Principles for designing Web searching instruction

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Abstract

Web searching is a timely topic which importance is recognized by researchers, educators and instructional designers. This paper aims to guide these practitioners in developing instructional materials for learning to search the Web. It does so by articulating ten design principles that attend to the content and presentation of Web searching instruction. These principles convey a mixture of insights gleaned from instructional theory, empirical research, and many hours of classroom experience. Together, these design recommendations elucidate the key characteristics of effective Web searching instruction, explaining not only what the instructional materials look like, but also why they look the way they do.

Keywords: learning, instructional design, information literacy, World Wide Web

Principles for Designing Web Searching Instruction

Introduction

Web searching closely resembles the work of a detective. To trace relevant information, one has to ask the right questions, consult proper sources of information and creatively combine search outcomes. Unfortunately, few students can measure up to Sherlock Holmes in this respect. According to a recent survey, nearly half of the Dutch high school freshmen consider themselves incapable of operating Web browsers and search engines (Ten Brummelhuis and Slotman, 2000). A comparative study further showed that these findings are consistent with the situation in many European countries (Pelgrum, 1999).

These studies imply that students should be taught to search for information on the Web. This training need is substantiated by the pervasive use of Internet in modern society. At school, the Web is increasingly being used as an arena for students to obtain information. Furthermore, a growing number of occupations require at least a rudimentary understanding of applications to access and navigate the Web. It is therefore important that educators seek opportunities to improve teenagers' Web searching skills. This in turn raises the question of how to foster these skills through the appropriate use of instructional strategies.

One might expect a good deal of direction on this issue from the research literature. Indeed, quite a few studies on Web searching have been published over the past years. Yet few attempts address the issue of how people *learn* to search the Web. And the studies that do, often do not give an explicit account of the principles used to design the instructional materials.

Useful guidance might also be gleaned from research on stand-alone information systems such as hypertext databases and online public access catalogues. However, it is unclear whether these insights can be generalized to Web searching. Being a global hypertext structure, the Web suffers from orientation problems, bandwidth problems, and download latencies (Ramsay et al., 1998). Another difference concerns the lack of indexing conventions. Controlled vocabularies, thesaurus classifications, and human indexing are uncommon for Web search engines (Schacter, Chung and

Dorr, 1999). This inconsistency makes Web searching so imprecise that even information specialists find it difficult to retrieve specific information (Bruce and Leander, 1997).

Deducing design principles from existing instructional materials would be another, yet equally unfeasible option. Although a multitude of materials designed to train students to become skilled Web searchers is available, few of these publications appear to have been developed from the research on the topic. For example, theorists acknowledge information literacy skills to be the key factor in information seeking, and research has repeatedly shown that students generally have little command of these skills (Elley, 1994; Guthrie et al., 1991; Thomas, 1999). Yet commercially available Web searching manuals seem to be unaware of these training needs as they predominantly focus on operating Web browsers and search engines, leaving the information literacy skills largely unaddressed.

This paper aims to compensate for this seeming lack of design recommendations. It articulates ten design principles that attend to the content and presentation of Web searching instruction. These principles convey a mixture of insights gleaned from instructional theory, empirical research, and many hours of classroom experience. The principles are primarily intended for designing paper Web searching tutorials for youths between the ages of approximately 10 and 14 (hereafter, students). But their usefulness is restricted neither to this audience nor to the design of printed training materials. Some principles may also facilitate the design of other kinds of instructional support (e.g., online help); other principles may generalize to different user groups. These extensions are not addressed in this paper, but readers are encouraged to consider the design principles beyond the context in which they are presented.

The sections below introduce the design principles, explain their rationale, and illustrate their application in Web searching tutorials. It is worth noting that the principles do *not* offer a prescriptive blueprint designers can follow mechanically. Rather, they constitute a framework of design recommendations that support designers in their thinking about Web searching instruction.

