Computers & Education xxx (2009) xxx–xxx

Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

Seeking and providing assistance while learning to use information systems

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ARTICLE INFO

Article history:
Received 2 June 2008
Received in revised form 14 January 2009
Accepted 17 January 2009
Available online xxxx

Keywords:
Help seeking
Interactive learning environments
Human computer interface
Pedagogical issues

ABSTRACT

Throughout their lives, people are faced with various learning situations, for example when they learn how to use new software, services or information systems. However, research in the field of Interactive Learning Environments shows that learners needing assistance do not systematically seek or use help, even when it is available. The aim of the present study is to explore the role of some factors from research in Interactive Learning Environments in another situation: using a new technology not as a means of acquiring knowledge but to realize a specific task. Firstly, we present the three factors included in this study (1) the role of the content of assistance, namely operative vs. function-oriented help; (2) the role of the user's prior knowledge; (3) the role of the trigger of assistance, i.e. help provided after the user's request vs. help provided by the system. In this latter case, it is necessary to detect the user's difficulties. On the basis of research on problem-solving, we list behavioral criteria expressing the user's difficulties. Then, we present two experiments that use "real" technologies developed by a large company and tested by "real" users. The results showed that (1) even when participants had reached an impasse, most of them never sought assistance, (2) operative assistance that was automatically provided by the system was effective for novice users, and (3) function-oriented help that was automatically provided by the system was effective for expert users. Assistance can support deadlock awareness and can also focus on deadlock solving by guiding task. Assistance must be adapted to prior knowledge, progress and goals of learners to improve learning.

1. Introduction

Throughout their lives, people are faced with various learning situations, for example when they use new devices. In the information technology domain, they need to learn how to use new software, services or information systems. Most of the time, learning is carried out through action, during the exploration of the new system, not by reading instructions (Mallen, 1996). During this learning-by-doing process, the user encounters difficulties or makes mistakes, and tries to solve them when he or she is aware of them. This situation may be viewed as a problem-solving situation in which the user has to discover what actions are licit or illicit, leading him or her to build a representation of the system and its functionalities. During this step, some mistakes lead users to deadlocks, and users need assistance to cope with them. The topic of human technological assistance concerns both the field of Interactive Learning Environments (ILEs) – in which a learner aims to acquire new knowledge by interacting with instructional systems – and the field of Human Computer Interaction (HCI) – in which a user aims to perform a task by interacting with a new device. In both fields, assistance systems are designed in order to guide a user or a learner in a complex situation. Research conducted on the assistance evaluation in ILEs showed that the effectiveness of assistance depends both on system-related factors and user-related factors that interact (for a review, see Aleven, Stahl, Schworm, Fischer, & Wallace, 2003). The aim of the present study is to explore the role of some of these factors in HCI. Firstly, we present the three factors included in this study (1) the role of the content of assistance, namely operative vs. function-oriented help; (2) the role of the user's prior knowledge; (3) the role of the trigger of assistance, i.e. help provided after the user's request vs. help provided by the system. In this latter case, it is necessary that the system provide help at the right time and then it is also necessary to detect the user's difficulties. On the basis of research on problem-solving, we list behavioral criteria expressing the user's difficulties coping with deadlocks and solving them. Then, we present two experiments that use "real" technologies developed by a large company and tested by "real" users. The goal of these two experiments was to explore the effects of the three factors mentioned above on assistance efficacy with users that discover authentic materials.

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doi:10.1016/j.compedu.2009.01.015

1.1. Content of the assistance message

In the ILEs domain, relevant assistance helps learners to detect and correct errors during the learning phase. In empirical studies, three main characteristics of the content of help messages was assessed (see Aleven et al., 2003 for a more detailed review).

The first interesting option is to provide various levels of help messages or hints, from a simple error feedback message to a detailed solution. On one hand, the efficiency of the content of help messages would depend on offering guidance which goes beyond mere confirmation or negation, i.e. advice, explanation, example, etc. (e.g. Anderson, Corbett, Koedinger, & Pelletier, 1995). On the other hand, the interactivity and encouragement to be active and constructive would improve learning. Moreno, Mayer, Spires, and Lester (2001) recommended soliciting the learner, rather than just providing direct explanations, in order to make him or her participate since this improves retention as well as transfer.

Secondly, the content of help messages may be context-dependant – such as information or hints about the problem situation or the solution path-, or context-free – such as general definitions or a domain glossary. Aleven and Koedinger (2000), in the field of geometry, and Bartholomé, Stahl, Pieschl, and Bromme (2006), in the field of botany, obtained a similar result: learners used the specific assistance and ignored the general advice. Moreover, in the study of Bartholomé et al., only the use of context-sensitive assistance was effective in improving learning performance.

Thirdly, the distinction between solution-based vs. principles-based messages is relevant. This distinction overlaps the one between procedural and declarative knowledge. The second type of assistance permits the learner to acquire not only procedural knowledge, but also the conceptual knowledge necessary for transfer to a new situation (De Crook & Van Merrienboer, 2007). Empirical results have confirmed the importance of the degree of abstraction of help messages in learning to use new software: the performance in transfer tasks was better with model-oriented (vs. task-oriented) help (Ben-Ari & Yeshno, 2006) and with function-oriented (vs. operative) help (Dutke & Reimer, 2000). A similar positive effect of principle-based assistance on transfer performance was obtained by Renkl (2002). These results are consistent with the well-known relationship between expertise and principle-based problem representation (e.g. Chi, Feltovich, & Glaser, 1981).

In the HCI domain, relevant assistance helps users to interact efficiently with a new technology, that is to perform the current task (Mallen, 1996) and only that task (Brusilovsky, 2001) by providing the information needed and only the information needed (Fischer, 2001; Jameson, 2006). In this case, the aim of guidelines for assistance system design is to avoid erratic behavior and abandoning of the task, and to improve the perceived usefulness of the technology.

Users, especially novices, should be centered on the realization of the task rather than the mastery of the use of the system (Carroll & Rosson, 1987). They would be reluctant to explore new software by trial and error in order to learn how it functions effectively. This preference was confirmed by the analysis of the types of aid provided by human experts to help novices (Capobianco & Carbonell, 2003). Nevertheless, such a procedural orientation of assistance may result in a too restricted mental model of technology functioning impeding the mastery of the use of the system and the transfer of previous knowledge or skills. That is why some researchers advocated distinguishing between problem assistance and explanatory assistance in HCI (Virvou, 1999) or associating procedural and non procedural instructions to improve the mastery of a new device (Kieras & Bovair, 1984).

In sum, as much in the ILEs as in the HCI areas, some relevant features of the content of help messages can be identified. Elaborated help messages are more effective than simple confirmations or negative feedback. Specific task-oriented help is more effective and more appreciated than general help. Finally, help messages focusing on the solution (rather than on principles) are preferred, possibly by novices only, and are effective for completing the current task, but not for transfer.

