

## A Portrait of CSCL Methodologies

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**Abstract:** This study analyzed the methodologies of empirical CSCL research published in seven leading journals of the field during 2005-2008 along four dimensions of research methods, that is, research design, research setting, data, and analyses. In addition, this study examined research methodologies in relation to theoretical frameworks. Through these analyses, this study provides a detailed picture of CSCL methodologies currently practiced in the field. In addition, the study also revealed a strong influence of theoretical frameworks on all aspects of research methodology.

### Introduction

Computer-Supported Collaborative Learning (CSCL) is an interdisciplinary research field concerned with how people can learn together with the help of computers (Stahl, Koschmann, & Suthers, 2006). Since its inception, researchers have brought diverse theoretical perspectives and methodological approaches to the study of CSCL. As a result, the field included an uncommon range of theoretical and methodological perspectives. Traditional information processing perspectives co-exist with socio-cultural perspectives such as activity theory and situated cognition in CSCL. The infusion of different theoretical perspectives has created a great deal of excitement and numerous efforts to bridge differences in disjointed and/or seemingly incompatible theoretical traditions (Anderson, 1997; Anderson, Reder, & Simon, 1996; Greeno, 1997; Greeno & Sande, 2007; Paavola, Lipponen, & Hakkarainen, 2004). The same is true for research methodology. In much CSCL research, the goal is no longer merely to understand the phenomena but also to transform the current practices. When working in the “blooming, buzzing confusion” of classrooms, researchers often no longer have the luxury to isolate and manipulate variables as they would in the laboratories (Brown, 1992). The environment is complex with many tightly interconnected components. Controlling variables is all but impossible in such environments. As a result, working in such settings often meant abandoning scientific rigor and theoretical relevance in the past. Borrowing from design sciences such as engineering and artificial intelligence, however, the introduction of a research strategy called “Design-based research” has allowed researchers to design changes in classroom practices while working toward the goal of developing theoretical models of learning and instruction. Design-based research became a tool not only to test and refine educational designs but also a tool to carry out formative research about learning theories (Brown, 1992; Collins, Joseph, & Bielaczyc, 2004).

Distinctions between quantitative and qualitative methodologies have long existed in many fields. Quantitative research refers to the empirical investigation of numerical properties of variables and relationships among these variables (Shadish, Cook, & Campbell, 2002). Heavily influenced by logical positivism and statistical theories, the objective of quantitative research is often to test hypothesis that are true to the population at large. It was typically associated with experimental and survey studies where numerical data are collected with active manipulation of variables. In such studies, large sample sizes are important to ensure statistical significance. Quantitative research is often contrasted with qualitative research that aims to construct an in-depth understanding of human behaviors. Qualitative research is associated with descriptive methods such as case or ethnographic studies where rich data such as videotapes, verbal transcripts, and artifacts are collected and analyzed qualitatively. Analysis typically deals with a small set of data and is aimed at uncovering meaningful patterns that may be context-specific. Statistical and numeric analyses are sparsely used. Quantitative research with its longer history has been the dominant methodology in many fields of research (Hunter & Leahey, 2008; Morrow & Brown, 1994). However, this picture is changing. Qualitative research, although initially a methodology practiced in a few fields such as anthropology and sociology, has been establishing itself as a major research methodology in many fields including education and CSCL. As qualitative methods become more popular, more attempts are made to triangulate data collection and analyses, and mixed- or multi-method research has become increasingly used (Hmelo-Silver, 2003; Johnson & Onwuegbuzie, 2004). Nonetheless, there are also cautionary voices regarding mixed-method approaches and/or methodological eclecticism on the grounds that they fail to consider theoretical backgrounds and conceptual framework for research (Maxwell, 2004; Morrow & Brown, 1994; Yanchar & Williams, 2006). What this means is that traditional descriptions of qualitative or quantitative research no longer adequately describe some of the research being carried out in the field. There is a need to develop a more sophisticated understanding of the kinds of research methodology currently practiced in CSCL investigations and ways to better align them with diverse theoretical backgrounds.

This study aimed at examining recent trends in CSCL research methodology. Our analyses examined the following dimensions of CSCL research methodology: (1) Research designs, (2) Research settings, (3) Data, and (4) Analyses. These methodological dimensions were then examined in relation to theoretical backgrounds

of the investigations. We analyzed empirical CSCL research papers published in seven leading journals of the field during 2005-2008. This study is an extension of Jeong and Hmelo-Silver (2010), which reported on some of the preliminary findings for subset of papers published during 2005-2007. We added additional studies published in 2008 as well as an additional coding category.

