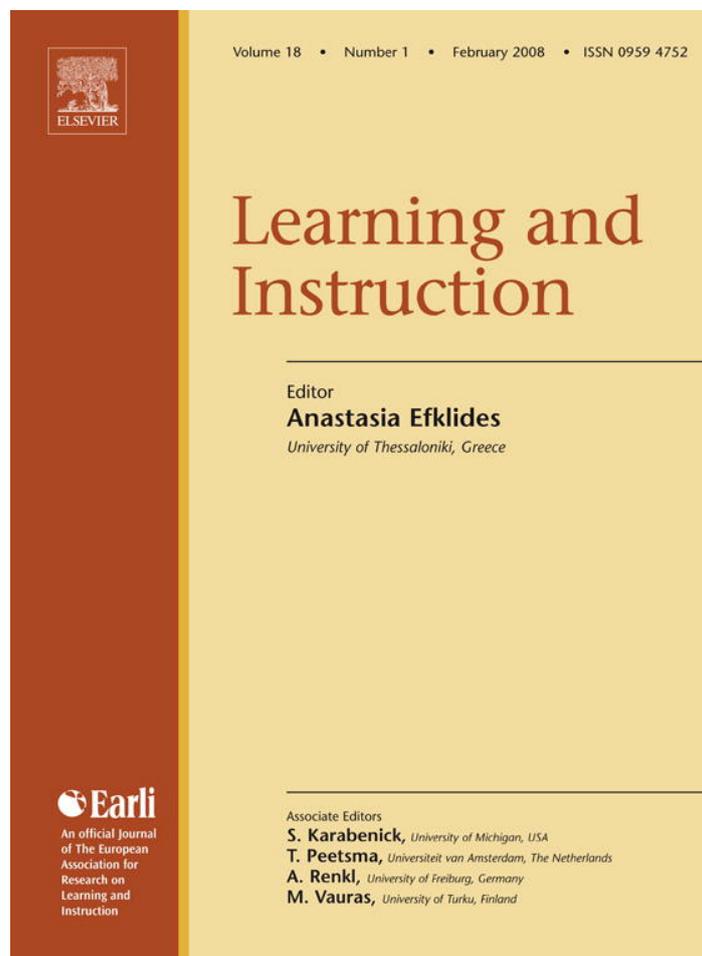


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# Designing for user cognition and affect in software instructions

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## Abstract

In this paper we examine how to design software instructions for user cognition and affect. A basic and co-user manual are compared. The first provides fundamental support for both; the latter includes a buddy to further optimize support for user affect. The basic manual was faster and judged as easier to process than the co-user manual. In addition, it facilitated re-use. Both manuals supported perceived task-relevance, self-confidence and learning equally well. Research is discussed to explicate why the design worked well and how it can be improved.

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*Keywords:* Software instructions; Affect; Minimalism

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## 1. Introduction

An increasing number of researchers from different fields have advanced systematic approaches to user affect (i.e., motivation and emotion). A recent special issue in *Interacting with Computers* (#2, Volume 14, 2002) reflects this movement within the Human Computer Interaction community. Exciting new paths emerge in the design of affect-oriented pedagogical agents. Such agents broaden the bandwidth of tutorial human computer interaction by their capacity to recognize and respond to the user's motifs and emotions (e.g., Brave, Nass, & Hutchinson, 2005; Paiva, Machado, & Martinho, 1999; Picard & Klein, 2002).

A special issue in *Educational Psychologist* (#2, Volume 37, 2002) depicts a similar movement in education with researchers seeking to understand the role of emotions in learning and achievement. The recent development of two design approaches focusing on emotions is in line with this trend. Both Fear, envy, anger, sympathy and pleasure (FEASP; Astleitner, 2000) and Emotional and cognitive aspects of learning (ECOLE; Gläser-Zikuda, Fuss, Laukenmann, Metz, & Randler, 2005) approaches aim at improving the quality of instruction by reducing negative emotions such as fear and anxiety, and increasing positive emotions such as pleasure and well-being. There is a close link between these approaches and motivation design research (e.g., Keller, 1987) as well as with studies that examine how emotions can influence learning (e.g., Efklides & Petkaki, 2005; Pekrun, Goetz, Titz, & Perry, 2002; Schutz & DeCuir, 2002).

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This paper fits within these developments as it examines the design and effect of special measures aimed at supporting and enhancing user affect in software instructions. We begin by describing the minimalist approach as a general framework that attends to basic issues of user cognition and affect in its design for software instructions. Next, we describe how we created a co-user manual in which an alleged co-student, or buddy, shares affect experiences and in which style is adapted accordingly. In an empirical study, this manual is compared to a basic manual.

## 2. Minimalism as a design approach

Software instructions generally serve the dual goal of supporting learning and doing. This is a daunting endeavor because there is an inherent tension between stimulating the user to think about task execution so that he or she remembers it afterwards (learning), and helping the user complete tasks quickly and without considerable cognitive effort (doing). Too little support for learning results in prolonged dependency on instructions. Too little support for task completion quickly kills user interest in the instructions.

The minimalist design approach attends to user cognition and affect as it seeks to attain the goals of learning and doing. The approach originated with John Carroll and his colleagues at IBM who were looking for a way to provide optimal support for people's actions and sense making in learning to use software. Minimalism has been articulated in four key principles: (1) choosing an action-oriented approach, (2) anchoring the tool in the task domain, (3) supporting error recognition and recovery, and (4) supporting reading to learn and do (Carroll, 1990, 1998).