Principles for selecting instructional content

Web searching calls upon various types of expertise. Web users should have a basic facility with the browser and search engine, possess knowledge of the topic being searched, and be capable of regulating their own search behavior (Carroll, 1999; Chen et al, 1998; Marchionini, 1995). While it may seem a contradiction in terms, inexperienced Web users can be quite knowledgeable in some of these areas. To illustrate, a vast majority of the students is familiar with common software programs such as word processors, games, and graphical editors. The core skills involved in operating these programs are typical for contemporary point-and-click applications, including Web browsers and search engines. As a result, students without prior Web-searching experience may already master the elementary skills to access and navigate the Web.

Web searching instruction should always take the learners' prior knowledge into account. It should focus on the expertise learners need to acquire, and adapt to or even exploit the knowledge already in place. The principles in this section provide general directions for selecting the content of Web searching instruction. As audiences and circumstances are widely divergent, the principles suggest rather than impose the subject matter. Designers can, and in fact should, tailor each recommendation to their personal training situation.

Principle 1: Focus on locating Web sites

Web searching comes down to locating a Web site and, subsequently, locating information within that site. Site location involves either performing a keyword search, entering a URL, or browsing subject categories. The order in which these strategies appear mirrors the students' preferred choice of strategies. Students show a strong tendency to search for keywords (e.g., Fidel et al., 1999; Wallace and Kupperman, 1997). In one of our studies, students used this strategy in nearly 70% of the occasions. Entering a URL occurred in one out of four attempts to locate a site, whereas the browsing strategy was used in only 4% of the trials (Lazonder, 1999).

Once a potentially relevant site has been retrieved, the target information can be located through browsing and searching using the site's built-in search engine. As with site location, students strongly

prefer searching to browsing. Yet they are often required to engage in browsing because not every site is equipped with a local search engine.

Prior experience with the Web yields superior search performance on the first part of the search process (Lazonder, 2000; Lazonder et al., 2000). Experienced Web searchers are more proficient at inferring and entering URLs. They are also more skilled at operating browsers and performing keyword searches compared to inexperienced users. However, no gains of Web experience are apparent in the search for information within sites. This may be due to the fact that locating information requires a substantial amount of browsing – a data-driven search strategy that calls upon few analytical search strategies. Together, these findings argue that Web searching instruction should concentrate on locating Web sites, and only touch on locating information within sites.

Principle 2: Teach advanced system knowledge

Web searching instruction need not elaborate on the procedural skills to operate Web browsers and search engines. Most students already have a basic facility with these retrieval tools, and those who don't can easily develop the required skills –even without instructional support (Khan and Locatis, 1998; Lazonder, 2000; Marchionini, 1989). However, this precept does not apply to the advanced options of the search engine. According to Bilal (2001), students generally possess inadequate knowledge of how to use search engines efficiently and effectively. Most students are unaware that the search engine's functionality goes beyond performing a single keyword search. And students that do try to use a search engine's advanced options are bound to make mistakes. Refining a search, using Boolean operators, and searching for multiple keywords are just a few examples of advanced options that are prone to error (Lazonder, 2000; Spink et al., 2001; Wallace and Kupperman, 1997). Using these options correctly and functionally should therefore be addressed in Web searching instruction.

Web searching instruction should specify what an advanced option does and how it should be used. In most cases, the reason why an advanced option has to be used is either self-evident or inherent in the selected search strategy. To illustrate, narrowing an existing search involves changing the search engine's search mode from 'New search' to 'Refine search'. Clearly, this switch needs no further

explanation. In other cases the rationale is irrelevant to users because of software conventions. There is, for example, little use in explaining why Boolean operators should be entered the way they do.

Principle 3: Teach self-regulatory skills

The third principle specifies the self-regulatory skills students should acquire to become competent at locating Web sites. These skills were adapted from empirically verified models of how students search electronic environments such as the Web (e.g., Eisenberg and Berkowitz, 1990; Hill, 1999; Marchionini, 1995; Sutcliffe and Ennis, 1998). Lazonder (2000) used one such model as analytical framework for identifying the training needs of novice Web searchers. This study revealed that Web searching instruction should primarily address self-regulatory skills to monitor search behavior (e.g., check for typos in URLs or keywords, watch the status bar for Web page loading progress, and consult the 'number of hits' system cue) and evaluate search outcomes (e.g., use system cues such as relevance ratings, keywords found, and URLs to assess the merit of Web sites included in the hit list).

