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LEARNING TO USE A WORD PROCESSOR WITH CONCURRENT COMPUTER-ASSISTED INSTRUCTION

HARM J. A. BIEMANS and P. ROBERT-JAN SIMONS

University of Nijmegen, The Netherlands

Abstract

In this study the effects of embedding regulation questions and regulation hints in a concurrent computer-assisted instruction (CAI) program aimed at learning to use a word processor were examined. This instructional shell WP-DAGOGUE controlled the interaction between the subject and the word processor WordPerfect. The three regulation conditions were characterized by: (1) content help plus regulation questions plus regulation hints; (2) content help plus regulation questions; (3) content help only. Half of the Ss (second graders, lower vocational education) worked individually and the other half worked in pairs during four training sessions. Ss assigned to the first regulation condition scored higher on the performance tests delivered after the training than Ss from the other two conditions. Especially Ss who were not very familiar with the word-processing concepts profited from the additional support of regulation hints. Ss working individually reached better learning results than Ss working in pairs. Thus, for situated learning to use a word-processing program to be effective, more than content help appears to be needed. Especially in the initial phases of learning, regulation questions and regulation hints can help students find their way.

Introduction

With respect to regular education, Bransford, Vye, Adams and Perfetto (1989) concluded that a vast proportion of the instructional time is reserved for transferring information (i.e., the learning content) to the learner. Hardly any attention is paid to the activities learners should undertake themselves to grasp the learning content. Aarnoutse (1990) reported that less than .1% of the teacher–pupil interactions in the classroom is aimed at improving reading and learning strategies. Recent studies concerning learning processes, however, revealed that knowledge and skills cannot be transferred in a direct way but result from mental activities by the learner (Resnick, 1989; Ali, 1990; Duffy & Jonassen, 1991; De Jong, 1992; Vermunt, 1992). The quality

Address for correspondence: H. Biemans, Department of Educational Sciences, University of Nijmegen, P.O. Box 9103, NL-6500 HD Nijmegen, The Netherlands.

of the learning results appears to be dependent on the quality of the learning activities. This implies that instructional strategies should focus to a higher extent on the learning activities. However, "the implicit goal of many instructional strategies espoused by instructional designers appears to be to supplant thinking rather than engage or enhance it" (Jonassen, 1991, p. 8). What are the crucial activities to be performed during learning? Following Shuell (1988), we distinguish five learning functions that have to be performed to ensure adequate learning (Simons, 1991):

(1) preparing learning;
(2) taking learning steps;
(3) regulating learning;
(4) providing feedback and judgment;
(5) maintaining concentration and motivation.

Each of these learning functions includes various activities that can be undertaken either by the learner or by an external source, for instance a teacher or a computer-assisted instruction (CAI) program, depending on the way the learning situation is organized (Simons, 1991).

Instructional systems can influence the learning functions in three different ways (see Vermunt, 1992). In the case of direct teaching the learning functions are fulfilled by an external source (see Broeckmans, 1990). This kind of instruction is characterized by a high degree of external control. The external source initiates and fulfills the learning functions (taking over), leaving only few possibilities for the learner. Another option is activation of the learning functions (see De Jong, 1992). Activation of a particular learning function pertains to forcing the learner to undertake the corresponding activities in a specified way. Although the learner has to perform the learning functions, the degree of external control is still relatively high. The learning functions are initiated and structured by the external source through the presentation of assignments. The last way in which instructional systems can influence learning functions is by stimulation (see Vermunt, 1992) which involves either providing general advice to execute certain learning activities or training the learner to fulfill the learning functions. Compared to the option of activation, stimulation is typified by a lower degree of external control. The learner is stimulated to initiate and perform the corresponding activities.

If the student is able to learn in an adequate way with a low degree of external support, the learning is self-regulated. In our opinion, self-regulated learning pertains to being able to prepare one's own learning, to take the necessary steps to learn, to regulate learning, to provide one's own feedback and judgment and to keep oneself concentrated and motivated. The more the learning functions are fulfilled by the learner, the more self-regulated learning is (Simons, 1991).

Empirical Background and Research Questions

Diagnostic studies have revealed that the self-regulation activities of successful students differ from the activities of less successful students both qualitatively and quantitatively (e.g., Bereiter & Bird, 1985; Zimmerman & Pons, 1986; Garner, 1988; De Jong, 1992). Based on a review of the literature on self-regulation and his own diagnostic studies, De Jong (1992) concluded that differences in learning results are connected with differences in the use of regulation activities. Especially regulation activities like "process monitoring", "directing" and "testing" appear to be important determinants of learning results.

During the last decade many training programs have been developed to improve self-regulation skills (for an overview see Nisbet, 1989). These training programs differ considerably with respect to the degree of external control provided by the learning environment. Some programs are characterized by a relatively high degree of external control (taking over or activating the learning functions) while with other procedures learners have to rely on themselves to a higher extent (stimulating the learning functions) (see Wittrock, 1990). A third option is an explicit gradual transfer of the responsibility for the learning process from the learning environment to the learner ("scaffolding") (Reeve, Palincsar, & Brown, 1987). This "fading" of external control is one of the most important principles of the so-called "cognitive apprenticeship" approach (Brown, Collins, & Duguid, 1989).

