Timing of Cueing in Complex Problem-Solving Tasks:

Learner versus System Control

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Abstract

Task-specific cueing formats that promote the automation and construction of problem

solving schemas should ideally be presented just in time to students learning to solve complex

problems. This article reports experimental work comparing learner-controlled cueing,

system-controlled cueing, and no cueing among 34 sophomore law students in a Multimedia

Practical aimed at learning to prepare and hold a plea in court. The cueing consisted of a

combination of Process Worksheets (PW) and Worked Out Examples (WOE). Our main

hypotheses that participants with cueing would outperform those without cueing and that

participants with learner-controlled cueing would outperform those with system-controlled

cueing, were partly confirmed by the learning and transfer outcomes on a training and transfer

task. Theoretical and practical implications of these findings are discussed.

Timing of Cueing in Complex Problem-Solving Tasks:

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Mastering complex problem solving in authentic situations is the ultimate goal of higher

education. Multimedia Practicals can provide authentic training to acquire complex skills such

as diagnosing diseases, searching literature, modelling stress-factors that cause burn-out, or

preparing a plea in court (Hummel & Nadolski, 2002). These programs are assumed to

support learners in interpreting and constructing problem schemas for transfer of these

complex problem-solving skills to other problems. In this paper *cueing* is defined as an

instructional technique to facilitate the interpretation and construction of a problem schema to

enable problem-solving transfer to related problems. The general opinion among educational

researchers (e.g., Hannafin, Land, & Oliver, 1999; Jonassen, 1999; Mayer, 1999) is that

transfer-oriented learning can best be achieved through the use of 'whole tasks' consisting of

a task description, an authentic environment and task-valid cognitive feedback (or cueing) to

carry out the task. Part-task approaches are rooted in behavioral psychology and teach

learners only a limited number of constituent skills at the same time, gradually adding new

constituent skills to practice. Part-task practice is most suitable for complex skills when little

coordination between constituent skills is needed. Whole-task approaches are rooted in

cognitive psychology and teach learners all constituent skills at the same time, gradually

increasing the complexity of the context. Whole-task practice is most suitable for complex

skills that require the coordination of constituent skills within 'authentic' cases. Whole tasks

that have been developed within MP typically have a well defined begin state, many possible

pathways, not a well-defined end state, and well-defined constraints. The task itself can be

practiced as a whole, provided that the necessary support is given to the learners. Exemplary

whole tasks developed in MP are: identifying environmentally protected areas (soil science)

(Ivens et al., 1998); modeling stress-factors that cause mental overload in workers (labor

psychology) (Gerrichhauzen et al., 1998); and selecting a suitable employee (personnel

assessment) (VanderMeeren et al., 1997). Such realistic whole tasks typically have a study

load of more than 10 hours and need to be segmented into smaller task assignments, subtasks

or steps. Segmentation offers a Systematic Approach to Problem solving (SAP) for the whole

learning task. Nadolski, Kirschner, Van Merriënboer, and Hummel (2001) have claimed that

task-valid cueing has to be provided for each of the consecutive steps in this problem-solving

approach.

In the MP *Preparing a plea* (Wöretshofer et al., 2000), that was adapted for this study,

students are offered a SAP consisting of nine steps to prepare a plea. Some steps consist of

process-oriented subtasks, like drawing up the 'pleading inventory' by selecting main legal

argumentation, other steps consist of *product-oriented subtasks*, like drawing up and

finalizing the 'pleading note'. Both product-oriented cueing in the form of Worked-Out

Examples (WOE) and process-oriented cueing in the form of Process Worksheets (PW) have

been identified as important for schema-based learning (e.g., Earley, Northcraft, Lee, &

Lituchy, 1990). Concrete, more product-oriented and abstract, more process-oriented cueing

formats are both needed for schema-based learning in each step. *Product-oriented* formats pay

no attention to the general characteristics of the problem solving process itself, but only

involve specific given states, goal states and solutions. Worked-Out Examples (WOE) focus

learners' attention on *concrete* problem states and associated operators, enabling them to

interpret and select existing schemata and *induce* more generalized solutions. *Process-

oriented* formats pay attention to the problem solving process by providing *general* strategies

and heuristics, enabling learners to construct or adapt schemata and *deduce* a specific

solution. PW may contain a layout with keywords or leading questions (Land, 2000)

reflecting a strategic approach. Ley and Young (2001) suggest a combination of evaluation

criteria in a quality control checklist (like a PW) during assignment preparation and later

provide assignment evaluations (like a WOE) based on the same criteria for individualized

learning. The Multimedia Practical *Preparing a plea* (Wöretshofer et al., 2000) requires law

students to learn and demonstrate the 'whole task' of preparing a plea to be held in court (see

Figure 1 for concrete examples of PW and WOE and Figure 2 for an impression of the

program). We asked participants to learn to prepare the plea while varying the availability and

learner control over the PW and WOE cueing formats.