1.2. Prior knowledge and help seeking

In cognitive psychology, it is well documented that prior knowledge in the domain of interest has a positive effect on comprehension and learning performance, and research on expertise has provided strong evidence about cognitive differences between novices and experts that may impact on help seeking. It can be noted that experts in a domain (or in a near domain) do not need assistance or very little (for example, the "successful rare-users" in Renkl's study, 2002). Conversely, it may be expected that learners with low prior knowledge seek more assistance than learners with high prior knowledge, but the lack of domain knowledge may impede relevant help seeking. First, it is generally argued that knowledge allows the learner to better assess what he does not know: in a word processing learning task, learners with less prior knowledge were less able to ask relevant questions because they had to know what was missing and what it was necessary to know (Miyake & Norman, 1979). Second, metacognitive skills that are required to detect accurately the need for help (Nelson-LeGall, 1987; Newman, 1998), increased with expertise (Glaser & Chi, 1988). Research on learning and on expertise showed that many learners, especially novices or low prior knowledge learners, failed to self-regulate their activity, both in self-monitoring and self-control components in various learning situations, such as self-paced learning task (e.g. Huet, Mariné, & Mariné, in press) or learning from worked-out examples (e.g. Chi, Bassok, Lewis, Reimann, & Glaser, 1989). Similarly, in the ILEs domain, Wood and Wood (1999) found that learners with high prior knowledge seek more relevant assistance and control their help seeking behavior better. The relationship between prior knowledge and metacognition may however be moderated. Sometimes, failures in self-monitoring were observed with experts or high prior knowledge learners who overestimated their knowledge (e.g. Aleven, McLaren, Roll, & Koedinger, 2004; Chi, 1978). Besides, several researchers stressed that self-regulation is cognitive resource-demanding (e.g. Guttentag, 1995; Kanfer & Ackerman, 1989). Thus, when the learning task is difficult or when the learner has little knowledge to cope with the task, he or she cannot engage in self-regulation activities because of a lack of remaining resources. This assumption was confirmed in help seeking by the difference of results obtained in the studies of Wood and Wood (1999) and Wood (2001).

In sum, seeking assistance and taking advantage of help provided by a system depends on knowledge of the domain, difficulty of the learning task and difficulty in understanding the content of the proposed assistance. Assistance should be adaptive, because the knowledge of the domain progresses during learning.

1.3. Assistance trigger and awareness of assistance need

Another important question in assistance design is to decide when the help message should be provided. In tutoring situations, human tutors use different criteria to determine when they must provide help to the learner, such as the learner's requests (Wood, Wood, Ainsworth, & O'Malley, 2002), pauses (Shah, Evens, Michael, & Rovick, 2002), errors (Anderson, 1989). In computer-based tutoring design, these criteria lead to two main options: either the assistance trigger is under the learner's control (that is, an aid message follows a learner's request) or it is managed by the system (that is, an aid message follows a learner's difficulty detected by the system). Globally, the first solution is supported by researchers (Aleven et al., 2003; Renkl, 2002). (1) The help message initiated by the learner increases the chances that the help is provided at the right time (Wood, 2001) and in relation with the user's current activity (Renkl, 2002). Conversely, the help initiated by the system may be inappropriate and intrusive. (2) The first solution allows the learner to be active and to solve some difficulties by himself without calling for help (Puustinen, 1998), whereas the second solution may prompt the learner to be passive by providing assistance too early or unnecessarily (Anderson et al., 1995). To be efficient, however, the trigger of help messages based on learner demand requires that some cognitive and metacognitive processes involved in help seeking run correctly. In the ILEs domain, results from help seeking have shown that learners do not always possess the metacognitive skills permitting them to judge the need for help (Aleven & Koedinger, 2000). In a tutoring learning situation, a study showed that 72% of learner actions regarding help seeking were unproductive (Aleven et al., 2004). On the one hand, they misuse help in order to find the right answer directly instead of understanding. On the other hand, they sometimes do not ask for help when it would be beneficial. In Aleven and Koedinger's (2000) research, learners waited too long before asking for help, not taking into account multiple errors at a given step which had indicated that they should ask for help. The results also showed a lack of help message comprehension leading to a failure of use. Given the limitations of the efficiency of the user's help request, it seems essential to use further criteria to determine when the user needs help. As a consequence, learner actions have to be understood and interpreted in order to trace the cause of problems and to remedy them.

1.4. Deadlock detection and assistance design

Errors, difficulties and deadlocks play an important role in learning. They often determine tutoring decisions in the problem-solving field (Anderson, 1989; Merrill, Reiser, Merrill, & Landes, 1995; Shah et al., 2002). According to Anderson, errors are the best indicator of help need. Feedback tutoring after errors improves learning in terms of success and time (Anderson et al., 1995), at least in a procedural domain such as problem-solving.

An error is an occasion during which a sequence of actions fails to reach the expected result, and the failure cannot be attributed to an external cause (Reason, 1990). In new complex situations, it is sometimes impossible to perform the task in an optimal way from the beginning. An exploration by trial-error is necessary to reach the goal. Errors are then inevitable, even necessary. As a consequence, an error is not considered as a difficulty or deadlock if it improves learning and if it is well understood (Van der Linden, Sonnentag, Frese, & Van Dyck, 2001). However, if the learner performs an action which moves away from the goal and he does not become aware of this or he does not know how to overcome the difficulty, then the situation is problematic. In other words, a difficulty is not an error but a negative consequence of an error. Based upon this definition, deadlock detection implies studying action sequences.

Different error types were distinguished in problem-solving and the taxonomy can be generalized to HCI. In a situation of computer programming tutoring, Merrill et al. (1995) studied two error types: low level errors are detected and corrected by the learners themselves; high-level errors are often detected by the tutor. In computerized tutoring, systematic errors (i.e. errors that are not slips due to a lack of attention) are closely linked to analogy processing (Anderson, 1989). These errors indicate help need and play an important role in the guidance of tutorial dialogues because they express the selection of inappropriate points of view or inadequate use of well-known procedures activated to reach a new goal (Richard, 1994).

Richard (Richard, 1994; Richard, Poitrenaud, & Tijus, 1993) elaborated a classification of errors in the case of the Tower of Hanoi problem. He distinguished: (1) misinterpretation of instructions; (2) stereotyped or cyclic action sequences (i.e. moves sequence, then back to initial state, other sequence, then back to initial state, etc.); (3) broken heuristic rules (two moves of the same disk or back to initial state). Unproductive actions were also identified in HCI. Indeed, Van der Linden et al. (2001) studied non-optimal behavior that interferes with learning in using Excel. They listed: (1) trial-error (namely solving without planning or control) due to a lack of knowledge or a loss of control hindering planning; (2) encapsulation in information seeking due to excessive information seeking and leading to a lack of progress; (3) repetition of the same action sequences due to disruption in metacognitive processing.

