

TECHNOLOGY-ENHANCED ASSESSMENT IN EDUCATION

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CONTEXT AND OUTLINE OF THE PROBLEM

Technology-enhanced assessment can play a key role in meeting the needs formed by the digital society in the context of a systemic reform of educational systems. If pedagogically rather than technologically driven, such an assessment can support a new vision of learning characterized by:

- Learner-centeredness. The learning environment encourages learners' active engagement.
- The personalization of learning. The learning environment is sensitive to individual differences.
- The social nature of learning. The learning environment encourages scaffolded cooperative learning.
- Emphasis on high-level skills such as creativity, problem solving, linguistic and verbal reasoning.

In the transition from the traditional school to that of the digital society, one of the main changes regards the underlying learning paradigm.

The traditional school is based on the idea that learning is the result of a process of transmission of knowledge from a teacher to a learner. This model is centred on the teacher who covers the standard content by lecturing in front of a class while students listen and then study at home. In this model, assessment is mainly aimed at identifying whether students can recall facts or are able to solve given tasks; thus, major emphasis is given to the grading function.

In the new educational systems, learning is seen as the result of interaction of students with innovative learning environments (ILEs) based upon information and communication technologies (ICTs) and new learning principles. In ILEs, assessment is a structural element of the learning process in view of the fact that:

- Content and methods are personalized on the basis of learners' characteristics and assessment is the process that allows to indentify these characteristics.
- The interaction between the learner and the environment is often mediated by technologies and shaped in accordance with the learner's pre-existing knowledge, beliefs, feelings and skills, i.e. the learner's initial state. Assessment is the procedure to detect and describe this state, before and during the learning process, and it can be effectively mediated by technologies.
- ILEs embody Web 2.0 technologies, which allow learners to cooperate among their peers and produce new knowledge. New assessments are aimed at evaluating the quality of students' cooperation and knowledge production throughout the process of interaction with a learning community.
- ILEs emphasize high-level skills and competences. New assessment processes are required to evaluate individual deep understandings and problem solving abilities related to real world tasks and the creation of new ideas and knowledge. Technology-enhanced assessment facilitates the evaluation of the acquisition of high-level skills and competences.

Technology-enhanced assessment can also play an important role in comparative surveys related to individuals' acquisition of new skills, carried out at national and international levels. In most of these studies, ICT is both the assessment content and the tool to carry out the study. Some examples include:

- The OECD Program for International Student Assessment (PISA) (OECD, 2011).
- The International Association for the Evaluation of Educational Achievement (IEA) Programs – Trends in International Mathematics and Science Study (TIMSS), Progress in International Reading Literacy Study (PIRLS), and International Computer and Information Literacy Study (ICILS).
- The Adult Literacy and Lifeskills Survey (ALL).

All these programs are aimed to systematically introduce technology-enhanced assessment, which offers more effective methods and tools.

TYPES OF TECHNOLOGY-ENHANCED ASSESSMENT SYSTEMS

ICTs facilitate assessment in the context of innovative learning environments with new possibilities ranging from simple web-based tests for self-assessment to group work assessment to recent developments in semantic analysis for automatic diagnosis. Examples of these new possibilities are:

- New approaches (peer assessment, self-assessment, etc.), methodologies and tools to evaluate learning processes based on participation, collaboration and production – these are typical for social constructivist approaches.
- Assessment within communities of practice which provides feedback and shared meanings essential to membership.
- More sophisticated assessment methods and tools that involve new types of questions and adaptive delivery procedures.
- Assessment of high-level skills and competences by means of Web 2.0 tools.

There are different types of technology-enhanced assessment systems that can be classified according to how ICT affordances are exploited. These systems could be positioned in a continuum, where at the lower extreme are those systems characterized by the transference from paper-pencil tests to ICT-based tests, and at the higher extreme are the systems that use ICTs and Web 2.0 for supporting the transition to a new pedagogy involving assessment for learning, participation and cooperation.

Class 1. Traditional assessment tests supported by computer

In an assessment system, a set of tasks (test items) is proposed to an individual. The individual response consists of a performance recorded and acquired by the system. Systems belonging to this class use the computer to support traditional tests. Test items are texts presented on the computer screen and answers are acquired by means of a keyboard. The administration procedure is sequential and predetermined. These systems do not require major changes in the ways assessment operates in the paper-pencil systems, but are useful to decrease the workload imposed on teachers to administer, correct and analyse test results. An example is the Graduate Management Admission Test (GMAT) taken each year by around 15 thousand people in Europe. GMAT is partly delivered in the form of computer-based adaptive multiple choice items.

