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Supporting Learning as an Iterative Process in a Social Context

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Abstract: This paper deals with today's shortcomings of learning in the working environment, it discusses the state of the art in the literature, and introduces our ideas of supporting the learning on demand process in a social environment. The support provides opportunities for creating, editing and using memos or registered screen actions and exchanging them within a group of domain workers. We are currently developing a conceptual framework that will be implemented and evaluated in a realistic work setting.

Current learning challenges in co-operative task accomplishment employing information technology in the working environment is not sufficiently supported neither by system introduction procedures (training) nor by technical system features (help facilities). With the system LEAR (Learner's Living Repository), we propose a solution to support users in exploiting and exchanging learning and consultation episodes on group level: Users can describe problems they encountered or solutions they found when using the tool and accomplishing tasks by memos or by registered screen actions, comment on them, and store them in a personal 'demotheque'. Users can send memos and clips that describe questions, problems with the tool, or breakdowns when using the tool as a request for off-line help to a consultant. Memos and clips that describe representative solutions can be made available to a group of users in a 'purse for demos'.

The Problem and the Aim

Learning becomes an integrated part of life and an integrated part of work, too. Learning happens planned and unplanned, controlled and uncontrolled, consciously and unconsciously, single and collectively. Today's working life and its widespread use of technology require more than ever to acquire permanently new domain and tool knowledge. System design also requires the feedback from users and their task performance during the design phase (i.e., by user participation - see [Mambrey, Oppermann & Tepper, 1986]) and after the design phase (i.e., by usability evaluation - see [Reiterer & Oppermann, 1994]). The optimal approach contains an analysis-design-evaluation-redesign process (see [Oppermann, 1994]).

As the user's task competence can dynamically be increased by a flexible work organisation and task support, the user's tool competence should dynamically be increased by systems suitable for learning, exploration facilities tolerant for correction, and support environments reinforcing recapitulation and re-evaluation of problems and solutions. In this paper, we focus our view on the latter: to increase the tool competence of the user by strengthen the learning process and the reuse of already acquired knowledge in further working situations in a social context.

Four aspects of learning will form the main focus of our work:

- learning is ubiquitous, it has to be supported in every working situation, not only in particular learning phases or environments,
- learning is a combination of exploration and instruction: people learn by trying things out and by consulting technical or human help facilities,
- learning is an iterative phenomenon; it evolves step by step using early knowledge for later understanding
- learning is an individual and a social activity: people learn on their own but they also appreciate the support and knowledge exchange in social interactions.

Solutions and Deficiencies

Training and learning on the job. We assume the learning process as being integrated into the task accomplishment [Dutke & Schönpflug, 1987, pp. 295f.; Paul, 1995, p. 168]. A substantial part of learning does not happen during the training but during task performance. Users explore the system in use and try out functions to reach their goals.

"...people learn best when engrossed in the topic, motivated to seek out new knowledge and skills because they need them in order to solve the problem at hand" [Norman & Spohrer, 1996, 26]. "...information that is accessed but never put to use during the learning process may be difficult to retrieve and use when the need arises in the real world" [Schank & Kass, 1996, 28]. A 'guided exploration' facility was proposed to support this kind of learning [Carroll et al., 1987-1988; Carroll, 1990]. Guided exploration owes its origins in the concept of 'discovery learning' out of the late '60s and early '70s [Williams, 1992, p. 41].

Not any breakdown or new situation creates the need for acquiring new knowledge, i.e., to learn. Users in contrast do avoid learning. As Carroll and Rosson cite: "I want to do something, not learn to do everything" [Carroll et al., 1987-1988, p. 83]; they resume: "adults resist explicitly addressing themselves to new learning" [Carroll et al., 1987-1988, p. 101]; see also [Knowles, 1973; Kidd, 1977]. In particular, if the critical situation is supposed to occur only once the user is not motivated to *learn* a solution. It is sufficient if he or she is enabled to create the solution, for instance by the help of step by step instructions not meant to induce a knowledge acquisition with the user. Williams and Farkas give an example where a user who has exceptionally to produce a footnote instead of known endnotes for a particular journal will not accept the "compel (...) to 'learn' or 'remember' the procedures that he or she explicitly needs now in order to create the footnotes" [Williams, 1992, p. 44]. Only for recurrent problems and tasks new knowledge will be acquired.

