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Assessment-Based, Personalized Learning in Primary Education

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Structured Abstract

Purpose – The aim of this paper is to synthesize two conceptual frameworks on school learning in order to create a theoretical foundation for differentiated education supported by information and communication technology (ICT). One of the main problems in school education is that there are large differences between pupils. As prior knowledge determines learning outcomes, a large proportion of students do not benefit from uniform instruction. Several methods have been proposed to differentiate teaching and adjust it to students' individual needs, but the lack of useable instruments to identify these needs has limited the success of such efforts.

Design/methodology/approach – We integrate the results of two different theoretical traditions. (1) One class of theoretical approaches has dealt with the issue of providing students with learning opportunities adjusted to their individual needs under the constraints of mass education characterised by heterogeneous classes. Several experiments have been conducted in this vein under the umbrella of individualization, personalization, differentiation and similar concepts. (2) Another class of theories deals with the concept of 'assessment for learning', which means that assessment is embedded in the teaching-learning processes to provide students with immediate feedback. We use this unified theory to build a complex, assessment-based, differentiated teaching system utilizing the possibilities of ICT. The first phase of the project has already been completed: an online assessment platform was created (the eDia) and item banks were developed for the assessment of reading comprehension, mathematics and science. In the current phase of the program, we integrate assessments into everyday teaching and learning processes.

Originality/value – Several elements of the complex instructional/developmental system introduced in this paper have already been explored previously, but an innovative system of this kind has not yet been built. The item banks are based on an innovative assessment framework that distinguishes three dimensions in each assessment domain: (1) a psychological dimension that assesses how students' cognitive functions and their

specific and general thinking skills develop, (2) application of their knowledge in new contexts and (3) progress in learning disciplinary knowledge defined in the curricula. The assessment items utilize the full range of multimedia, including video and simulation.

Practical implications – The online assessment system has already been in use for several years and aids teachers greatly in identifying students who need special assistance with objective data. The system now under construction will provide students with personalized and playful developmental exercises. Early interventions may prevent school failures.

Keywords – Assessment for learning, Diagnostic assessment, Technology-based assessment, Technology-based personalized instruction, Mastery learning

Paper type – Academic Research Paper

1 Introduction

One of the main problems in school education today is caused by the fact that there are large differences between pupils. These differences are natural consequences of the human developmental processes; they exist in a number of different dimensions and change dynamically over time. As prior knowledge and capabilities determine learning outcomes, a large proportion of students do not benefit from uniform instruction. This is clearly indicated by the results of large-scale international assessment projects, such as PISA (Program for International Student Assessment) carried out in three-year cycles under the aegis of the OECD (Organisation of Economic Cooperation and Development). Even in developed countries, up to 20-25% of students don't reach the basic proficiency (level 2) in the main literacy domains, in reading, mathematics and science (see e.g. OECD, 2016). The proportion of school drop-out rate (early leavers from education and training) is so high in the European Union countries, that decreasing it (for fewer than 10%) has become one of the main educational goals of the EU for 2020.

In recent decades, several methods have been proposed to differentiate instructional processes in heterogeneous classrooms and adjust them to students' individual needs so that every student benefit from teaching. Due to the lack of useable instruments to assess students' actual developmental level in the relevant domains and identify their needs has limited the success of such efforts. The aim of this paper is to synthesize two conceptual frameworks on school learning in order to create a theoretical foundation for a differentiated education system supported by the latest information and communication technology (ICT). The integrated theoretical model presented here is used to underpin the development of a complex online system which supports personalization of students' learning in the context of classroom teaching.

We propose an approach that applies the results of two different theoretical traditions. (1) One class of theoretical approaches has dealt with the issue of providing students with learning opportunities adjusted to their individual needs under the constraints of mass education characterised by heterogeneous classes. (2) Another class of theories can be characterised by the concept of 'assessment for learning', which means that assessment is embedded in the teaching-learning processes to provide students with immediate feedback. We integrate these two theoretical approaches and avail ourselves of the ICT options available to us to build a complex, assessment-based, differentiated teaching system. Several elements of such an instructional/developmental system have already been explored previously, but an innovative system of this kind has not yet been built.

2 Approaches to differentiated education

The problems of uniform learning in heterogeneous classrooms were identified and described as early as in the 1960s. The best known model for taking into account the key factors determining the success of school learning is the one proposed by Carroll. His model includes five classes of variables which influence the outcomes of learning: (1) aptitude, (2) opportunity to learn, (3) perseverance, (4) quality of instruction and (5) ability to understand instruction (Carroll, 1963, 1989). He proposed to optimize these variables so that the degree of mastering the learning material will be the highest for each student.

Several researchers attempted to apply this model, its extension or adaptation in the classroom practice under the umbrella of individualization, personalization, differentiation and similar concepts. One of the most elaborated systems was Bloom's mastery learning, which divided a longer instructional process into smaller learning tasks, each beginning with a pre-test that explores students' preliminary knowledge and followed by compensatory activities to fill the gaps in students' prior knowledge. Then the main part of the instruction was again followed by a post-test to assess the results of this learning period, and a final compensation phase was devoted to helping students who needed more support to meet the mastery criteria (Bloom, 1968).

