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# Measurement and assessment in computer-supported collaborative learning ☆

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ABSTRACT

The overall goal of CSCL research is to design software tools and collaborative environments that facilitate social knowledge construction via a valuable assortment of methodologies, theoretical and operational definitions, and multiple structures [Hadwin, A. F., Gress, C. L. Z., & Page, J. (2006). *Toward standards for reporting research: a review of the literature on computer-supported collaborative learning.* In Paper presented at the 6th IEEE International Conference on Advanced Learning Technologies, Kerkrade, Netherlands; Lehtinen, E. (2003). Computer-supported collaborative learning: an approach to powerful learning environments. In E. De Corte, L. Verschaffel, N. Entwistle & J. Van Merriëboer (Eds.), *Unravelling basic components and dimensions of powerful learning environments* (pp. 35–53). Amsterdam, Netherlands: Elsevier]. Various CSCL tools attempt to support constructs associated with effective collaboration, such as awareness tools to support positive social interaction [Carroll, J. M., Neale, D. C., Isenhour, P. L., Rosson, M. B., & McCrickard, D. S. (2003). Notification and awareness: Synchronizing task-oriented collaborative activity. *International Journal of Human–Computer Studies 58*, 605] and negotiation tools to support group social skills and discussions [Beers, P. J., Boshuizen, H. P. A. E., Kirschner, P. A., & Gijselaers, W. H. (2005). Computer support for knowledge construction in collaborative learning environments. *Computers in Human Behavior 21*, 623–643], yet few studies developed or used pre-existing measures to evaluate these tools in relation to the above constructs. This paper describes a review of the measures used in CSCL to answer three fundamental questions: (a) What measures are utilized in CSCL research? (b) Do measures examine the effectiveness of attempts to facilitate, support, and sustain CSCL? And (c) When are the measures administered? Our review has six key findings: there is a plethora of self-report yet a paucity of baseline information above collaboration and collaborative activities, findings in the field are dominated by 'after collaboration' measurement, there is little replication and an over reliance on text-based measures, and an insufficient collection of tools and measures for examining processes involved in CSCL.


## 1. Introduction

Computer-supported collaborative learning (CSCL) is one of the more dynamic research directions in educational psychology. Computers and various software programs were incorporated into education to aid the administration and measurement of solo and collaborative learning activities because software can: (a) be individualized in design and use, (b) represent problems more realistically, (c) display each step of a difficult problem solving task, (d) afford group discussion and collaboration across distances, and (e) provide immediate feedback for monitoring and evaluating student progress (Baker & Mayer, 1999; Baker & O'Neil, 2002; Schacter, Herl, Chung, Dennis, & O'Neil, 1999). Not surprisingly the increased prevalence and benefits of computer use in collaboration has spawned new directions for research in the field of educational psychology and beyond, demonstrated by studies in the learning sciences, computer science, human computer interaction, instructional psychology, educational technology, and education (Baker & Mayer, 1999; Hadwin, Winne, & Nesbit, 2005; Lehtinen, 2003).

The overall goal of CSCL research is to design software tools and collaborative environments that facilitate social knowledge construction via a valuable assortment of methodologies, theoretical and operational definitions, and multiple structures (Hadwin, Gress, & Page, 2006; Lehtinen, 2003). CSCL environments such as CSILE/Knowledge Forum (Lipponen, 2000; Salovaara & Järvelä,

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2003; Scardamalia & Bereiter, 1996) and gStudy (Winne et al., 2006) promote multiple collaborative learning models that vary by task, purpose, tools, access to product, access to peers, and theoretical position (see Gress, Hadwin, Page, & Church, 2010). The development and examination of various innovative and interactive software tools aim to facilitate and support individual and shared construction of knowledge, skills, process products (such as notes, drafts, and collaborative conversations) and final products via cueing, prompting, coaching and providing immediate feedback of both process and product (Hadwin et al., 2006; Kirschner, Strijbos, Kreijns, & Beers, 2004; Koschmann, 2001; Lehtinen, 2003; Salovaara & Järvelä, 2003). To empirically demonstrate the beneficial nature of these collaborative environments and tools, a focus on measurement tools, methods, and analysis is essential (Puntambekar & Luckin, 2003).

## 2. Measurement in CSCL

Measurement in CSCL consists of observing, capturing, and summarizing complex individual and group behaviours, from which researchers make reasonable inferences about learning processes and products. Factors affecting measurement in CSCL include individual differences, context, tool use, collaborative activities, and various theoretical backgrounds of the researchers and instructors. These inferences and interpretations form assessments which play a central role in guiding and driving student learning toward knowledge acquisition and learning outcomes (Chapman, 2003; Knight & Knight, 1995; Macdonald, 2003). Assessment targets learner's outcomes and it infuses instruction with objective information, to stimulate deeper knowledge and motivate personal goals in students and educators (Baker & O'Neil, 2002). Measurement and assessment in CSCL can take one of three forms: assessing the individual about the individual, assessing the individual about the group, and assessing the group as a whole.