Class 2. Computer-enhanced item presentation and performance acquisition and/or computer-based adaptive tests

In technology-enhanced assessments, test items are digital documents, which have the characteristics of being multimedia, hypermedia, interactive and easy to be reproduced, modified, processed, reused, transmitted and accessed. These characteristics open new challenging possibilities for assessment. For example, a test item can be a video or hypermedia; a request to operate in a simulation environment; a request to modify a document; an information problem to be solved with the help of the Internet, and so on. Moreover, a test item can be adaptive, accommodating individuals' characteristics detected during the previous interaction.

In systems belonging to this class, an item-administration procedure adaptively chooses an item to be presented from a test item pool, or asks an item generator to generate an item according to given rules.

The performance record is stored and evaluated. The evaluation produces:

- a representation of the individual's cognitive state (shortcomings, understandings, skills, competences, etc.) related to an area of a given knowledge domain, in formative assessment; or
- a score, in criterion-referenced and summative tests; or
- a ranking position in a predefined population, in normative tests.

The individual's understandings and shortcomings are automatically updated and used by the administration procedure to choose the next test item. For example, in National Tests in Denmark, tests adapt to the students' level of proficiency during the evaluation (Wandall, 2009). The first test item has an average difficulty. If the answer is correct, the next item will be more difficult. If the answer is wrong, the next item will be easier. In this way, the test adapts to the ability level of each individual examinee, so that the sequence of items is different for each student.

Class 3. Adaptive learning environments including an assessment module

Systems belonging to this class involve assessment as an integral part of learning and teaching. Herein, assessment is frequent and feedback is immediate. This helps to provide a picture of the learner's progress and achievements and to identify next steps in learning. These systems contain a learner model which identifies the learner's cognitive state related to a given domain indicating his/her understandings and gaps. This state is continuously updated during the interaction between the learner and the learning environment and is used by the instructional procedure to choose the next test item or learning activity. The learner's state is the base for shaping the learning process. Formative assessment is more efficient in an individualized educational context, where students follow their own developmental paths. Computer-based tests embedded in the learning environment have proven to be motivating for students who are given the opportunity to self-evaluate and monitor their learning in realistic settings.

Class 4. Assessment 2.0 systems

Systems belonging to this class are based on Web 2.0 tools and innovative assessing methodologies (Whitelock, 2010). Many authors propose new approaches reflecting a new pedagogical framework called Pedagogy 2.0, emerging from the Web 2.0 technology which stresses participation, collaboration and learner productivity in the form of cooperative knowledge creation (Lee and McLoughlin, 2010). This new paradigm shifts the focus from the individual to the collective and from control to participation. In the traditional pedagogy, assessment is aimed at evaluating learners' acquisition of expert-validated knowledge, while in Pedagogy 2.0 individuals are involved in cooperative production of new knowledge and assessment should evaluate the quality of their actions in the context of a community, i.e. how these actions contribute to knowledge creation, how they improve social interactions, and how they contribute to a harmonic social climate.

Elliot (2008) proposes the following set of characteristics of Assessment 2.0:

- Authentic. Involving real world knowledge and skills.
- Personalized. Tailored to the knowledge, skills and interests of each student.
- Negotiated. Agreed between the learner and the teacher.
- Engaging. Involving the student's personal interests.
- Recognize existing skills. Willing to accredit the individual's existing works.
- Deep. Assessing deep-knowledge, not memorization.
- Problem-oriented. Original tasks requiring genuine problem solving skills.
- Collaboratively produced. Produced in partnership with fellow students.
- Peer and self-assessed. Involving self-reflection and peer review.

Examples of systems belonging to this class are (Whitelock, 2010):

- Netfolio which connects e-portfolios in a unique structure facilitating peer assessment (Barbera, 2009). In this system, students can share a body of evidence, reflecting and revising their own contribution in the process.
- WebPA¹ is an open source online peer assessment tool that enables every team member to recognize individual contributions to group work. A well-known criticism of assessed group work is that each student receives the same team mark, regardless of individual performance. By using WebPA to peer assess group work, each student receives an adjusted mark.
- Open Mentor² is a web-based tool for tutors, which assists them through analysing and then providing reflective comments on their assessment and feedback of student assignments. Open Mentor sets this framework on an open source foundation (Whitelock and Watt, 2007).