A number of experiments have been conducted based on this model and the effectiveness of mastery learning programs have been proved (for meta-analyses see Guskey and Gates, 1986; Kulik, Kulik and Bangert-Drowns, 1990). On the other hand, preparing and administering the tests and delivering the compensatory activities required a great deal of materials and teacher's time; therefore; these methods could not be broadly used in practice (Guskey, 2007; Lamidi, Oyelekan and Olorundare, 2015). In some recent approaches computers have already been applied and the game-based approach has been utilized (Lin, et al., 2013; Miller, Baker and Rossi, 2014; Grant, Fazarro and Steinke, 2014; Small, 2014; Paiva, 2017), but these experiments provide only partial solution for the general problem of the need for frequent assessment and immediate feedback.

3 Assessment for learning: Formative and diagnostic assessment

Assessment in education has a long history, and tests in educational contexts have been used for a number of different purposes. In the system of assessments, formative assessment has a well established place (Sadler, 1989). It is often characterised as embedded in the learning processes for supporting mastery, and is distinguished from summative assessment, what is used at the end of a longer learning process (Black and Wiliam, 1998; Shepard, 2000; Clarke, 2001; Crooks, 2001; Black, Harrison, Lee, Marshall and Wiliam, 2003a, 2003b).

In other context, three levels of assessment are distinguished, according to the level of feedback. Large-scale international assessments (such as PISA) provide feedback about entire education systems (comparing countries to each-other) while national assessment systems provide feedback at the level of institutes (for comparing schools) and may be used for accountability purposes. Formative assessments provide feedback at student level about the results of a shorter period of learning. Its results can be compared to other students' results or to a defined mastery criterion (standard), or can be used for monitoring students' progress comparing the actual achievements or developmental levels with previous ones (Ainsworth and Viegut, 2006).

Diagnostic assessment may be interpreted as a special class of formative assessment, when the emphasis on the supporting learning is even stronger, and assessment may include exploration of students' preparedness for a learning task. It may test prerequisites of successful learning, therefore it should be based on detailed models of learning and development at a given literacy domain. One of the main functions of the diagnostic assessment is identifying the needs of intervention in order of preventing failures. It should be frequent and should provide immediate feedback to avoid the accumulation of learning difficulties (see e.g. Leighton and Gierl, 2007). Because of practical reasons, these requirements are difficult to meet by traditional paper and pencil tests.

Formative tests are the typical instruments used in differentiated instructional models, like Bloom's mastery learning. In a mastery learning model, formative tests may function as pre-tests as well as post-test. If testing has to be adjusted to students' actual developmental levels and to their specific needs, testing raises further logistic problems: different tests have to be administered to students being in different phases of learning. These problems can be solved only by the means of technology.

4 Providing frequent feedback with technology-based assessment: the eDia system

Due to the rapid development of technology-based assessment, the problems mentioned in the previous section may be solved by the means of online testing. Building a technology-based assessment system also requires lots of resources, but when it is

completed, it can be operated as a low-cost easy-to-use instrument (Csapó, Ainley, Bennett, Latour and Law, 2012). Such a system, called eDia was created to provide diagnostic assessment for the first six grades of the primary schools.

The first phase of the project has already been completed: an online assessment platform was built and item banks were developed for the assessment of reading comprehension, mathematics and science. The item banks are based on an innovative assessment framework that distinguishes three dimensions in each assessment domain: (1) psychological dimension that assesses how students' cognitive functions and their specific and general thinking skills develop, (2) application of knowledge in new contexts and (3) disciplinary (curriculum-based) knowledge. (For the frameworks of the three main domains and the detailed description of the three dimensions in each domains see Csapó and Szendrei, 2011; Csapó and Csépe, 2012; Csapó and Szabó, 2012).

The assessment items utilize the full range of multimedia, including video and simulation. The item bank contains approx. 6000 items per domain what made possible detailed assessments at the nine well-defined dimensions. The system stores students' data; the results of testing may be longitudinally connected and the individual developmental trajectories may be outlined.

This diagnostic assessment system is fully functional and is used in approx. 900 schools from different regions of Hungary under piloting conditions. Stability and availability of the system have been tested in a number of different ways and it proved to be robust and stable. Media effect studies have indicated that the online tests were more reliable than their paper-and-pencil versions (Csapó, Molnár and Nagy, 2014).

In the current phase of work, integration of assessments into everyday teaching and learning processes is in progress. There are several ways as the online assessment system can be utilized for supporting individualization and personalization of students' learning. As teachers receive detailed and objective feedback about their students' developmental level and progress in nine assessment dimensions, they may find ways for adjusting teaching to the needs of their students.

Further development of the assessment system and extending it with teaching functions, additional support can be given to the students and their teachers. For those students whose assessment results indicate learning difficulties or atypical development, special remedial training programs may be offered. Developing instructional materials deliverable online is in progress for intervention in the case of students whose diagnostic tests indicate the need for help and special support. Online developmental exercises are prepared by applying the principles of game-based learning and gamification. Some pilot studies in this field have already confirmed its feasibility.

5 Conclusions

The online assessment system has already been in use for several years and aids teachers greatly with objective data in identifying students who need special assistance. The extensions of the system now under construction will provide students with personalized and playful developmental exercises. Early interventions may prevent school failures. Further research and development is needed to create remedial materials for the major types of learning difficulties what then can be routinely delivered online to the students in need. When enough online training material is available, comprehensive mastery programs may be constricted which could ensure that most students reach high level of proficiency at each assessment domain.

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