INSERT FIGURE 1 ABOUT HERE

In the research literature hardly any guidelines on efficient formats and timing of cueing

in realistic whole tasks can be found. Hummel, Paas, and Koper (2004), who compare

Worked-Out Examples (WOE) and Process Worksheets (PW), have recently examined

possible formats of within-step cueing. The results of this study suggest that WOE and PW

can be used to promote near and far transfer respectively. This study is designed to investigate

if these cueing formats can best be presented at fixed (instructor-determined) moments, i.e.

system-controlled, or upon learner's demand, i.e. learner-controlled. In most MP within-step-

cueing is provided at fixed moments, determined by the 'instructor'. For example, in the MP

Preparing a plea the PW are provided together with the instruction for each step and WOE at

the end of each step. Learner control has become an important instructional issue, and refers

to the extent to which trainees can time and use feedback (but also method and practice) in

training. It has been suggested (Ford, Weissbein, Smith, Gully, & Salas, 1998) that learners

become more engaged and motivated when they are (or perceive to be) in charge of these four

portions of training, and can more actively adapt the training to meet their needs. Key

dimensions that may influence feedback effectiveness in MP include the need for more

elaborative feedback (providing cueing to guide the learner in complex tasks), adapting

feedback to individual learner characteristics, and the timing of feedback (Morrison et al., 1995; Mason & Bruning, 1999). Amongst others, Kay (2001) and Renkl (2002) have shown that giving learners more control and responsibility over their learning process, e.g. over using supportive tools and instructional explanations, offers promising possibilities for improved and more adaptive learning. In addition, cognitive load research has shown that learners are able to monitor their cognitive load, and to use this information for decisions about the need to reduce or increase the complexity of learning tasks (e.g., Paas, Renkl, & Sweller, 2003).

Generally speaking, there are two views with regard to timing of information presentation (e.g., Kester, 2003). According to the educational view, information that is relevant to the acquisition of a skill should be presented *before* practicing the skill. According to the psychological view, information should be presented just in time, on learner demand, that is *exactly when needed* during the acquisition of a skill. In the 4C/ID-model for instructional design (see Van Merriënboer, 1997) a distinction is made between: *procedural*, more rule-based, more process-oriented or 'how to' knowledge; and *supportive*, more product-oriented or 'what to' knowledge. In contrast to declarative knowledge, procedural knowledge is goal-specific and deals with how to attain goals in an effective way, given certain circumstances. According to the model procedural information should be provided *just in time* to enable the acquisition of more general *recurrent* aspects of the complex skill, which can be traced back to specific steps. Supportive knowledge is declarative knowledge that is relevant for the acquisition of more specific *non-recurrent* aspects of the complex skill, which often can't be traced back to specific actions, and should be provided before consecutive steps. Kester (2003) demonstrated that the search behavior with the 'supportive before, procedural during' information presentation format was most effective, using practice problems from the domain of physics (i.e., electrical circuits). She explains that, when task complexity does not cause cognitive load to overflow, timely provided procedural information can be directly activated

in working memory when necessary for performing the learning task. However, in Kester's studies the timing of supportive and procedural knowledge was also determined by an 'instructor'. A recent review of feedback research (Mory, 2003) has shown that 'time control' is an important issue and that most of the studies examining the issue so far have used small, contrived, experimental learning tasks, such as list learning, stemming from an objectivist paradigm. For instance, a review study by Hamaker (1986) on the timing of higher order, comprehension adjunct questions demonstrated that the widely accepted general facilitative effect of adjunct questions is not general at all. In his review both 'backwards effects' (to review material that has been questioned) and 'forward effects' (to develop a set to attend to the information that will be questioned) of certain adjunct questions were found. Hamaker (1986) further established *time control* as a major design feature that may not only determine the size of adjunct questions effects, but also the way in which the pattern of learners' processing activities is changed. As a general result, Kulik and Kulik (1988) in their meta-study on feedback found immediate cueing to be more effective than delayed feedback. On the other hand, other studies showed *delay-retention effects* (e.g. Clariana, 2000; Kulhavy & Anderson, 1972; Schroth, 1992), which were explained from various learning hypotheses, e.g.: interference-perseveration (Hannafin & Reiber, 1989; Kulhavy & Stock, 1989); frequency of feedback (Kulik & Kulik, 1988); guidance (Lewis & Anderson, 1985; Schmidt et al., 1989); and from the mathemagenic perspective (Landauer & Bjork, 1978; Robins & Mayer, 1993).