Other studies suggest that novice users should also be taught to select search strategies (Bilal, 2001; Hill and Hannafin, 1997; Khan and Locatis, 1998, Watson, 1998). Inexperienced Web searchers generally engage in primitive search strategies that are either inefficient or unsuccessful. Our own observations support this stance: most of the students we observed employed rather naive search strategies. When given a search task, students systematically used the keywords from the task description as search term or URL. Obviously, this rather straightforward approach often proved unsuccessful, causing students to conclude that the target site was not available on the Web. Very few students were observed to apply sophisticated search strategies such as combining multiple keywords into a query or searching for keywords that are synonymous with the wording used in the task description.

These conclusions probably generalize to a larger audience. Lazonder's (2000) study revealed various instances of inefficient search behavior by experienced Web searchers. Similar to novice users, experienced Web searchers hardly used system cues to evaluate search outcomes. Not did they monitor their search behavior on a regular basis. Spink et al. (2001) analyzed over one million Web

queries by over 200,000 users of the Excite search engine. Their findings indicate that most people use few search terms, few modified queries, and rarely use advanced search strategies. Together, these studies suggest that experienced users might benefit from instruction in self-regulatory Web searching skills.

Web searching instruction should inform students on the 'what, how, and why' of a self-regulatory skill (De Jong, 1992; Osman and Hannafin, 1992; Shunk and Ertmer, 2000). The 'what' and 'how' parts are typical of skill training programs, indicating which skill should be applied and how it should be performed. As can be seen from Figure 1, the instructional content of these parts depends on the nature of the user's activity. If the user has to perform a mental action (e.g., formulate a search term, recall the search task, determine the number of search outcomes), the 'what' part contains an elaborate description of that action. The 'how' part details the way in which this action has to be performed. In case the user has to make a decision (e.g., select a search strategy, choose the most relevant Web site), the 'what' part details the choice users have to make and (if appropriate) the alternatives from which they can choose. The 'how' part presents the selection rules users can apply to make a conscious choice. The 'why' part points out the relevance and efficacy of a self-regulatory skill, independent of the user's activity (i.e., action or decision). It informs students on the advantages of performing that skill by highlighting its facilitative effect on the quality of the search outcomes and the efficiency of search behavior.

Insert Figure 1 about here

Principle 4: Arouse and sustain motivation

At the risk of stating the obvious, this principle attests that Web searching instruction can only be effective if students are motivated to learn. Clearly, this principle is not new: motivation has long since been acknowledged to play a pivotal role in learning and instruction. Furthermore, one might question whether it is in fact necessary to arouse motivation since students appear to be intrinsically motivated to learn to search the Web (e.g., Bilal, 2000; Watson, 1998). In one of our classroom studies, students

completed a motivational questionnaire prior to the instruction. Results indicated that the students' motivation was high: the mean scores ranged from 5.5 to 6.4 on a seven-point scale (Lazonder, 2001a).

There is, however, reason to believe that designers cannot trust blindly on the students' task motivation. In the aforementioned study, students' expectations about the course appeared to be at odds with the actual course content. Most students perceived Web searching as entering keywords and URLs and clicking hyperlinks. And their initial motivation scores showed that these were the topics they were anxious to learn. Unfortunately, their learning preferences were not met by the instruction. Consistent with the third design principle, the instruction centered on the self-regulatory parts of the search process and paid virtually no attention to the hands-on skills. As a result, students' motivation decreased during the instruction. This would probably not have been the case if the students' motivation were based on the actual course content instead of on their beliefs about what the course would be like.

Having students perform a complicated search task prior to the instruction may arouse proper task motivation. This search task should be so arduous that pervasive use of self-regulatory skills is required for its completion. Among other things, this implies that students should be unable to locate the site via its URL. Furthermore, the target site should not appear on the first three or four pages of the hit list when students search for the most obvious keywords (i.e., the terms used in the task description). The target site should readily appear in the hit list only if students search for multiple keywords. And at least one of these keywords should be a synonym of the terms used in the task description. No requirements apply to the 'locate information' part of the task because these skills are not included in the training needs of new Web users.

