

# Technology–Enhanced Progressive Inquiry in Higher Education

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## INTRODUCTION

In higher education, students are often asked to demonstrate critical thinking, academic literacy (Geisler, 1994), expert-like use of knowledge, and creation of knowledge artifacts without ever having been guided or scaffolded in learning the relevant skills. Too frequently, universities teach the content, and it is assumed that the metaskills of taking part in expert-like activities are somehow acquired along the way. Several researchers have proposed that in order to facilitate higher-level processes of inquiry in education, cultures of education and schooling should more closely correspond to cultures of scientific inquiry (e.g., Carey & Smith, 1995; Perkins, Crismond, Simmons & Under, 1995). Points of correspondence include contributing to collaborative processes of asking questions, producing theories and explanations, and using information sources critically to deepen one's own conceptual understanding. In this way, students can adopt scientific ways of thinking and practices of producing new knowledge, not just exploit and assimilate given knowledge.

## BACKGROUND

The best practices in the computer-supported collaborative learning (CSCL) paradigm have several features in common: consideration in an interrelated manner of the development of technological applications, use of timely pedagogical models, and attention to the social and cognitive aspects of learning. Emphasis is placed on creating a collaborative community that shares goals, tools, and practices for taking part in an inquiry process.

Synthesizing these demands, Hakkarainen and his colleagues at the University of Helsinki have developed a model of *progressive inquiry* as a pedagogical and epistemological framework. It is designed to facilitate expert-like working with knowledge in the context of computer-supported col-

laborative learning. It is primarily based on Scardamalia and Bereiter's (1994) theory of knowledge building, on the interrogative model of scientific inquiry (Hintikka, 1999; Hakkarainen & Sintonen, 2002), and on the idea of distributed expertise in a community of learners (Brown & Campione, 1994). The model has also been implemented and studied in various educational settings from elementary to higher education (see, e.g., Hakkarainen, Järvelä, Lipponen, & Lehtinen, 1998; Lipponen, 2000; Veermans & Järvelä, 2004; Muukkonen, Lakkala, & Hakkarainen, 2005; Lakkala, Lallimo, & Hakkarainen, 2005; Lakkala, Ilomäki, & Palonen, 2007).

## The Progressive Inquiry Model

In progressive inquiry, students' own, genuine questions and their previous knowledge of the phenomena in question are a starting point for the process, and attention is drawn to the main concepts and deep principles of the domain. From a cognitive point of view, inquiry can be characterized as a question-driven process of understanding; without research questions, there cannot be a genuine process of inquiry, although in education, information is frequently conveyed or compiled without any guiding questions. The aim is to explain the phenomena in a deepening question-explanation process, in which students and teachers share their expertise and build new knowledge collaboratively with the support of information sources and technology.

The progressive inquiry model specifies certain epistemologically essential processes that a learning community needs to go through, although the relative importance of these elements, their order, and actual contents may involve a great deal of variation from one setting to another. As depicted in Figure 1, the following elements have been placed in a cyclic, but not step-wise succession to describe the progressive inquiry process (Hakkarainen, 2003; Muukkonen, Hakkarainen, & Lakkala, 1999, 2004):

- a. *Distributed expertise* is a central concept in the model. Progressive inquiry intends to engage the community in a shared process of knowledge advancement, and to convey, simultaneously, the cognitive goals for collaboration. Diversity in expertise among participants, and interaction with expert cultures promotes knowledge advancement (Brown et al., 1993; Dunbar, 1995). Acting as a member in the community includes sharing cognitive responsibility for the success of its inquiry. This responsibility essentially involves not only completing tasks or delivering productions on time, but also learners taking responsibility for discovering what needs to be known, goal setting, planning, and monitoring the inquiry process (Scardamalia, 2002). There should be development of students' (and experts') social metacognition (Salomon & Perkins, 1998): students learning to understand the cognitive value of social collaboration and gaining the capacity to utilize socially distributed cognitive resources.
- b. The process begins by *creating the context* to anchor the inquiry to central conceptual principles of the domain or complex real-world problems. The learning community is established by joint planning and setting up common goals. It is important to create a social culture that supports collaborative sharing of knowledge and ideas that are in the process of being formulated and improved.
- c. An essential element of progressive inquiry is *setting up research questions* generated by students themselves to direct the inquiry. Explanation-seeking questions (Why? How? What?) are especially valuable. The learning community should be encouraged to focus on questions that are knowledge driven and based on results of students' own cognitive efforts and the need to understand (Bereiter, 2002; Scardamalia & Bereiter, 1994). It is crucial that students come to treat studying as a problem-solving process that includes addressing problems in understanding the theoretical constructs, methods, and practices of scientific culture.
- d. It is also important that students explain phenomena under study with their own existing background knowledge by *constructing working theories* before using information sources. This serves a number of goals: First is to make visible the prior (intuitive) conceptions of the issues at hand. Second, in trying to explain to others, students effectively test the coherence of their own understanding, and make the gaps and contradictions in their own knowledge more apparent (e.g., Hatano & Inakagi, 1992; Perkins et al., 1995). Third, it serves to create a culture in which knowledge is treated as essentially evolving objects and artifacts (Bereiter, 2002). Thoughts and ideas presented are not final and unchangeable, but rather utterances in an ongoing discourse (Wells, 1999).
- e. *Critical evaluation* addresses the need to assess strengths and weaknesses of theories and explanations that are produced, in order to direct and regulate the community's joint cognitive efforts. In part, it focuses on the inquiry process itself, placing the process as the center of evaluation and not only the end result. Rather than focusing on individual students' productions, it is more fruitful to evaluate the community's productions and efforts, and give the student participants a main role in this evaluation process. Critical evaluation is a way of helping the community to rise above its earlier achievements, creating a higher-level synthesis of the results of inquiry processes.
- f. Students are also guided to engage in *searching deepening knowledge* in order to find answers to their questions. Looking for and working with explanatory scientific knowledge is necessary for deepening one's understanding (Chi, Bassok, Lewis, Reiman, & Glaser, 1989). A comparison between intuitive working theories produced and well-established scientific theories tends to show the weaknesses and limitations of the community's conceptions (Scardamalia & Bereiter, 1994). The teacher of a course must decide how many of the materials should be offered to the students and how much they should actually search out for themselves. Questions stemming from true wonderment on the part of the students can easily extend the scope of materials beyond what a teacher can foresee or provide suggestions for. Furthermore, searching for relevant materials provides an excellent opportunity for self-directed inquiry and hands-on practice in struggling to grasp the differences between various concepts and theories.
- g. *Generating subordinate questions* is part of the process of advancing inquiry; learners transform the initial big and unspecified questions into subordinate and more specific questions, based on their evaluation of produced new knowledge. This transformation helps to refocus the inquiry (Hakkalainen & Sintonen, 2002; Hintikka 1999). Directing students to return to previously stated problems, to make more subordinate questions and answer them, are ways to scaffold the inquiry.
- h. *Developing new working theories* arises out of the fresh questions and scientific knowledge that the participants attain. The process includes publication of the summaries and conclusions of the community's inquiry. If all productions to the shared database in a collaborative environment have been meaningfully organized, participants should have an easy access to prior productions and theories, making the development of conceptions and artifacts a visible process.

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