The principle of *choosing an action-oriented approach* touches on the complex design issue of finding a way to balance the learner's need to act and the learner's need for knowledge with which to plan and evaluate action. Invariably, people trying to learn a skill are eager to act, to do something meaningful. But users also need to learn in order to act. A manual should therefore "make genuine activity available to the learner and to scaffold, stage, and structure this activity to ensure that it is tractable and understandable" (Van der Meij & Carroll, 1998, p. 21).

The principle of *anchoring the tool in the task domain* addresses the fundamental issue of finding ways to address the user's interest in the software as a means to accomplish personal objectives. Because the tool is almost never an end in itself, the manual should capitalize on a person's original motivation and help satisfy it. Also, when there are prerequisite tasks people need to be persuaded to try to achieve these before turning their attention to realizing their personal goals. One of the ways of dealing with these issues lies in the careful sequencing and crafting of headings that minimalism promotes (Van der Meij & Carroll, 1998). This is in line with studies that point to the impact of headings on reader interest, comprehension and recall (e.g., Hartley & Trueman, 1985; Lorch & Lorch, 1996; see also Ainley, Corrigan, & Richardson, 2005).

The principle of *supporting error recognition and recovery* addresses the issue that people frequently face failures or breakdowns in learning to use software. Minimalism seeks to mitigate and leverage such moments. It addresses potentially frustrating experiences by stressing that mishaps are to be expected, explains that they may arise from different causes, and supports error recovery. Failures or breakdowns are further exploited to present conceptual information because during these moments people are eager to learn about the software.

The principle of *supporting reading to learn and do* embodies several strategies for dealing with how and when people process software instructions. Reading to learn is supported by giving the user just the right amount of conceptual information needed for understanding. In addition, procedural information is sometimes deliberately incomplete to stimulate inferences and it is faded to stimulate the user to memorize actions. Supporting reading to do requires that the design enables users to quickly locate the most pertinent information when they scan or gloss over a page or text segment. These processes can be facilitated by adopting an approach in which information types are given a unique presentation format. The four types that comprise procedures (i.e., goal information, background information, unwanted states and actions & reactions, see Van der Meij & Gellevis, 2004) should each be given their own format (and place) to make each type recognizable and to allow users to examine or skip these at will. Reading to do can further be facilitated by highlighting key concepts or words within information types. For example, a bold verb in an otherwise plain text of action steps draws the user's attention to the kind of action that is required.

### 2.1. Assessment of the minimalist approach

The minimalist approach converges with instructional design theories that focus on user cognition by proposing a simple to complex sequencing of tasks, a meaningful division of complex main tasks into subtasks, and the

application of various techniques for scaffolding and fading support (e.g., Merrill, 2002; Van Merriënboer, 1997). These strategies also influence user motivation and affect. For example, fading, which is a gradual decline of instructional support and hence important for stimulating learning, also carries a novelty aspect. If properly designed, it has the important collative property of raising student interest and attention.

The minimalist approach also converges with instructional design theories that focus on user affect such as FEASP (Astleitner, 2000) and ECOLE (Gläser-Zikuda et al., 2005) by stressing the need to engage people in meaningful tasks and to guarantee safe progress, among others. Also its explicit treatment of error, an understudied and underestimated component in instructional design theories, is an acknowledged strategy for reducing fear.

Research has repeatedly found better results for minimalist instructions compared to other designs. For example, Carroll, Smith-Kerker, Ford, and Mazur-Rimetz (1987) report statistically significant differences favoring users of a minimal manual over a control manual with a 40% reduction of training time and 50% more basic tasks completed successfully after training. Similar effects have been reported by other researchers (e.g., Lazonder & Van der Meij, 1993; Ramsay & Oatley, 1992; Van der Meij, 1992; see also Van der Meij, 2003).

These studies assess the end results with tasks that users must solve on their own, or for which users can consult their instructions. In this study we refer to the first type of assessment as a *learning* effect, and the latter as a *re-use* effect. Empirical studies have examined learning only for moments immediately after training. The present study also looks at delayed effects (i.e., three weeks after training).

Assessments of minimalist instructions effects on user *affect* after-training have yielded equivocal outcomes. Ramsay and Oatley (1992) report greater satisfaction overall, and higher preference for minimalist instructions in re-use conditions. In contrast, Lazonder and Van der Meij (1993) and Van der Meij (1992) found no differences between minimalist and conventional instructions for measures of user attention, relevance, confidence and satisfaction. The only study reporting absolute scores for affect mentions a modest score of 6.6 on a 10-point scale for measures of relevance and confidence for a minimal manual without illustrations (Gellevis, 2002).

In this study we have tried to further optimize minimalist instructions for user affect with three special measures: relevance organizers, screen displays and deliberate vocabulary use in error-information. Relevance organizers depict a before–after scenario (see Fig. 1). In theatrical plays such a presentation technique is known as ‘late point of attack’ used for engaging and persuading the audience (Goodwin, 1991). The instructions further show screen shots of all major screen states encountered while processing the instructions. This fits the recommendation from Keller’s (1987) motivational design theory to show visual representations of important sets of ideas or relationships. Compared to earlier research, the words used in presented error information were also better attuned to moderating user frustration. In Section 5 we further describe these measures.

Together with the other instructions these measures led to a basic manual that was expected to satisfy fundamental requirements for user affect. We compare the effects of this manual with those of a co-user manual in which an affect-oriented co-student, a type of persona, was introduced to enhance the user’s positive feelings and moderate frustrating experiences. This design measure links with the FEASP principle to ‘establish cooperative learning structures’ with peer helpers serving as a buddy (Astleitner, 2000). The general design of a co-user, along with the stylistic adaptations that followed suit, is discussed in the next section.