The basic idea behind this search task is to confront students with their inability to solve this search problem. Once students recognize they need additional, self-regulatory skills to complete this task, they may become motivated to learn these skills. Evaluating the search task and demonstrating its solution seem vital in this respect. Either the teacher or the instruction manual should elucidate which

skills were needed to complete the introductory search task. Students should also be given an advance organizer: a preview that details where these skills are addressed in the instruction.

Once the proper motivation is aroused, it should be sustained. This is especially important in view of the extensive amount of repeated practice required to acquire self-regulatory skills (see principle 8). Learners typically resent rehearsing the same routine over and over again, causing them to skip most review exercises (Carroll, 1990). The amount of repeated practice should therefore be well balanced, allowing students to master a skill without loosing interest. This may be achieved by integrating repeated practice in self-regulatory skills into course curricula. Such an integrated approach seems promising, especially since teachers increasingly ask their students to obtain information from the Web. This in turn will maintain students' motivation: their success in other school activities may depend on their proficiency to search the Web.

Principle 5: Do not overestimate the importance of domain expertise

Although some people 'surf the net' just for the sake of it, Web searching is no end in itself. Rather, it is a means to obtain information on a particular topic. Knowledge of this topic and its underlying task domain is acknowledged to enhance search performance. Users with high levels of domain expertise are, for example, more proficient at identifying the key facets of a search task, using vocabulary of the task domain to formulate queries, and differentiating between relevant and irrelevant search outcomes (Marchionini, 1995). Research has shown that these skills yield superior performance in terms of efficiency and effectiveness. That is, domain experts need less time to complete search tasks and produce a greater number of correct solutions (Hirsh, 1997; McDonald and Stevenson, 1998; Patel et al., 1998).

There is, however, reason to believe that Web searching instruction need not always cater for differences in domain expertise. Knowledge of the task domain may, for example, be left out of account when teaching a homogeneous group of students to search the Web. In that case, within-group differences in domain expertise are so insignificant that they do not affect search performance (Lazonder, 2001a). Domain expertise is also less important when teaching the basics of Web

searching. According to Hsieh-Yee (1998), domain expertise becomes a factor only after a certain amount of search experience had been acquired.

Yet this is not to say that designers can completely ignore the task domain. The students' attitude towards the topics being searched has important consequences for the design of practice. Carefully designed training tasks can foster students in practicing distinct Web searching skills. This is especially important during the initial phases of learning when the unanticipated use of advanced search skills can easily disrupt or even obstruct learning. For assigned search tasks to be effective, they should comply with the students' interests and preferences. Assignments that do not satisfy this condition are likely to be abandoned by students. Insight into the topics students are anxious to search for may thus serve as a basis for designing authentic hence motivating practice tasks.

Principles for presenting the instructional content

The second set of principles aims to guide designers in developing materials that convey the instructional content detailed in the previous section. The majority of these principles was adapted from the minimalist approach to instruction (Van der Meij and Carroll, 1995) and validated in various studies on initial computer skill training. In all of these studies, minimalist instruction was found to lead to faster training and better learning as compared to other instructional approaches (e.g., Carroll, 1990; Lazonder and Van der Meij, 1993; Ramsay and Oatley, 1992). Recently, Lazonder (2001a) showed that the functionality of minimalist instruction also applies to acquiring procedural skills to operate Web browsers and search engines.

Theoretical evidence suggests that minimalism holds promise for the development of self-regulatory skills. That is, the main characteristics of minimalist instruction correspond to the instructional conditions for self-regulatory skill learning. An early attempt to substantiate this theoretical evidence with practical findings failed to produce the anticipated effects (Lazonder, 2001b). However, this study did reveal valuable directions for improving the Web searching instruction. These suggestions are included in the principles presented below.

Principle 6: Teach procedural and self-regulatory skills concurrently

Self-regulatory skills may be taught in two fundamentally different ways. Instructional designers can either embed self-regulatory skills within lessons, or afford the opportunity for learners to learn and practice the skills in an adjunct course, detached from of the procedural skill instruction (Osman and Hannafin, 1992; Puntambekar and Du Boulay, 1997; Shin, 1998). Both theoretical and empirical evidence suggests that embedded instruction is the most effective way to develop self-regulatory skills (Bielazcyc et al., 1995; Hattie et al., 1996; Osman and Hannafin, 1992).

