Computer-Based Assessment of Complex Problem Solving:
Concept, Implementation, and Application

Samuel Greiff, Sascha Wüstenberg, Daniel V. Holt, Frank Goldhammer, and Joachim Funke

Universities of Luxembourg and Heidelberg, German Institute for International Educational Research, and Centre for International Student Assessment

(Editor's note: See full text for reference citations.)

CPS [complex problem solving] can be decomposed into two overarching processes: acquiring new knowledge ("knowledge acquisition") and applying this knowledge ("knowledge application") while interacting with a dynamically changing system. Some research suggests to further separate these two processes into sub-processes such as generating and reducing information during knowledge acquisition or systematically intervening during knowledge application.... The assessment of CPS relies strongly on the availability of flexible tools and platforms for authoring and computer-based delivery of complex simulations as assessment vehicles for CPS.

This paper focuses on computer-based assessment of CPS skills employing the Micro-DYN framework, which was used in PISA 2012 as conceptualization of CPS. MicroDYN is a generic theoretical and assessment framework for developing CPS tasks, which is based on theories from cognitive psychology, relies on computer-based testing, and has been empirically validated in various studies.

This article is excerpted from *Educational Technology Research and Development,* published online first, April 26, 2013. Read the full text by logging in at the AECT website, http://aect.org/, and clicking on Publications.

CALL FOR PAPERS

Check out calls for papers, proposals, and participants. Get involved.

Page 2

JOURNALS

Members have instant online access to a wide variety of journals.

Page 5

RESEARCH

The topic this month asks the question: Are MOOCs a game-changer?

Page 6

2013 AECT International Convention
October 29 – November 2

"Innovate! Integrate! Communicate!"

Register Today
http://aect.org/

Association for Educational Communications and Technology

320 West 8th Street
Suite 101
Bloomington, IN 47404-3745

U.S. Toll-Free:
877-677-AECT

Local Phone:
812-335-7675

Email:
aect@aect.org

Website:
http://aect.org/

iTECH DIGEST

Calls for Papers, Proposals, and Participants

Call for Proposals. Need funding to develop a research proposal? Consider applying for a Collaborative Research Grant. The purpose of the grant is to provide monetary support to enable association members to develop research project proposals that include active collaboration among researchers, research institutions, and AECT. Information at: http://aect.org/.

Call for Papers. Express your ideas in a white paper for AECT directed at our field or our world. For more information please go to: http://aect.site-ym.com/?page=call_for_academic_wh.

Call for Papers. The AECT flagship practitioner journal, *TechTrends*, is seeking manuscript submissions, including from international and newer authors. For more information, see the Instructions for Authors online: http://aect.site-ym.com/?page=techtrends. AECT's premier research journal, *Educational Technology Research and Development* welcomes submissions: http://www.editorialmanager.com/etrd.

Call to Converse. Participate in online discussions through the AECT website in ITForum. Join in and read what others are saying and contribute your own thoughts. ITForum is reached from the AECT homepage: http://aect.org/.

Call for Manuscripts. AECT, in collaboration with Springer, has announced a new series of books and monographs under the title, "Educational Communications and Technology: Issues and Innovations."

The purpose of the series is to extend AECT's ongoing publications with Springer and to offer the Springer Briefs innovative format to AECT authors and contributors. For more information potential authors are asked to see: http://aect.site-ym.com/news/112234/Announcing-a-New-AECT-Book-and-Briefs-Series.htm.

AECT Has Moved

AECT offices are now located in Bloomington's historic Showers Plaza, which includes City Hall and a variety of congressional, corporate, and nonprofit organization offices. See at left for the new address. Phone numbers are unchanged.

SHOWERS PLAZA

Support for Self-Regulation in Learning Complex Topics from Multimedia Explanations:
Do Learners Need Extensive or Minimal Support?

Héctor García Rodicio, Emilio Sánchez, and Santiago R. Acuña
Universities of Cantabria and Salamanca
Spain

Learners must self-regulate their learning if they are to gain a deep understanding of complex conceptual systems. Self-regulation involves planning, to set learning goals, activating task value beliefs and judging self-efficacy, to enhance motivation, monitoring ongoing understanding, to detect possible flaws, and regulating this understanding in order to repair those flaws. Given that these processes are difficult to execute, learners are usually provided with support. Prior research has explored the effects of broad support systems (i.e., support for a broad spectrum of self-regulatory processes), with the finding that they are beneficial for learning. Here we report the results of an experiment aimed at examining whether learners need broad support systems or whether they are also able to learn with more economical support configurations.