## Methods

### Journal Selection

Seven journals were selected for this study: (1) *International Journal of Computer Supported Collaborative Learning* (ijCSCL) (2) *Journal of the Learning Sciences*, (3) *Learning and Instruction*, (4) *Computers and Education*, (5) *Journal of Computer Assisted Learning*, (6) *International Journal of Artificial Intelligence in Education* (ijAlinEd), and (7) *Computers in Human Behavior*. The journals were selected based on a survey of 16 CSCL community leaders (e.g., CSCL committee of ICLS and the editorial board members of ijCSCL). These are all peer-reviewed journals published by well-known publishers with international authorship and readership. Articles published in the seven journals during 2005-2008 period, that is, four years of publication and three years of publication in the case of *ijCSCL* were examined for the study.

### Paper Selection

Excluding non-research articles (e.g., editorials, book reviews, or obituaries), 1,423 articles were published in the seven journals during the 2005-2008 period. We screened them to identify empirical CSCL research papers. *Empirical* research was determined based on whether the study examined primary data. Secondary data analysis, simulated results, theoretical papers, and meta-analyses were excluded. The data may have been collected as part of a larger project, but the analyses and findings had to be new. *CSCL* research was determined in terms of whether learners learned collaboratively using technological tools. Learning needed to be collaborative, but as long as parts of the learning process involve interaction (e.g., collaborative discussion after individual study), it was considered as collaborative learning. The focus was on small group peer collaboration, so that student-teacher interactions or whole class discussions were excluded unless they also included small group peer collaboration. The applied technologies needed to be specific (studies examining general IT usage were not included), but did not necessarily have to be so-called collaboration technology such as e-mails or discussion boards. Interaction with computerized agents or intelligent systems were included if they involved learning. Studies that examined social and technical issues were included if they were studied in relation to CSCL. In addition to empirical CSCL papers, we included methodological papers that addressed various methodological issues related to CSCL (e.g., introduction of new methods such as Social Network Analysis, development of specific rating schemes). Studies with special population students (e.g., ADHD, autism) were excluded.

The selection process proceeded in two stages. First, initial selection of empirical CSCL papers was conducted based on the title and abstract of the paper. At this stage, we tried to be as inclusive as possible so as not to miss any potential CSCL papers and included papers if their title and abstract suggested empirical CSCL investigations. This initial screening was verified at the coding stage so that final judgment about the eligibility was made based on a more comprehensive examination of the papers. Currently, the number of the papers in the coding pool is 315, which is roughly about 22% of the papers published in the journals during 2005-2008.

### Content Analyses

In order to examine research methodologies, we examined the studies along the following dimensions: (1) Research design, (2) Study setting, (3) Data, and (4) Analysis. We then examined these features of research methodology in relation to (5) Theoretical frameworks of the study. Coding categories were developed based on a combination of inductive and deductive approaches. They were initially generated top-down (e.g., using categories drawn from the submission descriptors of the 2005 CSCL conference) and later refined through a bottom-up process of multiple coding iterations. We describe coding schemes for each category of codes below.

### Research Designs

Research designs were coded as: (1) Experimental, (2) Descriptive, or (3) Design-based research methods. Experimental designs refer to studies where some interventions were applied and was further divided into (a) randomized, (b) quasi-experimental, and (c) pre-post design. Descriptive studies referred to studies that aimed at describing a phenomena or case. These included case studies, surveys, and ethnographic investigations. Design-based method referred to the research strategy in which CSCL designs and interventions were investigated in theoretically-driven ways and refined progressively over several iterations. In order to be coded as design-based method, the study not only needed to design CSCL systems or environments, but also the design needed to be theoretically grounded, instantiated in specific contexts, studied and refined iteratively as part of a bigger design-based research (Barab & Squire, 2004; Brown, 1992; Collins, Joseph, & Bielaczyc, 2004). Note that

design-based research refers to an approach or framework of research that can transcend the design of individual iterations that may have been either experimental or descriptive. Once a study was coded as design-based method, the design of individual iterations was not coded separately.