The CAI programs designed by De Jong (1992) were based on a similar transition from external to internal regulation. In his intervention programs students were trained in the use of various regulation skills based on knowledge about regulation activities. His training programs were embedded in regular reading courses. Subjects were students from primary, secondary and special education, ages ranging from 10–18. Supported by a regulation heuristic in the form of questions and hints Ss had to regulate their learning process (see Biemans, 1989). Information concerning the regulation heuristic was presented at three levels, varying with respect to the nature of the information being provided and the level of abstraction (see De Jong & Simons, 1990). At the first level the heuristic was depicted as a flow chart and at the second level the steps of the flow chart were translated into regulation questions to be answered by the student. At the third level additional information was presented in the form of regulation hints (the so-called "What", "How" and "Why" parts). These parts contained information about what was meant by a particular step, about the way to perform this step and about the reason why it was important to do this ("informed training"). In an earlier study, Paris, Newman, and McVey (1982) had shown that "informed training" led to more adequate strategy use and to better learning results in terms of maintenance than "blind training".

During the first part of De Jong's training procedures the heuristic was presented all the time as a flow chart and the two deeper levels could be consulted any time the student wanted to do so. At regular times the program also intervened without request of the student. The program checked whether the student was using the heuristic and provided regulation hints to the student when he/she did not (activation). In that case the two deeper levels of the learning aid were presented again. These interventions were "scaffolded" during the last part of the training in that the frequency of their occurrence was lowered (see Reeve, Palincsar, & Brown, 1987). Finally, the interventions of the program stopped completely.

The training had positive effects on the learning activities and the learning results of Ss from secondary schools (De Jong, 1992). For students from primary schools and learning-disabled students, however, the effects of the training were poor. Probably, the developmental level of cognitive and/or reading skills was a crucial explanatory factor (see also Brown & Barclay, 1976; Garner, 1988). An additional explanation, especially with respect to the learning-disabled students, could be that the training should be more focused on the affective, volitional and motivational factors impeding active, adequate learning (see Corno, 1988).

However, De Jong's studies showed that a training procedure based on regulation questions and hints can be successful in terms of regulation activities and learning results. Similar findings were reported by other researchers like Salomon (1988), Wade and Trathen (1989) and Van Deursen (1991): Embedding regulation questions and hints can enhance the adequacy of strategy use and lead to better learning results. Besides, these projects proved that the computer can be used to train self-regulation.

The present study focused on the effects of regulation questions and hints as such. Thus, in this case, there was no gradual withdrawal of the regulation help. The training was aimed at learning to use a word-processing program (WordPerfect 4.2). As was shown by Carroll and his colleagues (Carroll, 1984; Carroll & Mack, 1984; Carroll & Rosson, 1987), new users prefer to learn such a program as they are using it. They tend to start as soon as possible, they hate to use manuals and they prefer to learn actively. New users show the tendency to rely on a trial-and-error strategy. They simply strike out into the unknown without regulating the learning process (Van Merriënboer & Krammer, 1987). This does not appear to be an effective strategy (Leemkuil, 1992).

How can we help new users to learn a word-processing program, taking these preferences into account? Carroll and his associates devised new kinds of manuals, the minimal manuals, in which the amount of text to be read is as limited as possible. Another option is to provide help through a concurrent shell. Then, feedback and support can be given and asked for whenever learners need it. Learning can be "situated" (see Brown, Collins, & Duguid, 1989) in the sense that the new user can learn when he/she encounters a problem while working on real tasks. Such a concurrent shell is WP-DAGOGUE, available on the commercial market in The Netherlands. Typically, a concurrent shell only provides content help on word-processing. Can students learn to use WordPerfect using such a shell, or do they need more help? In particular, should regulation help as described in the abovementioned studies of De Jong and others be added to WP-DAGOGUE?

The first research question was whether embedding regulation questions (with or without regulation hints) in the shell would improve the learning activities and learning results of the Ss. Three versions of a CAI program were developed, all characterized by a different but constant degree of external regulation control:
(1) content help plus regulation questions plus regulation hints;
(2) content help plus regulation questions;
(3) content help only (control condition).

The three versions varied with respect to the degree in which the learning function "regulating the learning" was fulfilled by the learning environment. For the first version of the program, the degree of external control was the highest. Not only was content help provided, but regulation questions were posed by the program as well. In the case of an incorrect answer, additional help was provided in the form of regulation hints (activation of the learning function "regulating learning"). Working with the second version of the program, Ss had to regulate their learning process based on the regulation questions but without the support of the regulation hints (stimulation of the learning function "regulating learning"). The third version of the program was characterized by the lowest degree of external regulation control. No regulation questions were posed and no regulation hints were given. With this third version, Ss had to fulfill the learning function "regulating learning" themselves. This regulation condition served as a control condition. Based on the above-mentioned studies of De Jong and others, our hypothesis was that the first (and probably the second) regulation condition would lead to more adequate learning activities and to better learning results than the control condition.