We are interested in the measurement of individual and shared learning processes, the steps each learner takes and retakes as they progress towards a learning outcome, typically tracked by process products such as notes, drafts, discussions, and traces of learner to learner and learner to computer interactions. Of particular interest is the measurement of process products in real time and to find a way to summarize and present these products to learners to provide opportunities for them to monitor, evaluate, and adapt their learning during collaborative activities. For example, Puntambekar and Luckin (2003) and Baker and O'Neil (2002) suggested learners gain a better understanding of their learning processes when provided opportunities to reflect on their collaborative learning products, such as notes, conversations, drafts, group management skills, and so on. These reflection opportunities arise when instructors or software programs provide real-time analysis of the artifacts learners produce, such as chat records, drafts, and learning objects, and process statistics, such as traces of learner-software interactions (Hmelo-Silver, 2003). Process measurement and real-time analysis, however, is highly complex and challenging, as it includes (a) measuring the cognitive steps taken by the individual and the group in the collaborative process requires, (b) measuring individual differences in these steps, (c) designing meaningful assessments of the processes, and (d) developing analytical methods for understanding and analyzing collaborative processes and products, which includes dealing with a wide variety of interaction types and developing means for automatically and efficiently processing collaborative process data (logs and tracings) and products (demonstrations of learned skills and content) so it can be viewed by learners, educators and researchers (Lehtinen, 2003; Martınez, Dimitriadis, Rubia, Gómez, & de la Fuente, 2003), adapting methods for different contexts (Puntambekar & Luckin, 2003).

## 3. Purpose of this paper

This paper stems from a literature review that identified current methods of measuring and assessing learning processes in CSCL. We wanted our comprehensive review of measurement tools and methods used in CSCL to describe the current state of the literature by answering three fundamental questions: (a) What measures are utilized in CSCL research? (b) Do measures examine the effectiveness of attempts to facilitate, support, and sustain CSCL? And (c) When are the measures administered? For example, collaboration typically includes student-centered small group activities, in which learners develop the necessary skills to share the responsibility of being active, critical, creative co-constructors of learning processes and products. Conditions shown to facilitate and influence collaboration include, for example, positive interdependence, positive social interaction, individual and group accountability, interpersonal and group social skills, and group processing (Kreijns, Kirschner, & Jochems, 2003). Various CSCL tools attempt to support these constructs, such as awareness tools to support positive social interaction (Carroll, Neale, Isenhour, Rosson, & McCrickard, 2003) and negotiation tools to support group social skills and discussions (Beers, Boshuizen, Kirschner, & Gijselaers, 2005), yet few studies evaluate these tools in relation to the above conditions. They focus instead on comparing collaborative products or investigating tool usability or tool effects on collaborative products.

This paper describes the findings of our review. First, we answer the three questions stated above. Second, framed by our coding to meet the first objective, we highlight key findings and discuss potential directions for CSCL research. Finally, we will explore how future research in CSCL the Learning Kit project might contribute to developing a systematic and thorough approach for measuring collaborative processes and products using *gStudy* (Winne, Hadwin, & Gress, 2010; Winne et al., 2006).

## 4. Method

We conducted an extensive literature search for all articles related to CSCL from January 1999 to September 2006 in five academic databases: Academic Search Elite, Computer Science Index (which includes IEEE and ED/ITLib, formerly the AACE Digital Library), ERIC, PsycArticles, and PsycInfo. Search terms included variations and combinations of computer, collaboration, and learning. After the search, we focused on empirical studies, including case studies, as long as the focus of the study was collaboration among learners, not software usability (23 studies), resulting in 186 articles. We acknowledge that some studies may be missing from this analysis but we felt 186 articles should provide a strong representation of the field.

Initially we critically reviewed and coded each article to delineate contextual aspects of the literature, clarifying five broad aspects of CSCL research (see Gress et al., 2010): (1) the focus of the article (for example, was it CSCL, computer-supported collaborative work, computer-supported problem solving, or computer-mediated communication); (2) whether or not the technology proposed was designed to provide a CSCL environment or if the technology was add on, such as email, or stand alone chat; (3) models of collaboration, defining mode and purpose of communication, level of knowledge construction, group membership, and individual access to the group project; (4) collaborative tools; and (5) collaborative support. Discrepancies were resolved through discussion to consensus between researchers.

For this paper, we added a sixth coding category, research methods and design. We were interested in three main attributes of existing CSCL research: constructs of interest, measures and