It has been argued before (e.g., Derry & Lesgold, 1996; Van Merriënboer & Sweller, 2003) that these findings and explanations on timing of cueing are now in need of re-examination in more authentic contexts and highly interactive environments, where learners must receive or actively seek information to carry out more complex tasks within training programs of longer duration. We expect that the 'teachable moment' of cueing may not only

depend on task characteristics (e.g., more descriptive or more prescriptive content), but even more so on the characteristics of the individual learner. Therefore, we assume that the ideal moment for information presentation should be determined by. This hypothesis is examined in the present study by using learner-controlled cueing in authentic, schema-based learning situations, where supportive knowledge is thought to promote schema construction, and procedural knowledge to promote schema automation. In line with our previous findings (Hummel et al., 2004), we expect that participants receiving cueing will outperform participants not receiving cueing on training and transfer tasks. In addition, we expect that learner-controlled cueing will lead to higher training and transfer performance than system-controlled cueing.

Method

Participants

Forty students enrolled in the experiment and were assigned to three experimental conditions in a randomized controlled trial. A full dataset could eventually be obtained of 34 students (learner-controlled cueing condition, $n = 12$; system-controlled cueing condition, $n = 12$; and no cueing condition, $n = 10$). Students received the equivalent of about 100 US$ for participating. The participants were Law students (22 female, 12 male; mean age = 23.26, *SD* = 5.22) in their third year of study at a Dutch university. Comparability of pleading experience was assured by a prior knowledge questionnaire. A One-Way ANOVA revealed that the overall prior presentation skills on an 18-point scale were low ($M = 3.47$, $SD = 2.73$) and did not differ as a function of experimental condition ($F (2, 31) = 0.19$, $MSE = 7.95$, $p = .98$, $\eta^2_p = .001$).

Learning materials

An adapted version of the Multimedia Practical *Preparing a Plea* (Wöretshofer et al., 2000) had to be studied as part of the Court Practical participants had enrolled for. The goal of the program, with an average study load of about 40 hours, is to promote the ability to prepare and carry out a plea in court. Figure 2 shows some of the main screens of the Multimedia Practical.

INSERT FIGURE 2 ABOUT HERE

The Multimedia Practical starts with the participants' familiarization with the program and the stepwise procedure. Then, the participants receive a nine-step whole-task training, consisting of one compulsory *training task* (the civil law case 'Bosmans'), together with another training task (the criminal law case 'Ter Zijde') and two additional cases for extra practice. Participants are required to hold the training plea about 'Bosmans', but can either choose to hold their *transfer plea* about the second non-compulsory training task (i.e., criminal law case) or about one of the two practice tasks (i.e., one commercial and one administrative law case). Performance on the second plea, which was held about one month after the initial training, was taken as a measure of transfer.

Within every step of the whole-task training students have maximal freedom of study. During nine steps (or subtasks) the following constituent skills for holding a plea are trained and combined: (1) ordering the file of case X; (2) getting acquainted with the file; (3) studying the file; (4) analysing the pleading situation; (5) determining the strategy for the pleading note and plea making; (6) writing a pleading note; (7) transforming the pleading note into a plea; (8) practicing the plea; and (9) actually carrying out the plea. At the end of each of the steps (3) to (6) students are required to send in a report to their (virtual) coach. After her

approval they are allowed to proceed to the next step. The last three steps are carried out

outside the computer program. For two consecutive steps, the latter always includes cognitive

feedback on the former as well as a new subtask instruction. Each consecutive report thus

builds on the previous one. Since our previous study showed that students might need more

opportunity to practice the SAP, during this experiment also the criminal law case 'Ter Zijde'

could be prepared according to this nine-step procedure with every step containing

comparable cueing. Extra cases are included to create a higher variability of practice.