The joint practice of procedural and self-regulatory skills may provoke additional cognitive load. In fact, the coordinate handling of manual, keyboard and screen already requires considerable mental effort (Chandler and Sweller, 1996). Adding self-regulatory skills could make it even harder for students to allocate their attention to the relevant parts of the learning task. The success of embedded self-regulatory skills instruction thus seems to hinge on its potential to manage the students' cognitive load (Osman and Hannafin, 1992).

Timesharing strategy is a potentially fruitful strategy to resolve the difficulty involved in simultaneously performing procedural and self-regulatory skills (Perkins et al., 1990). Guided by the notion of parallel processing, timesharing instruction prompts learners to shift attention from performing procedural skills to execute a search, to performing self-regulatory skills to manage search behavior. Timesharing instruction therefore provides self-regulatory skills instruction on the spot, fully integrated with the procedural skills to operate the search engine. Self-regulatory skills are introduced and explained only if they actually have to be performed. Students are thus prompted to perform a self-regulatory skill every time it is needed. This in turn teaches them the positioning of a given skill in the search process.

Due to this integrated presentation, self-regulatory skills instruction has to be signaled to indicate its distinct nature and to facilitate recognition. In Figure 1, two different icons are used for this purpose: a 'light bulb' signals the 'what' and 'why' part, a 'hand' indicates the 'how' part.

Principle 7: Teach procedural and self-regulatory skills in context

Web searching instruction should be designed around real tasks. This principle reveals itself especially in the design of practice. Training tasks should include genuine activities that represent the core tasks of a domain. The students' interest in and understanding of these tasks is what incited them to learn to search the Web in the first place. By building the instruction from within these tasks, students' learning preferences are met and, consequently, their motivation to learn is sustained.

The need for contextual instruction is further substantiated by the conditions for self-regulatory skill learning. Research suggests that self-regulatory skills should be taught in context (Boekaerts, 1997; Hattie et al., 1996; Puntambekar and Du Boulay, 1997). Self-regulatory skills are always used within a given task domain. Their spontaneous application in that content area seems to depend on the students' conditional knowledge about when and where to use particular skills. Without this knowledge, the self-regulatory skills remain inert, and students may fail to invoke them during task performance. The instruction should therefore associate the self-regulatory skills with the circumstances in which they are applicable. This in turn may increase the students' perceived utility of a self-regulatory skill (Shunk and Ertmer, 2000).

From a learner's perspective, tasks are 'real' when they represent the activities users intend to perform with an application. To illustrate, Dutch high school students predominantly use the Web in language classes to retrieve summaries and book reports, to find background information on authors and literary movements, to explain the meaning of proverbs and sayings and so on. Consequently, the practice tasks we designed for this target audience resembled these activities as much as possible and each task was embedded in an authentic setting (see Figure 2). In the instruction, search tasks were presented in an box at the beginning of each section, thus making it explicitly clear to students which search task they had to perform.

Insert Figure 2 about here

Principle 8: Provide ample opportunities for practice

New software users show a strong desire to act. They want to learn the program by working with it, not by reading about it. Web searching instruction should comply with this request in various ways, depending on the type of skill. For procedural skills, it should provide students with an immediate opportunity to act. It should emphasize the operation of the program, leaving out nearly all information that does not directly relate to 'doing things'. To illustrate, the Web searching instruction we designed had no preface, long-winded introduction on the origin and current proliferation of the Internet, or general description of how data are digitally stored and transferred. Rather, students received their first instructions to act on page 2. The initial stress on learning by doing was maintained throughout the instruction, thus providing students with ample opportunities for practice.

Practice in procedural skills can further be enhanced by encouraging students to explore designated parts of the program. Action prompts are a fruitful means to invite students to discover new features of the browser and search engine. For example, detailed instructions on how to open subsequent result pages can be replaced by the prompt "Click on the digits at the bottom of the screen and see what happens", thus inviting students to infer the meaning of these links on their own. Explorations can also be encouraged in a "Do it yourself" chapter. We included such a chapter in one of our Web searching manuals. This chapter invited students to locate Web sites, but did not specify the action steps needed for site location. Nor did it inform students on the information they should locate within sites. Students were merely given a list of URLs and keywords they could use to rehearse the procedural skills addressed in the preceding chapters.