### 3. Creating an affect-oriented co-user and a corresponding style

*Co-user.* In their studies on how emotions influence learning and achievement, Pekrun et al. (2002) point to attention as an important mechanism or mediating variable in the influence of emotion on learning and achievement. This idea is also reflected in FEASP (Astleitner, 2000) and ECOLE (Gläser-Zikuda et al., 2005) when these design approaches discuss means to direct the student’s attention to emotions they may want to strengthen or diminish (e.g., in the principle “to let anger be expressed in a constructive way”, Astleitner, 2000). In designing the co-user we decided to focus on two affect-related factors, namely, values and expectancies (i.e., task-relevance and self-confidence) and thereby to direct the student’s attention specifically to these aspects during task execution.

The literature gives only general guidance for creating a co-user. For example, Cooper (1999) argues that designers should aim for creating “one single, well-realized person and forego the useless task of trying to please an aggregate of actual users” (p. 327). Paiva et al. (1999) suggest that important decisions in designing a persona revolve around creating his or her personality, goals, emotional profile, perceptions and (re)actions. A key criterion in such a design is to instill *believability*. The user must perceive the persona as the representation of a real person. Coney and Steehouder

(2000) propose a two step procedure in designing a persona. First, one needs to decide about his or her roles and goals. Will the persona be presented as a person who has just completed the manual, or is he or she a novice plodding along just like the real user? And should the persona instill confidence, arouse interest, reduce distress and so on. Second, the designer should consider the values of the persona and whether to express these directly or indirectly.

In our co-user design we focused on the issues of gender, role, goals and values. First, we chose to present a female co-user, Lineke, because we expected to obtain the biggest gains for girls with their generally lower self-confidence in working with computers (see Colley & Comber, 2003). Next, we constructed a personal profile for Lineke who was to play the role of another novice processing the software instructions for the first time. Her goals and values transpire in the comments she gives on issues of *task-relevance* and *self-confidence* (see Section 5).

*Style.* Lineke, the co-user, presents information of a personal nature in her own personal voice. This contrasts rather sharply with the distant, businesslike manner in which minimalist instructions are commonly presented. Minimalist instructions have very few signs, if any, of the designer attempting to build a personal relationship with the user. There is a sparse use of rhetorical strategies for trying to engage or persuade the user.

The formal nature of this writing style most clearly transpires in the action steps which are always formulated as commands telling the user what to do. Action steps concentrate on their essence, which is to help the user to act on an object (e.g., 'Select File', 'Press the Delete button'). Action steps are also always presented in the same way as numbered steps in a to-do-list (see Fig. 2). There are no stylistic variations to make the information more attractive. All these measures are derivative features from (mainly) the minimalist principle to support reading to do. Befitting the minimalist notion to slash the verbiage, very limited rhetoric is used overall, making the style very basic.

The features that make the basic style easy to process may also give it an impression of being impersonal. It can be perceived as emotionally distant or cold. Instructions presented in this style seem oddly matched with an affect-oriented co-user. We therefore decided to also modify the manual's style and make it more in line with that of the co-user.

We adopted a conversational style in the co-user manual because that is also how the buddy speaks to the real user. This style was expected to strengthen the influence of the co-user. The well-known 'dummies' manuals have a similar style. These books often include a commentator who sides with the user and who appears to be in conversation with the reader.

The contrast with the style in the basic manual is most vivid in the actions steps with full, run-on sentences that are presented as statements that put the user on stage, referring to him or her as you (see Fig. 3). As a result, Action steps in the co-user manual display more variation in syntax and choice of words. Furthermore, each action step is not always presented as a distinct unit. Occasionally linked steps are presented jointly in a single sentence or paragraph.

#### 4. Main research issues

We examine whether the basic manual yields positive results for user cognition and affect. In addition, we investigate whether the measures taken to increase user affect in the co-user manual have their intended effect and also do not negatively influence other outcomes. It is conceivable, for example, that the co-user diverts the user's attention from the other instructions in the manual (compare Harp & Mayer, 1997, 1998). Although the co-user is by no means a seductive detail that is only tangentially related to the topic, her presence may nevertheless function as a diversion. Likewise, it is conceivable that, compared to the simple and repetitive style of the basic manual, the more varied and complex style of the co-user manual negatively influences the time and effort users need to process the instructions. More specifically, the study tests the following predictions:

- (a) *The basic manual yields shorter training time and reduces experienced difficulty compared to the co-user manual.* The user does not need to process the co-user's comments and his or her attention can also not be diverted by these comments. Furthermore, sentence length, syntax and choice of words is more standardized in the basic manual which should facilitate their processing (Hypothesis 1).
- (b) *The co-user manual yields higher judgments of relevance and confidence than the basic manual.* Co-user and style of writing create a co-user manual that should strengthen the user's positive feelings and diminish negative ones (Hypothesis 2).
- (c) *Girls working with the co-user manual score higher than boys on judgments of reading frequency of, and identification with, the co-user. In turn, this influences their judgments of relevance and confidence after training.* Girls

are probably more likely to perceive the female co-user as a buddy, hence to read her comments more often and to identify themselves more with her as a person with whom they share momentary feelings. In turn, this may positively affect their scores for task relevance and confidence (Hypothesis 3).

(d) *Substantive learning effects are expected.* Given earlier positive findings for minimalist instructions participants in both conditions are expected to display a fair level of proficiency on trained tasks both immediately after training and three weeks later (Hypothesis 4).

