Fostering Information Problem Solving Skills Through Completion Problems and Prompts

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Introduction

An information problem occurs when a person lacks the knowledge needed to solve a problem and must undertake a search to find it. This process of information problem solving is generally divided into five steps which encompass the required skills: 1) defining the problem, 2) searching for information, 3) selecting information based on relevance, reliability and correctness, 4) presenting the information, and 5) evaluating and regulating the process itself (Brand-Gruwel, Wopereis, & Vermetten, 2005). Research has shown that teenagers and adults encounter significant problems when solving complex information problems online (Brand-Gruwel et al., 2005; Walraven, Brand-Gruwel, & Boshuizen, 2008). These findings make it evident that there is a need for carefully designed formal training to develop information problem solving skills.

This study aims to develop a theoretically sound instructional approach to foster the acquisition of information problem solving skills based on the guidelines presented in the Four-Component Instructional Design model (Van Merriënboer & Kirschner, 2007). Two instructional approaches were tested: completion problems and emphasis manipulation.

Completion Problems. In the beginning of the learning process, learners have restricted and incomplete schema of solution procedures, and most often fall back on naive strategies such as means-ends analysis or a trial-and-error approach. This places high demands on working memory. These high demands can be avoided by integrating sufficient support for learners into the learning tasks. One method of integrating support is to provide a partially solved problem, then ask the student to solve the remaining steps. By providing worked-out steps, the correct strategies and domain-principles are reinforced, while the strain on working memory is reduced. However, as training progresses and learning occurs, knowledge is constructed and problem solving strategies are incorporated into schemas. The support that was necessary in the beginning now becomes redundant and detrimental to learning, since it is already present in the learner’s memory. This means that the implemented worked-out steps need to fade as the training progresses.

Emphasis manipulation. A second method of support is to emphasize only one of the constituent skills in each learning task, instead of all the skills. In this case, the student still performs the whole task, but instructional emphasis is placed on just one sub-skill (Gopher, Weil, & Siegel, 1989). In this emphasis manipulation approach, learner support is focused on a single sub-skill, but then shifts to a different sub-skill in the next learning task. Specific sub-skills can be emphasized by providing prompts at the moment the target skill is executed. A prompt at that time can offer information to the learner, or ask to reflect on the skill after it was performed. By prompting for specific principles that are at play when executing the target skill, the relevant knowledge and procedures are activated in the learner’s mind. By using reflective prompts, learners can evaluate their own performance and identify any existing gaps in their knowledge.
Method
A total of 118 first-year university level students participated in the computer-based training at the Katholieke Universiteit Leuven (Belgium). The training session consisted of: taking a prior knowledge test, watching a 15 min. instructional video, watching a video of a step-by-step worked out example while answering several explanation prompts in between, completing three learning tasks (in which students are required to search the web) and a performance task (another search but without any support), and taking a post-test. The three learning tasks differed between the conditions, and each learning task ended with an evaluation and a subjective measurement of mental effort by means of two rating scales.

In the completion condition, two steps were worked out in the first learning task, the first step was worked out in the second task, and no steps were worked out in the third. Worked-out steps were presented as video fragments. In the emphasis manipulation condition, principle-based prompts were presented on just one step in each learning task, asking the learner to briefly explain the key principles at play in the current step. After answering the prompt, the correct answer was presented before the student engaged the problem solving step. After performing the step, a reflective prompt asked the learner to evaluate her/his performance. A third combination condition combined both approaches as described. Finally, students in a fourth condition received conventional problems with no added support other than a simple step-by-step guide through the process.

Results and Discussion
A repeated measures ANOVA showed that scores in all conditions increased from pre-test to post-test, $F(1, 88) = 356.35, p = .000, \eta^2 = .802$, indicating that instruction was effective. However, between conditions, no significant differences were found in either the increase in scores or the mental effort ratings. From these results it appears that the condition that received conventional problems was powerful enough to reach a substantial learning effect. The extra support in the other conditions was therefore unnecessary. Further research now underway will attempt to identify which element in this ‘conventional’ condition can account for this strong learning effect.

References