In the present study, the Tower of Hanoi problem was used to constitute the deadlock analysis framework and to test this deadlock classification in the design of assistance.

This allowed us to qualify:

- The action sequences related to deadlocks: repeat the same sequence, back to the initial state, break instructions, etc.
- The nature of help messages: function-oriented (general rule not directly related to a goal) or operative (relation between actions and their consequences to reach the goal),
- The help trigger (after an explicit request or after a deadlock detection from the system).

Then, this framework was used to generalize the taxonomy of action sequences described above to situations in which the goal and optimal procedure are unknown and to design assistance messages for using information services: an online photo sorting service, and a browsing assistant in an information system. Two empirical studies assessed the effectiveness of the assistance and analyzed its interaction with users' expertise.

1.5. Research objectives

The approach was to trace user activity and to intervene at the opportune moment by providing help. The objective was to detect help need and to provide adequate help that did not interfere with current activity. The hypotheses were as follows:

Adaptive help given after deadlock detection should give better learning outcomes than help provided after learner request. Adaptable help (i.e. given after request) leaves control with the learner. But it requires some effort and capabilities, such as becoming aware of help need (hindsight, observation of own activity, result evaluation). These activities are difficult to perform, in particular for novice learners. Should the system guide the learner as early as possible to avoid negative perception and interference or should it leave him free to explore the application in order to learn the functionalities and avoid intrusion? An adaptive assistance, which is more precise, but also more intrusive, should be more effective than an adaptable assistance, such as help request.

Automatic assistance must support mastery of application use without interfering with task-oriented current activity. The goal is to provide relevant information for the current task according to the learner's prior knowledge. There are two alternatives: providing either operative information to help the learner perform the task or general information to help the learner acquire conceptual transferable knowledge. Operative assistance relating goals and functionalities of the device should be more effective than function-oriented assistance offering general explanations about the system. The effectiveness of assistance will be influenced by expertise in that the benefit of operative assistance should be higher for novices than experts. According to previous results it was however expected that function-oriented assistance has a positive effect on transfer.

2. Experiment 1

An empirical study was carried out on a complex and authentic situation of interaction with an existing information system, in which the problem space was open. This work required on the one hand listing the types of deadlock experienced and their criteria and on the other hand determining help messages provided during interaction with a prototype of photo sorting service developed in France Telecom R&D. It was a general public service used to organize and share photos.

2.1. Method

2.1.1. Participants

Fifty-five participants (twenty six women and twenty nine men, recruited outside the company) took part in the experiment. The mean age was 35 (SD = 12.31). Participants had never used the service before. They were given a profile questionnaire to determine their familiarity with computers and with photo services. Twenty-nine participants had already used a photo retouching service while 26 had never done so.

2.1.2. Materials

The service had the following menus: "my photos", "received photos", "exhibition". The menu "my photos" allowed users to create albums and send them to other users. It also allowed users to display, browse or delete photos. In the "received photos" menu, users could integrate and delete albums received from other users. This menu also allowed users to display and browse received photos. The third menu "exhibition" contained public photos displayed by users. The experiment focused on the two main activities of the service: creation and modification of albums and photos; sending and receipt of photos.

2.1.3. Tasks

In order to place participants in a test situation, they were given fifteen tasks of photo sorting and sharing in the form of scenarios, on the basis of the functionalities available in the service (e.g. "you want to create an album"). More precisely, three series of tasks were designed: the first contained eight tasks, the second five tasks similar to the first series (only superficial differences) and the third contained two tasks including a new one. The goal of these three series was to distinguish three steps in system use learning: (1) exploration with assistance messages, (2) practice without help, (3) transfer to new tasks. These tasks were designed so that help messages concerned only steps 1 and 2, and did not interfere with step 3 (transfer to new tasks). Time was not limited. But when participants thought they had completed the task, they received a message, informing them of whether the task was done or not.

2.1.4. Prior knowledge evaluation device

A profile questionnaire was used (age, gender, occupation). The questionnaire was also used to determine the familiarity of the participants with computers. It consisted of three items on the frequency of Internet, e-mail and office software use with 5-point scales (from very frequent to almost never). An extra item was proposed concerning the use of photo retouching.

2.1.5. Help need detection and help messages

Help need was detected with criteria that were defined by applying the principle used in Tower of Hanoi problem, that are presented previously in this article.

When one of these criteria occurred, it was considered as a deadlock, and a vocal help message was immediately provided.

Two lists of help messages were constructed: operative and function-oriented. Operative messages were production rules that related actions and their consequences to goals. Function-oriented messages provided the general principle necessary to complete the task. In order to warrant equivalence between operative and function-oriented messages, the same information was given in a operative and in a function-oriented message. Function-oriented messages gave general rules to complete tasks and did not focus on relations between actions and their consequences on the one hand and goals on the other. The length of operative and function-oriented messages was identical. For example, for the subtask "album creation", the operative help message was "in order to create an album, click on my photos page". The corresponding function-oriented help message was "my photos page permits the creation of albums and the browsing of photos". Messages were designed so that they would provide an easy step to perform, containing only one action, thus avoiding the risk of high cost of memorizing.

2.1.6. Procedure and experimental design

Participants were greeted in a quiet test room then answered the profile questionnaire. General instructions were presented on a sheet then explained orally by the experimenter. The sorting service was presented. In particular, participants were asked to use its functionalities. Then a sheet was provided with a series of tasks. Instructions also specified that if participants experienced deadlocks and felt blocked during service use, they could receive help messages by simply asking for help aloud. Before the beginning of the tasks, participants had a

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familiarization phase of five minutes consisting of browsing in menus and albums and a presentation of key-words (color codes). At the end of each sub task, a confirmation was sent, notifying them that the task was done and that they could do the following task. Then, they realized a test session in which they performed five tasks similar to the previous ones (with superficial names changes). Moreover, this second series was done without assistance. Finally, a last series of two tasks, different from the previous ones, was proposed. The entire experiment did not exceed fifty minutes. The Wizard of Oz technique was used: a human simulated a help system, the user ignoring this deception. During the test, the experimenter was in a control room and the participant was in a test room. To send assistance messages, the experimenter had:

– A computer to send vocal files in a synthetic voice corresponding to assistance messages.
– A monitor displaying data gathered by the cameras and the microphone of the test room to observe and listen to the user.
– A duplicated user screen.

In the test room, the user had:

– A computer to perform the task by means of the screen and the mouse.
– A microphone to make the requests.
– A loudspeaker to listen to help messages sent by the experimenter.

A video recorder recorded observed data thanks to the monitor (in particular, moment of requests and help messages provided during the problem-solving). Screen recorder software recorded the actions (click and typing during the interaction with the system).