(e) *The basic manual better facilitates re-use than the co-user manual.* The basic manual focuses on realizing optimal support for reading to do and is therefore expected to yield higher scores in re-use conditions (Hypothesis 5).

## 5. Method

### 5.1. Participants

A total of 114 participants from four, third year vocational educational training classes took part in the study. There were 53 boys and 61 girls with a mean age of 15 years and 6 months. All participants had at least 2 years of computer experience. They could perform basic tasks in Word but generally failed in the formatting options discussed in the instructions. Classrooms were randomly assigned to conditions.

### 5.2. Procedure

A week before training students filled in questionnaires about computer experience and affect. Training took place in a computer room, one class at a time. Students were instructed to “process the entire manual which helps you in better formatting reports”. They were to work on their own and call on the experimenter for help only when stuck. They were also instructed to answer the perceived difficulty questions and time measures during training. Participants could work with the manual for a maximum of 90 min. After a short break, they filled in the questionnaire about affect and then were tested for learning. Three weeks later retention of learning was tested first and then re-use.

### 5.3. Instruments

#### 5.3.1. Manuals

The manuals discussed three main formatting topics in MS Word. The first chapter dealt with adjusting the margins for a complete text. The second discussed indents for text components such as paragraphs, citations and enumerations. The third chapter covered creating and adjusting columns in a table. Participants needed these skills to give their school reports the appearance that is required.

Compared to their predecessors, the minimalist instructions were improved with exercises to stimulate self-exploration, relevance organizers, and a consistent coupling of screen displays with action information. In addition, the wording of error-information was fine-tuned for anxiety reduction.

*Exercises.* It is difficult to achieve a high level of proficiency with a manual. Success hinges mainly on optimizing the balance between mindless copying of procedural instructions and mindful reflections on these actions. Recent studies indicate that minimalist instructions can be improved by replacing its ‘on your own’ sections with exercises (Glasbeek, 2001; Wiedenbeck, Zavala, & Nawyn, 2000). Exercises extend the one-shot experience of following procedural instructions. They give instructions about related goals, but not about the means to achieve these. Thus, they stimulate the user to engage in further practice that is important in developing skill. The manuals used in this study present exercises at the end of each chapter.

*Relevance organizers.* The manuals use an annotated before–after display to increase task-relevance of the student’s training goal (see Fig. 1).

*Screen displays.* Screen captures are frequently presented next to action steps to facilitate an integration of otherwise distinct sources. This is in line with suggestions from cognitive load theory (e.g., Sweller & Chandler, 1994) and also follows Keller’s (1987) suggestion that displays of important objects or situations increase user motivation. The design further adopted the empirical finding that a left-to-right presentation format for text and picture optimizes their processing (Van der Meij, 2000, see Figs. 2 and 3).