The second research question was whether co-operative learning would enhance the effectiveness of the regulation training. In the literature on self-regulated learning, the viewpoint that learning is (or should be) social, is strongly defended. Vygotsky (1978) already stressed the social aspects of learning in relation to the development of higher psychological processes. In the training programs of Brown, Palincsar, and Armbruster (1984), dialogues between the teacher and the students and between the students themselves were critical elements ("reciprocal teaching"). Other researchers like Paris, Cross, and Lipson (1984) and Miller, Miller, and Rosen (1988) also designed social-interactive learning environments that were successful in terms of learning activities and learning results of the students. With respect to learning to use a computer program the benefits of cooperative learning are frequently accentuated too (see Krammer & Berendsen, 1989; Nilshon, 1989). Thus, to examine the effects of cooperative learning in relation to the particular regulation condition, Ss were assigned to two way of working conditions. Half of the Ss had to work individually and the other half had to work in pairs.

Method

Subjects

Ss were 133 second grade students (lower vocational education), ages ranging from 13 to 16. As part of a regular course in Dutch, Ss had to learn to use several basic functions of the word-processing program WordPerfect (version 4.2). In the first grade most students had learned the basics of the use of the personal computer and the word processor PC-TYPE.

Design

In this experiment a factorial design was used. Ss were randomly assigned to six training conditions. These conditions were defined by the combinations of the levels of two between-subjects factors called Regulation and Way of working. The factor Regulation had three levels and the factor Way of working consisted of two levels. Besides Regulation and Way of working two other factors called Competence and Familiarity were used as independent control variables.

The factor Competence was derived from the score for computer science in the first grade. Based on this score, Ss were assigned to the High competence group or the Low competence group.

The factor Familiarity was based on the total score on the Familiarity inventory filled in by the Ss prior to the first training assignment. It was a list of 16 word-processing concepts selected from the four training assignments. With each word Ss had to state on a 3-point scale how often they had heard, read or seen something about that particular concept before. Based on the total familiarity score, Ss were assigned to the High familiarity group or the Low familiarity group.

The effects of the between-subjects factors on the learning results were measured by means of a reproduction test, an insight test and an application test. Since the total reproduction score, the total insight score and the total application score were regarded as repeated measures, a mixed between-within-subjects design (Tabachnik & Fidell, 1983) was used. The factor Level of measurement with the levels Reproduction, Insight and Application was introduced as a within-subjects factor.

The effects of the between-subjects factors on the learning activities were measured by means of two inventories, the ULC-1 and the ULC-2. The total scores on the six scales of the ULC-1 on the one hand and the total scores on the six scales of the ULC-2 on the other hand were regarded as repeated measures. Therefore, in this case, a mixed between-within-subjects design was used as well. The factor Trial with the levels Pretest and Post-test was introduced as a within-subjects factor for each of the six scales.

Tests

The effects of the between-subjects factors on the learning results were measured after the training by means of a theoretical test and a practical test. The theoretical test consisted of 32 multiple-choice questions, each with three alternatives. The first half of these questions involved reproduction while the second half measured insight and understanding. The questions were directly related to the assignments Ss had done during the training. A total reproduction score and a total insight score were calculated. The practical test consisted of 16 exercises with WordPerfect and was aimed at application. These exercises were also based on the training assignments. During the practical test Ss had to use basic word-processing functions. The key strokes of the Ss were saved by means of a registration program that was developed by the Dutch Institute for Achievement Test Development (CITO). For each subject the file of key strokes was split into strings corresponding to the various exercises of the test. Each string was scored in terms of adequate or inadequate execution of the corresponding exercise and after that a total application score was calculated.

The effects of the between-subjects factors on the learning activities were measured by means of two inventories, the ULC-1 and the ULC-2. These instruments were based on two existing inventories of learning styles, the ILS-TW (Van Rijswijk, Vermunt, & Teurlings, 1990) and the ILS (Van Rijswijk & Vermunt, 1987). Both the ULC-1 and the ULC-2 consisted of 26 statements about learning activities that could be employed while doing assignments with WordPerfect. Before the training Ss had to fill in the ULC-1. With each statement they had to predict on a 5-point scale how often they would employ the corresponding learning activity while doing the training assignments. The ULC-2, which Ss had to fill in after the training, consisted of the same statements in the same order. The only difference was that Ss had to tell how often they had actually employed the corresponding learning activity during the training.