Participants received a general prior knowledge questionnaire (Nadolski, Kirschner, &

Van Merriënboer, 2004) with about fifty items pertaining to commitment to the field of law

(like reading law journal, looking at law programs), prior presentation skills (prior writing and

oral presentation skills, membership of a debating club), and ICT skills (computer literacy,

attitude towards learning with computers), age and gender.

Pleading measurement instruments

Specific pleading measurement instruments (see also, Nadolski, Kirschner, & Van

Merriënboer, 2004; Hummel, Paas, & Koper, 2004) were used to determine the quality of the

pleading inventory (PI, outcome of step 3), the pleading note (PN, outcome of step 6), and the

plea (PB, outcome of step 9), each for training task 'Bosmans'. An average of sixty, pre-

defined and weighted, detailed items was scored for each of these instruments; these items

pertain both to correctness of selected legal content (e.g., Does the pleading inventory contain

a specific legal question?) and adequateness of presentation (e.g. Does the introduction to the

pleading note not exceed 10 percent of the total text?). The performance scores on the PI, PN,

and PB instruments were taken as measures of learning outcome on the training task. The

transfer pleas were scored with the 'plea-checker' tool that is contained in the MP; this tool

consists of nine, pre-defined items, that pertain to getting attention (introduction), consistency,

legal correctness, captivity and clarity of the plea (main body of text), and to 'anchoring' the

main points and giving initiative back to the judge (closing remarks). All scores were normalized on 100-point scales. Inter-rater reliability and consistency of all scores were assessed using Intra Class Correlation and Cronbach's Alpha. The ICC (3, k) two-way mixed model (Shrout & Fleiss, 1979) for the PI, PN, PB, and P2 instruments revealed significant AMR's (Average Measure Reliability) on absolute agreement of .89, .77, .86, and .93 respectively, with ICC > .70 generally considered to be acceptable (Yaffee, 1998). Cronbach's Alpha's for internal consistency of these instruments were .97, .94, .86, and .93. The use of the plea-checker for scoring plea performance appeared reliable, which was confirmed by a high Cohen's Kappa (Kappa = .67, $p < .001$), although variance of all transfer plea results appeared to be too narrow ($M = 72.94$, $SD = 9.22$, Variance = 8.50) for sufficient differentiation between conditions.

The participants were asked to rate the perceived amount of mental effort invested in each step of the training task on an adapted version of the 9-point scale developed by Paas (1992). Extra time-on-task spent outside the program for each step, together with relevant scores on the questionnaire, was taken to assess motivation (on a 12-point scale). As all conditions were computer-delivered, the participants' actions (e.g., when using cueing) and study times were logged.

Design and Procedure

Three versions of the computer program were produced that only differed on the cueing provided for the both training tasks (cases 'Bosmans' and 'Ter Zijde'). In the learner-controlled cueing condition participants could look into available PW and WOE for all steps and cases at any time; the filled-in PW could however only be send in for assessment within the appropriate step. In the system-controlled cueing condition participants received a PW with subtask instruction at the start of each step, and an expert WOE after submitting their own report at the end of each step. In the no-cueing condition participants received rather

global subtask instructions without further cueing. All versions presented identical support tools, like a 'plea checker' to analyse pleas, discussions of ethical issues in pleading, numerous files and documents, and the two non-compulsory practice dossiers.

Before the start of the experiment the participants were informed, both by a recruitment text and later by a written instruction and manual with the program, about the study load and the required prior knowledge and ICT skills. Participants were then randomly assigned to one of the experimental conditions. All learning materials (including the written instructions and manuals) were sent to the participants' home addresses. Together with the program participants received the questionnaire, which they had to fill in and return before starting to work on the program. The experimental program had to be completed within three months. After about eight weeks (having spent approximately 24 study hours on the MP), participants were required to hold the plea for the training task (case 'Bosmans'). This plea was recorded on videotape. About four weeks later (approximately an extra 12 study hours), participants were required to hold the transfer plea about a case of their choice. Two court practical teachers that used the 'plea checker' tool assessed closing pleas live.

Participants were advised to work step-by-step on the reports they had to send in electronically for rating and logging after the training plea. They were urged and controlled to work individually and not to discuss anything with fellow students or teachers in order to maintain independence. The experimenters extracted the pleading inventories and pleading notes, copied the videotaped training pleas, and forwarded these to the raters (graduated law students). The reports and videotaped pleas were blindly and independently scored.