We asked undergraduate students with little prior domain knowledge to learn a complex conceptual system, plate tectonics, from a computer-based multimedia presentation. The presentation included modules of animation with concurrent narration and support for self-regulated learning. The participants received support for planning in the form of a planning episode, which included an overall learning goal, sub-goals, and messages intended to elicit self-efficacy and interest.

Learning complex conceptual systems with hypertext, multimedia, and hypermedia materials requires learners to deal with a number of difficulties. In order to overcome them, learners must self-regulate their learning process by planning, monitoring, and regulating cognition and motivation/affect. Although there is evidence that these are critical processes, research has indicated that learners carry them out poorly. As a solution to this, researchers have developed support systems for self-regulation. There is evidence to suggest that they are effective; however, since previous research has used broad support systems, it is not clear whether minimal or intermediate forms of support can also work effectively.... The results of our experiment clearly revealed that the condition including the broadest support was the most effective in promoting learning as compared to the other three, and, more interestingly, that there were no differences between those other conditions, which were not so effective in the promotion of deep learning. Therefore, based on our results, when low-prior-knowledge learners are expected to acquire complex conceptual systems, it seems critical to provide them with support for a broad spectrum of self-regulatory processes.

AECT Mission

The mission of the Association for Educational Communications and Technology is to provide international leadership by promoting scholarship and best practices in the creation, use, and management of technologies for effective teaching and learning in a wide range of settings.

Goals:

• Define the disciplines and professional activities that comprise the field of educational communications and technology.
• Serve and represent professionals in the field and support professional growth.
• Advance scholarship and practice that contribute to and enlarge the knowledge base of the field.
• Promote policies that ensure the humane and ethical use of educational communications and technology at all levels, from the personal through the international.

CPS…continued from page 1

Interactive CPS tasks such as MicroDYN require computer-based assessment to allow dynamic interactions between problem solver and problem. Additionally, computer-based assessment provides further benefits such as highly standardized and economical instruction and data collection, tests with adaptive difficulty levels, automatic scoring, and recording of detailed process data. Despite these benefits the adoption of computer-based testing has been lagging behind expectations. While the widespread availability of computers in industrialized countries makes lack of equipment or limited computer literacy of participants less of an issue, the technical expertise required for authoring, delivering, and scoring computer-based tests remains an entrance barrier. Computer-based assessment requires the integration of different technologies and expert skills, such as programming, user interface design, server administration, and data management in addition to research expertise and content knowledge. To acquire this combination of skills either requires considerable time or incurs high costs when contracted out. We therefore aimed to establish an authoring and test deployment platform that makes using computer- based assessment with interactive problem solving tasks such as MicroDYN more efficient and less time-consuming for researchers and instructors. A major requirement for such a tool was that it could be easily used by non-IT-specialists to author, test, assemble, and deliver tasks as well as provide access to response data in a form that can be further processed by common statistical software packages.

The CBA Item Builder is a generic assessment platform, which has been designed to meet these requirements. This tool is provided by the German Institute for International Educational Research (DIPF) who organizes the development of the software and collects and coordinates new requirements.

The ultimate goal of education is to foster and enhance students' personal and academic potential…. In pursuit of optimizing education, we argue that assessment platforms could be used as learning environments. Specifically designed tasks may be used to assess students' domain-specific problem solving skills with specific contents (e.g., a simple physics or chemistry experiment) or on a more general level (e.g., finding a fault in a malfunctioning technical device). Results provide direct individual feedback for students and could also be used by the teacher to adapt and modify subsequent instruction. In future, the approach may be extended towards online tutoring while working on specifically designed tasks.

Remembering David H. Jonassen

Learning, Problem Solving, and Mindtools, published by Routledge this spring, was conceived as a festschrift, honoring the life and work of David H. Jonassen. Sadly, Jonassen died December 2, 2012, while the book was still in preparation.

Learning, Problem Solving, and Mindtools was inspired by "the substantial body of learning research by David H. Jonassen in the areas of mindtools and problem solving," according to the volume's editors, J. Michael Spector, Barbara B. Lockee, Sharon E. Smaldino, and Mary C. Herring.

The collected work includes seventeen scholarly essays on a range of related topics, such as mental models, practice-centered approaches to instructional design, games and simulations, mobile technologies, and taxonomies.

