Chapter 10
E-Learning Tools with Intelligent Assessment and Feedback for Mathematics Study

Christine Bescherer
University of Education Ludwigsburg, Germany

Daniel Herding
RWTH Aachen University, Germany

Ulrich Kortenkamp
University of Education Karlsruhe, Germany

Wolfgang Müller
University of Education Weingarten, Germany

Marc Zimmermann
University of Education Ludwigsburg, Germany

ABSTRACT
Mathematics students, often among large university classes of several hundreds of students, are easily daunted when solving math problems. Lacking individual feedback, they easily give up. To bolster learning, Computer-Aided Assessment may help students by giving them individual feedback about their progress. This article presents some general requirements for Intelligent Assessment using semi-automatic feedback in mathematics education with a special focus on solution processes. Intelligent Assessment implies the combination of human assessment along with electronic assessment via intelligent software for evaluating a student’s performance in a specific subject. Assessment tools are used to categorize solutions and detect errors as accurately as possible. Unusual and novel solutions and errors that the computer cannot categorize are forwarded to a tutor or teacher for assessment. Several examples demonstrate that semi-automatic and process-oriented Intelligent Assessment can help to improve learning and, ultimately, student self-confidence in mastering problems.

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INTRODUCTION

In Germany and many other countries, mathematics lectures at universities, especially those for freshmen, are accompanied by assignments with problems students have to solve and submit. In courses with several hundreds of students, it is nearly impossible for professors to give individual feedback to each student. Traditionally, advanced students act as tutors who either grade the submitted worksheets or demonstrate model solutions in smaller tutorial groups. Students typically obtain feedback about their solutions through grades or by comparing their own solution with the model solution, e.g. proofs of theorems presented during the weekly tutorials (Holton, 2001). This traditional teaching philosophy is widely used in mathematics lectures across Europe.

While working on their assignments, students in introductory mathematics courses often encounter difficulties. Many students do not even start working on the problems that appear too challenging. Others give up quickly after briefly trying solving them. Every unsolved task may frustrate the student and reinforce a negative attitude towards mathematics. Eventually, the students copy each other’s solutions instead of solving the exercises on their own. In most cases, adequate feedback or hints at the right time – while working on the problem – would suffice for the student to master the task at hand.

Unfortunately, such feedback is usually only obtained when the student discusses the problem personally with the teacher. When students work on their exercises at home, however, lecturers and tutors generally are not available to help out. In such cases, computer-based approaches, where hints and feedback are provided on demand by using software, can be a real asset to learning. However, such feedback needs to be more differentiated than merely pointing out “right, “wrong”, or “reread chapter X.”

The following handles the requirements to provide such feedback. After a brief discussion of the approaches and challenges of student assessment, our proposed approach, based on the paradigm of Intelligent Assessment, is introduced and discussed in detail. Moreover, examples are presented that demonstrate the application of Intelligent Assessment technology in mathematics education.

ASSESSMENT AND FEEDBACK

Assessment usually has one of the two following purposes:

a. **Judgment.** In this type of assessment, usually denoted as ‘summative assessment’, the goal is to decide whether the learner has passed a course and with what grade. Such summative assessment typically occurs at the end of a semester or course and determines whether a student passes or fails. It is mostly an ‘assessment of learning’ and used to measure students’ understanding of a specific topic (Ainsworth & Viegut, 2006).

b. **Development.** Assessment in this context is denoted as ‘formative assessment’. Here, the teachers use the results of the assessment to analyze the students’ levels of understanding and thus adapt their teaching to the students’ needs. This is an ‘assessment for learning’, and the results are not used to grade students’ work (Ainsworth & Viegut, 2006).

This chapter deals with formative assessment, whereby students are evaluated individually and continuously to give both the teacher and the students the information necessary to adjust teaching and learning (Black et al., 2004). Such feedback plays a crucial role, because learning only happens if students understand their mistakes yet stay motivated to learn (Brown, 2004). The following focusses on mathematics assessment as well as discusses mathematics education and mathematics itself.
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