Results

Data were analyzed with one-way analyses of variance (ANOVA) to examine the expected main effect of cueing condition (either 'learner-controlled cueing', 'system-

controlled cueing' or 'no cueing') as the between-subject factor on various dependent

variables: learning outcomes (pleading inventory, pleading note, training plea), transfer plea

outcome, and time-on-task, mental effort and motivation measures. Following significant

omnibus F-tests on these variables, two planned contrasts using Bonferroni's correction were

carried out to confirm expected group differences both between groups that did and did not

receive cueing, and between the learner- and system-controlled cueing groups; all reported

significances are one-tailed. Pearson's *r* correlations were used to examine possible relations

between dependent variables.

Learning outcomes

   Logging data show that all participants sent in required reports for pleading inventory and

pleading note and did not skip steps. The learning outcomes as a function of cueing condition

are summarized in Table 1.

INSERT TABLE 1 ABOUT HERE

   Analysis of variance on the learning outcomes reveals main effects of cueing condition

on the pleading inventory (F (2, 31) = 8.46, MSE = 218.26, p < .01, η^2_p = .35) and the training

plea (F (2, 31) = 7.83, MSE = 89.80, p < .01, η^2_p = .34), but not on the pleading note (F (2, 31)

= 2.55, MSE = 462.42, p = .09, η^2_p = .141). Contrasting both cueing conditions with the 'no

cueing' condition reveals a significant difference (t (31) = 3.22, p < .01) on pleading

inventory in favor of cueing. Furthermore, contrasting the learner- and system-controlled

cueing conditions reveals a significant difference (t (31) = 2. 56, p < .05) on pleading

inventory in favor of learner control. Contrasting both cueing conditions with the 'no cueing'

condition reveals a significant difference (t (31) = 3.62, p < .01) on training plea in favor of

cueing. Furthermore, contrasting the learner- and system-controlled cueing conditions reveals

a difference (t (31) = 1.60, p = .06) on training plea, although only approaching significance, in favor of learner control. An independent samples t-test comparing training plea outcomes between learner- and system-controlled cueing groups did reveal a significant difference (t (22) = 1.82, p < .05) on training plea outcomes.

Transfer

Analysis of variance on the transfer outcomes reveals no main effect of cueing condition on the transfer plea (F (2, 31) = 2.00, MSE = 80.19, p = .15, η^2_p = .114). The choice of transfer plea did not influence final performance (F (2, 31) = .25, MSE = 89.07, p = .78, η^2_p = .016).

Motivation, mental effort and time-on-task

Differential effects of cueing condition on motivation, mental effort and time-on-task scores were analysed to control for possible confounding effects on learning outcomes. Analysis of variance of the motivation scores for the learner-controlled (M = 2,25, SD = 1.14), system-controlled (M = 2.17, SD = 1.03) and no cueing condition (M = 1.80, SD = 1.69) reveals no differences as a function of cueing condition (F (2, 31) = .37, MSE = 1.66, p = .70, η^2_p = .02). Likewise, average mental effort scores for these conditions (of M = 4.75, SD = .62; M = 5.17, SD = .84; and M = 5.30, SD = .68 respectively) do not differ as a function of cueing condition (F (2, 31) = 1.81, MSE = .52, p = .18, η^2_p = .10). Also, logged average time-on-task on the training task (of M = 687.75, SD = 446.62; M = 665.50, SD = 268.35; and M = 545.60, SD = 147.95 respectively) do not differ as a function of cueing condition (F (2, 32) = .61, MSE = 102,686.76, p = .55, η^2_p = .04).

Significant Pearson's r correlations were found between time-on-task and mental effort scores (r = .41, p < .05), between pleading inventory results and results for both the training (r = .42, p < .05) and transfer plea (r = .38, p < .05), but not with pleading note. A relation was found between pleading note results and results for training plea (r = .37, p < .05), but not

with transfer plea. Training and transfer plea results are related ($r = .46$, $p < .01$). Relations between learning outcomes also indicate that consecutive steps build on each other.