The manipulated factors were the trigger, the content of the assistance and user prior knowledge on a between-subjects basis. Two groups were constructed. Twenty-seven participants received help only after request (Request Condition). Twenty-eight received help both after request and after deadlock detection (Assistance Condition). In addition, 26 received operative help while 29 received function-oriented help. Finally, answers gathered at the item "use of photo service" of the questionnaire showed that 29 participants had already used a photo retouching service while 26 had never done so. In consideration of influence of prior knowledge on interaction with a system, this use of a photo service has been introduced as a between-subjects factor. In fact, participants having already used photo services were likely to have acquired knowledge (declarative or procedural) reusable with a new photo service. In order to facilitate reading, this factor was called "expertise" even if, obviously, expertise is not limited to the fact of having already used a photo service.

2.1.7. Measures

The solution time and the rate of failure in the tasks were measured for each of the three series of tasks. Concerning help messages given during the first series, the number of help requests and the number of help messages provided after deadlocks were also gathered.

2.2. Results

A General Linear Model (GLM) procedure was employed for the data analysis. The factors "help trigger" (after request vs. after detected deadlock), help content (operative vs. function-oriented) and expertise (experts vs. novices) were processed on a between-subjects basis. The interactions were studied using planned comparisons. Given the size of the sample, only principal effects and simple interactions were studied, not double interaction.

2.2.1. Help messages

Firstly, the effects of the three factors on the received help messages were analyzed. The mean scores are presented in Table 1. The first column presents the mean number of asked help messages in the Request Condition, that is the total number of received help messages. The following three message columns present the mean number of help messages. Given that participants could ask for help or receive help after a deadlock detection in this condition, these columns distinguish the number of asked help messages, the number of given help messages after a deadlock and the total of received messages.

The main effect of help content on the number of received help messages was marginally significant ($F(1,47) = 3.63$, $p = .06$). Participants received more operative help ($M = 3.73$, SD = 3.34) than function-oriented help ($M = 2.34$, SD = 2.19). The effects of trigger and expertise were not significant (respectively $F(1,47) = 0.69$, $p > .1$ and $F(1,47) = 2.78$, $p = .1$). But the analysis revealed an interaction effect of the trigger of help and expertise on the number of received help messages ($F(1,47) = 4.15$, $p < .05$). Planned comparisons showed an effect of the trigger with experts ($F(1,47) = 4.29$, $p < .05$) and an effect of expertise inside the Request Condition. In other words, experts asked for help less often ($M = 1.35$, SD = 1.69) than novices ($M = 4.15$, SD = 4.37) in the Request Condition. Experts received less help messages in the Request Condition ($M = 1.35$, SD = 1.69) than in Assistance Condition ($M = 3.40$, SD = 1.80) with the simulated help system. They may not become aware of their deadlocks or they may become aware of them but they want to correct them without assistance. Concerning the effects of factors on the number of requests, a non-parametric analysis (U Mann–Whitney) was conducted, because of the problems of variance

Table 1
Means (and standard-deviations) of asked, not asked and received help messages in the Request and Assistance Conditions.

		Request Condition	Assistance Condition		
		Asked messages	Asked messages	Not asked messages	Total of received messages
Experts	Function-oriented	1.25 (1.67)	0.89 (0.93)	2.56 (1.67)	3.44 (1.42)
	Operative	1.50 (1.87)	0.67 (1.03)	2.67 (1.86)	3.33 (2.42)
Novices	Function-oriented	1.67 (3.14)	1.33 (1.03)	1.67 (1.75)	2.83 (2.23)
	Operative	5.29 (4.15)	0.43 (0.53)	3.00 (2.52)	3.43 (2.70)

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homogeneity and distribution. The number of requests seemed higher in the Request Condition than in the Assistance Condition, (respectively $M = 2.44$, SD = 3.20 and $M = 0.82$, SD = 0.90). Giving assistance would increase the passivity of participants. But the effect of trigger was not significant ($U = 299$, z adjust = 1.39, $p > .1$). The participants in the Request Condition did not ask for help more often than in the Assistance Condition.

First tasks series: Exploration of the system with assistance. An analysis of the three factors was conducted for solution time and failure rate (Table 2). Concerning the solution time, the main effects of help trigger and of user expertise were significant (respectively $F(1,47) = 4.35$, $p < .05$ and $F(1,47) = 6.38$, $p < .02$). The effect of content of assistance was not significant ($F(1,47) = 0.72$, $p > .1$). Assistance given after a detected deadlock by the simulated system ($M = 548.9$, SD = 188.6) was more beneficial than assistance given after a request ($M = 675.4$, SD = 276.3) (Table 2). Besides, experts ($M = 534.9$, SD = 194.8) were more rapid than novices ($M = 695.8$, SD = 264.4). Function-oriented ($M = 601.8$, SD = 263.5) and operative help ($M = 621.2$, SD = 220.5) were not different.

Second series of tasks: Practice (without assistance). The main effects of trigger and help content on solution time were not significant. However, the interaction effect between help content and expertise was significant ($F(1,47) = 5.29$, $p < .03$). The mean scores are presented in Table 2. Results seem show a benefit from function-oriented help for experts and a benefit from operative help for novices. Planned comparisons were performed in order to study interaction effect of assistance content and expertise. In particular, the difference between novices and experts was significant only in the function-oriented help group ($F(1,47) = 9.6$, $p < .005$), not in operative help group ($F(1,47) = 0.003$, $p > .1$). In other words, for the solving of the second tasks series, i.e. the test series, novices ($M = 308.1$, SD = 215.2) were slower than experts ($M = 155.7$, SD = 45.9), when they had received function-oriented help at the first series. On the other hand, novices ($M = 228.6$, SD = 79.9) were as rapid as experts ($M = 231.7$, SD = 153.5) at the second tasks series, when they had received operative help at the first series. This showed the benefit of operative help compared to function-oriented help for novices but not for experts (Fig. 1). For experts, it seemed that function-oriented help was more beneficial than operative help. However, planned comparisons did not reveal difference between the two types for experts ($F(1,47) = 2.39$, $p > .1$).

Third series of tasks: Transfer. The analysis showed main effects of expertise and of help content on the tasks failure rate during the third series of tasks (respectively $U = 303$, z adjust = 2.16, $p < .04$ and $U = 275.5$, z adjust = 2.96, $p < .004$) (Table 3). The novices ($M = 0.23$, SD = 0.43) failed more often than experts ($M = 0.03$, SD = 0.19). The participants having received operative help during the first series ($M = 0.27$, SD = 0.45) failed more, at the third series, than participants having received function-oriented help ($M = 0.0$, SD = 0.0). However, the effect of help content was significant only for novices ($U = 48$, z adjust = 2.53, $p < .02$), not for experts ($U = 93.5$, z adjust = 1.19, $p > .1$). Novices having received operative help at the first series had a higher failure rate for the transfer tasks than novices having received function-oriented.

