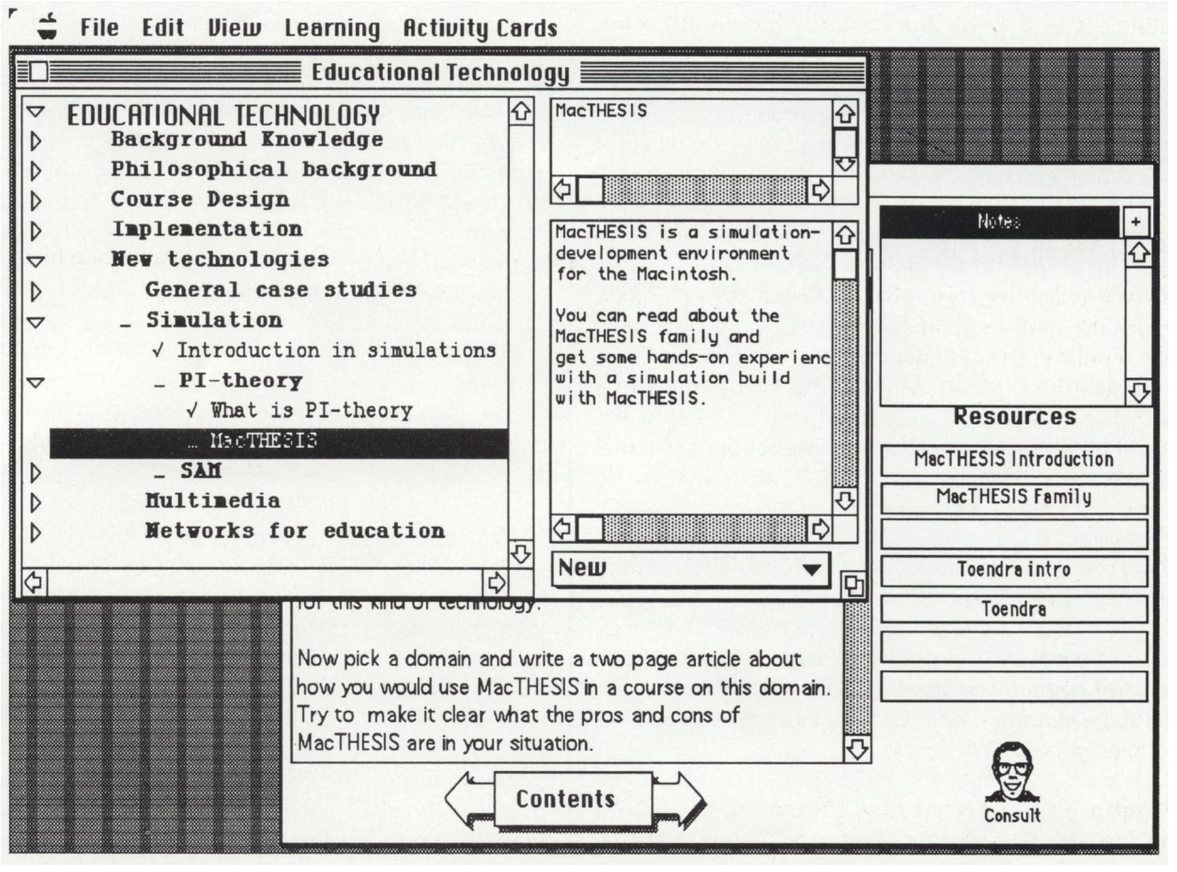

Figure 4. Example of a learning-support environment display in "The Study Planner" (from Baaren, Koehorst, & Wonderen, 1993, p. 13).

What is most different here is the sense of "support while on the job," although this idea could be re-expressed as "support while on the (study) job," and also the sense of how much the user selects material because it is necessary for the course compared to being an intrinsic response to a "real" need. The communication aspect of "The Study Planner" is more likely to be structured and directed toward one or a few persons (i.e., the tutor and perhaps some classmates) than is the case in the more diffuse communication situations supported by Toolkit and the Network examples. The next example brings group communication support to the forefront.