An action-oriented approach should be maintained in teaching self-regulatory skills. Because self-regulatory skills require significant effort to learn, Web searching instruction should offer ample opportunities for repeated practice (Garner and Alexander, 1989; Vermunt, 1998; Weinstein et al., 2000). Paradoxically, this call for repeated practice is at odds with practical findings on the acquisition of procedural skills. Lazonder (2001a) found that three 50-minutes training sessions can enhance procedural skills. Yet this amount of practice proved insufficient to develop self-regulatory Web searching skills. In view of these findings, significantly increasing the length of the instruction would

be the most straightforward way to create opportunities for repeated practice. Unfortunately, this has a negative impact on the students' motivation. Integrating repeated practice in self-regulatory skills into other courses may be a more fruitful option.

Principle 9: Support error recovery

New users inevitably make mistakes, and correcting these mistakes can be both time-consuming and frustrating. Web searching instruction should therefore teach how to 'do things' *and* how to undo the things that have gone wrong.

Prevention is better than cure. Web searching instruction should therefore help students to avoid making mistakes. Observations are a powerful means to signal situations, tasks and actions that are prone to errors. The results of these tests are used to further improve the instruction, for instance by further decomposing a task, providing hints, or including error information. For example, our Web searching instruction contained the hint "Please note: Your target site may be on a subsequent results page" to remind students that additional results pages are created in case their search produced more than ten hits. Although accessing additional results pages had been explained in a previous section, observations revealed that most students ignored these pages. This caused them to erroneously conclude that their search had failed to produce the desired outcomes.

Obviously, not every single error can be prevented. When actions are error prone or when errors are difficult to correct, error information can support users in recognizing and recovering from errors. The 'proverbs and sayings' search task from Figure 2 serves as illustrative example of the need for error information. User observations indicated that students frequently chose "proverb" instead of "proverbs" as a search term. Surprisingly this search did not produce the target site. Because this mistake is difficult to avoid, error information was included to support students in dealing with this error. It is shown as example 1 in Figure 3. As can be seen from this example, error information supports the detection, diagnosis and correction of an error. The problem part directs the students' attention to the screen to check if that particular error has been made. The cause part explains what

accounted for the error. The solution part suggests how students can recover from the error. Also note that errors in performing procedural and self-regulatory skills are supported in similar fashion.

Early detection of an error is especially important for its correction. Error information is therefore presented directly after the actions it refers to rather than in a separate trouble shooting section. Because students who have not made the mistake also read the error information (and also because some find it difficult to discern error information from action steps), an icon may be used to signal its presence.

Insert Figure 3 about here

Principle 10: Gradually fade instructional support

Web searching instruction should capitalize on the users' accumulating understanding of the program. This principle hinges on the concept of cognitive scaffolding. The Web searching instruction should initially provide detailed guidance and support. Throughout the instruction the amount of external support can be gradually reduced as a function of the users' increasing understanding of the instructional content. Among other things, this requires a gradual fading of action prompts to perform procedural skills. An example of the use of this fading technique is shown in the left-hand column of Figure 4.

Insert Figure 4 about here

Two fading techniques may be used to decrease the amount of self-regulatory skills instruction. The first one pertains to the specificity of the instructional support. In this respect, De Jong (1992) proposed to fade self-regulatory skill instruction from a full description of a self-regulatory skill, through a brief description, to a question that prompts learners to perform that skill (see Figure 4). The second fading technique concerns the locus of control. In keeping with the aforementioned call for genuine learning activities, students should always perform practice tasks in full. However, their share

in performing the self-regulatory parts of a search may vary as a function of their prior learning experiences. We applied this strategy in one of our Web searching manuals. On the first search task, students merely had to identify the number of hits. The instruction detailed all other self-regulatory activities, explicitly stating the keyword students should enter, the buttons to they should click, and the Web site they should retrieve. In the course of practice, the responsibility of performing these skills was gradually transferred from the instruction to the learner.