No other comparison reached statistical difference.

2.3. Discussion

The analysis revealed a main effect of expertise on help seeking. As expected (e.g. Renkl, 2002), experts asked for help less often than novices, proportionally to their errors. Experts are not aware of all their deadlocks because parts of deadlocks are detected by the system or they may become aware of them but they want to correct them without assistance. Help trigger and user expertise influenced solution time for the first tasks of exploration of the system. Indeed, novices were slower than experts. Participants having received help after request were slower than those having received help after deadlock. The content of received help messages during the exploration tasks influenced solution of the second series as a function of participant expertise: operative help was more beneficial than function-oriented help for novices, not for experts. When novices received operative help, they were as rapid as experts. To sum up, operative help and help after deadlock were beneficial in terms of solution time. More precisely, the trigger (after request vs. after deadlock detection by the simulated system) influenced the learning series with assistance whereas help content (operative vs. function-oriented) influenced the test series without assistance. Results of this experiment showed a better effectiveness of adaptive help than adaptable (i.e. asked) help on service exploration, but not on learning and transfer. The benefit of help after deadlock was not gained to the detriment of transfer to a new task. However, the benefit of operative help for the novice was gained to the detriment of the transfer.

Table 2
Means (and standard-deviations) of task failures, solution time of the three series.

		After request		After request and detections	
		Failure	Time	Failure	Time
First series					
Experts	Function-oriented	0.13 (0.35)	540.8 (277.8)	0.11 (0.33)	513.2 (160.8)
	Operative	0.0 (0.0)	611.8 (145.1)	0.17 (0.41)	482.8 (175.6)
Novices	Function-oriented	0.50 (0.83)	813.7 (364.6)	0.17 (0.41)	604.5 (180.7)
	Operative	0.0 (0.0)	765.4 (235.9)	0.0 (0.0)	603.6 (244.6)
Second series					
Experts	Function-oriented	0.0 (0.0)	149.6 (45.1)	0.0 (0.0)	161.1 (48.7)
	Operative	0.17 (0.41)	288.0 (202.8)	0.0 (0.0)	175.3 (55.4)
Novices	Function-oriented	0.17 (0.41)	363.7 (286.7)	0.0 (0.0)	252.5 (110.9)
	Operative	0.0 (0.0)	246.0 (68.0)	0.0 (0.0)	211.1 (92.1)
Third series					
Experts	Function-oriented	0.0 (0.0)	82.1 (40.8)	0.0 (0.0)	103.2 (94.2)
	Operative	0.17 (0.41)	85.5 (56.1)	0.0 (0.0)	102.5 (75.9)
Novices	Function-oriented	0.0 (0.0)	93.3 (39.9)	0.0 (0.0)	95.0 (43.8)
	Operative	0.43 (0.53)	150.1 (124.3)	0.43 (0.53)	113.3 (82.3)

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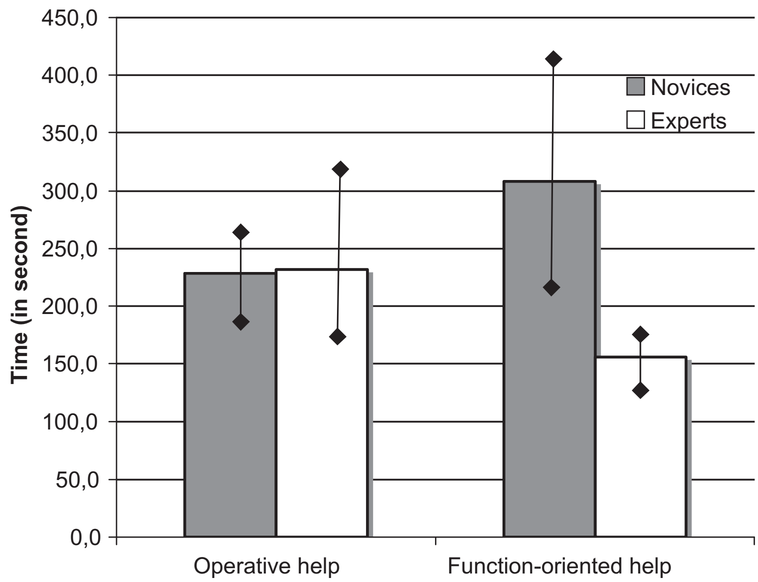

Fig. 1. Effects of help type and expertise on solution time of the second series, experiment 1.

3. Experiment 2

The aim of experiment 2 was to reproduce effects of help content and prior knowledge in an interaction situation with another system, a written dialogue system in natural language. Consequently, the factor "trigger of help message" was cancelled in order to focus on the interaction effect and to clarify the effects on transfer. The system, called Eliot, is a natural language information retrieval system for the website France Telecom. In particular, Eliot answers user requests by providing web links.

3.1. Method

3.1.1. Participants

Forty-seven participants took part in the experiment (23 women and 24 men recruited outside the company). Each participant received a 15 euro voucher. The mean age was 41 (SD = 13.83). Participants had never used either the dialog system Eliot or the website of France Telecom.

3.1.2. Materials

Eliot is an information retrieval assistant in written dialogue for the France Telecom website. The user interacts with Eliot in natural language in order to retrieve web pages. The assistant provides answers for products and services addressed to private persons and professionals by proposing links matching the user's requests. Interaction is made via a dialogue window in which the user types his question in a text zone and in which the answer is presented. Moreover, Eliot is represented as an avatar animated differently depending on the type of answer. This assistant – based on a natural dialogue technology – aims at simplifying the web search of a product or a service and making it user-friendly. The interaction is performed in writing and by means of hypertext links matching proposed solutions. During a search, the user can browse solutions, but also specify his request or change it, by using the textual zone. Finally, each utterance is analyzed in the context of current dialogue. The user can perform his search in key-words or in natural language. He can use his own vocabulary. He can specify multiple criteria at once for a search. Therefore, he can specify his profile for information retrieval ("I'm a private person and I'm seeking a package for my phone"). The proposed pages will match his profile. Interaction between the user and Eliot goes beyond a question–answer interaction in that Eliot helps the user to specify his query by questioning him in order to get clarification and details. This phase is called restriction. Besides, when Eliot does not find a precise solution to a query, it proposes closely related solutions at the semantic level. This phase is called relaxation.

The same Wizard of Oz technique was used as in the previous experiment.