"Electronic Meeting Support": An Example of Support for Distributed Collaboration. A seemingly different type of electronic support environment is the "Electronic Meeting System" (EMS), such as described by Dennis, George, Jessup, Nunamaker, & Vogel, (1988); and Grohowski, McGoff, Vogel, Martz, & Nunamaker (1990). EMSs provide support for communication and for support of groups at work on a task requiring reaching a decision, planning, or solving a problem. They come out of a developmental stream that includes group communication support systems (GCSSs), group decision support systems (GDSSs; see Pinsonneault & Kraemer, 1989, for a thorough review of both these and GCSSs); computer-supported cooperative work environments (CSCW); and shared drawing tools.

Tools available in a representative EMS include: tools for electronic brainstorming, issue analyzers, voting tools, topic commenters, and tools for the session leader in his or her guidance and summary of session activities. Grohowski and colleagues (1990) in their analysis of EMSs in practice refer heavily to the social and organizational frameworks in which such support environments are used, and offer guidelines based more on group management than on support of the individual, such as "Post-meeting distribution of the

session data is critical" (p. 378). While such a comment relates to the functionalities offered by the electronic system, it comes from a group-and-organizational perspective rather than a user-as-worker or a user-as-learner or a user-as-professional-seeking-resources perspective, as was the case in the previous example types.

Other Examples of Electronic Support

While the above examples represent types of EPSSs, they by no means exhaust the different possibilities of electronic support resources now available. We conclude this overview by simply mentioning four more sub-categories, each of which could be extensively illustrated with examples of applications in education:

"Intelligent" Support: Expert systems, intelligent help, AI systems, intelligent assistants, intelligent agents, expert support systems.

Decision Support: decision support systems, group decision support systems (the work of Winograd & Flores, 1986, is classic in this area).

Collaboration Support: CSCW, shared drawing tools, groupware, conferencing support, collaborative performance support, workgroup productivity systems.

Information Handling Support: Hypertext browsing systems, network information-handling tools (such as the Internet's WWW, Gopher, WAIS, Archie, Veronica).

Looking for a Unifying Perspective

There is no doubt that a wide variety of examples are proliferating, utilizing different terminologies and often developing out of different disciplines and traditions, all with application to learning and thinking and educational practice. The category EPSS comes close to describing them generically, but is not "quite right" for various aspects of different exemplars. Looking for a way to describe this category or system as a class is more than an academic exercise. Because of their different origins and application emphases, much parallel development is going on in different fields, and even different groups within education, without apparent awareness on the parts of the various developers that many of the issues they are grappling with are also under examination in other areas, or have been previously examined (see Collis, 1993, for an analysis of the parallel and not-aware-of-each-other development of CSCL [computer-supported collaborative learning] and CSCW concepts). Not only is "reinventing the wheel" a waste of time and resources, but the particular strengths of different disciplines and perspectives are not allowed the sort of synergy that could occur with a better sense of common aspects and focus.

Thus, the attempt to find, and simply state a term and/or metaphor for the range of such electronic environments is important. Gery's list of EPSS functionalities is a good starting point, but should be reexamined in terms of applications other than that of performance-support-in-a-workplace-context in order to broaden its recognizability to developers coming out of different backgrounds and working in different contexts.

In the next section, we offer two possibilities to such a classification. The first is based on a systems-oriented definition, the second on a human-oriented metaphor.

A Systems Approach

We could set about looking for a unifying perspective for these different types of support systems by attempting to first suggest a global definition, and then identify key distinguishing parameters relative to systems within that definition. This is our first approach. This global definition needs to reflect that of EPSSs but with flexibility in some of its aspects. We take as a starting point that we are talking about an electronic system, through which, via a common front-end, ***the user can interact with the system to obtain various types of local or distributed help and resources for individual or group-oriented activities related to learning, problem-oriented thinking, and collaboration.***

With this system-oriented definition, there are at least six basic dimensions which could be used for classification of such resources. These dimensions can be extracted from each group of words in the simple global definition:

–" The user can interact with the system..."

A key issue here is how easily the user can access the system. If the user interacts with the system in the context of other computer-based activities she is already doing, or if the use of the support system is an apart type of activity, requiring different facilities than that usually available to the user as she goes about her work or study will critically affect the usability and just-in-time aspects of the environment.

–"To obtain..."

To what extent does the user control the nature of the support that is obtained through the electronic system and to what extent does the system itself contain algorithms and procedures by which it decides what is provided to the user? Thus, a dimension of "User Steers–User Reacts" relative

to how the decision is made as to what is obtained is included.

