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# GUEST EDITORS' INTRODUCTION

# SPECIAL ISSUE: INTERNATIONAL PERSPECTIVES ON INQUIRY AND TECHNOLOGY

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## Introduction

Preparing young people to successfully use science during the course of their lives requires more than just providing them with a body of factual knowledge. We must also help them develop strategies for continuously acquiring new knowledge and relevant skills in response to the ever changing issues and choices that will confront them. This view of learning holds that students should acquire a certain attitude of mind, making them willing and able to grow throughout the course of their lives. An important goal of science education is thus to foster a sense of inquiry and lifelong learning, enabling them to continuously inquire about their environment in order to respond to scenarios they encounter in everyday life. Should they reject genetically modified foods? Is nuclear energy dangerous? Are we at risk from various diseases?

The term "inquiry" has been applied to a broad range of perspectives about learning and instruction, with a variety of activities like questioning, information seeking, hypothesizing, experimenting, evaluating results, reasoning, and designing artifacts. A wide array of research has investigated various approaches to structuring inquiry, much of which has relied on technology enhanced materials or environments such as the Knowledge Forum (Scardamalia & Bereiter, 1996), ThinkerTools (White & Frederickson, 2000), BGuILE (Sandoval, 2003), Model-It$^{TM}$, (Metcalf *et al.*, 2000) ModellingSpace (Avouris *et al.*, 2003), KIE (Bell *et al.*, 1995), WISE (Slotta & Linn, 2009), Viten (Jorde & Mork, 2007), Cool Modes (Pinkwart, 2005), and Co-Lab (van Joolingen *et al.*, 2005). These studies have explored a variety of designs for inquiry-based learning, and have revealed some of the benefits and challenges for students and teachers (Krajcik *et al.*, 2008).

While research has varied in term of theoretical constructs, curriculum activities and materials employed, there is some agreement on the general goals for inquiry learning in science education. First, students must develop a conceptual understanding of specific science content, just as in more didactic forms of instruction. A second goal of scientific inquiry learning is to provide students the opportunity to acquire inquiry skills, including formal strategies that are valuable in scientific domains as well as collaboration, problem solving and critical thinking skills that are often referred to as "21st century knowledge skills" (Partnership for 21st Century Skills, 2009; Collins and Halverson, 2009). A third goal is concerned with students' understandings of the nature of science: By engaging in scientific methods and reflecting about those methods, students can better understand how science works, what kind of results science generates, and how scientists proceed in their investigations.

One common feature across many research programs is that of guiding students to search for relevant resources using both online and print media; this information must then be integrated with the student's prior knowledge and applied in the context of inquiry activities. Another commonality is that inquiry often begins with the formulation of questions and hypotheses that serve to focus the endeavour. Not quite as universal, but nonetheless fairly common, is the view of inquiry as consisting of a positivistic process of hypothesis testing, revision, and cyclical investigation (Bell *et al.*, 2010).

The specific curriculum activities, materials and assessments employed in the context of "inquiry-oriented instruction" have varied from open-ended reflections and qualitative discussions to more formal processes of experimentation and quantitative measurement. The various theoretical constructs, materials, and technology environments are not generally interoperable, and cannot be applied from one learning context to another. As a result, it has been difficult for the field to achieve any common definition of inquiry, or even a meta-language to describe inquiry processes. Collaborations can help, as they bring previously disparate views of inquiry into alignment and promote the development of shared discourse amongst learning scientists. Special issues of journals, such as this one and conference symposia can also provide a platform for critical comparison and aggregation of ideas.

This special issue of Research and Practice in Technology Enhanced Learning (RPTEL) was organized in order to invite contributions from an international audience of researchers concerning their own current work in the area of technology-enhanced inquiry learning. Our goal was to "capture this rich variety of theoretical perspectives about inquiry and the research materials and technology environments they entail" (Call for Papers, RPTEL Special Issue, 2009).

The notion of a special issue arose from a unique scientific network called Net-COIL — The Network for Collaborative Inquiry Learning — a community of scholars from Europe and North America that explored these issues from 2004–2008. Funded by the German Research Foundation (DFG) and coordinated by the IPN — Leibniz Institute for Science Education (Kiel, Germany), NetCoIL had three principal aims: (1) the critical comparison of different approaches to inquiry learning, to understand and compare the individual characteristics of different approaches, (2) the technical integration of tools and environments from different groups and (3) research collaboration to further define a common theoretical perspective and contribute new tools and approaches to the research literature.

