Local and Global Feedback

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Abstract. We distinguish local and global feedback. This paper partly describes the global feedback in ACTIVEMATH, a learning environment for mathematics.

1 Introduction

ACTIVEMATH is a user-adaptive, web-based learning environment for mathematics. It generates learning material for the individual learner according to her learning goals, preferences, and mastery of concepts as well as to the choosen learning scenario [7].

Previously, ACTIVEMATH primarily served the adaptive generation of documents. It integrates service systems the student can use for interactive exercises and produces local feedback on student's actions in interactive exercises [3]. Now the system also provides more global feedback because there is evidence that such a feedback is needed as well.

2 Local and Global Feedback

Usually, feedback and help in intelligent tutoring systems (ITSs) is designed for a direct response to students' problem solving actions and it is designed in order to help students to accomplish a solution, e.g., in the cognitive tutors [2].

Although in most ITSs the feedback is a reaction to the actual problem solving, some systems provide feedback targeting meta-cognitive skills of the student. For instance, Andes [4] tries to support self-explanation of worked-out examples and SciWise [9] provides advice for planning and reflecting activities in experimental science and for collaboration.

Frequently, this *local* feedback reflects the author's experience with typical errors in a specific problem solving context or it results from a comparison of the student's problem solving steps with paths in a (completely represented) problem solving search space. The specific feedback is questionable in the sense that authoring all the specific feedback or all correct and erroneous steps is a very laborious task and often requires an extreme effort for explicitly authoring what can go wrong and what the reason is for each erroneous action. Partially, we try to avoid such a kind of diagnosis and corresponding feedback in ACTIVEMATH.

We think that two kinds of feedback and guidance can be provided by an ITS, a *local* response to student activities which is supposed to coach the correction of a problem solving attempt of the learner and a *global* feedback coaching (several aspects of) the entire learning process. This differentiation somewhat resembles the distinction of task-level and high-level described in the process model in [1].

Local and global feedback differ with respect to content, realm, aim, and point in time and could even have different user interfaces:

Realm and Content As opposed to the local feedback which essentially informs the student about the (in)correctness of problem solving steps and may also provide more elaborate hints and suggestions, the global feedback additionally may scaffold the student's overall learning process including her navigation in the learning material, her meta-cognition and motivation, it may suggest how to plan further learning, and may suggest learning material including examples and exercises.

Objectives Usually, the purpose of local feedback is a support for a student in problem solving, by correcting a particular solution or by guiding her back to a pre-determined problem solution, whereas global feedback is usually not concerned with one particular exercise.

Frame of Student's Mind The frame of mind differs as well: When the student's mind is (hopefully) focused on solving a particular problem she receives local feedback, whereas before she starts a new learning activity she receives global feedback.

Immediate vs. Delayed Local feedback is provided immediately after each problem solving step of the student (and can possibly presented in the same exercise window). Instead, the global feedback and suggestions can be provided independently of an exercise and may be delayed, i.e. delivered, when the user has finished reading a text, studying an example, or working on an exercise. There is some evidence that the delay may improve the effect of the global (meta-cognitive) feedback [8].

Feedbacks in ITSs Most ITSs do not provide global feedback in addition to local feedback. And even if they do, such as SQL-Tutor and CAPIT, they do not clearly separate local and global feedback, e.g., architecturally

In ACTIVEMATH, local and global feedback is distinguished because of their different aims, different learning dimensions, and different mechanisms. In addition, our usage of service systems for the check of the correctness of problem solving steps and for the generation of local problem solving feedback is a practical reason for separating local and global feedback. The local feedback such as 'syntax error', 'step not correct, because...', 'task not finished yet', or 'step not applicable' is computed with the help of a system and related to a problem solving step in an exercise or to the final achievement in an exercise.

We group this into the two categories rather than far more classes that would result from the four dimensions discussed above because working on an exercise focuses the student's objectives and frame of mind in a way that typically requires a scaffolding within this problem solving frame rather than taking a broader perspective or targeting the overall learning process. This is also a reason for delaying the global feedback.

3 Global Feedback in ACTIVEMATH

The computation of global feedback requires *diagnoses* for several types of user activities. Currently, the information about the student's navigation, her reading, understanding, and problem solving actions, e.g. the duration and success rate, serves as a basis for the user-adaptive suggestions. That is, information from the history of the learner's actions and information about her mastery is necessary to generate useful suggestions.

From the diagnoses, currently navigation suggestions and content suggestions are generated according to a *suggestion strategy* (For more details see [6]). These include

- present new or skipped example
- present similar example
- present new exercise
- present same exercise
- present again the focus-concept maybe also examples, exercises
- present (missed) instructional items
- present certain prerequisites of the focus-concept maybe together with examples and exercises
- presentation of different instructional items connected to a concept depending on the learning goal and the mastery achieved so far.

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