The statements of the ULC-1 and the ULC-2 were classified in two categories: transformation activities and executive-control activities. The transformation activities were divided into three scales:
(1) deep transformation (characterized by searching for relations and main ideas);
(2) step by step transformation (characterized by analyzing step by step and memorizing factual information);
(3) concrete transformation (characterized by personalizing and selecting practically useful information).
The executive-control activities were also divided into three scales:
(1) self-control (characterized by control of the learning process by the student);
(2) external control (characterized by dependence on the control hints provided by the learning environment);
(3) lack of control (characterized by perception of difficulties regarding the control of the learning process).
These scales were identified by Van Rijswijk and Vermunt (1987). For each subject a total score was calculated for each of the six scales both before and after the training.

Procedure and Training

Introduction, Training and Testing Sessions

The experiment was embedded in the regular curriculum. As the students had been divided into 10 groups there were 10 sessions a week, one for each group. All training sessions lasted 50 minutes.

During the introduction session Ss first had to fill in the ULC-1. After that a short and global introduction was given. Ss were informed that they had to do four assignments with WordPerfect. Besides, they were told that the instructional program WP-DAGOGUE would help them if necessary while they were doing the assignments.

During the second part of the introduction session Ss had to do the assignment "Working with WP-DAGOGUE". This assignment contained information about the program WP-DAGOGUE itself, instructions how to work with WP-DAGOGUE and exercises to discover the kinds of help WP-DAGOGUE could provide. These possible kinds of help depended on the particular Regulation condition (see the section "Regulation conditions").

Before doing the introduction assignment, Ss who had to work in pairs were instructed to change roles each session. One of them had to manipulate the keyboard and the other one had to concentrate on the screen. They were stimulated to discuss with each other the theoretical information and the help they received from WP-DAGOGUE and the exercises they had to make with WordPerfect. Ss who had to work individually, had to do the various assignments on their own.

At the beginning of the first training session Ss had to fill in the Familiarity inventory. During each of the four training sessions Ss had to do a particular assignment with WordPerfect. When Ss asked questions or experienced difficulties, the experimenter only provided procedural information and no content information about WordPerfect.

He stimulated Ss to be active and to rely on the help of WP-DAGOGUE. The various assignments dealt with basic functions and operations (e.g., typing and removing text, saving a text, working with word-processing codes and printing).

The week after the last training session Ss filled in the ULC-2. During the last two sessions Ss had to make the theoretical test and the practical test. Therefore, each group of Ss was split into two subgroups. Subjects assigned to the various training conditions were divided equally over the subgroups. The first subgroup made the practical test one week after the last training session and the theoretical test another two weeks later. The second subgroup first made the theoretical test and then the practical test. All Ss had to make both tests individually, without the help of WP-DAGOGUE or other sources.

WP-DAGOGUE and Content Help

WP-DAGOGUE could be classified as a concurrent CAI program that functioned as a shell around WordPerfect. This meant that the instructional program WP-DAGOGUE and the application program WordPerfect were active at the same time. The shell WP-DAGOGUE fully controlled the interaction between the subject and WordPerfect. The original version of WP-DAGOGUE had been developed and evaluated by the Centre for Interactive Training Rotterdam (BIT) in cooperation with the Software Development Centre Eindhoven (SWOP) (see Van Meeuwen & Schoneveld, 1989).

As part of the starting procedure of WP-DAGOGUE, WordPerfect was started as well. After the selection of the particular assignment, a text window with the corresponding name was presented on the upper part of the screen. The rest of the screen was reserved for the WordPerfect working area. The second text window contained a list of WordPerfect functions that had been dealt with during the last session and the third text window showed a list of topics of the ongoing assignment. Theoretical information about word-processing functions was also presented in text windows. Each series of theoretical text fragments dealt with a certain basic word-processing function. On the average there were two to three text fragments in a row in which the function was explained and the corresponding key or combination of keys was identified. Ss could go back and forth through a series of text fragments. They were instructed to study the theoretical information very thoroughly. The last window of a series of text fragments always showed the corresponding exercise with WordPerfect. To solve this exercise, Ss had to use the particular WordPerfect function in the way that had been explained before. When solving an exercise, Ss worked with the standard version of WordPerfect 4.2. WP-DAGOGUE monitored the performance of the Ss by comparing their key strokes with the corresponding solution string. If the input was correct, the operation was carried out. Besides, a text window with the message "OK" was usually presented. If the input was not identical with the specified string, the key strokes of the Ss were blocked by WP-DAGOGUE. Besides the error blocking, Ss received content help according to the flow chart depicted in Figure 1.

Two types of errors were discerned: anticipated errors and unanticipated errors. Certain errors had been anticipated based on a rational analysis. Although these anticipated errors were most likely based on incorrect reasoning, they were considered to be "logical" for novices in the domain of wordprocessing. The unanticipated errors were the errors that had not been identified before, i.e., all other errors.