Support from on-line help. When problems arise, breakdowns occur or solutions are unknown, addressing the on-line-help is often insufficient for the user. The support users get from on-line help systems is restricted to the information that experts have brought into the system. Help from the system is restricted to information about system functionality and to well-known notorious problem situations [Fox, Grunst & Quast, 1994, pp. 186f.]. We only know one example that provides growing support based on questions of users and answers of consultants: 'Answer Garden', see [Ackerman & Malone, 1990][1].

On-line help support should be extendible to the user's individual results of exploration based learning and to co-operative learning with consultants so as to integrate the learning results into technical support facilities (individualised help system). This individual help environment can be perceived as a user own created guiding solution in contrast to the 'guided exploration' manuals proposed by [Carroll, 1990] that was critiqued by [Williams, 1992, p. 49] for its inefficiency and ineffectiveness and its authoritarian nature.

Consulting local or central experts. The learning process may occur individually where the user helps him- or herself by exploration (trying things out) but often the user asks for help by consulting a competent colleague ('power-user') in face-to-face interaction or by consulting an expert by telephone or remote diagnose.

Learning supported by computer help and documentation without social support is not appreciated by many users. Users tend to prefer to "consult the 'local expert' or other users ... to translate their intentions into specific questions" [O'Malley, 1986, pp. 378f.; see also Brockmann, 1990 and Horton, 1990]. This consultation includes a constructive and co-operative communication between humans with complementary types of knowledge and expertise but being familiar with the same tasks and the same working environment, speaking the same jargon. Users are sometimes specialists themselves "assigned topics to master, and other users are made aware of when and whom to consult" [Carroll et al., 1987-1988, p. 85]. It is an illusion that users work alone with a system. "End users make good use of other people in their social environments to help them solve their computing problems and to compensate for gaps in their own knowledge of computers" [Nardi, 1993, pp. 104, 186]. Local experts can be enlarged by professionals with technical knowledge about the system in use but with less connection to the user community and the task at hand. The latter are less accessible for and less accepted by the users [Bannon, 1986, p. 406].

Computer experts or skilled domain workers cannot be strictly differentiated. Computer experts dispose of profound knowledge about information technology but only a thin spread of application or domain knowledge. Skilled domain workers dispose of profound knowledge about their technical domain but only of limited knowledge of information technology. Computer experts and domain experts ('users') are no homogeneous entities. Users are widely differentiated by novice and expert users. This distinction is insufficient in supposing a sudden leap from a novice to an expert. Most users will be positions in between as they have knowledge and experience in a limited area of an application and no or only little knowledge in the others. There will be a process of learning different areas of the application's functionality, in particular with occasional or 'discretionary users' [Santhanam, 1993]. Communities of system users will emerge, in which individuals have different backgrounds of knowledge: substantial computer and substantial domain expertise distributed among different members of the community. The competence of the user groups together with the competence of professional system experts is the basis for their constructive interaction in problem solving.

User support by personal interaction is limited by the capacity and availability of human experts. In particular in repeated situations of the same or a similar problem the consultation of a human expert confronts with restrictions: the user is ashamed to ask for the same help again and again and the expert pulls a long face over the same support demand. Personal interaction is also limited by the access of the consultant to the critical action episode of the user (the

[1] 'TeamInfo' was developed as a shared repository for informal group-relevant information by [Berlin et al. 1993]. For producers of software, a 'Living design Memory' was proposed by [Terveen, Selfridge & Long 1993].

problem or error situation). The error occurred *before* the consultant appears. The error or the problem cannot adequately be reconstructed by the user for the local expert and additionally not adequately be described for remote diagnoses. Exploratively acquired knowledge and solutions developed in consulting local experts or professionals are not reusable for the learner to exploit the substance when needed to solve a similar problem. In particular the way and the pitfalls of a solution are not available.

Empirical studies show that users have problems with consultants and consultants have problems with their clients [Brezizinski, 1987; Liechti, 1988; Moning, 1993]. Consultants are overloaded; their increasing number is overcompensated by a yet increasing number of clients; members of the user service units show limited availability; they are often not interested in the needs of users; they 'forget' promises of problem solving that can't be executed immediately. Consultants have to solve (in their eyes) trivial problems and are therefore not motivated. User support is often organised on several levels [Brancheau, Vogel & Wetherbee, 1985] where the communication requires an exchange of problem and solution representations where verbal or written descriptions are expensive and misunderstandable.