–"Various types of...help and resources..."

Is the nature of the support primarily through access to information, to persons, to tools, or to a combination of these?

–"...Local or distributed..."

–Are the resource(s) and the sources of help all contained in one stand-alone system, or available via (inter)networking from potentially many external sources?

–"Individual, or group oriented..."

To whom is the system directed? To an individual or a group? How well do the group know one another and share a common task?

–"In activities related to learning, problem-oriented thinking and collaboration?..."

The distinction between "learning" and handling complex tasks such as problem-solving, decision-making, creating, and group collaboration is often difficult to establish. We will use a distinction among "Work," "Learn," "Think," and "Collaborate" as a first attempt (and with an admitted overlap) to show variants in this activity dimension.

The above systems-oriented approach could be useful, at least in finding a common way to describe exemplars of the domain in question by using a core set of descriptors based on these dimensions. Thus, for example, we could take the five systems we described earlier, and using the above dimensions attempt to see similarities and differences in the systems. Table 1 shows this analysis.

A matrix such as that in Table 1 is interesting, but somewhat academic. Will it be likely to catch the collective imagination of persons working with the many different examples of electronic support systems? Our own feeling is that a focus on the user, confronting a complex task, such as was the starting point in Gery's (1991) list shown in Table 1, might lead to a more powerful organizing principle than the sort of systems-oriented approach used above. Thus, we turned more explicitly to the human dimension.

We looked at the problem-solving literature, and at ourselves in our own intellectual tasks, and thus alighted upon a different approach to conceptualization and categorization of the EPSS family: an approach using the person as a problem solver as its point of reference.

A Human Approach

Not only can we describe our second approach at identifying a common category for the various EPSS-related system types by focusing on the user and what his or her needs are when he or she confronts a problem setting, but also we can search for a metaphor to help us visualize and communicate our perspective. We have done this through what we are calling (perhaps not very scientifically) the "Champagne-Glass Metaphor." We are finding this metaphor both useful and communicable in a variety of disciplines. We describe it in the next section and illustrate it in Figure 5.

Instead of focusing on the different functions of a system, we relate the three components of the champagne glass to three phases of activity that a person more-or-less undergoes when he or she is confronted with a complex intellectual task, for which he or she might desire support. These phases are "Browsing and Getting Familiar," "Focusing and Coming to a Tentative Solution," and "Getting Feedback on the Tentative Solution and on Its Revisions."

Phase One: Browsing and Getting Familiar

What are the user's activities and needs?

During the exploratory phases of a problem or a learning task, or in anticipation of an eventual decision, the individual must spend time browsing, "listening in" to discussions, "window shopping" in order to get a sense of "what's going on," of what are major issues, examples, new possibilities, etc. The goal is to get oriented and to select what and who may be of more specific interest to his or her eventual learning or problem-solving task.

The needs of the person in this phase are access to large range of exemplars, in a variety of forms; the opportunity to unobtrusively "listen in" to conversations among persons already in the domain; and the chance to "window shop" to sharpen one's sense of the domain.

Using Gery's questions (1991, p. 33), the browser might be asking:

"What is it?"
"What is related to it?"
"Show me an example?"
"Compare this or these for me..."
"Where am I?"
"What next?"

How does the Champagne-Glass Metaphor relate to this?

The Champagne-Glass Metaphor associates this

Table 1

Distinguishing Dimensions of EPSS-Type Support Systems

	Accessible While Working?	Who is in Control?	Dominant Type of Resources?	Where Located?	Who?	Doing What?
Example:	*Via workplace computer / Computer apart from workplace resources*	*System controls/ User controls*	*People/ Stored information/ Tools/ Learning Modules*	*Stand-alone/ Distributed*	*Individual/ Group*	*Work/ Think/ Learn/ Coop-erate*
"Tool Kits"	Workplace computer, but not accessed during work and not in own room	User, within limits of what is provided	Stored Info/ Tools; Sometimes people	Mostly, stand-alone, but also some distributed aspects	Individual	Work
"P/LSSs"	Workplace computer, accessed during work	User, but sometimes also system, as the system "notes" deficiencies	Stored info/ Learning Modules/ Tools	Stand-alone	Individual	Work/ Learn
"Network"	Computer may be at workplace or home; not accessed during work	User, within limits of what is provided	People/ Stored info /	Distributed	Individual/ Group	Work/ Think
"Open Learning" Support	Computer at home, not at workplace; not accessed during work	User, but also some aspects of tutor or system control	Stored info/ People	Distributed	Individual	Learn/ Think
"EMSs"	At workplace, accessed during worktime	Leader, not individual user	People/ Tools	Distributed, but also with stand-alone support	Group	Think/ Coop-erate

phase with the wide bowl of the champagne glass, complete with its sparkles. Certain ideas will capture the person's attention, analogous to the bubbles coming from the champagne. Figure 6 shows the metaphorical focus in more detail.

