

Chapter XII

Adaptive Procedures for Efficient Learning

INTRODUCTION

The rapid diagnostic approach to evaluating levels of learner task-specific expertise was introduced in Chapter IV and used in several studies that were subsequently described throughout this book. The rapid diagnostic techniques (first-step method and rapid verification technique) were instrumental in investigating some instances of the expertise reversal effect and in optimizing levels of cognitive load in faded worked example procedures (Section II and Chapter XI). This chapter describes some specific adaptive procedures based on rapid diagnostic methods for evaluating ongoing levels of learner task specific expertise. Two specific approaches to the design of adaptive instruction are considered, adaptive procedures based on rapid measures of performance and adaptive procedures based on combined measures of performance and cognitive load (efficiency measures).

The expertise reversal effect established interactions between learner levels of task-specific expertise and effectiveness of different instructional methods. The major instructional implication of this effect is the need to tailor instructional methods and procedures to dynamically changing levels of learner expertise in a specific class of tasks within a domain. The rapid diagnostic approach was successfully used for real-time evaluation of levels of learner task-specific expertise in adaptive online tutorials in the domains of linear algebra equations (Kalyuga & Sweller, 2004; 2005) and vector addition motion problems in kinematics (Kalyuga, 2006) for high school students. Both first step diagnostic method and rapid verification technique were applied in adaptive procedures.

According to the rapid assessment-based tailoring approach, these tutorials provided dynamic selection of levels of instructional guidance that were optimal for learners with different levels of expertise based on real-time online measures of these levels. The general designs of those studies were similar. In learner-adapted groups, at the beginning of training sessions, each student was provided with an appropriate level of instructional guidance according to the outcome of the initial rapid pretest. Then during the session, depending on the outcomes of the ongoing rapid tests, the student was allowed to proceed to the next learning stage or was required to repeat the same stage and then take the rapid test again.

At each subsequent stage, a lower level of guidance was provided to learners (e.g., worked-out components of solution procedures were gradually omitted and progressively replaced with problem solving steps), and a higher level of the rapid diagnostic tasks was used at the end of the stage. In control non-adapted groups, learners either studied all tasks that were included in the corresponding stages of the training session of their yoked participants, or were required to study the whole set of tasks available in the tutorial.

ADAPTIVE PROCEDURES USING RAPID MEASURES OF PERFORMANCE

Two rapid assessment methods described in Chapter IV, first-step diagnostic method and rapid verification diagnostic method, were used for measuring learner levels of task-specific expertise in different studies. For example, in an experiment using coordinate geometry tasks, the rapid assessment approach (first-step method) was used for the first time to successfully predict which students should be presented with worked examples and which should be presented with problems (Kalyuga & Sweller, 2004, Experiment 3).

Then, the rapid first-step testing method was used in a simple adaptive computer-based tutor in linear algebra equations for real-time adaptation of instructional procedures (worked examples, faded worked examples, and problem-solving practice) to ongoing levels of individual learners' knowledge (Kalyuga & Sweller, 2004, Experiment 4). The aim of the study was to demonstrate that the rapid test could be effectively used in a computer-based training environment for adapting instruction to changing levels of learners' knowledge of specific solution procedures.

The rapid test was used for initial selection of the appropriate levels of instructional materials according to levels of learner preliminary knowledge, as well as for monitoring learner progress during instruction and real-time selection of the most appropriate instructional formats. For learners with lower levels of expertise, as measured by the rapid test, additional worked examples were provided. For

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