Improving Science Learning through Valid Assessments: Diagnostics and Inquiry-Based Contexts

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Modern scientific research would not be possible without sophisticated measurement instruments. In social sciences, measurement emerged only at the beginning of the 20th century, but then it became one of the engines of progress at a number of key areas, including educational research. Today, educational assessment is one of the most rapidly developing areas of educational research and practice, and it still has great unitized potential for science education as well. This paper presents research at two areas of science education where assessment has only recently been introduced. It summarizes the work already done and outlines the further steps necessary to advance progress.

From the turn of the millennium, large scale international comparative studies, such as TIMSS and PISA have highlighted the importance of educational assessment, and inspired the development of educational evaluation in several ways, including re-conceptualizing the expected outcomes of school education, framework development, sophisticated data analyses, data-driven management of educational systems, and evidence based educational policy. On the other hand, there are several areas of assessment where new approaches are needed, especially in those contexts that are closer to the everyday teaching and learning processes. The projects reported here belong to this group.

Diagnostic assessment is a special form of formative assessment, which is embedded in the teaching and learning processes. It may examine students’ pre-requisite knowledge necessary for successful learning as well as the results of a certain instructional period. In each case, its main function is to provide students and teachers with feedback; inform them about what has already been mastered and what should still be learnt. Diagnostic assessment has to be frequent (preventing the accumulation of learning deficiencies), detailed and it should provide immediate feedback. Because of these specific requirements, a fully functional diagnostic assessment system cannot be implemented with paper-based tests. On the other hand, the rapidly developing technology-based assessment (Csapó, Ainley, Bennett, Latour, & Law, 2011) would mean an adequate solution to these problems, as it may provide precise, detailed and frequent assessment with immediate feedback, furthermore it allows innovative item formats, utilization of multimedia and construction of more authentic and valid tasks. Such an online diagnostic assessment system has been designed and implemented by the Center for Research on Learning and Instruction, University of Szeged. The system is prepared for three main domains, reading mathematics and science. Diagnostic assessment of science in the first phase of schooling requires a sophisticated framework that takes into account the psychological aspects of students’ learning, as well as the content of the given disciplines and the context where students’ knowledge is expected to be applied. Based on these requirements, a three-dimensional framework was devised (Csapó, 2012; Csapó & Szabó, 2012), and an item-bank containing several thousands of items was developed. The experimental operation of the system started in September
2014 in more than 500 schools. The students may be assessed online several times during the school year. The results may be longitudinally connected, and this way, students’ progress may be monitored, and intervention may be taken if necessary.

The second project aims at advancing students’ science learning at an older age and it is carried out in an international cooperation. In the past decade, the European Union has supported over 20 science education projects; most of them applying the approach of the Inquiry-Based Science Education (IBSE). In recent years, several projects received support which implemented assessments, especially formative assessments in the context IBSE. One of these is the Strategies for Assessment of Inquiry Learning in Science (SAILS) project carried out by a consortium of research groups from 12 European countries. The main goal of the project is training teachers for the assessment activities required for supporting inquiry science learning. The project covers science education for students aged 12-18 years. It is built mostly on existing learning materials resulting from previous IBSE projects. Defining of what to assess and how to assess in the specific context of IBSE was the first task of the project. A four-dimensional framework has been devised which forms the basis of task development and the training of teachers alike (Csapó, Csikos, Korom & B. Németh, 2013). The first dimension focuses on the inquiry skills, as their development is the primary aim of IBSE. The second dimension covers the disciplinary content knowledge of biology chemistry and physics. The third dimension deals with the application of scientific knowledge (scientific literacy) in several contexts, and the fourth dimension describes students’ cognitive skills that may be developed when learning sciences through inquiry methods.

The results of these two projects highlight the relevance of assessment in science education and indicate that similar approaches may be applied at different contexts of assessment. These projects emphasize the importance of assessment in science education and show how technology can be adequately utilized to make learning more efficient.

References


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Web links: edia.hu, sails-project.eu