How can electronic support help?

How can electronic support systems help in this phase? They need to offer the user an affordable and easy way to browse and listen in, to "sample the goods" at a casual level, to be able to discard the majority of what is available, but to be able to get more information about items (ideas, issues, examples, etc.) that do seem interesting, and to be able to keep a useful record of who and what he or she might like to find out more about.

Thus, the following characteristics could be important for electronic support systems relating to the Browsing Phase:

- *–Personal control over time, range, direction of browsing, and of "listening in."*
- *–Different types of examples, with relevant aspects of the information easy to locate (as, for example, one wants to looks at the price tag when window shopping).*
- *–Ability to "get your hands" on some items or conversations, to "get a feel for them."*

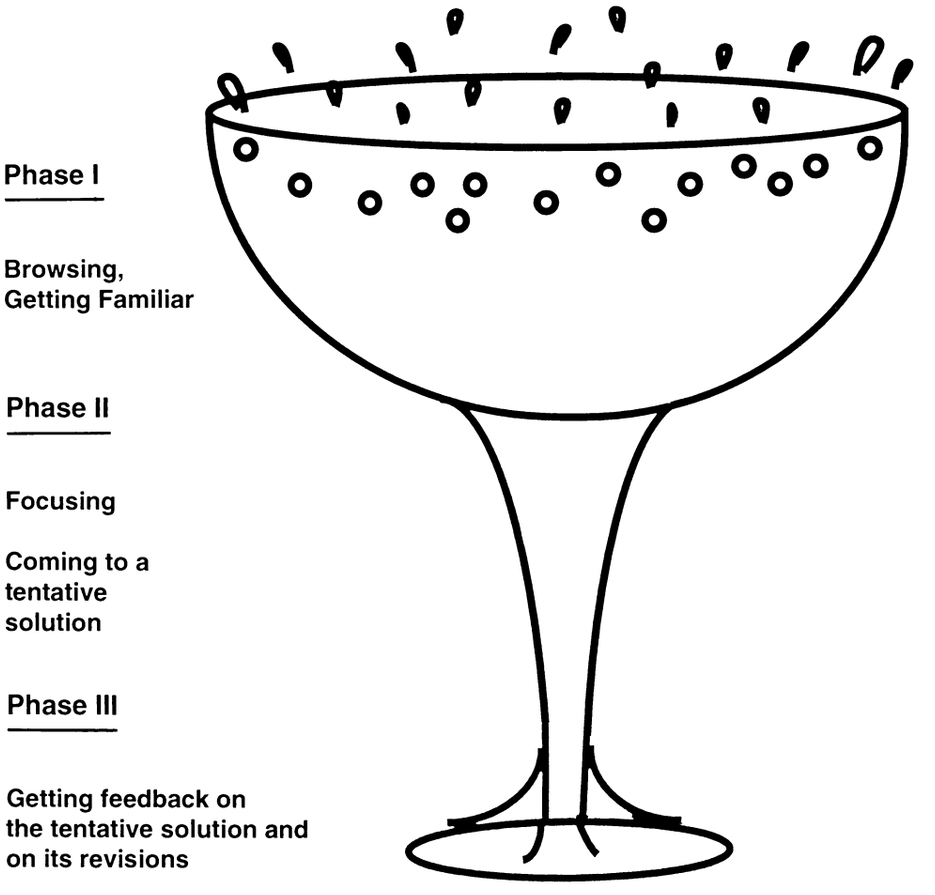

Figure 5. The Champagne-Glass Metaphor for three phases of an intellectual task.

–*Ability to mark what you find interesting, or retrieve a sample of it.*
–*Ability to ask some informational questions.*

Types of electronic support systems?