Our Approach: Learning as an Iterative Process Requires Support for the Re-Use of Competence

Iterative Learning: The learning process is iterative, i.e., the learner proceeds in his or her competence by several trials of acquisition and application of qualifications. The first trial to acquire knowledge may be (a) exploratory, (b) supported by technical or human consultants, (c) error prone, (d) with indirect solutions, and (e) with dead ends. The first step of learning provides the user with rudimentary knowledge about errors, risks, and solutions. Making only one experience is not sufficient for full an understanding and it is not robust to forgetting. It has to be reinforced and extended by re-use in later similar situations. The following figure shows the idea of the approach.

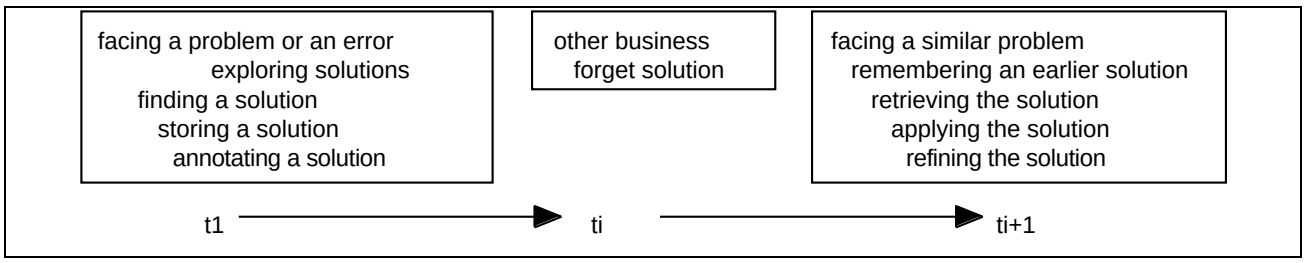

Figure 1: Learning process from finding a solution to applying the solution later

Learning is knowledge-dependent. Skills learning can be described as "consisting of three stages: often called the cognitive, associative and autonomous stages. In the cognitive stage the individual learns the basics of the skill through instruction or observation. In the associative stage the individual practises the skill until it becomes smooth and accurate. In the autonomous stage the individual is able to perform the skill essentially without attention" [Santhanam, 1993, p. 223]. Simon reports evidence from learning experiments conducted by [Waugh & Norman, 1965] showing only limited retained items in a first learning step, but with some residual retention of the remaining items in later [Simon, 1992, p. 82].

Multimedia Demonstrations with Annotation Facilities: There are situations the user learns a particular feature of an application that only implies 'declarative knowledge' [see Anderson, 1976]. A simple description of handling details, parameter settings or other *static* features is helpful if this description is at hand on demand. For this purpose we propose an individual explanation facility that we call an 'individual memo' where the user enters his or her comments–either text or voice–, sticks it to the relevant interface element, and activates it on demand. Scenic films can support the (re-)understanding of 'procedural knowledge'. To exploit *dynamic* features of tasks or system interaction, we propose a recording facility to produce a film of the interaction sequence. Such a 'living' clip is easier to grasp than a formal description. The demonstration supports the user's understanding because it shows the process of actions and the effects of actions. The film can be annotated to comment the rationale, the reasons for a solution, warnings to misleading assumptions, or hints to unexpected side effects to support the transfer of the former solution to the current problem.

Annotation facilities may give support to the user with respect to his or her goals. Verbal comments can denominate the general concept of a solution and can support its transfer to similar tasks [Alpert, 1995, p. 72]. While the file of the action sequence supports what is called the 'procedural knowledge' the annotation is to support the 'declarative knowledge' [Anderson, 1976]. A film can support the procedural knowledge type usually possessed by casual or discretionary users [Santhanam, 1993, p. 227]. Procedural knowledge can hardly or not at all be learned by description but

best be acquired be observation or even best by practice, see [Brockman, 1990] cited in [Rettig, 1991, p. 22]. A film cannot replace experience but it can exploit the user's own former practice to support his or her recapitulation of solutions in later situations. [Palmiter & Elkerton, 1991] and [Palmiter, Elkerton & Bagget, 1991] showed that a film with animated demonstrations are superior for learning both in speed and accuracy during training sessions of highly graphical systems. Written instructions supported the deduction of necessary procedures much better. The transfer of knowledge in subsequent sessions was better in the written instruction group. [Payne, 1992] showed positive effects of uncommented, silent video recordings as instructions for a graphics editor. The results can be interpreted as a demand for harmonising of methods and tools to present processes, concepts and effects to the user in different application domains. What is good for direct copying of procedures in a graphics system is not good for the in-depth understanding of concepts in a data-base. Combinations of methods are requested that take into account the particular application domain, the interaction style and the concepts to be conveyed.