### Research Settings

Research settings were defined as the contexts in which the research was conducted and was coded as: (1) Laboratory, (2) Classroom, or (3) Other settings. Laboratory referred to lab-like controlled settings where data collection was carried out outside the context of classrooms or other authentic learning situations. Classroom setting referred to more or less formal learning situations that were guided by teachers both within and outside of physical classroom (e.g., field trips). Other settings meant settings outside laboratories or classrooms such as workplace or informal learning environments (e.g., teacher workshop or professional conference).

### Data

Data were coded as: (1) Process, (2) Outcome, and (3) Miscellaneous. Process data were further divided into (a) text-asynchronous, (b) text-synchronous, (c) video/audio, (d) log data, and (e) other. Outcome data referred to data collected to get static snapshots at the learners' cognitive and other states and could be collected at the beginning of a study (e.g., pre-test) as well as at the end. Sub-categories were: (a) multiple-choice questions, (b) open-ended questions, (c) artifacts (e.g., contents of multi-media whiteboard), and (d) other (e.g., expert ratings, final course grades). Miscellaneous data included (a) self-reports/questionnaires (e.g., demographic information, affective measures, perceived acceptance, etc.), (b) interview or focus groups, (c) field notes or observations, and (d) other (e.g., IQ, learning styles).

### Analysis Methods

Analysis methods refer to the kinds of analyses carried out on the data and consisted of two general categories: (1) Quantitative and (2) Qualitative. Quantitative analyses were further coded as: (a) simple descriptive (e.g., frequencies or means, quantitative analysis of qualitative data such as coding numbers of words in messages or scoring an open-ended answers), (b) code and count, (c) inferential statistics (e.g., t-test, analysis of variance, regression), (d) modeling (e.g., log-linear analysis, structural equation modeling), (e) Social Network Analysis (SNA), and (f) other miscellaneous quantitative analysis (e.g., comparison with simulated data). Among simple descriptive, inferential, and modeling statistics, we coded the more sophisticated form of analysis since the use of inferential statistics and modeling assumes descriptive statistics and inferential statistics, respectively. If a study did a code and count and then ran inferential statistics, they were coded separately, however. Qualitative analyses were further coded as: (a) (qualitative) content analysis, (b) Conversational Analysis (CA) and Discourse Analysis (DA), (c) grounded theory, (d) Interaction Analysis (IA), (e) other (e.g. narrative analysis or phenomenography), and (f) loosely defined where data was qualitatively described with some examples.

### Theoretical Frameworks

Theoretical frameworks were coded as: (1) Information processing, (2) Socio-cognitive, (3) Constructivism, (4) Socio-cultural (e.g., distributed cognition, activity theory), (5) Communication, (6) Social psychology, (7) Motivation, (8) Atheoretical, and (9) Other. Information processing theory refers to traditional cognitive theories with a strong emphasis on individualistic cognitive processes such as encoding and retrieval from memory (Klahr & Kotovsky, 1989; Newell & Simon, 1972). Socio-cognitive theory refers to theories related to Piagetian notion of cognitive conflicts and conceptual change (De Lisi & Golbeck, 1999; Doise, Mugny, & Perret-Clermont, 1975). Constructivism refers to a broad range of theoretical approaches that emphasize active learner processing and knowledge construction either in individualistic and collaborative settings (Chi, 2009; von Glaserfeld, 1987). Socio-cultural theory refers a diverse range of theories such as generic Vygotskian approach, distributed cognition, or activity theory (Engeström, 2001; Hutchins, 1995). Communication theory refers to theories addressing linguistic and communicative aspects of collaboration (Krauss & Fussell, 1990). Social psychology theory refers to theories that focus on social aspects of collaboration such as status difference, gender, or group dynamics (Levine & Thompson, 1996). Motivation theory refers to theories with a focus on motivational aspects of learning addressing issues such as self-regulation (Pintrich, 1999). Atheoretical framework refers to investigations that are more or less guided by practical concerns. Other theory category refers to theories that did not fit into any of the categories that we have described.