Discussion

We compared cueing on learner demand, cueing at fixed moments, and no cueing in a Multimedia Practical to prepare and hold a plea in court. We hypothesized that participants receiving cueing would outperform those not receiving cueing, and that participants receiving learner-controlled cueing would outperform those receiving system-controlled cueing. Both hypotheses could be partly confirmed. When compared to participants that received no cueing, those receiving cueing at fixed moments delivered significantly better pleading inventories and pleas on the training task, replicating earlier results found by Hummel et al. (2004). The superiority of learner-controlled cueing over other conditions was clearly demonstrated by higher performance results on these outcomes of the training task.

Results from this study provide evidence for the added value of timed cueing as process support in more adaptive problem-based learning environments. MP offer fertile learning environments to investigate the benefits of learner control on problem-solving performance, and the possibilities for improved and more adaptive learning. It has been suggested (Ford, Weissbein, Smith, Gully, & Salas, 1998, p. 219) that taking into account individual learner's needs and preferences of timing or feedback offers a method "for engaging learners more actively during training [that] leads them to learn the deeper, structural elements of the task more effectively". It should be noted that the relation between learner-controlled cueing and learning may not only be mediated by the timing of feedback, but also by the perceived control over feedback (Morrison et al., 1995; Mason & Bruning, 1999). Although we were not able to consider the separate contributions of both factors to learning in the naturalistic multimedia of this study, continued research on these separate issues is considered

worthwhile. Another issue is related to a possible effect of cueing condition on the amount of extra practice by the participants. For instance, one could argue that participants who received cueing and / or learner control are more inclined to look into the extra practice cases. The amount of extra practice with the practice files was low for all participants ($M = 6.71$, $SD = 13.12$, in minutes), did not influence the learning outcomes, and was not influenced by cueing condition ($F (2, 31) = .93$, $MSE = 172.70$, $p = .40$, $\eta^2_p = .057$).

Although we find similar trends for the transfer task, we were not able to establish significant differences between both cueing conditions and the no cueing condition on transfer plea outcomes. Here some experimental flaws became clear during analysis, and might be held partly accountable. *First* of all, although pleading performance on the transfer task could be reliably measured using the 'plea checker', the overall variance is narrow and seems to have washed away significant differences in transfer. Furthermore, more specific performance on the pleading inventory of the transfer task is not assessed, so no direct measure for transfer on this subtask is available. *Second*, due to organisational conditions, students were left the choice over which dossier to take as transfer task. Eleven out of thirty-four participants decided not to hold a transfer plea about the second training task in the MP ('Ter Zijde'), but about one of the practice dossiers without cueing and a stepwise procedure to prepare the plea (thus experiencing less 'variability of practice' with the cueing formats in the remainder of the program). 'Variability of practice' is considered an essential element for transfer to occur (e.g., Paas & Van Merriënboer, 1994). *Third*, the overall poor results on the pleading inventories when compared to the results on both pleading notes (required to hold the plea) and pleas indicate a rather result-oriented learning style of students that are accustomed that only the pleas will get graded. It will be harder to find beneficial effects of cueing on transfer when students do not take intermediate training task outcomes that seriously.

Cueing was either absent or present and consisted of a combination of Process Worksheets (PW) and Worked Out Examples (WOE). The twofold purpose of whole task training is the construction of schemata that allow learners to learn unfamiliar task aspects (schema-based behavior, supported e.g. by WOE) and the automation of schemata that allow learners to effortlessly perform familiar task aspects (rule-based behavior, supported e.g. by PW) in other situations. Just-in-time presentation of cueing aimed at schema automation can be considered especially important for procedural, more process-oriented knowledge (Kester, Kirschner, & Van Merriënboer, 2001). This indicates the importance of learner control for PW and the special contributions of PW to both process-oriented subtasks and transfer. Van Merriënboer and Sweller (2003) recently mentioned the amount of freedom students have in using prompts for self-regulation (like driving questions in a PW) as a promising method for adaptive e-learning. Differentiating between cueing formats was left out of scope in the experimental method of this study, so we will have to further research these differential effects of both learner-controlled PW and WOE on learning and transfer performance.

This study further shows that experimentation on schema-based learning can be carried out in the context of complex, more ecologically valid, authentic training programs of longer duration. However, due to ethical considerations, the experimental effects might have to be reduced. Even with the lack of cueing and learner control, some basic support mechanisms in the MP still guaranteed that participants, that were regular students working for credits, could successfully study the MP. Inclusion of a 'poor' condition with no learner support would most likely have induced stronger effects of cueing and learner demand, but this was not an ethical option with regular students working for credits. Even the learning materials in the 'no cueing' condition were of high quality and, except for cueing, consisted of identical support tools. The experimental conditions had the aim to 'make this good material even better'. Furthermore, although participants were urged and controlled to work individually at home

and not to discuss anything with fellow students or teachers during the experimental period in order to maintain independence, it was impossible for us to control this.