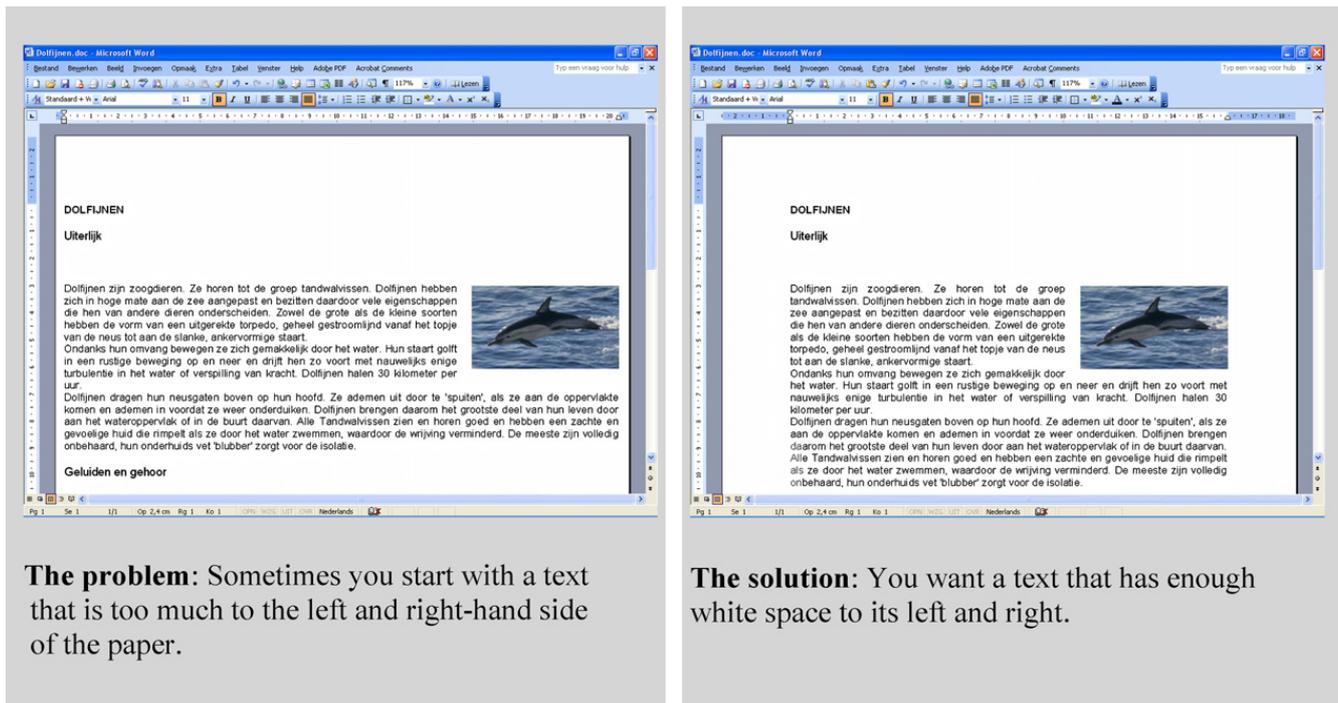


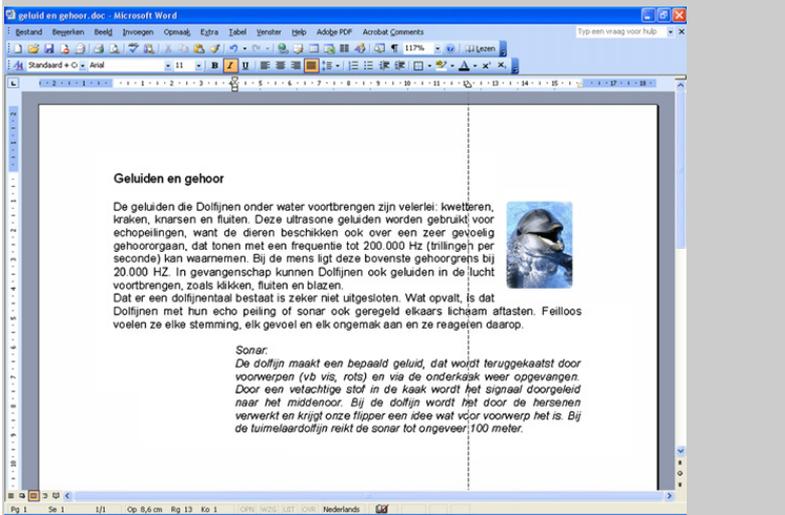
Fig. 1. A before–after display to enhance the perception of task-relevance.

*Error information.* The frequent presence of error information has always been a central component in minimalism. But until now their design has focused on optimizing the support for cognitive processes (i.e., how to detect, diagnose and correct mistakes). In this study, we also paid special attention to optimizing the support for user affect. That is, we deliberately inserted soothing words to moderate user frustration from mistakes and other goal obstructions (e.g., “if

- Position** the cursor in the paragraph you want to change.
- Put** your mouse pointer on 

*Near your mouse pointer a window appears with “Right Indent”.*
- Click** the left mouse button and **keep it pressed down**.
 

*Your screen displays a dotted vertical line.*
- Drag**  to 12 cm.



**1. Position** the cursor in the paragraph you want to change.

**2. Put** your mouse pointer on 

*Near your mouse pointer a window appears with “Right Indent”.*

**3. Click** the left mouse button and **keep it pressed down**.

*Your screen displays a dotted vertical line.*

**4. Drag**  to 12 cm.

Fig. 2. A section from the basic manual.