Social learning: Learning in the working environment takes place in a social context. People have similar tasks using similar applications. They consult and support each other and exchange experiences and solutions. Technical support should enable the users to send and receive typical solutions (demo film) found by an individual provided to the group.

Support facilities can be provided for different interaction types between a user and a consultant. The user can (a) explore problems and solutions on his or her own (no social interaction at all), the user can (b) consult somebody face-to-face (typically a power-user or a member of the decentralised local support unit) or the user can (c) consult somebody remote (typically a specialist of the central user support unit). The consultation can happen synchronous and asynchronous. The following figure shows the different (inter-)action types with the supporting illustration facilities for an error, problem access from the user for a consultant and a solution from a consultant for the user.

Table 1: Kinds of (inter)actions for different time and site conditions

User-consultant interaction **Time** **of interaction**	**user alone**	**face-to-face**	**remote**
synchronous	(explorative) learning with a film or memo about the past (errors or problems) and for the future (solutions)	consultation with one screen about the presence and films or memos about the past (errors or problems) and for the future (solutions)	consultation with shared screen about the presence and films or memos about the past (errors or problems) and for the future (solutions)
asynchronous	—	—	consultation with the user's films or memos about the past and presence (errors or problems) and the consultant's film or memos for the future (solutions)

Elements of the Proposal:

With LEAR (Learner's Living Repository), we introduce a conceptual framework that places special emphasis on integrating working and learning and on supporting self-directed and group learning. Prototypes of a support environment for learning and consultation in and after face-to-face or remote interactions will be developed and evaluated in a realistic work setting.

With LEAR users can identify portions of an animated interaction sequence describing problems they encountered or solutions they found when using the tool, comment on them, and store them as episodes in a database called 'demotheque'. Users can send episodes that describe questions, problems with the tool, or breakdowns when using the tool as a request for off-line help to a consultant. Episodes that describe learned tool knowledge can be stored in the 'demotheque' for later use. Episodes that describe users' personal experiences of solutions can be made available to a group of users in a 'purse for demos'.

- **Individual memos:**
  The user can stick an electronic description to system elements to explain system features used for individual needs.

- **Recording interactions**:
  The user can replay and explore his or her own interaction history (e.g., an error situation).

- **Defining relevant demos**:
  The user can select a relevant episode and keep it for similar future situations in a personal 'demotheque'.

- **Annotating demos:**
  The user can add comments and warnings referring to what he or she has done. Different modes of annotations should help to avoid information overload of a single sense organ.

- **Retrieving demos:**
  The user can select different access methods to retrieve the relevant episode from the demotheque.

- **Selecting Views:**
  The user can select different kinds of views to exploit a relevant episode from the 'demotheque' for supporting the re-learning of a solution and for supporting the transfer of the solution to the current task.

- **Exchanging questions and answers:**
  A remote consultation can be supported to enable the user and the consultant to exchange questions and answers independent of their time and space constraints.

- **Exchanging solutions:**
  The users of a co-operative work environment can exchange task and tool competence by providing and requesting solutions typical of the workspace.

Conclusion

The problem of exploiting own and peer experience is of great practical relevance. People learn continously but they have difficulties in finding and using prior established competence. Lear is a self - learning support system to bring the user in touch with his or her learning history and to open the access to the competence of peers. The learners might exchange their problems and solutions by this mean. The learners can exchange their problems and solutions through a network so that cooperative work is supported more effectively than by a mail system. The idea of Lear is designed for the working environment but it might also stimulate in distant learning.

Lear is limited in the form of the acquired knowledge: using memos or registered screen actions and exchanging them within a group of domain workers for the moment. No AI techniques—knowledge acquisition techniques and tools—are used in the paradigm. The knowledge remaines fully in the head/hand of the user. Multi media techniques are used scarcely not to distract the user from his or her main task.

First results of the implementation of the proposed facilities will be prepared for the conference. Evaluations have to show if and to which extent the proposed functionality of Lear will be accepted and used in a real working environment. Variables like time pressure, frequency of similar tasks, but also personality traits may influence the resonance of the facilities.

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