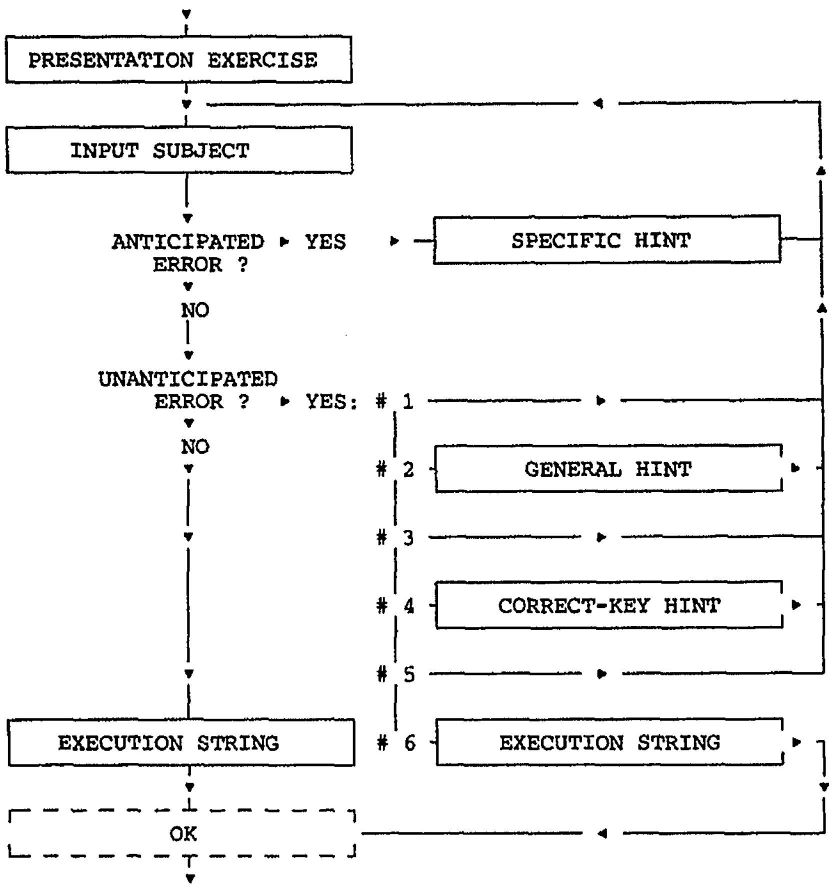

Figure 1. Interaction flow chart of the content help of WP-DAGOGUE (see Van Meeuwen, 1989, p. 17).

If Ss made an anticipated error, they received a specific hint. A specific hint was directly related to the error the subject had made. The subject was told what he/she had done wrong or what he/she should have done. The correct string was not given as part of a specific hint. If Ss made an unanticipated error, the kind of help they received depended on the number of errors being made. After the second error help was offered in the form of a general hint. A general hint could be described as a cue how to solve the exercise. After four consecutive errors Ss received a correct-key hint, i.e, the first key of the correct string was indicated. Finally, if Ss had made six errors in a row, the correct string was executed.

All kinds of help described so far could be classified as content help. Content help always appeared in a special help window. Ss were instructed to read these help windows very carefully and to try to follow the hints immediately and as well as possible. The help windows disappeared in the case of new input. The content help was strictly related to the exercises Ss had to make. The number of exercises per assignment varied from 16 to 28.

Regulation Conditions

As mentioned above in the section "Design" the factor Regulation had three levels. These three Regulation conditions differed with respect to the kinds of help given by

WP-DAGOGUE. In one condition only the content help described above was provided. In the other two conditions additional support in the form of regulation questions was given (see De Jong & Simons, 1990).

The first question was presented after the text window that contained the list of topics of that particular assignment. This question was aimed at planning. Ss had to specify the order in which the various operations should be carried out. The second regulation question was posed after a series of exercises and corresponding text fragments concerning a specific WordPerfect operation. This question was aimed at understanding and insight. Ss had to explain in what way the particular operation should be carried out. By answering this question Ss could test and monitor their learning results. The third and fifth question were aimed at insight and understanding as well. The fourth question was presented when Ss had done half of the assignment. Ss had to identify which operations they had carried out so far. Although this question also had a monitoring function, it was not aimed at monitoring insight but at monitoring one's own activities. The last regulation question, posed at the end of the assignment, could be classified as an evaluation question. Ss were asked which operations they had carried out while doing the assignment. All regulation questions had to be answered by choosing between three answer alternatives. If Ss had chosen the correct answer, a text window with the message "OK" was presented and Ss were allowed to continue with the assignment.

The feedback given in the case of an incorrect answer depended on the particular Regulation condition. If a subject or pair of Ss had been assigned to the condition Content help plus Regulation questions, the following command was presented in the help window: "Try again to answer this question from WP-DAGOGUE". After the presentation of the command WP-DAGOGUE waited for new input. In the case of a second incorrect answer, the same command was presented.

If they had been assigned to the condition Content help plus Regulation questions plus Regulation hints, Ss received help in the form of regulation hints if they had given an incorrect answer. These regulation hints also appeared in the help window. Ss had to regulate their learning process by using a particular part of the regulation heuristic depicted in Figure 2. This scheme was based on the heuristic developed by Biemans (1989).