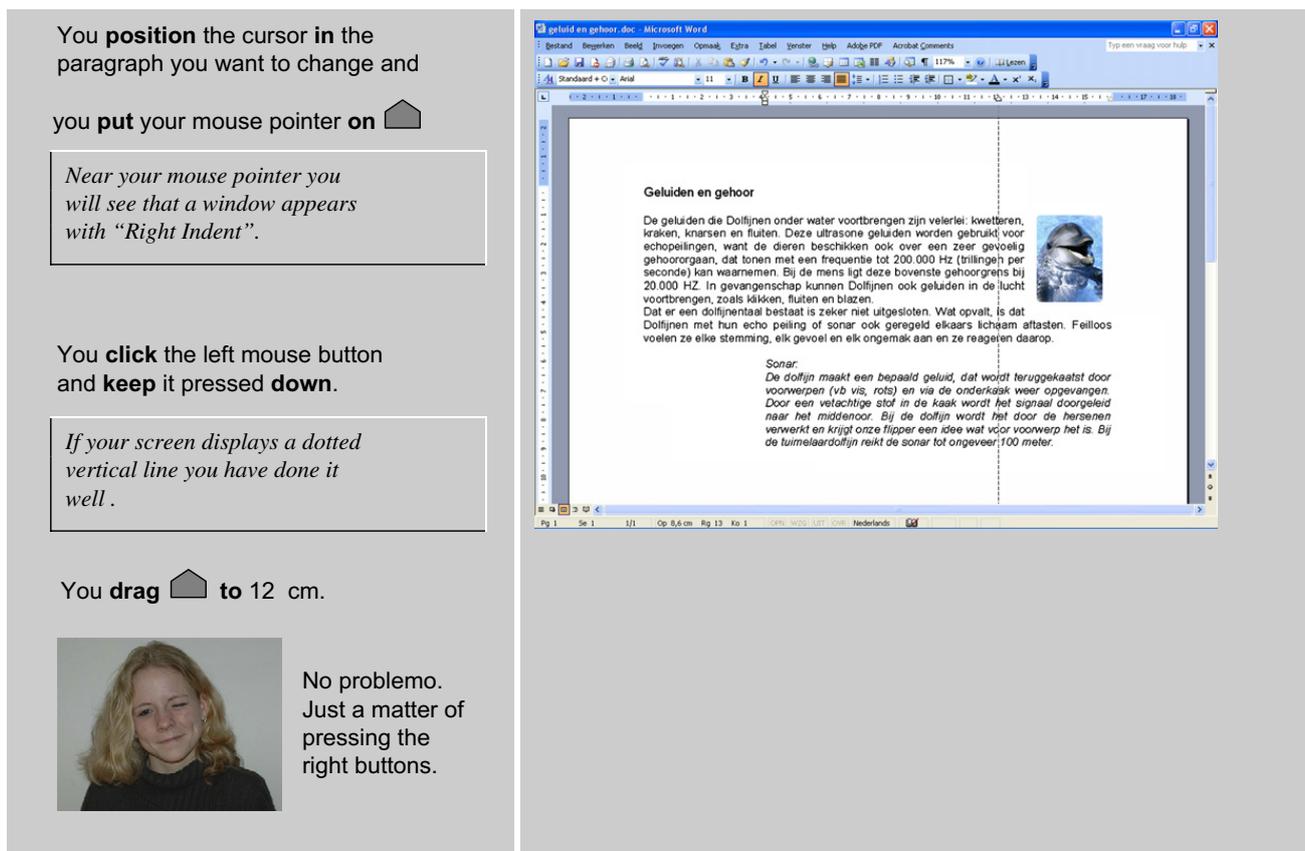


Fig. 3. A section from the co-user manual.

you have *accidentally* clicked...”, “This may be odd, but *it’s just how things are*”, and “... will shift. *Don’t worry*”, emphasis added).

The co-user manual was grounded on the basic manual. The general nature of the added co-user and of the corresponding, conversational style has already been discussed. The specific aspects involved in designing the co-user are presented below.

*Persona.* First a personal profile was created. This was based on the data from a female participant from the pilot study who displayed just the right amount of interest and uncertainty we set out to influence. The profile concentrates on the co-user’s role, goals and values (compare Paiva et al., 1999). Her role was that of a reflective user, commenting on moments that called for such a reaction. Her goals and values mainly dealt with issues of task-relevance and self-confidence. In the actual design we attended to the ‘when’, ‘what’, and ‘how’ for presenting co-user comments.

Typical moments for presenting persona comments (‘when’) are the introduction and successes or failures in task completion. First, the co-user, Lineke, introduces herself in the manual as a 15 year old girl from the target population. She says that she frequently must hand in well-formatted reports in which she fails. She further expresses her interest in the instructions and expresses the hope that the effort she spends in their processing will improve her formatting skills. In the remainder of the manual, Lineke mainly comments on successes or failures (e.g., formatting problems, new system states, (sub)task completion, and system feedback). This is in line with the design approach of Paiva et al. (1999), and can also roughly be linked with the observation that in literary texts character emotions tend to culminate with the plot structure (i.e., with goal success and goal failure, see Dijkstra, Zwaan, Graesser, & Magliano, 1994).

Content of the co-user (‘what’) varied systematically on goals and processes. She always addresses task relevance (e.g., “Oh yes. How funny. That’s handy”), or user confidence (e.g., “I can remember this”). In addition, she expresses important thought processes (e.g., “Just one word? All one by one?”), feelings (e.g., “Cool”, “Careful”, “... awful ...”), or a combination of the two.

For proper tone of voice, expression and word choice ('how') we used think-aloud protocols from pilot study participants and consulted popular youth magazines. Occasionally affect words were inserted such as "funny", "happy", "odd", and "relaxed". The comments were critically evaluated by some participants of the target audience and then finalized. Each comment was accompanied with a matching facial picture from Lineke (compare Brave et al., 2005). These pictures depicted affect states and frames of minds such as happiness, gloominess, appreciation, confidence and daring.

The added presence of the persona and change in style increased the length of the manual. Whereas the basic manual has 2.992 words on 33 pages, the co-user manual has 4.004 words on 38 pages.

### 5.3.2. *Measuring the dependent variables*

All questionnaires in the study use a 10-point Likert-scale. Answers are scored by drawing a cross somewhere on a continuous line of which only the two extreme positions are marked by a description (e.g., 'completely agree' and 'completely disagree'). The student's score is measured by looking at the corresponding number on a transparent template that divides the line into 10 equal sections.

*Computer experience* is measured with five questions (e.g., "I often work with computers", "I often use Word"). For *affect* two components from Keller's (1987) Attention, relevance, confidence, and satisfaction (ARCS) model are measured, namely, relevance and confidence. The affect pre-test has 10 questions about general aspects of using the computer for reports (e.g., "I find the computer handy to write reports"). The affect post-test has 16 questions about relevance of and confidence in formatting (e.g., "I can use what I learned for my reports", "I can now give my reports a nice format"). Reliability was satisfactory (Cronbach's  $\alpha$  ranged between 0.68–0.81).

Instead of believability, we measure the user's *identification* with the persona. The first is conditional for the latter. Identification signals the presence of shared affect between user and co-user. The identification questionnaire consists of 12 questions. The first inquires after reading frequency (i.e., "How often did you read Lineke's comments?"). The remainder are questions such as "Lineke said what I was thinking of", and "I felt just as Lineke did" (Cronbach's  $\alpha = 0.67$ ).

*Perceived difficulty* is measured by asking students repeatedly (11 times) during training about the experienced difficulty immediately after completing task instructions (i.e., "How difficult was this task for you?"). *Training time* is the total time for processing the instructions. *Learning* and *re-use* are measured with hands-on tests which present trained tasks on the three main topics of the manuals. Successful task completion is reported. The two parallel test versions yielded nearly identical outcomes and their distinction is ignored in reporting the findings.