3.1.3. Tasks

In order to place participants in a test situation, they were given several scenarios, i.e. sets of information retrieval tasks. Participants were asked to find web pages matching queries by means of the assistant. The scenarios were presented in the form of sentences (for instance, "you're seeking a page on different types of high speed internet rental"). Depending on the scenarios, the solution could be found (in an optimal way) with one, two or three communication turns. In fact, for some queries, Eliot directly proposed web pages while for others, it had to initiate a restriction or a relaxation (respectively by asking for precise details or on the contrary, by extending the scope of the query and proposing close solutions). For instance, faced with the query "I'm seeking a page concerning internet rentals", Eliot asked the user to clarify his query by proposing several alternatives before giving him solutions. By manipulating the number of restrictions (0, 1 or 2), twelve scenarios were created. In particular, two series were created, one with eight scenarios and the other with four. The first series contained four scenarios with no restriction and four scenarios with one restriction. These eight tasks corresponded to exploration and practice. The second series contained two scenarios with no restriction and two with two restrictions and were considered as transfer.

The order of the scenarios with 0 and 1 restriction (first series) was counterbalanced using Latin Squares. The order of the second series was fixed. As in the first experiment, participants received a message, informing them of whether the task was done or not.

3.1.4. Prior knowledge evaluation device and satisfaction questionnaire

The first experiment profile questionnaire was also used to determine the familiarity with computer environments. Two further items focused no longer on the system but on the domain: products and services of France Telecom. A satisfaction questionnaire assessed the simulated help system. Participants assessed their satisfaction concerning adaptation of help, ease of understanding and to apply.

3.1.5. Help need detection and help messages

Applying and adapting the guidelines previously described in the research on errors and suboptimal behavior within the fields of cognitive psychology and Human Computer Interaction and the results of previous experiments defined the criteria of deadlock detection. The following actions were considered as deadlock criteria for which the experimenter provided assistance messages, whatever the current task might be:

– Incomprehension message from the assistant.
– Repeated actions: proposition of the same solution for two different successive queries or repeated clicks on the links of the same solution.
– Sequence of actions started without ongoing action at the end (new query before having obtained pages, such as a restriction without a user's answer).

The detection of help need on the basis of user's requests or deadlock criteria was identical for all subtasks and could be generalized to a situation in which the goal was unknown. The help messages provided a simple step to realize (i.e. a single action). As in the first experiment, on the basis of deadlock detection criteria, two lists of help messages were constructed: operative and function-oriented. In order to warrant equivalence between operative and function-oriented messages, the same information was given in a operative and in a function-oriented message. The length of operative and function-oriented messages was identical.

3.1.6. Procedure and experimental design

Participants were greeted in a quiet test room and then answered the profile questionnaire. The general instructions were presented on a sheet then explained orally by the experimenter. The browsing assistant was presented. The instructions specified that if participants experienced deadlocks during the use of the service, they could receive help messages by asking for help aloud and after deadlock detection. Participants performed the first series of tasks. At the end of each subtask, the participants were notified that they could do the following task. Then, they realized a test session without help messages. Finally, they answered a satisfaction questionnaire. The entire experiment did not exceed fifty minutes.

The manipulated factors were help content (operative vs. function-oriented) and prior knowledge (experts vs. novices) on a between-subjects basis. Participants were distinguished according to their web knowledge, assessed by their frequency of web use (less than five hours per week for novices, more than twenty hours per week for experts). The familiarity with the domain (products and services of France Telecom) was controlled.

3.1.7. Measures

Measures were gathered: success of task, solution time, number of requests and number of times assistance was provided. Subjective measures were also gathered with the answers to the satisfaction questionnaire.

3.2. Results

A GLM procedure was conducted to analyze data. Three analyses were conducted: two for the first task series (one for the simple tasks with 0 restrictions and one for the difficult tasks with 1 restriction) one for the second series (for transfer tasks with 2 restrictions).

3.2.1. Help messages and task performance

The analysis did not reveal effects of the expertise and content of assistance factors on the number of received help messages (Table 3). The mean number of help messages was 5.77 (SD = 3.10). No statistical difference ($F(1,43) = 1.24$, $p > .1$) between novices ($M = 7.0$, SD = 2.9) and experts (in terms of web knowledge) ($M = 8.0$, SD = 3.0) was revealed for the domain knowledge (number of known products and services).

Table 3
Means (and standard-deviations) of asked, not asked and received help messages, success, satisfaction and time.

		Help messages				Satisfaction	First series		
							0 restriction	1 restriction	2 restrictions
		Asked	Not asked	Received	Success		Time	Time	Time
Experts	Function-oriented	0.33 (0.49)	5.50 (3.00)	5.83 (3.18)	0.94 (0.06)	4.07 (0.80)	364.2 (168.8)	407.3 (123.8)	207.8 (217.9)
	Operative	0.50 (0.79)	6.50 (2.54)	7.00 (2.66)	0.92 (0.11)	4.60 (0.45)	578.6 (267.5)	436.8 (158.1)	159.4 (42.3)
Novices	Function-oriented	0.50 (0.67)	4.83 (3.13)	5.33 (2.90)	0.82 (0.26)	4.40 (0.53)	523.7 (210.7)	598.8 (279.8)	257.3 (222.3)
	Operative	0.55 (0.82)	4.27 (3.10)	4.82 (3.60)	0.93 (0.08)	4.53 (0.51)	447.1 (240.7)	538.1 (268.9)	208.9 (127.1)

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Given the low number of failures for the tasks, task success was calculated at a global level, for the two series (Table 3). The success level was equivalent in the four groups (91–94%), except in the groups of novices receiving function-oriented assistances which had a success level of 82%. But the difference was not significant.

3.2.2. Solution time and number of requests

Firstly, an analysis was conducted on exploration and practice in the first tasks series, only for the tasks with 0 restrictions. The main effects of expertise and help content on solution time were not significant (respectively $F(1,43) = 0.04$, $p > .1$ and $F(1,43) = 1.10$, $p > .1$). But the analysis revealed an interaction effect of help content and user expertise ($F(1,43) = 4.92$, $p = .03$). The mean times are presented in Table 3. In the expert group, planned comparisons revealed a difference between the two help contents ($F(1,43) = 5.47$, $p < .03$). Experts were more rapid with function-oriented help than with operative help. Conversely, operative help were beneficial for novices. The analysis conducted on the tasks with 1 restriction revealed a main effect of user expertise on solution time ($F(1,43) = 5.33$, $p < .03$). Experts ($M = 422.1$, SD = 139.7) were more rapid than novices ($M = 569.8$, SD = 270.1). There was no effect of help content ($F(1,43) = 0.06$, $p > .1$) (Table 3). The interaction was not significant ($F(1,43) = 0.50$, $p > .1$).