NetCOIL conducted a series of meetings in Germany, the United States and Canada, leading to research collaborations (Urhahne *et al.*, 2010) and technical achievements. We presented our work as symposia at conferences (e.g. Bell *et al.*, 2007) and created an online repository to support the sharing and exchange of resources (see http://www.encorewiki.org/display/encore). We also progressed in the development of a framework for technical integration, which has contributed to several new funded initiatives in the E.U. and North America. As the official period of funding for NetCOIL came to an end, the members decided to coordinate a special issue of RPTEL, consisting of separate but supportive articles that together serve to reflect some of the progress on the NetCOIL aims cite above. The following section provides a brief outline of our articles, and how they fit together to address those aims.

## Organization of the Special Issue

The exact composition of this special issue has depended on the number and topics of articles submitted. Most of the papers included here originated at least partly from the NetCOIL community. Ultimately, however, this set of papers extends beyond the bounds of NetCOIL, and represents a truly international community of scholars from Europe, North America and Asia. This international complexion is representative of the increasingly global community of scholarship that characterizes the learning sciences in general, and those concerned with inquiry in particular. Perhaps through continued focus on common issues, we will ultimately arrive at a more coherent set of theoretical ideas and a greater level of interoperability and exchange for our tools and materials. Hopefully, this special issue can promote such efforts in the near future. Certainly, those of us who were engaged in NetCOIL and subsequent funded networks will continue our own efforts toward this end.

We have organized this issue around the themes targeted by our Request for Papers. First, we address our call for papers concerned with "Foundational issues: Inquiry learning principles within or across cultures, and their implications for learning technology." In this category, we present a paper by Slotta and Jorde (this issue), who discuss the challenges and opportunities of establishing inquiry curriculum that includes discussions and exchanges between international peers (i.e. students from different countries). This paper first describes a long running international collaboration between Norwegian and U.S. scholars in the WISE project, then describes how the authors created a hybrid curriculum using a blend of local and global curriculum components. Ultimately, the goal of this research program is to establish a set of design principles for such curriculum, and providing rich illustrations of the principles in the form of curriculum where students leverage international differences to achieve greater depth of scientific understandings.

The next goal of the special issue was to highlight "Systems and technology design: System design principles and technologies that have successfully been applied for building inquiry learning environments". In this category we present a paper by Pinkwart, Harrer and Kuhn (this issue) concerned with how to support collaborative modeling activities with technology environments. This study also includes an element of "scripting" to help guide students' interactions and support their collaboration processes, and blend individual and collaborative inquiry activities.

The final category was that of "Empirical studies: Experiences from classroom or lab studies with educational technology in inquiry learning contexts." The first paper, by Braun and Rummel (this issue) investigates an application of collaboration scripts to help guide collaborative inquiry. The authors conducted a controlled experiment to compare learning gains between scripted and unscripted conditions, and also compared the learning processes and interaction patterns to inform a set of design recommendations. The next paper, presented by Kluge and Bakken (this issue), present a study of Norwegian students performing an inquiry project on climate change. The students in this study first conducted an inquiry project using the Norwegian environment described by Slotta and Jorde (this issue), followed by a unique new simulation environment. Here they explored "future climate" in different scenarios. The study investigated students "modes" of making meaning with the simulator. The final paper, presented by Jong, Chen, Tse, Lee and Lee (this issue) investigated students' issue-based discussions within a collaborative inquiry context using a massively multiplayer online role-play games (MMORPG). The study employed a new technology called a posting template to guide student contributions, and found that this innovation helped students create stronger arguments that included warrants for their assertions. Technology enhanced inquiry learning scenarios are complex, with many influencing variables. The three empirical studies illustrate Eysenck's (1976) statement, "sometimes we simply have to keep our eyes open and look carefully at individual cases — not in the hope of proving anything, but rather in the hope of learning something" (p. 9).

Together, the papers in this special issue illustrate a breadth of research that continues within the domain of collaborative inquiry, underscoring the need for continued discourse amongst researchers concerning our theoretical constructs, curriculum designs, and technology environments. The fact that the papers arrive from 3 different continents spanning 18 time zones further emphasizes the international character of this research area. We look forward to the continuation of these discussions within this and other related journals, and hope that our efforts to bring some focused attention to this topic have proved valuable to the readership.

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