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# Scaffolding in Open-Ended Learning Environments (OELEs)

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https://sites.google.com/site/scaffoldingoeles/home

# Preface

Open-ended learning environments (OELEs) offer students opportunities to take part in authentic and complex problem solving and inquiry tasks by providing a learning context and a set of tools for exploring, hypothesizing, and building their own solutions to problems. Also referred to as exploratory environments, examples include hypermedia learning environments, modeling and simulation environments, microworlds, scientific inquiry environments, and educational games featuring open worlds. OELEs may be characterized by choices students have as they are involved in their learning and problem solving tasks; in OELEs, students are faced with a multitude of decisions about what, when, and how to learn. Naturally, these choices offer critical opportunities for students to exercise higher-order skills that include:

- *Cognitive processes* for accessing, organizing, and interpreting information, constructing problem solutions, and assessing constructed solutions;
- *Metacognitive monitoring and self-regulatory processes* for coordinating the use of cognitive processes and reflecting on the outcome of solution assessments; and
- *Emotional and motivational self-regulatory processes* that include curiosity and persistence, especially in the face of difficulty.

This presents significant challenges to novice learners because they may not have the proficiency for using the system's tools, nor the experience and understanding necessary for explicitly monitoring and regulating their emotions and behaviours as they pursue learning goals. Not surprisingly, research has shown that novices often struggle to succeed in OELEs. Without *adaptive scaffolds*, these learners typically use tools incorrectly, adopt sub-optimal learning strategies for goal selection and planning, and fail to regulate key cognitive, motivational, and emotional processes. Adaptive scaffolds in OELEs refer to actions taken by the learning environment, based on the learner's interactions, intended to support the learner in completing a task and understanding the topic. Broadly, providing adaptive scaffolds consists of two sub-problems: (1) measuring and interpreting student behaviours to determine which adaptive scaffolds will be beneficial for their learning, and (2) providing adaptive scaffolds that effectively support student needs.

Given the developing interest in this area, this workshop sought papers on: (1) theoretical frameworks for designing scaffolding; (2) implementations of adaptive scaffolds; (3) cognitive, metacognitive and self-regulation models for designing scaffolds; and (4) formative assessments that support students' learning, performance, and learning-related behaviors. 14 papers have been accepted for this workshop: 8 as long papers that have each been allocated 8 pages, and 6 as short papers that have each been allocated 4 pages in the workshop proceedings.

A number of the accepted papers present games for learning science and math content as an open-ended learning environment where students have choice in constructing their own solutions to targeted problems. However, when the system detects non-optimal or incorrect behavior, it provides adaptive scaffolds to help the

students discover and correct their incorrect solutions. Some of the papers discuss scaffolds in the form of representation schemes and selective tasks assigned to the student that aid their learning processes. Other papers use machine learning and data mining techniques to analyze student activity data and determine their learning behaviors and approaches to solving problems. A few papers adopt self-explanation as the framework for providing adaptive scaffolds, while others use Open Learner Modeling (OLM) as a mechanism for promoting student reflection, planning, and decision-making. One of the papers uses scaffolding to help students improve their metacognitive judgments. Another paper studies the effect of scaffolding as students work on invention activities related to data analysis. Finally, we also have a paper that discusses taxonomy of adaptive scaffolds in computer-based learning environments. We hope this set of papers leads to interesting and important discussions, and all participants can take away something that benefits their own work and advances the state of the art in this very important field of research.

In addition to the paper presentations and discussion, this workshop features other events:

1. A combined 90 minute hands-on activity and demonstration session where participants create levels to target and assess specific competencies in the Newton's Playground game (see http://www.gameassesslearn.org/newton/; the system has a level editor built into the game environment).
2. In the second half of the demonstration session, participants can demonstrate their creations.
3. A panel, where we compare and contrast approaches to scaffolding in traditional ITS problem solving environments and OELEs.

This workshop is the next in the series of Intelligent Support in Exploratory Environments (ISEE) Workshops that started in EC-TEL '08 and has had representations in previous AIED, ITS and ICLS conferences. The last workshop was held at the Intelligent Tutoring Systems (ITS-2012) conference in Chania, Greece in June, 2012 (https://sites.google.com/a/lkl.ac.uk/isee/isee-its-12). Finally, we would like to acknowledge the contributions of all of the authors, without which this workshop would not have taken place. Many thanks to the program committee that helped review the submitted papers and provide valuable feedback to the authors. Last, but not the least, a special thanks to James Segedy, who helped put together the Workshop proceedings.

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Gautam Biswas, Roger Azevedo, Valerie Shute, and Susan Bull

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## Table of Contents