Conclusion

The design principles articulated in this paper aim to guide practitioners in developing instructional materials for learning to search the Web. The principles offer an integrated set of design recommendations that were based on a mixture of theoretical, empirical and practical evidence. Most principles are rather straightforward. And that is exactly what design recommendations should be like. While practical constraints may complicate the application of a design principle, its description should not interfere with the designer's understanding of instructional specifications.

There is, however, a potential danger to presenting design principles as explicit guidelines for this might raise the impression that designing Web searching instruction merely comes down to applying well-tried solutions. Clearly, this is not the case: design always involves a certain level of creativity. It requires a constant balancing between approved ideas and new, original input or expressions that arise from the need to optimally adjust instructional materials to the features of the search system, the task domain or the target population. Practitioners should therefore treat the principles outlined in this paper as starting points for their thinking about the design of Web searching instruction, rather than as a set of trusty techniques they can follow mechanically.

Additional empirical and practical evidence is needed to further validate the current set of design principles. The design principles may thus serve a research agenda for scholars in the field of education and information technology. Research should primarily address the issue of how self-regulatory skills should be treated in Web searching instruction. Theoretical evidence suggests that the presentation principles outlined in this paper facilitate the development of self-regulatory skills. Their

instructional efficacy has been established in various tasks domains. With regard to Web searching, these principles have been found to enhance procedural skills (Lazonder, 2001a); their efficacy in fostering the development of self-regulatory Web searching skills remains to be shown.

The principles attending to the selection of instructional content were extrapolated from studies on Web searching. Assessing their validity therefore seems less imperative even though information technology is evolving at a mind-boggling rate. One reason is that these principles hold no reference to specific browsers and search engines. Furthermore, the instructional content mainly consists of self-regulatory skills. Because of their generic nature, self-regulatory skills can be applied with different search systems (e.g., the selection of search strategies is largely independent of the search system). The advent of more sophisticated browsers and search engines is therefore unlikely to affect the training needs of inexperienced Web users. Nor will the use of these systems affect a user's level of self-regulation. While users can develop procedural skills by interacting with a search system, instructional support and ample opportunities for guided practice are needed to cultivate self-regulatory Web searching skills. This paper exemplified how such instructional support can be designed.

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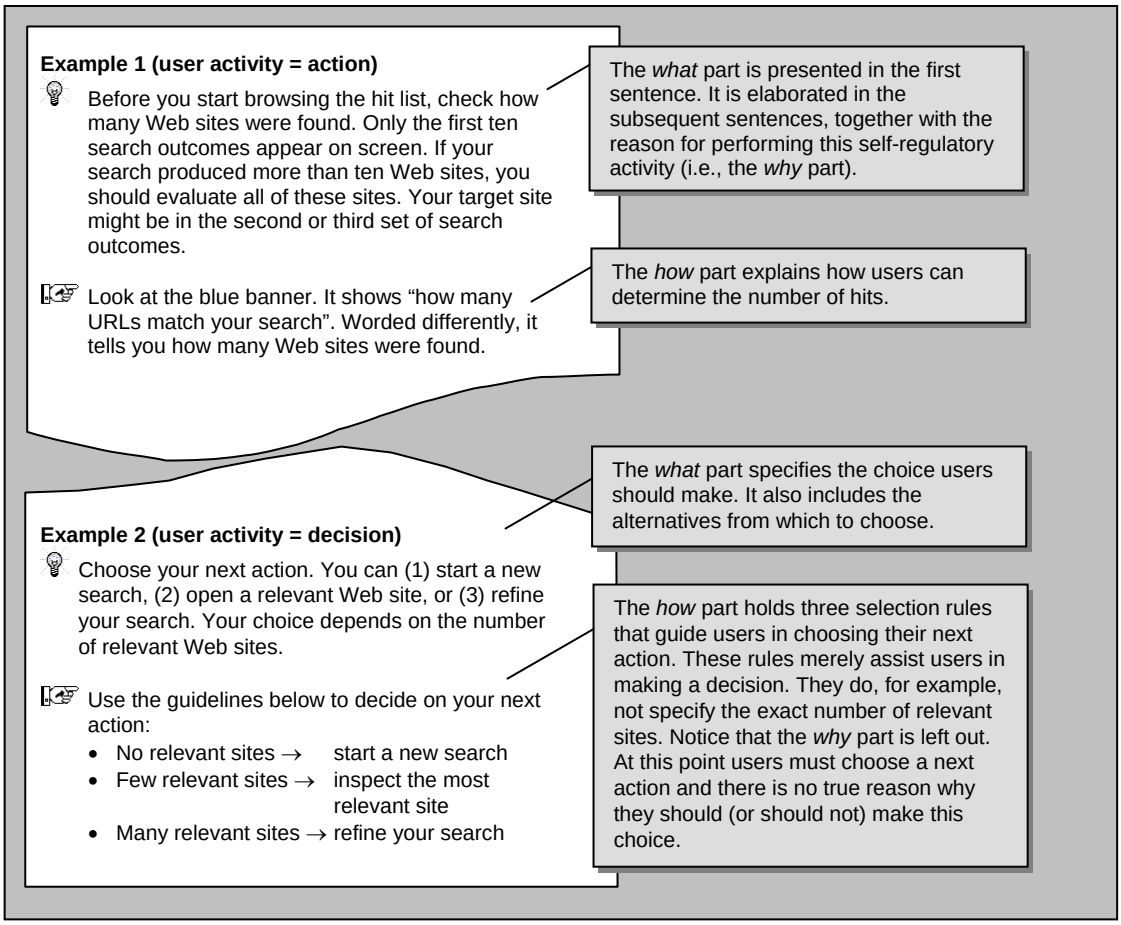

