

Guest Editorial - Creative Design: Scaffolding Creative Reasoning and Meaningful Learning

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Design is a cognitive activity that adds much economic, social and cultural value. Creativity is a desired core competency of individuals and organizations alike. It follows, then, that design and creativity are, or ought to be, among the main goals of learning and teaching. However, we do not fully understand the connections between design and creativity on the one hand, and between learning design and creativity and teaching design and creativity on the other. How, precisely, can design and creative capabilities be promoted in formal and informal education? What are the principles for generating activities and curricula that promote creative design? What scaffolding do learners need to become more creative and to learn to design? How can responsibility for scaffolding be distributed between teacher, peers, and computing technologies?

Information processing theories and technologies impact these issues in at least three fundamental ways. First, we now have the beginnings of information theories of creative design that provide insights into the content, representation, organization, use and acquisition of knowledge. During the 1990's, for example, Kolodner (1994) and Wills & Kolodner (1994) presented a case-based theory of creativity in design while Goel (1997), and Bhatta & Goel (1997) described a theory of creative design that integrates case-based and model-based reasoning. Second, during approximately the same period, constructivist (Savery & Duffy 1996; Jonassen 1999) and social constructivist (Palinscar 1998) theories of learning and teaching became prominent. Third, a new generation of interactive technologies has developed over the past two decade that has the potential for transforming the learning of creative design. These interactive technologies include multimedia technologies and of course the World Wide Web.

The articles in this special issue begin to address the broad issues listed above, taking into account what we know about the reasoning involved in creative design, cognitive and socio-cognitive theories of how people learn, and the affordances of hardware and software technologies. The six papers in this issue answer four core questions: What can we infer from constructivist and socio-constructivist theories of learning about how to help youngsters learn to design and solve problems creatively? What social constructivist practices can be used to promote learning to design, and especially learning to design creatively? How may theories of design, creativity, and creative design inform these practices? How can interactive technologies be exploited to promote such learning?

Lee & Kolodner in "Scaffolding Students' Development of Creative Design Skills: A Curriculum Reference Model" explore the implications of case-based theories of creative design for the design of curriculum that will help high school students learn to design and become more creative designers and problem solvers. Using what we know about constructivist practices and design cognition, they propose a curriculum framework for promoting creative design and describe how it can be operationalized for national and local educational standards. They advocate the teaching creative design within the context of sustainable development projects relevant to the local communities where the high school students live. As stakeholders, it is argued, learners will find the context personally meaningful and be motivated both to do well at achieving project goals and at learning to design and solve problems creatively. Lee & Kolodner's potential reach is global; they envision high school students in cities as disparate as Atlanta, USA, and Kuala Lumpur, Malaysia, working together and learning from each other.

Global outreach aimed at supporting teaching and the development of meaningful learning at the higher education level is investigated in Keskitalo, Pyykkö and Ruokamo's Global Virtual Education (*GloVED*) model. Students from different parts of the world interact with each other in Second Life (SL) to solve a creative design challenge. Analysis suggests that individualized guidance, clear identification of roles, rules and objectives contributing towards effective teamwork, provision of practical examples within contextualized frameworks, critical self-evaluation study, and sufficient time to design and reflect lead to more creative student thinking and better design outcomes.

In “Redesigning a Web-Conferencing Environment to Scaffold Computing Students’ Creative Design Processes,” Bower reports on the evolution of the design of a web conferencing environment over three semesters of college-level education of computer programming. He begins with an information-processing account of creative design based on the interrelated roles of factual, conceptual, and procedural knowledge. He then describes how the web conferencing environment evolved over three iterations from an instruction-based model into a student-led collaborative tool. The final version of the tool also afforded the teacher to better assess students’ mental models and help them correct the models. Bower also extracts some design principles from the empirical study.

The impact of Web 2.0 technologies on learning has been relatively positive in institutions of higher learning and in secondary/high schools. However, their effect on primary school students has been less explored. Woo, Chu, Ho and Li’s case study helps to fill this gap. They have investigated the challenges and potential benefits that a Wiki may bring to students and teachers in a Primary five English language class in Hong Kong and subsequently, identified the Wiki’s key affordances, which can be used to help students improve on their writing abilities. Analyses of students’ collaborative writing projects are positive. Students view the use of the Wiki to learn English as a second language enjoyable, helpful in building teamwork and in improving writing skills.

Sullivan also investigates ways to promote creative design among young learners. However, instead of providing them with information technology, she asks them to solve robotics problems together, identifies the discourse practices that led to key understandings, and traces the conditions under which these understandings led to creative solutions. This work provides key insights into design of learning spaces where creativity, and especially collaborative creativity, can be promoted.

Finally, the article by Vattam, Goel, Rugaber, Hmelo-Silver, Jordan, Gray, and Sinha pulls together an interdisciplinary team of computer, cognitive and learning scientists to investigate how to help middle school students (grades 6 to 8; ages 12 to 14) understand natural complex systems. They propose scaffolding that makes the functional abstractions and the invisible causal behaviors of such systems visible to the students. Such functional understanding is critical to explaining how complex systems work and to developing solutions to problems that occur with such systems, including prediction, monitoring, diagnosis, and redesign. A software system called ACT (the Aquarium Construction Toolkit) helps middle school students reason about structures, functions, and behaviors in aquarium systems, providing a model for designing software that can scaffold systems thinking around other natural (and designed) complex systems.

These selected papers have provided a diverse range of possibilities for modeling ecosystems and creative experimentations; providing rich testbeds for exploration and collaboration. We hope that you will enjoy this special issue.

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