¹ <http://webpaproject.lboro.ac.uk/>

² <http://www.rgu.ac.uk/research/research-institutes/institute-for-innovation-design-and-sustainability-research/themes/digital-technologies/information-systems/learning-technologies>

INTRODUCING TECHNOLOGY-ENHANCED ASSESSMENT INTO EDUCATION SYSTEMS

Technology-enhanced assessment has been implemented in several contexts at national and international level. For instance, in 2006, the Danish Parliament promoted the development of IT-based tests as a compulsory pedagogic tool in the Folkeskole (Wandal, 2009). The tests were designed by the Agency for the Evaluation and Quality Development of Primary and Lower Secondary Education and were developed by a consortium involving different companies as well as educational and research institutions. These tests were IT-based and the pupils answered the questions online. Test results were automatically calculated and generated. The teachers did not have to correct the tests. The schools were supplied with the tests free of charge.

At international level, the OECD PISA (Programme for International Student Assessment) is running in 65 countries and has been going on since the year 2000. An important part of the study is trying out new ways of measuring educational outcomes. The first step into the direction of technology-enhanced PISA assessments was pioneered by Denmark, Iceland and South Korea. The results from this first computer-based assessment of science highlight numerous challenges and have encouraged countries to take the work further.

The design of large scale technology-enhanced assessment is a complex process involving the expertise of different professionals such as content domain experts, knowledge engineers, psychometrics experts, test development experts, test administrators, evaluators, and software engineers.

Although these examples highlight relevant innovations introduced by the use of ICT in the assessment practice, the deepest change related to technology-enhanced assessment is the shift of the underlying ideas:

- from tool to certify to instrument to promote learning;
- from disciplines to high-level skills;
- from uniformity to diversity of techniques;
- from summative to formative assessment (Mateo, 2006).

In new educational systems based on innovative learning environments, assessment is a major influence on what and how students learn. Assessment cannot be separated from learning.

Several national policies assume this vision of assessment. For instance, in the UK, the 'Assessment for Learning Strategy'³ has been defined in a project involving the Department for Children, Schools and Families, the National Strategies and Qualification and Curriculum Authority (QCA), together with the Chartered Institute of Educational Assessors. It outlines a strategy for assessment for learning, which forms a significant part of the government's commitment to developing personalized learning. In January 2010, the Scottish government defined a policy for quality evaluation by publishing a framework for assessment⁴. That document stated that a rigorous and systematic national approach to quality assurance and moderation would be developed with a range of support structures and processes at the local and national levels. This guidance provides information on

³ <https://www.education.gov.uk/publications/eOrderingDownload/DCSF-00341-2008.pdf>

⁴ <http://www.scotland.gov.uk/Resource/Doc/317246/0101044.pdf>

the national approaches to quality assurance and moderation through understanding, applying and sharing standards in assessment for Curriculum for Excellence to ensure that the local and national practices are aligned.

Assessment design is a part of learning design, since assessment shares the same knowledge representation with the learning process, and provides information to shape the learning process. Only teachers have the knowledge, experience, and appropriate context for developing effective innovative learning environments and the related assessment. Effective use of learning technology will not come about unless teachers are at the helm of innovation (Laurillard, 2010).

In new education systems, teachers should be able to develop their own assessment systems, which can include technology-enhanced tests implemented by themselves, tests available as Open Educational Resources (OER)⁵ developed by educational bodies (assessment institutions, universities, etc.), or educational products distributed by publishers and other commercial bodies.

Teachers should be aware of how Web 2.0 tools, such as blogs, wikis, social networks, media production sharing applications and social bookmarking facilities can be integrated for developing an assessment environment for their students in a social constructivist context.

Several conditions are required for integrating technology-enhanced assessment in the classroom:

- Teachers and learners have to be digital literate.
- Teachers and learners have access to ICTs.
- Teachers have to be able to design ILE and related assessment systems.
- Teachers can operate as designers in the school context.
- Teachers have time to design and implement assessment tools.
- Methodologies, tools and products (OER, institutional and commercial products, etc.) have to be available to support teachers in the design of technology-enhanced assessment.

The appearance of teachers' communities of practice should be encouraged. Within these communities, teachers can share principles, models, methodologies, techniques, tools and products for technology-enhanced assessment. Within these communities, teachers can also practice Web 2.0 evaluations based on peer reviews, self assessments and self-regulated learning. A bridge should join these communities with other institutions, such as research centers, assessment bodies, universities, publishers, OER developers, etc.