Jonassen's own essay, "First Principles of Learning," concludes the volume. In it he pairs David Merrill's "first principles of instruction"—activation, demonstration, application, and integration—and his own "first principles of learning"—problem-based, analogizing, modeling, reasoning causally, and arguing. The essay summarizes what Jonassen believed to be "the most important cognitive processes that lead to the most meaningful learning."

He concludes briefly but piquantly: "Learning environments should support productive thinking by students."

Jonassen was a fellow of the American Educational Research Association, served on the *ETR&D* Research Section Editorial Board, and was named the first recipient of the David H. Jonassen AECT Excellence in Research Award.

Member Access Publications

Educational Technology Research and Development
Bimonthly
ISSN: 1042-1629 (print)
ISSN: 1556-6501 (electronic)
Journal no. 11423
Springer US

TechTrends
Bimonthly
ISSN: 8756-3894 (print)
ISSN: 1559-7075 (electronic)
Journal no. 11528
Springer US

Instructional Science
An International Journal of the Learning Sciences
Bimonthly
ISSN: 0020-4277 (print)
ISSN: 1573-1952 (electronic)
Journal no. 11251
Springer Netherlands

International Journal of Designs for Learning
Quarterly
ISSN: 2159-449X
(electronic)
AECT

Journal of Applied Instructional Design
Quarterly
ISSN: 2160-5289
(electronic)
AECT

Visit the AECT website http://aect.org/, log in, and click on Publications for instant access.

Research Roundup

Are MOOCs a Game-Changer?

MOOCs are Massive Open Online Courses, free Internet-based courses covering a range of topics.

Many MOOCs are transitioning toward a closer resemblance to traditional on-campus and online courses, although usually shorter in length. MOOCs often are delivered by highly qualified professionals. MOOCs usually do not lead to formal qualifications, but they are useful for building knowledge and skills that support career goals. Some observers are looking at MOOCs as a game-changer, particularly in higher education, and wondering whether for-credit MOOCs lie ahead.

Increasingly MOOCs are competing for students who might otherwise take traditional online or bricks-and-mortar courses, from which education institutions derive income. Because MOOCs are Internet based, these free courses can be offered anywhere to any size "class" imaginable.

Following are major MOOC platforms:

- *Coursera* (www.coursera.org) provides courses in economics, computers, the sciences, music, and other fields. The organization encompasses a consortium of universities, including Harvard, Stanford, and London.
- *EdX* (www.edx.org) is operated by Harvard University and Massachusetts Institute of Technology, drawing course content from their traditional course offerings.
- *FutureLearn* (www.futurelearn.com) is a consortium of major universities in the United Kingdom, including The Open University, and the first UK-led MOOC effort. It is still in early stages of development.
- *Khan Academy* (www.khanacademy.org) is a MOOC platform for K-12 learners with courses in math, the sciences, history, and other fields.
- *Udacity* (www.udacity.com) focuses on computer science and offers courses for beginners to advanced learners.

The first pan-European MOOC initiative, called OpenupEd (www.openuped.eu), was launched earlier this year with the support of the European Commission. Free courses in a variety of subjects and taught in a number of languages will be available. Led by the Netherlands-based European Association of Distance Teaching Universities (www.eadtu.nl), the initiative includes mainly open universities. Among the countries involved are France, Israel, Italy, the Netherlands, Portugal, Russia, Spain, Turkey, and the United Kingdom.

MOOCs—and online courses in general—also are driving a new discussion of the traditional measure of accomplishment: the credit hour. This bedrock of higher education is an ill-fit in Digital Age education. So how should online courses be evaluated and how should credit hours (or their equivalent) be awarded?

Traditional online education overall is under pressure still, despite a lengthy track record, to prove itself equal in rigor and quality to bricks-and-mortar courses. While many are looking to MOOCs as the future of digital education, some organizations and consortia are making efforts to shore up traditional online options. For example, UIU Link (uiulink.com) coordinates online course offerings for subscriber institutions to increase paying enrollments. Institutions pay a fee, while the service is free to students.

Another is WICHE ICE (www.wiche-ice.org), for Western Interstate Commission for Higher Education Internet Course Exchange, which coordinates online course offerings of the member institutions.

Are MOOCs a game-changer?

Exchange views in ITForum. Access the Forum through the AECT homepage at http://aect.org.