All regulation questions and regulation hints corresponded to a particular part of the training heuristic. If Ss had given an incorrect answer to the first question, they had to

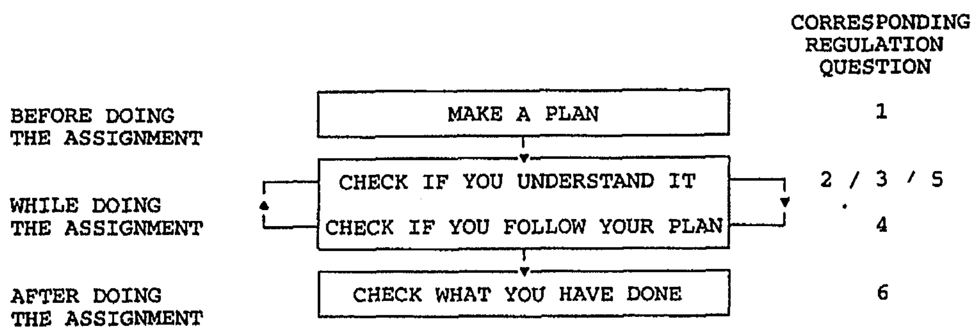

Figure 2. Regulation heuristic of WP-DAGOGUE (see Biemans, 1989, p. 290).

write down which order of operations was the most logical one and why. In the case of an incorrect answer to questions 2, 3 or 5, WP-DAGOGUE concluded that Ss did not understand in what way the particular operation should be carried out. Ss first had to try to specify their problem on paper. After that, they had to write down a possible solution to their problem. When question 4 had been answered incorrectly, Ss had to write down which operations they had already carried out and which operations were still left to be done. Finally, in the case of an incorrect answer to the last question, Ss were instructed to think of their activities and to write down which operations they had carried out while doing the assignment. Ss were instructed to read the help windows very carefully and to try to follow the hints immediately and as well as possible by writing down the requested information. If Ss experienced difficulties following a particular regulation hint, they were instructed to go to the corresponding part of the Learning Aid.

The Learning Aid was a distinct part of the instructional program WP-DAGOGUE. It could be described as a data base containing information about the heuristic training. The main screen of the Learning Aid showed the different parts of the heuristic (see Figure 2). Ss could get more information about a particular part by selecting it. Additional information was provided about WHAT was meant by that part of the heuristic and the corresponding regulation question, about HOW that part of the heuristic could be realized in terms of concrete activities and about WHY that part of the heuristic was important at all (see De Jong & Simons, 1990). Ss were instructed to follow the provided hints. When they had written down the requested information, Ss could return to the regulation question to select another answer alternative. If this second answer was incorrect again, the same procedure had to be followed.

Results

Due to experimental mortality the data of 7 Ss were left out of the analyses. Besides, 40 cases were rejected because the score for computer science in the first grade was missing. This meant that the statistical analyses were performed based on the data of 86 Ss.

Two ANOVAs were carried out to see whether the training conditions differed with respect to the score for computer science in the first grade and the degree of familiarity with the word-processing concepts from the training assignments. There were no differences between the various training conditions.

To find out whether embedding regulation questions and regulation hints had an effect on the learning results of the Ss, a MANOVA was carried out. This analysis

Table 1
Mean Scores and Standard Deviations for the Three Regulation Conditions on the Three Level of Measurement Scales

	Content help + questions + hints		Content help + questions		Content help	
	M	*SD*	*M*	*SD*	*M*	*SD*
Reproduction	10.09	2.17	9.31	1.93	9.32	2.56
Insight	12.24	2.14	11.46	2.07	11.52	2.42
Application	7.14	2.21	5.91	2.03	6.18	1.88

revealed a significant main effect of the factor Regulation ($F(2,64)=3.23$; $p \leq .05$). Ss from the condition Content help + questions + hints scored higher on the performance tests than Ss from the other two conditions (see Table 1).

Besides, there was a significant interaction effect between the factors Regulation and Familiarity ($F(2,64)=3.41$; $p \leq .05$). If Ss were very familiar with the concepts from the training assignments, the performance scores for the three Regulation conditions were comparable. However, if Ss were not very familiar with these concepts, the condition Content help + questions + hints led to the highest performance scores and the condition Content help + questions led to the worst learning results (see Table 2).