⁵ <http://www.unesco.org/new/en/communication-and-information/access-to-knowledge/open-educational-resources/>

FACTORS HINDERING TECHNOLOGY-ENHANCED ASSESSMENT

Efforts to transform traditional assessment practices and to introduce technology-enhanced assessment have been so far hindered by a number of factors:

- Technology-enhanced assessment requires a technologically rich environment. Many learners (and teachers) have no regular access to technology.
- Many learners (and teachers) are digitally illiterate.
- In the traditional school, knowledge is confined to individual learning and removed from any social context. Cultural conditions do not exist to introduce social constructivist approaches and related assessment techniques.
- There is a great inertia of educational systems, when it comes to shifting the focus from a transmissive paradigm to an active one. Classroom assessment generally encourages superficial and rote learning, focusing on evaluating whether what has been taught has been understood, remembered and practiced (Black and Dylan, 1998).
- Teachers do not generally review the assessment questions that they use and do not discuss them critically with peers, so there is little reflection on what is being assessed.
- The grading function is over-emphasized and the learning function is under-emphasized. There is a tendency to use an approach which emphasizes competition between pupils rather than personal improvement.
- High-level skills needed in the information society are rarely considered in most of curricula.
- Initial teacher education and continuing professional development do not address the new roles of assessment and technology-enhanced assessment techniques.
- The development of good classroom assessments places significant demand on teachers.
- Teachers must have tools and other support if they are to implement high-quality assessments efficiently and use the resulting information effectively.

RECOMMENDATIONS AND CONCLUSIONS

This section contains some recommendations for policy-makers to support the introduction of technology-enhanced assessment as an innovation tool in the context of a systemic reform of the educational system.

Create conditions to use technology-enhanced assessment as a learning tool

- Promote teachers' and learners' access to ICT and digital literacy.
- At national level, define a vision, a strategy and a plan for introducing assessment for learning into the school system. This plan should also revise the actual curricula.
- Create a culture of assessment as a learning tool: assessment for learning should be regarded as one of the most important objectives of assessment.
- Promote projects to design and set up comprehensive evaluation systems taking into account both the actual educational ICT tools and the underpinning theoretical models.
- At national level, make agreements with proprietary institutions to use online international ICT-enhanced tests (such as PISA tests) to help schools in monitoring their students' performance.
- Identify areas where technology-enhanced assessment is most needed (digital literacy, 21st century competences, spelling, reading, writing, mathematics, science, etc.).
- Promote research projects to develop and disseminate technology-enhanced assessment methodologies and tools, fully exploiting the characteristics of digital documents and social constructivist environments.
- Encourage test producers (OER developers, publishers, assessment bodies, universities, etc.) to follow generally accepted quality criteria, e.g. International Guidelines on Computer-Based and Internet Delivered Testing⁶.
- Plan a shift from traditional testing to computer-based assessment approaches by organizing a smooth process of transition, finding a compromise solution to combine potentials and constraints (technological, economical, etc.).
- Be aware that each advantage of ICT-enhanced assessment also provides problems that may not be immediately apparent and have to be studied and solved (gender problems, digital divide problems, etc.).

Take into account the new roles of teachers and improve their initial education and continuing professional development

- Promote the role of teachers as designers of learning environments with assessment systems.
- Promote digital literacy among teachers.

⁶ <http://www.intestcom.org/Downloads/ITC%20Guidelines%20on%20Computer%20-%20version%202005%20approved.pdf>

- Allocate time and resources for teachers to design their learning environments and assessment.
- Provide tools and other support for teachers to implement high-quality assessment.
- Provide an environment in which teachers work together to frame what they believe to be good practice, conduct field-based research to confirm or disprove the approaches they develop.
- In initial teacher education (ITE), support teachers in learning how to develop innovative learning environments embodying technology-enhanced assessment.
- Have a continuous professional development plan in place to support teacher professional development in the use of learning technologies and ICT-enhanced assessment.
- Support the creation of talented teachers' communities of practice and help teachers to develop new formative ICT-based tests and innovative learning environments.
- Encourage teachers' communities of practice in developing and sharing innovative assessment methodologies, ICT-enhanced tests and innovative learning environments.

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ICTs offer new opportunities for innovation in educational assessment. These opportunities could be positioned in a continuum where the lower extreme is the transference from paper-pencil tests to ICT-based tests and the higher extreme is the use of ICT and Web 2.0 for supporting the transition to a new pedagogy involving assessment for learning, in which both teachers and learners participate in reflection, dialogue and decision-making and assessment includes strategies for self-assessment and peer assessment emphasizing the next steps needed for further learning.

The Policy Brief contains an overview of the state-of-the-art, major trends, challenges and policy recommendations on design, implementation and monitoring of ICT-based assessment.

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