What types of electronic support systems relate well to this Phase? From the literature, we can select categories such as the following (selected references are given if the category has not been earlier addressed in this article):

–Electronic Information Files (Comes & Kirkwood, 1992).
–Intelligent Assistants.
–Access to BBSs, to on-line discussions.
–Hypertext browsing systems (Nowaczyk & Snyder, 1993).
–Cooperative on-line environments for exchange of ideas and resources.
–(Some) Just-in-time performance support systems.

Human aspects?

This browsing phase, like all aspects of problem solving and learning, is at its center a task that depends much on the human involved. Humans will vary considerably in what they notice and extract from the same "champagne glass" of resources and ideas. Technology can only go so far to compensate for the ability of the user to grasp a sense of trends and patterns through his or her browsing, for the ability to separate out a few potentially valuable sources from a mass of possibilities, for good time management and idea management, for differences in intellectual capacity to compare and contrast, in ability to

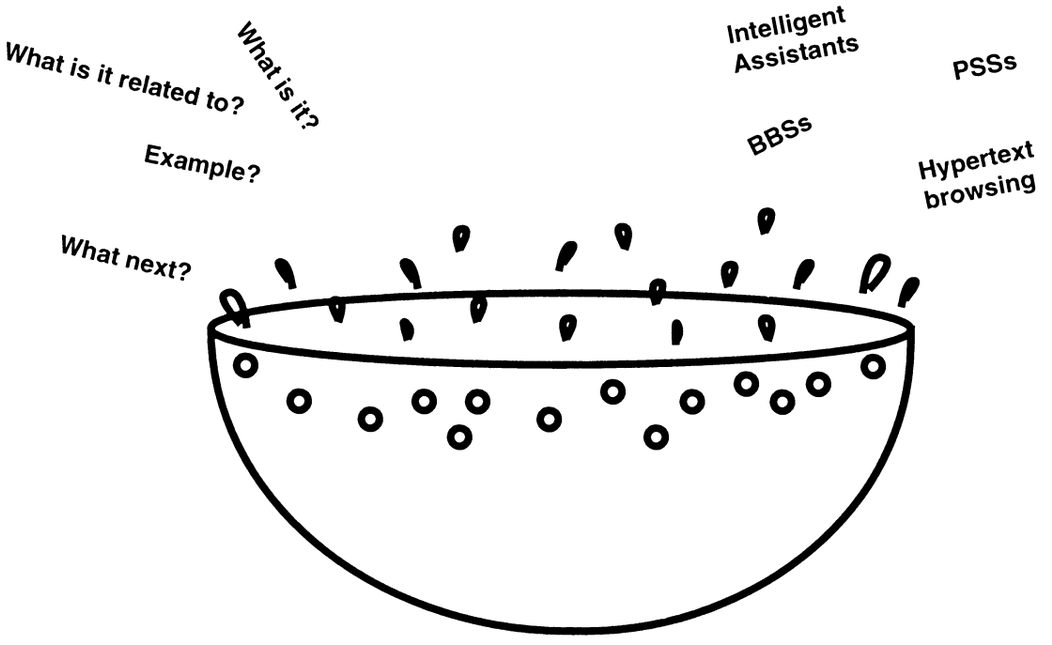

Figure 6. The Browsing Phase: Sipping, or drowning?

categorize, to spot new ideas and appraise their potential relevance. Mostly, these are human issues, not electronic.

Balance between human and technological aspects?

The more a person already knows, or the more she/he has already seen, the less browsing is necessary to update one's sense of the domain.

The better the person's cognitive capacity for seeing trends, spotting a good idea or new example, etc., the less likely it is a large amount of browsing will be necessary. A risk that can come from electronic support making it easy to browse and listen is that the person may come to drown, or may just continue to "sip the champagne," continually being attracted by new bubbles.

Browsing is of course possible without special software environments (we can and do (or did?) go to libraries or conferences or attend discussion groups, etc.). Electronic support systems appropriate for browsing increase the range of browsing and listening available, and allow it to occur from the workplace, and add the "just-in-time" aspect. If they save time for the user or not depends on when the user can pull away from the temptation to explore something else, to listen in to one more discussion, to follow up one more new idea, etc. Having tens of thousands of potential references at one's fingertips can lead to something like being drunk, to carry through with our champagne-glass metaphor.