Figure 1. Annotated examples of self-regulatory skill instruction.

You have to give a talk on one of Kees van Kooten's books. Your friends particularly enjoyed the book *Zwemmen met droog haar*. You have decided to read a book review first to see if you share their opinion. Find this book review on the Web.

Your best friend is looking for a summary of *Phileine zegt sorry* by Ronald Giphart. This summary should contain at least four quotations from the book. Help your friend and find this summary on the Web.

As of August 1998, the German spelling has been reformed. Your German teacher has asked you to list the four most important changes. Search for these changes on the Web.

Your Dutch teacher has asked you to explain the meaning of proverbs and sayings. The saying *Als een pareltje in het goud zitten* is not listed in your dictionary. Search the Web for the meaning of this saying.

The Duitsland Institute Amsterdam had recently launched the Duitsland Informatie Net (DUIN), a Web site especially intended for students from secondary education. On DUIN you'll find information on various topics regarding Germany. Two famous German hiphop/rap groups are introduced in the section on popmusic. What are the names of these bands? And what are the Web addresses of their homepages?

Figure 2. Illustrative Web search tasks.

Example 1 (self-regulatory skill)

Problem:	The link **Proverbs and sayings [NL]** does not appear
Cause:	You have selected the wrong keyword
Solution:	Go to the Address bar, type **www.stack.nl/~jeroene/index.html** and press the Enter key.

Example 2 (procedural skill)

Problem:	The text “Sorry, your search had no results” appears
Cause:	You have made a typing error
Solution:	Click the text-entry box, type **Nieuwenhuys**, and press the Enter key.

Figure 3. Two examples of error-information.

PROCEDURAL SKILLS	SELF-REGULATORY SKILLS
First presentation 1. Go to the Address bar 2. Press the left mouse button 3. Type **www.ad.nl** 4. Press the Enter key **Second presentation** 1. Go to the Address bar and press the left mouse button 2. Type **www.loesje.nl** and press the Enter key **Third presentation** 1. Go to the Address bar, type **www.ilse.nl** and press the Enter key **Fourth presentation** 1. Open the site **www.efteling.nl**	**Full description** Before you start browsing the hit list, check how many Web sites were found. Only the first ten search outcomes appear on screen. If your search produced more than ten Web sites, you should evaluate all of these sites. Your target site might be in the second or third set of search outcomes. Look at the blue banner. It shows “how many URLs match your search”. Worded differently, it tells you how many Web sites were found. **Brief description** Before you start browsing the hit list, look at the blue banner to see how many Web sites were found. Your target site might be on an additional results page. **Question** How many Web sites did you find?

Figure 4. Gradual fading of procedural and self-regulatory skill instruction