### 5.4. *Data analyses*

The study is quasi-experimental with two conditions. There are assessments before, during, and after training (both immediately after and three weeks later). ANOVAs on the data gathered before training indicated there were no differences between conditions for computer experience and affect. There was no gender difference for computer experience,  $F(1,107) = 1.78$ , n.s., but there were gender differences for affect. Boys scored higher on relevance,  $F(1,107) = 8.64$ ,  $p = 0.004$ ,  $d = 0.33$ , as well as confidence,  $F(1,107) = 18.03$ ,  $p < 0.001$ ,  $d = 0.83$ . Gender was therefore treated as a covariate in the analyses. Scores for the three chapters (i.e., topics) are treated as repeated measures. Significance level for the ANCOVAs is set at an  $\alpha$  of 0.05. For effect size we report Cohen's (1988)  $d$ -statistic.

## 6. Results and discussion

### 6.1. *Training time and experienced difficulty*

The results for training time supported Hypothesis 1 (see Table 1). Participants working with the basic manual consistently needed less time to complete training,  $F(1,105) = 9.31$ ,  $p = .002$ ,  $d = .059$ . Participants in both conditions found the instructions easy with an overall mean score of 2.27 on a 10-point scale. Even so, judgments of lower experienced difficulty were consistently found for the basic manual,  $F(1,104) = 3.40$ ,  $p = .015$ ,  $d = 0.32$  (see Table 1). Perhaps this is so because users of the co-user manual must digest more text. However, it is also possible that the simpler style of the basic manual led to this finding.

Table 1  
Instruction type and training time (in minutes) and experienced difficulty per topic

	Margins		Indents		Columns		Overall	
	M	s.d.	M	s.d.	M	s.d.	M	s.d.
<i>Scores for training time</i>								
Basic manual	9.76	2.07	14.18	2.74	36.00	7.59	59.92	10.35
Co-user manual	10.98	2.52	16.91	4.93	40.80	13.36	67.18	14.06
<i>Scores for experienced difficulty</i>								
Basic manual	1.42	0.69	2.11	1.16	2.86	1.39	2.13	0.87
Co-user manual	1.66	0.99	2.38	1.23	3.20	1.48	2.42	1.01

Note. Judgments for experienced difficulty are made on a 10-point scale (1 = very easy, 10 = very difficult).  
M = mean. s.d. = standard deviation.

### 6.2. Judgments of relevance and confidence

The findings for judgments of relevance and confidence did not support Hypothesis 2. Participants working with the co-user manual gave only slightly more favorable scores for affect after training ( $F_{\text{relevance}} < 1$ ;  $F_{\text{confidence}} < 1$ ). The absolute scores signal high levels of appreciation with mean scores well above 8 on a 10-point scale (see Table 2). Participants in both conditions said that they found the tasks very relevant, and also expressed considerable confidence in being able to perform similar tasks later on. In short, both manuals sufficiently supported these aspects of user affect. The high scores on user affect in the basic manual left little room for additional gain in the co-user manual. In other, more complex learning situations, a stronger impact might have emerged. It is certainly too early to judge on the basis of just this study that co-user presence does not matter. At the very least, the data for learning effects show that she did not function as a seductive detail.

### 6.3. Gender differences

The findings supported Hypothesis 3 that girls would attend to the co-user more often. Girls mentioned reading 76.7% (s.d. 27.6) of all her comments; boys said they did so for 58.1% (s.d. 36.2). The difference is statistically significant,  $F(1,53) = 4.47$ ,  $p = .02$ ,  $d = 0.58$ . As predicted, girls also identified more with the co-user than boys,  $F(1,53) = 3.05$ ,  $p = .04$ ,  $d = 0.48$ . Reading frequency and identification data both suggest that participants believed they were reading about a real person. Believability of the persona appeared to be not challenged.

The absolute scores for identification were relatively low with a mean score of 3.4 on a maximum of 10. This is a cause for concern as it may lead to a low influence of the persona. In the conclusion we further debate this issue when persona content is discussed. No main effect was found for gender on after-training scores for judgments of task relevance,  $F(1,51) = 1.69$ , n.s., or confidence,  $F(1,51) < 1$ , n.s.

### 6.4. Learning effects

The findings for learning indicated that participants in both conditions developed a moderate overall proficiency on assessments immediately after training and three weeks later. But there were considerable differences between topics (see Table 3). Participants succeeded in completing the majority of tasks for margins and indents without support of

Table 2  
Instruction type and affect scores after training

	Relevance		Confidence	
	M	s.d.	M	s.d.
Basic manual	8.14	1.32	8.07	1.55
Co-user manual	8.30	1.33	8.16	1.21

Note. Judgments are made on 10-point scales (1 = very low appreciation, 10 = very high appreciation).  
M = mean. s.d. = standard deviation.

Table 3  
Instruction type and scores (percentages) for learning and re-use per topic

	Margins		Indents		Columns		Overall	
	M	s.d.	M	s.d.	M	s.d.	M	s.d.
<i>Scores for learning immediately after training</i>								
Basic Manual	72.5	39.6	86.5	21.3	15.5	10.4	50.2	12.8
	63.3	46.9	89.1	16.9	17.1	14.8	51.0	14.6
Co-user Manual	68.1	43.3	87.8	19.3	16.3	12.7		
<i>Scores for learning three weeks after training</i>								
Basic Manual	35.7	44.5	81.5	26.4	8.5	12.0	39.6	15.1
	32.7	44.1	78.7	20.6	10.2	10.0	39.1	11.6
Co-user Manual	34.2	44.1	80.0	23.5	9.3	11.0		
<i>Scores for re-use three weeks after training</i>								
Basic Manual	58.3	49.8	93.4	13.7	19.3	26.4	52.4	16.0
	42.0	49.9	89.2	20.0	19.0	21.0	48.9	13.1
Co-user Manual	50.0	50.3	91.2	17.3	19.1	23.7		

M = mean. s.d. = standard deviation.

a manual, which confirmed Hypothesis 3. However, there was only marginal success for columns. This may be caused by a mixture of task complexity and lack of sufficient practice. The instructions described the creation of a complex column with four tab types (i.e., right, left, center, and decimal) and two different ways of presenting these (i.e., selecting standard tabs, or creating self-chosen ones). This array of options may have confused the user. And with only one exercise on the differential use of tabs, users may have had insufficient practice to consolidate learning.