Something has to make the user decide to stop browsing and dabbling and instead "get to work." It may be the user him or herself, or it may be a constraint or demand in his or her environment—the assignment is due, the problem must be solved, the article must be written, the decision must be made. It then becomes time to focus.

Phase Two: Focusing and Coming to a Tentative Solution

What are the user's activities and needs?

At a certain moment, either through personal or external motivation, the person must come to grips with the subset of the problem domain that will be of relevance for his or her task. The browser must become a problem solver, constructing his or her own view of the problem situation and solution. The thinker needs to identify the subset of resources most promising for his/her own context and problem; to be able to locate and obtain these resources and study them in more detail; to order or reorder them to see his/her own view of them and their relation to the problem; to follow up

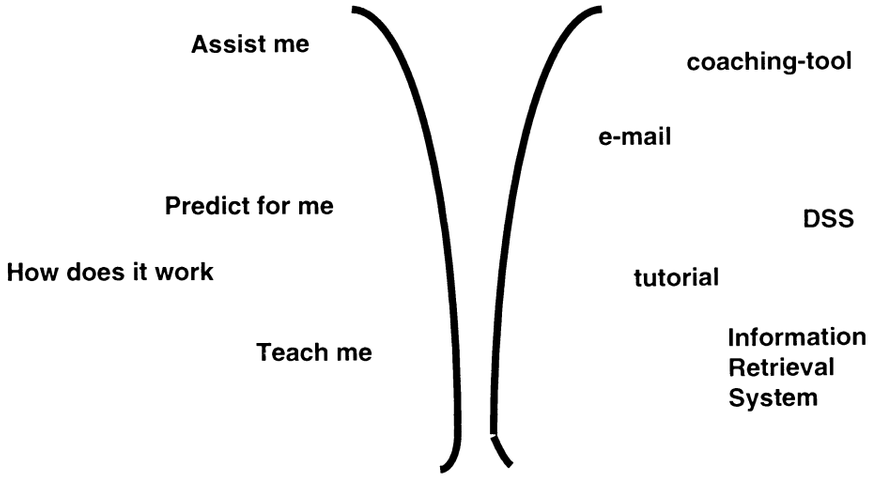

Figure 7. The Focusing Phase: The light at the end of the tunnel.

in more depth a few particular exemplars or persons for details and full(er) information. The goal is to construct a personal solution.

This may be done with a collaborator, but basically it is an intensely intellectual task, and to a large extent, one that goes on within the individual.

Using Gery's questions (1991, p. 33), the user might be asking:

–"How Do I Do It?"
–"How or Why Did This Happen?"
–"Show Me an Example..."
–"Teach Me..."
–"Assist Me..."
–"Let Me Try..."
–"How Does it Work?"
–"Why Does it Work Like That?"
–"Predict for Me..."

How does the Champagne-Glass Metaphor relate to this?

In the Champagne-Glass Metaphor, this phase is symbolized by the stem of the champagne glass—narrow, with a filter at the top and conveying the idea that the person will not emerge from the stem at its bottom until he or she brings a first iteration of a "solution," some idea or conception or decision that needs to be tested through the reaction of others. Figure 7 shows the focus during the second phase of the problem-solving process, relative to the champagne-glass metaphor.

How can electronic support help?

One way in which electronic support can be useful during this focusing phase is to offer some "guidance" or "intelligent" or "expert system" coaching, or to make available "tutorial" modules for better understanding of key concepts, if the thinker finds this pertinent.

Another way is to help the thinker in a quick, efficient, and targeted way to get access to certain key, core documents or even persons that are integral to his or her solution process.

Also, tools may be available to help the person make projections, test sample sets of data, or do other sorts of activities to help in some preliminary testing of a proposal solution.

Types of electronic support systems?

–Information Retrieval Systems (for specific documents).
–An on-line system offering e–mail interconnection to a particular person or persons for specialized information.
–Tools for downloading and marking and manipulating examples, documents, etc.
–(Some kinds of) IT Tools for Open Learning (Goodyear & Steeples, 1993).
–(Some kinds of) prompting, coaching, advising, on aspects of the key resources (Winkels, 1992).
–(Some kinds of) decision support or expert systems,

preferably integrated (El-Najdawi & Stylianou, 1993).
–(Some kinds of) toolkits if certain applications such as calculators or spreadsheets, or tutorial or simulation modules, etc., are helpful in better understanding of the key chosen resources.