Table 2
Mean Scores and Standard Deviations for the Six Regulation by Familiarity Groups on the Three Level of Measurement Scales

	Content help + questions + hints		Content help + questions		Content help	
	M	*SD*	*M*	*SD*	*M*	*SD*
Reproduction						
High familiarity	9.28	1.90	9.83	2.05	9.42	2.14
Low familiarity	10.69	2.33	8.78	1.11	9.22	3.01
Insight						
High familiarity	11.36	1.83	11.92	2.12	11.24	2.79
Low familiarity	12.91	2.31	11.00	1.86	11.80	1.83
Application						
High familiarity	6.39	2.00	6.21	2.09	6.25	1.89
Low familiarity	7.70	2.37	5.61	1.81	6.12	1.93

MANOVA was also used to determine which of the two Way of working conditions was more effective in terms of learning results. A significant main effect of the factor Way of working ($F(1,64)=4.54$; $p \leq .05$) was found. Ss from the condition Working individually scored higher on the performance tests than Ss from the condition Working in pairs (see Table 3). No other effects turned out to be significant (including the

Table 3
Mean Scores and Standard Deviations for the Two Way of Working Conditions on the Three Level of Measurements Scales

	Working individually		Working in pairs	
	M	*SD*	*M*	*SD*
Reproduction	9.84	2.20	9.33	2.27
Insight	11.99	2.32	11.52	2.12
Application	6.42	1.93	6.43	2.09

interaction effect between Regulation and Way of working and the interaction effects involving Level of measurement).

To determine whether embedding regulation questions and regulation hints had an effect on the learning activities of the Ss, six MANOVAs were carried out. These analyses also were performed to find out which of the two Way of working conditions was more effective in terms of learning activities.

Regarding the Deep transformation scale, none of the relevant effects was significant. This also was the case for the Step by step transformation scale, for the Concrete transformation scale and for the Self-control scale.

In the case of the External control scale, a significant interaction effect between Regulation and Trial ($F(2,64)=3.58$; $p\leqslant.05$) was found. Ss from the condition Content help scored lower on the post-test than on the pretest. Ss from the other two conditions, however, scored higher on the post-test than on the pretest (see Table 4). The other effects were not significant.

Table 4
Mean Scores and Standard Deviations for the Three Regulation Conditions on the Pretest and the Post-test (External Control Scale)

	Content help + questions + hints		Content help + questions		Content help	
	M	*SD*	*M*	*SD*	*M*	*SD*
Pretest	16.31	2.87	17.21	3.13	18.23	2.86
Post-test	17.76	3.69	19.65	3.33	17.83	3.69

Finally, regarding the Lack of control scale, there was a significant interaction effect between Way of working and Trial ($F(1,63)=5.96$; $p\leqslant.05$). The decrease in the number of perceived difficulties was larger for the condition Working individually than for the condition Working in pairs (see Table 5). The other effects were not significant.

Table 5
Mean Scores and Standard Deviations for the Two Way of Working Conditions on the Pretest and the Post-test (Lack of Control Scale)

	Working individually		Working in pairs	
	M	*SD*	*M*	*SD*
Pretest	8.73	2.80	7.93	2.68
Post-test	6.00	2.76	7.31	2.54

Conclusions and Discussion

With respect to the effects of regulation questions and regulation hints on the learning results and the learning activities of the students, several conclusions can be drawn. First, the present study confirms the findings of Salomon (1988), Wade and Trathen (1989), Van Deursen (1991) and De Jong (1992). The combination of regulation questions and corresponding regulation hints appeared to lead to higher learning performance. Apparently, embedding regulation support in the learning environment can enhance the quality of the knowledge construction process of the student. Therefore, the conclusion that regulation questions and hints can serve as important support strategies for the purpose of increasing understanding and retention of learned material, seems justified (see Jonassen, 1988). This study also proves that the computer can be used to provide such effective regulation help (see also De Klerk & Verschaffel, 1990). Besides, embedding both regulation questions and regulation hints in the learning environment appeared to enhance learning performance not only in reading (as shown by the researchers mentioned above) but also in the domain of word-processing (as shown by the present study).

Embedding regulation questions only, however, was not sufficient to have a positive effect on learning performance. The addition of regulation hints was necessary to achieve this. In terms of the instructional theory postulated by Simons (1991), activation of the learning function "regulating learning" led to higher learning performance than stimulation of this learning function. The learning environment characterized by stimulation, was typified by a low degree of external regulation control. According to Vermunt (1992), such a learning environment can be appropriate provided that the student has mastered the thinking skills and strategies the learning environment appeals to. Apparently, the students participating in the present study (second graders, lower vocational education) were not (yet) able to apply these skills and strategies themselves. They appeared to need the concrete support of regulation hints to be able to regulate their learning process in an effective way. With respect to students from lower vocational education, De Jong (1992) also showed that these students do not spontaneously regulate their learning process to a high extent.