There was an overall decline for learning over time,  $F(1,85) = 36.84$ ,  $p = .001$ ,  $d = 0.79$ , especially for the margin instructions. For indents the performance remained at a high level of proficiency.

### 6.5. Re-use effects

The findings for re-use supported Hypothesis 5. The scores for the basic manual were higher for all topics (see Table 3). The difference was marginally significant,  $F(1,96) = 2.50$ ,  $p = 0.059$ ,  $d = 0.24$ . The present study cannot reveal whether re-use benefits from simply having less pages to wade through, from an absence of a persona, or a simpler style. This is an issue for future study. The scores for re-use were significantly higher than for learning,  $F(1,95) = 69.34$ ,  $p = 0.001$ ,  $d = 0.80$ , which signals that performance was strongly affected by having instructions available for consultation.

## 7. Conclusion

The basic instructions did best in achieving the dual purpose of supporting learning and doing. As predicted, training time was shorter, experienced difficulty was lower, and there was a higher performance in re-use conditions compared to the co-user manual. In both conditions we found substantive learning on two of the three topics that were taught, as well as high ratings for relevance and confidence.

These findings indicate that the minimalist approach offers an attractive framework for designing instructions for self-directed learning on software use. We believe that this stems from the fact that minimalist instructions explicitly address both user cognition and affect. Minimalism originated in observations that in learning to use software most people have an urge to act and to exercise meaningful practices. Observations further revealed that users repeatedly encountered problems for which they needed support, and that users had varied reading goals (i.e., to learn and do) which they expected to be accommodated. Existing software instructions insufficiently addressed these issues which prompted minimalism and led to its four key principles (e.g., Carroll, 1990, 1998).

In the present study we took special measures to further optimize the support for user affect. Relevance organizers, screen displays, and deliberate affect-related vocabulary use in error-information all may have contributed to positive appraisals for task relevance and self-confidence, leaving very little room for the additional improvements of the

added co-user and an adapted, conversational style. What else than a ceiling effect, and perhaps the need to examine a more complex instructional setting, can explain the lack of effectiveness of the latter measures?

There are at least three arguments about co-user *content* that could explain its lack of influence. First, the co-user may not have been a plausible person. While every effort was made to make her believable, we cannot be sure that we succeeded because we did not measure believability directly. Reading frequency and identification data can be only suggestive in this respect. Second, the experiences of the co-user may not have been shared by the real user. The majority of users may have experienced different emotions than the co-user and hence not be influenced by her emotions. Indeed, we may even have been wrong in assuming that empathizing or siding with a co-user is a necessary and sufficient condition for affecting the real user's values and expectancies. Third and finally, the co-user may have influenced reader interest. The co-user presents the experiential emotional arousal of Lineke as she processes the instructions. She may thus have made it more salient to real users that they too should reflect on their judgments of relevance and confidence. Instead of a seductive detail that stood in the way of learning (compare Harp & Mayer, 1997, 1998) the co-user may have 'both quantitatively and qualitatively altered the texts' (Sadoski, 2001, p. 272). She may have turned user's attention to additional goals in their text processing. That the co-user did not, in the end, affect the outcomes for these goals is a different matter.

Also the *timing* of the co-user may have reduced its effect. In concert with design guidelines from the literature, the co-user was mainly a commentator, reacting after-the-fact on successes or failures in goal achievement. As a result, her influence on the user's initial perceptions of task-relevance or self-confidence was low.

The various arguments presented above suggest that further research on the influence of a persona on such processes as shared emotions and interest should consider the very dynamic role of affect. That is, it should capture the changing patterns of interactions between cognitive and affective processes during task execution. An example of how such a study can be conducted is given by Ainley, Hidi, and Berndorff (2002) and Ainley et al. (2005) who followed a set-up in which real-time measures were taken of momentary emotions (rather than difficulty ratings) and interest triggered by topic titles. The set-up helped support claims about a causal chain in which individual interest in a domain influenced topic interest in a text, topic interest triggered affect, affect influenced the decision to keep on reading (persistence) and persistence influenced outcomes.

And what about the influence of style? Since it has been mixed with the presence of a persona, its effects on the outcomes cannot be tracked. Clearly, this is an issue for further research, using more controlled experimentation so that key factors can be examined. Such efforts could be framed, among others, within research on concreteness which posits that design variations such as the presence of a human voice, the incorporation of concrete actions and the use of a less formal, more conversational language (including personal referencing with 'you') makes texts more interesting, more comprehensible and yields better learning (e.g., Moreno & Mayer, 2004; Sadoski, 2001).

In conclusion, the present study indicates that good outcomes on user cognition and affect can be realized by adopting a minimalist design approach to support learning to use new software. But knowing that it works and knowing how it works are different matters. This study departed from a design approach, seeking to find a design solution for a very relevant practical problem. As we articulated our design it became increasingly clear that further optimization hinges on more fully understanding the underlying processes. This does not mean that we should refrain from designing user support on the basis of what is already known. It is merely an argument that we should also get to know better how user cognition and affect conspire in realizing reader interest, comprehension and learning.

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