Human aspects?

Personal intelligence is of high importance in this phase: in the selection of resources for in-depth study, in their analysis, in the selection of the best sources for extra information and help, and in the aspects of creativity that are involved in problem solving and higher-level thinking.

Balance between human and technological aspects?

The broader and freer the initial information and resource pool was, the less chance there will be at the focusing phase to offer "intelligent guidance" via an electronic support system, unless it is through connection to appropriate persons. And, of course, the capable learner/problem solver can handle this focusing phase without electronic support.

However, electronic support can (a) provide him or her with certain tools for projections, calculations, etc., that can help in getting a first reaction to a decision or plan; (b) connect him/her quickly and directly to key persons wherever they might be for personal communication, if this is helpful for some aspect of the thinking process; (c) supply him/her quickly and directly with full-form resources of items selected as pertinent (for example, the complete copy of a dissertation or report can be retrieved on-line in a very short turn-around time, allowing a quicker in-depth study than would be the chance if ordinary retrieval channels had to be utilized).

If the problem domain in which the person is working is well defined, certain sorts of tutorial modules or simulation modules can be available, to help learning of key concepts. However, the more complex the problem, the more this stem-phase of the Champagne-Glass Metaphor relates to an individual, intellectual activity where electronic support has at most a limited role.

Phase Three: Getting Feedback on the Tentative Solution and Its Revisions

What are the user's activities and needs?

In this phase, the person must now try to come to a decision as to the tentative plan of action that has been derived. The tentative solution must be tested through bringing it to the examination of others relevant to the person's context. Feedback from those relevant persons must be quickly obtained, and analyzed and sometimes clarified, and then the proposed solution must be modified accordingly. This is an iterative process, involving argument and defense of one's ideas as well as a good channel for getting feedback from others. Iterations of the plan of action may be tested in different ways through different forums for feedback.

From Gery's list, (1991, p. 33), various questions are pertinent here:
–"Why Do This?"
–"Advise Me..."
–"Watch Me..."
–"Evaluate Me..."
–"Understand Me..."

How does the Champagne-Glass Metaphor relate to this?

Here the problem-solver comes out of the stem of the glass into a wider bowl, but not as wide as was the case with the upper part of the glass in which the champagne was bubbling away. The base is tighter and stronger, as it is here that the person's ideas must come stand up in confrontation with feedback, with reaction, in the face of the evaluation of significant others. From what the problem-solver hears here, he or she hopefully can reshape his or her plan and ideas, and begin the dialogue-and-confrontation stage again, as many times as is necessary to win some acceptance. Figure 8 visualizes this last part of the metaphor.

How can electronic support help?

A major support function in this phase is to facilitate group discussion and exchange of ideas around a common document. Electronic communication support environments and group-oriented work and collaborative task environments are important here. There must be ample opportunity, in a well-chosen group, to present new versions of the plan or solution, and to respond and discuss and defend one's ideas. While this can of course happen with a good colleague down one's hall, EPSSs with distributed communication and collaboration support can lengthen and widen that "hallway" so that it is the length of the world, if this is where the best feedback can come to an idea or plan.

Types of electronic support systems?

–DSS aspects of EPSSs.
–GPSS and GDSS.
–EMSs, particularly functions such as issue analyzers, and tools for the discussion leader.
–"Collaborative Performance Support."
–Document sharing systems.
–CSCW environments.
–Conferencing environments.

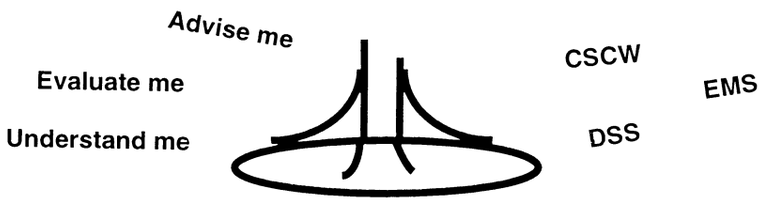

Figure 8. The Feedback and Revision Phase: Confronting the Critics.

Human aspects?

As always, human skills are paramount. Not only are communication skills important in this component, but also:

–Capacity to learn from feedback and interaction with others about one's plan.
–Skills for functioning well in a group.
–Flexibility and willingness to change and adapt.

Balance between technological and human aspects?