Finally, a number of possible directions for future research emerge. *First*, future research could further examine timing of isolated cueing formats either supporting schema construction or automation in relation to adaptive learning. *Second*, Winne's (1997) review of self-regulated learning research advocates a shift away from outcome-oriented feedback towards more cognitive types of feedback that support self-regulated engagement and enhance self-calibration. What exactly goes on during students' monitoring when applying this support needs to be further examined. Task-valid cueing (like PW and WOE) relates cues from the task to achievements, and has been found more effective in supporting learning and problem solving. Mory (2003) emphasises timing of these new feedback types as one of the prevailing areas of future feedback research by stating "… it [feedback] can inhibit learning if it encourages mindlessness, as when the feedback is made available before learners begin their memory search or if the instruction is too easy or redundant" (p.752). She further states that future research into this 'teachable moment' (Clariana, 2000; Lewis & Anderson, 1985) should be carried out in more practical learning environments in 'real world' learning environments, with newer technologies for instructional delivery of feedback making this issue even more promising. *Third*, future research should try to find out if the results of this study could be generalised to other constructivist learning environments within a wider variety of learning domains. These domains should include (e.g., more algorithmic) problem solving ontologies that differ from the ones in law or related domains (e.g., those primarily driven by heuristic rules of thumb). This study shows that the examination of the effects of timing and task-valid cueing can be carried out reliably in authentic training programs of longer duration, yielding promising results about learner control.

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Table 1

Performance results (normalized to 100 point-scales) on the pleading inventory, pleading note, training plea, and transfer plea as a function of condition

condition	learner control (*n* = 12)		system control (*n* = 12)		no cueing (*n* = 10)		All *N* = 34	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Pleading inventory	44.83	21.25	29.42	10.27	19.20	8.43	31.85	17.80
Pleading note	67.67	18.16	48.58	27.39	53.20	16.62	56.68	22.49
Training plea	77.00	9.26	70.83	7.22	61.00	11.86	70.12	11.27
Transfer plea	77.08	9.16	70.42	8.38	71.00	9.37	72.79	9.22

Figure Captions

Figure 1. Excerpts taken from concrete cueing examples

When studying the file of case X (step 3 of the SAP) students draw up a pleading inventory for case X. Some of the leading questions that have to considered can be found on the left side (excerpts from the PW); part of the expert solution (i.e., possible answer to leading question 6) can be found on the right side (excerpts from the WOE), with article numbers referring to Dutch Law.

Figure 2. Screen dumps *Preparing a plea*: an example of a CMP in the domain of Law

The learner is given the role of trainee or junior lawyer in a (virtual) legal firm. He or she must prepare a plea for various cases. A (virtual) mentor introduces the way a plea should be prepared and comments on various activities of the learner during preparation. Clockwise you find the following virtual environments: The trainee's office (where he/she can search a file cabinet, or mailbox, and e-mail reports on tasks to the mentor) and where students provided with 'learner-controlled cueing' can ask for PW ('vragen' button) and WOE ('vb' button) whenever they feel is the appropriate moment; the mentor's office (where the trainee may go to ask questions); external experts and colleagues within the law firm that learner can consult; and the 'reporting tool' where PW can be worked on during every subtask, but can only be send in to the (virtual) mentor for assessment when learners have actually proceeded to that subtask.

PW

4a. What are the most important arguments of the opposing party?

4b. Could you refute these arguments? If so, how?

5. Which articles of the law are of importance for this case?

6. Which criteria should be fulfilled?

7. What are the judicial consequences if these criteria are / are not fulfilled?

8. Which judicial consequence suits your client the most / the least?

....

WOE

6. Which criteria should be fulfilled?

Relating to shortcomings in the compliance:
• the demand is claimable (6:38-6:40 BW)
• compliance stays out or is carried out in an inferior way. To establish this the content of the obligation concerned needs to be examined accurately (art. 3:33, 3:35, 6:2, 6:248 BW)
• no compliance is not justified by an appeal on the authority to suspend