3.2.3. Satisfaction questionnaire

The analysis showed a marginally significant effect of the help content ($F(1,43) = 3.60$, $p = .06$). Interaction effect did not reach statistical difference ($F(1,43) = 1.34$, $p > .1$). Operative help ($M = 4.56$, SD = 0.47) was more appreciated than function-oriented help ($M = 4.23$, SD = 0.69), for novices as well as experts (Table 3). The detailed analysis conducted on each item showed that operative help was more satisfying than function-oriented concerning ease to understand ($F(1,43) = 7.12$, $p < .01$), adaptation to users' needs ($F(1,43) = 4.74$, $p < .05$) and general appreciation($F(1,43) = 6.37$, $p < .02$).

3.3. Discussion

Function-oriented help was more beneficial for experts than operative help in terms of solution time. Conversely, operative help was more beneficial than function-oriented help for novices. These results confirmed those obtained with experiment 1. This benefit must be tempered given the high-level of success. Operative help was more appreciated than function-oriented help, even by experts, although it was less effective.

4. General discussion and perspectives: Theoretical and industrial challenges

The aim of the present study was to evaluate a set of properties of assistance that warrants its effectiveness on learning outcomes. The approach adopted was to trace user activity in order to detect help needs and to intervene at the appropriate time. Simulated help systems aimed at providing adequate assistance that met user needs and did not interfere with current activity. Assistance design requires to take into account processes that interact: awareness of help need, help request formulation, initiative of assistance, adaptation of content to user knowledge and tasks. Assistance can support deadlock awareness and can also focus on deadlock solving by guiding task performance. Our results contribute to understanding the effects of assistance on system use learning. In particular, they highlight the fact that assistance must be adapted to prior knowledge, progress and users' goals in order to improve learning. These results can be used in automatic assistance design.

4.1. What is the benefit of assistance given after help need detection?

Results of experiment 1 showed benefits of adaptive assistance given on the basis of action sequences. Problematic action sequences were determined that were generalized to situations with unknown goals and optimal procedures (Richard, 1999; Van der Linden et al., 2001). These sequences can be used as indicators of help need in order to give automatic assistance without user solicitation. They can be used in intelligent tutorial systems as well as in intelligent help systems (Virvou & Kabassi, 2002). Assistance must be adequate, otherwise intrusion can prove to be disruptive (Tiernan, Cutrell, & Czerwinski, 2001).

4.2. To what extent does prior knowledge influence help need detection?

Automatic detection of help need requires considering the user at two levels that can interact: (1) prior knowledge, (2) progress through interaction (Fischer, 2001). As Fischer underlined, different criteria related to prior knowledge and progress have to be combined and integrated. The analysis of experiment 1 revealed an effect of expertise not only on performance but also on help seeking. Experts asked for help less often than novices, in proportion to their deadlocks. This result confirmed the well-known relationship between prior knowledge and metacognitive skills (Glaser & Chi, 1988).

4.3. To what extent does help content effectiveness change as a function of expertise?

The content of automatic assistance must guide users to progress in task performance or in reaching their goal (Mallen, 1996), but also permit the mastery of application use. In experiments 1 and 2, operative assistance was more beneficial than function-oriented, for novices. These results confirmed literature showing a preference for specific assistance focusing on current steps compared to general abstract assistance (Ben-Ari & Yeshno, 2006; Dutke & Reimer, 2000). They also confirmed the influence of individual characteristics on help content effectiveness (Calisir & Gurel, 2003; Mitchell, Chen, & Macredie, 2005). However, operative help hampered transfer success in experiment 1. As highlighted in some studies, the two types of content, operative instructions and conceptual information, can influence practice and transfer differently (Ben-Ari & Yeshno, 2006; De Crook & Van Merrienboer, 2007; Dutke & Reimer, 2000). Assistance messages tested in experiment 1 may direct the practice too much, making users too passive, and thus disrupting transfer. Indeed transfer requires active learner participation (Moreno et al., 2001). In experiment 2, experts benefited more from function-oriented assistance than operative, but they appreciated operative assistance more. The preferred assistance is not necessarily the most effective.

4.4. Implications for assistance design

Deadlock criteria in the form of action sequences have to be used to provide assistance even if users do not solicit help.

Expertise influences help need detection and help content effectiveness; most experienced users detect their need for help better and are not bothered by adaptive assistance.

Despite the risk of intrusion mentioned in literature, adaptive assistance is beneficial in terms of learning time compared to adaptable assistance (after user's request), in particular for novices, during the initial exploration of the system.

Help content influences learning in later steps (performing tasks without assistance), but differently as a function of expertise; operative help is beneficial compared to function-oriented help and is more appreciated by users; benefits of operative help must be qualified: in experiment 2, only novices were concerned and in experiment 1, the benefit was made to the detriment of transfer success.

A better understanding of processes in learning situations with an interactive system could enhance methods of help need detection. Technological advances should be tested in experimental studies in cognitive psychology. The results could be applied to improving instruction system design. Given the diversity of learners and users and use contexts, adaptability plays an important role. Therefore, the study of adaptive automatic assistance will permit the emergence of systems which adapt themselves to learners' needs and goals in a dynamic way.

5. Uncited references

Q2 Narciss and Huth (2004) and Richard (2004).