Being able to transcend time and space to get timely feedback from a special colleague or to engage in dialogue about one's ideas with a well-informed group are important contributions that a distributed EPSS can make to the Champagne-Glass metaphor for learning and working. However, the human aspects continue to be critical: if one cannot communicate effectively, or cannot steer the on-line discussion in the most profitable manner, or cannot make use of feedback constructively, then the electronic group-feedback oriented support will be of little value.

Looking for Coherence: Hybrid EPSSs

The above analysis suggests to us that the following specifications seem desirable for this new class of electronic resource environments:

- That the environment offer integrated tools to support the user at each of the three components of the "champagne-glass metaphor" but that these tools and their functions be clearly separated from each other, so that the user gets some epistemological help in visualizing his or her own learning and thinking process and in supporting it most effectively.

- That the environment offer easy passage from one phase (or part of the champagne glass) to another, when the user feels it appropriate. This involves being able to go back to the stem or the bowl of the champagne glass, but to return quickly to where one was, in case the time needed to rebrowse or refocus is quickly over.

- That integrated resources therefore seem a basic requirement; that support for both individual and group perspectives also is critical; as is access to not only information, but also to appropriate persons (different persons in Phase One than in Phase Three), and to appropriate tools.

Our Suggestion for a Class Name: Hybrid EPSSs

Given these global design requirements, and reexamining the many names being used for different variants of this class of electronic resources, we suggest the following class name:

"Hybrid EPSSs"

The "hybrid" relates to the three-phase model of problem solving expressed in our champagne-glass metaphor; the EPSS retains the powerful generic aspects of the term as it is now being popularly used and as were so well expressed by Gery in 1991. The term has associations with "Hybrid Knowledge-Based Systems" (Hedberg, 1993), systems that combine "the usual knowledge-based technologies (rules, frames, object-oriented programming, and GUIs) with case-based reasoning, corporate databases, and multimedia" (p. 108).

New Paradigm for Educational Software?

Are Hybrid EPSSs a new paradigm for educational software? Yes, in some ways; although in other ways they are "simply" an extension of long-available electronic resources. What is different is the scale, the integration, the range of resources and tools now capable of being accessed by the user through one front-end. New dimensions of design difficulty enter the

picture. We suggest some of these to conclude our discussion.

Hybrid EPSSs: Design Guidelines

- The designer must focus on integration and seamless interoperability, not only among technical components but among different user environments with their differing social and organizational cultures.

- The designer should focus not so much on the logic and sequence of learning material, but rather as a first priority on the working and thinking patterns of many different users, and focus on designing well organized services rather than on instructional routes and sequences.

- A high emphasis must be given to eventual usability; thus, principles and techniques of usability engineering will be critical in the design and development of Hybrid EPSSs (Nielsen, 1993).

- The designer of Hybrid EPSSs for educational settings cannot begin with a technical blank page; he or she must connect with "end-user computing" developments and workstations already available or coming to be available in the user's workplace (Bishop, 1990; McLean, Kappelman, & Thompson, 1993). Thus, Hybrid EPSSs must relate to and integrate with electronic tools and environments the end user already is using for his or her on-going tasks.

- In addition, we think AI-applications (as "built-in" intelligence) have not much applicability in Hybrid EPSSs, but instead emphasis should be given to helping the user connect to "external intelligence" (i.e., knowledge in the form of examples, references, human experts, colleagues, etc.) which can be accessed via various appropriate media and channels (such as, for example, audio conferencing, desktop video, computer conferencing, hypertext-linked resources, etc.).

- Finally, the browsing possibilities (Phase One of the metaphor) and the confrontation and feedback possibilities (Phase Three of the metaphor) should get more attention than the learning-support possibilities (Phase Two of the metaphor) as these are aspects where electronic system support can bring the most added value in comparison with "ordinary" practice.

Conclusion

At this moment we are busy with the design of a Hybrid EPSS as support for trainers in a large company specializing in different sorts of training delivery for different target audiences, including the Dutch military (Collis & Moonen, 1993). The focus of the support is on media combination and choice, given different strategies for training delivery. The Hybrid EPSS must be usable to the client trainers; thus, the usability analysis phases of our work are critical to the Hybrid EPSS's eventual value in practice. But we think that the Champagne-Glass Metaphor is proving helpful to us in sorting out what we are reading about and what we are trying to provide in our own system. □

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