Therefore, with respect to learning to learn training procedures for such a target group, a learning environment characterized by a rather high degree of external control (activation or — if necessary — taking over) seems to be appropriate to start with. When the student is able (and prepared) to initiate and perform regulation activities, the external control can be gradually removed. At this stage, a learning environment characterized by stimulation, seems to be more suitable. So, to promote self-regulated learning, an explicit gradual transfer of the responsibility for the learning process from the learning environment to the learner ("scaffolding") seems to be the most promising approach (see Reeve *et al.* 1987). This seems to hold especially for Ss who are not very familiar with the material to be learned (the learning content). Ss who were not very familiar with the word-processing concepts from the training assignments appeared to need the additional support of regulation hints to grasp the information that was presented during the training. Apparently, it is possible to compensate for a lack of prior knowledge by means of embedding regulation support in the learning environment. However, in order to compensate for a lack of familiarity with the learning content, the degree of external control provided by the learning environment should be rather high (at least at the beginning of the training procedure). The presentation of regulation questions without regulation hints even caused interference with the learning process, with poorer learning performance as a result (compared to the learning environment in which external regulation control was absent). This finding showed that regulation help can even lead to poorer learning results if the degree (or the form) of the external support is not adequate to serve the student's needs (see Lohman, 1986). In our view, the external regulation help should not be withdrawn until the student has learned how to regulate his/her own learning in order to overcome a lack of familiarity (see also Ali, 1990; Biemans & Simons, 1992).

Independence of external control is one of the core characteristics of self-regulated learning (see also Simons, 1991; Vermunt, 1992). In the present study, only Ss assigned to the condition Content help reported a decreased dependence on external control hints after the training. This condition was characterized by the lowest degree of external control because no regulation questions were posed and no regulation hints were given. Therefore, this condition offered fewer opportunities to rely on control hints from the learning environment than the other two conditions. A decrease in reported dependence on external hints was the logical consequence. This decrease in dependence, however, went hand in hand with weaker learning performance. Apparently, this was due to the lack of self-regulation skills of the students. Subjects from the other two Regulation conditions reported an increased dependence on external control hints. The increased dependence on external control hints as reported by the Ss assigned to the condition Content help + questions + hints seemed to have a positive effect on their learning results. They seemed to follow the available external control hints in an adequate way. Ss from the condition Content help + questions, however, had poorer learning results. Apparently, they experienced the need to react to external cues but they lacked concrete support in the form of regulation hints to be able to do this.

Thus, more extensive regulation help led to better performance, but also to greater dependence on external support. This, of course, is an undesirable side effect. Therefore, we believe that such extensive regulation help should only be provided in the initial phases of learning. In these early stages regulation help is necessary, in later phases of learning it can and should be "scaffolded".

In our view, reduction of dependence on external control hints is not a goal in itself. The main goal of training procedures concerning self-regulated learning, should be to enhance learning (see Jonassen, 1991). As mentioned above, "scaffolding" seems to be the most promising approach to reach this goal, provided that it is based on the actual level of self-regulated learning of the student. If the external support is withdrawn without the student being able (or prepared) to perform regulation activities, weaker learning performance, in our opinion, is inevitable. However, if "scaffolding" is tuned to the self-regulation knowledge and skills of the student, not only his/her dependence on external control hints can be reduced but also the quality of self-regulated learning as well as learning performance can be improved (see De Jong, 1992; Vermunt, 1992). Further research is needed to examine this hypothesis and to explore the instructional conditions to promote self-regulated learning.

In this study, the benefits of cooperative learning with respect to learning to use a computer program, as reported by Krammer and Berendsen (1989), Nilshon (1989) and others, are not confirmed. The study even provides evidence to the contrary. Ss from the condition Working individually got better learning results than Ss from the condition Working in pairs. This effect was independent of the particular Regulation condition. So, in this case, cooperative learning turned out to be ineffective and inefficient (see also Salomon & Globerson, 1989). Apparently, the match between the help provided by WP-DAGOGUE and the learning activities and answers of the student was better for the condition Working individually. This support of WP-DAGOGUE depended on the given input. For Ss assigned to the condition Working in pairs, it was possible that one of the Ss would have chosen another learning activity or another answer, if he/she had had the opportunity to do so. In that case, the support of WP-DAGOGUE did not make sense for one of the two students. This disadvantage seemed to be more influential than the possible advantages of cooperative learning like the opportunity to ask questions and discuss problems. Working individually also led to another positive result: in the condition Working individually the decrease in the number of perceived control problems was larger than in the condition Working in pairs. This suggests that working individually resulted in a stronger awareness of control. The absence of a third source of control, namely the partner, as in the condition Working in pairs, could account for this finding. Probably, the directions provided by the partner regularly interfered with the control hints given by WP-DAGOGUE or with the control activities of the learner, with feelings of confusion and loss of control as a result. Vermunt (1992) showed that perception of lack of control is correlated with weak learner performance. This conclusion can also be drawn from the present study. In summary, a concurrent instructional shell (like WP-DAGOGUE) seems to be more suitable for individual learning than for cooperative learning because of the nature of the support provided (see O'Malley, 1991). However, this does not mean that collaborative learning can not be fruitful; to the contrary, it can be very powerful if learners support each others' knowledge-construction processes (see Brown *et al.*, 1984). But cooperative learning can also be very ineffective and inefficient (see also Salomon & Globerson, 1989). Some teams do not function the way they ought to. Some learners prefer to learn without social support. Some contents do not lend themselves to social learning. Besides, students can discuss and interact with themselves and be "social" in this way (Simons, 1991).

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