References

Aleven, V., & Koedinger, K. R. (2000). Limitations of student control: Do students know when they need help? In G. Gauthier, C. Frasson, & K. VanLehn (Eds.), *Proceedings of the 5th international conference on intelligent tutoring systems, ITS 2000* (pp. 292–303). Berlin: Springer-Verlag.
Aleven, V., McLaren, B., Roll, I., & Koedinger, K. R. (2004). Toward tutoring help seeking: Applying cognitive modeling to meta-cognitive skills. In J. C. Lester, R. M. Vicari, & F. Paraguaçu (Eds.), *Proceedings of the seventh international conference on intelligent tutoring systems, ITS 2004* (pp. 227–239). Maceio, Brazil: Springer-Verlag.
Aleven, V., Stahl, E., Schworm, S., Fischer, F., & Wallace, R. (2003). Help seeking and help design in interactive learning environments. *Review of Educational Research, 73*(3), 277–320.
Anderson, J. R. (1989). The analogical origins of errors in problem solving. In D. Klahr & K. Kotovsky (Eds.), *21st Carnegie–Mellon symposium on cognition: Complex information processing* (pp. 343–371). Hillsdale, NJ: Erlbaum.
Anderson, J. R., Corbett, A. T., Koedinger, K. R., & Pelletier, R. (1995). Cognitive tutors: Lessons learned. *Journal of the Learning Sciences, 4*, 167–207.
Bartholomé, T., Stahl, E., Pieschl, S., & Bromme, R. (2006). What matters in help-seeking? A study of help effectiveness and learner-related factors. *Computers in Human Behavior, 22*, 113–129.
Ben-Ari, M., & Yeshno, T. (2006). Conceptual models of software artifacts. *Interacting with Computers, 18*, 1336–1350.
Brusilovsky, P. (2001). Adaptative hypermedia. *User Modeling and User-Adapted Interaction, 11*(1–2), 87–110.
Calisir, F., & Gurel, Z. (2003). Influence of text structure and prior knowledge of the learner on reading comprehension, browsing and perceived control. *Computers in Human Behavior, 19*, 135–145.
Capobianco, A., & Carbonell, N. (2003). Online help for the general public: Specific design issues and recommendations. *Universal Access in the Information Society Journal (UAIS), 2*(3), 265–279.
Carroll, J. M., & Rosson, M. B. (1987). The paradox of the active user. In J. M. Carroll (Ed.), *Interfacing thought: Cognitive aspects of human–computer interaction* (pp. 80–111). Cambridge, MA: MIT Press.
Chi, M. T. H. (1978). Knowledge structures and memory development. In R. S. Siegler (Ed.), *Children's thinking: What develops?* (pp 73–96). Hillsdale, NJ: Erlbum.
Chi, M. T. H., Bassok, M., Lewis, M. W., Reimann, P., & Glaser, R. (1989). Self-explanations: How students study and use examples in learning to solve problems. *Cognitive Science, 13*, 145–182.
Chi, M. T. H., Feltovich, P. J., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science, 5*(1), 121–152.
De Crook, M. B. M., & Van Merrienboer, J. J. G. (2007). Paradoxical effects of information presentation formats and contextual interference on transfer of a complex cognitive skill. *Computers in Human Behavior, 23*, 1740–1761.
Dutke, S., & Reimer, T. (2000). Evaluation of two types of online help for application software. *Journal of Computer Assisted Learning, 16*, 307–315.
Fischer, G. (2001). User modeling in human–computer interaction. *User Modeling and User-Adapted Interaction, 11*, 65–86.
Glaser, R., & Chi, M. T. H. (1988). Overview. In M. T. H. Chi, R. Glaser, & M. J. Farr (Eds.), *The nature of expertise* (pp. xv–xxvii). Hillsdale, NJ: Erlbaum.
Guttentag, R. E. (1995). Mental effort and motivation: Influences on children's memory strategy use. In F. E. Weinert & W. Schneider (Eds.), *Memory performance and competencies: Issues in growth and development* (pp. 207–224). Hillsdale, NJ: Erlbaum.
Q1 Huet, N., & Mariné, C. (in press). Expertise and self-regulation processes in a professional task. *Applied Cognitive Psychology*.
Jameson, A. (2006). Adaptive interfaces and agents. In J. Jacko & A. Sears (Eds.), *Human–computer interaction handbook* (2nd ed., pp. 305–330). Mahwah, NJ: Erlbaum.
Kanfer, R., & Ackerman, P. L. (1989). Motivation and cognitive abilities: An integrative aptitude–treatment interaction approach to skill acquisition. *Journal of Applied Psychology, 74*, 657–690.
Kieras, D. E., & Bovair, S. (1984). The role of mental model in learning to operate a device. *Cognitive Science, 8*, 255–273.
Mallen, C. (1996). Designing intelligent help for information processing systems. *International Journal of Human–Computer Studies, 45*, 349–377.
Merrill, D. C., Reiser, B. J., Merrill, S. K., & Landes, S. (1995). Tutoring: Guided learning by doing. *Cognition and Instruction, 13*, 315–372.
Mitchell, T. J. F., Chen, S. Y., & Macredie, R. D. (2005). Hypermedia learning and prior knowledge: Domain expertise vs. system expertise. *Journal of Computer Assisted Learning, 21*, 53–64.
Miyake, N., & Norman, D. A. (1979). To ask a question, one must know enough to know what is not known. *Journal of Verbal Learning and Verbal Behaviour, 18*, 357–364.
Moreno, R., Mayer, R. E., Spires, H. A., & Lester, J. C. (2001). The case for social agency in computer-based teaching: Do students learn more deeply when they interact with animated pedagogical agents? *Cognition and Instruction, 19*, 177–213.
Narciss, S., & Huth, K. (2004). How to design informative tutoring feedback for multimedia learning. In H. Niegemann, R. Brünken, & D. Leutner (Eds.), *Instructional design for multimedia learning* (pp. 181–195). Münster: Waxmann.
Nelson-LeGall, S. (1987). Necessary and unnecessary help-seeking in children. *Journal of Genetic Psychology, 148*, 53–62.
Newman, R. S. (1998). Students' help seeking during problem solving: Influences of personal and contextual achievement goals. *Journal of Educational Psychology, 90*, 644–658.
Puustinen, M. (1998). Help-seeking behavior in a problem-solving situation: Development of self-regulation. *European Journal of Psychology of Education, 13*, 271–282.
Reason, J. T. (1990). *Human error*. New York: Cambridge University Press.
Renkl, A. (2002). Learning from worked-out examples: Instructional explanations supplement self-explanations. *Learning and Instruction, 12*, 529–556.
Richard, J.-F. (1994). La résolution de problèmes: bilan et perspectives. *Psychologie Française, 39*, 161–175.
Richard, J.-F. (1999). Comportements, buts et représentations. *Psychologie Française, 44*, 75–90.
Richard, J.-F. (2004). *Les activités mentales: de l'interprétation de l'information à l'action*. Paris: Armand Colin.
Richard, J.-F., Poitrenaud, S., & Tijus, C. (1993). Problem solving restructuration: Elimination of implicit constraints. *Cognitive Science, 17*, 497–529.

Shah, F., Evens, M., Michael, J., & Rovick, A. (2002). Classifying student initiatives and tutor responses in human keyboard-to-keyboard tutoring sessions. *Discourse Processes, 33*(1), 23–52.

Tiernan, S. L., Cutrell, E., & Czerwinski, M. (2001). Effective notification systems depend on user trust. In M. Hirose (Ed.), *Human–computer interaction INTERACT 01* (pp. 684–685). Tokyo: IOS Press.

Van der Linden, D., Sonnentag, S., Frese, M., & Van Dyck, C. (2001). Exploration strategies, performance, and error consequences when learning a complex computer task. *Behaviour and Information Technology, 20*(3), 189–198.

Virvou, M. (1999). Automatic reasoning and help about human errors in using an operating system. *Interacting with Computers, 11*, 545–573.

Virvou, M., & Kabassi, K. (2002). Reasoning about users' actions in a graphical user interface. *Human Computer Interaction, 17*, 369–399.

Wood, D. (2001). Scaffolding, contingent tutoring and computer-supported learning. *International Journal of Artificial Intelligence in Education, 12*, 280–292.

Wood, H., & Wood, D. (1999). Help seeking, learning and contingent tutoring. *Computers and Education, 33*, 153–169.

Wood, D., Wood, H., Ainsworth, S., & O'Malley, C. (2002). On becoming a tutor: Towards an ontogenetic model. In C. Desforges (Ed.), *Teaching and learning: The essential readings*. Oxford: Blackwells.

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