Coding was conducted based on researchers' description of studies. If researchers described their study as "experimental" and/or "interaction analysis," then we coded them as such. In a few cases where their description was controversial, we followed a more conventional definition so that "near synchronous" interaction was coded as asynchronous interaction and that an "experiment" without any control condition was coded as a descriptive study. In unclear cases in which the authors did not explicitly state the information relevant to the coding categories (e.g., no mention of whether the study was carried out in lab or in classrooms), we relied on the contextual information presented in the paper. For example, when a study did not specify data

and only stated that the number of words in asynchronous notes was analyzed, it was assumed that asynchronous text messages were collected as data (e.g., Hewitt & Brett, 2007). Multiple coding was possible depending on the features of the study. For example, when the study collected more than one type of data such as asynchronous text messages and interview data, all of them were coded. Two coders independently coded a subset (20%) of papers from the 2005-2007 set and discussed disagreements. Cohen's kappa was above .75 for all codes (Jeong & Hmelo-Silver, 2010). The coders divided the rest of the papers and are in the process of coding them independently while discussing unclear cases.

## Results

### Portraits of CSCL Methodologies

About 8% of the papers in the paper pool were methodology papers. Note that methodology papers may not have reported on actual data as some discussed approaches or issues in analyses (Strijbos, Martens, Prins, & Jochems, 2006; Weinberger, Stegmann, & Fischer, 2007). Because research design or settings were not always identifiable in methodology papers, the results reported in this section are based on a random sample of the papers that contained actual data, excluding methodology papers ( $N=265$ ).

### Research Designs

The most prevalent CSCL research design were descriptive designs (54%), followed by experimental research (37%), and design-based research (9%). Of the studies with experimental design, about half (54%) were randomized experiments, followed by quasi-experimental (31%) and pre-post designs (15%).

### Research Settings

Most often, CSCL research was conducted in classrooms (73%), followed by laboratory (21%) and other settings (9%). A small proportion of studies (3%) was conducted in multiple settings, so that an experiment was first carried out in the laboratory and then in classrooms (de Jong, Kolloffel, van der Meijden, Staarman, & Janssen, 2005). Laboratory studies have been typically associated with experimental design, whereas classroom studies have been typically associated with descriptive design in the past. Although this was generally true, there were many exceptions. Of the laboratory studies, 36% were descriptive studies, whereas a similar proportion of classroom studies (31%) were experiments (Figure 1).

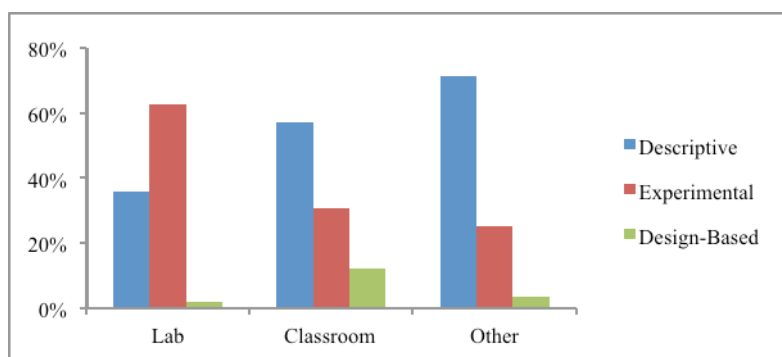


Figure 1. CSCL Research Settings by Design.

### Data

Researchers collected diverse types of data in CSCL investigations. The most frequently collected process data were asynchronous text messages (29%), followed by log data (28%), video/audio (26%), synchronous text messages (15%), and other (2%). For outcomes, the most frequently collected data were artifacts (24%), followed by open-ended questions (17%), multiple-choice questions (16%), and other (15%). For miscellaneous data, most frequently collected data types were self-report (54%), interviews (30%), field notes/observations (16%), and other (8%). Overall, CSCL research collected process data in 68% of the studies, outcome data in 54% of the studies, and miscellaneous data in 72% of the studies.

Multiple data types were collected in typical CSCL investigations with the average number of data types being 2.82 per study. Interestingly, research design seemed to have influenced the amount of data collected. Design-based research collected the most types of data ( $M=3.52$ ), followed by experimental ( $M=2.78$ ) and descriptive ( $M=2.72$ ) studies (Figure 2).

### Analysis Methods

CSCL research used a variety of analysis methods. Overall, 86% of the studies carried out quantitative analyses and 52% of the studies carried out qualitative analyses. Percentages exceeded 100%, because 38% of the studies

included both quantitative and qualitative analyses. Studies with quantitative analyses relied on descriptive statistics (20%), code and count (48%), inferential statistics (66%), modeling such as multi-level modeling (6%), SNA (1%), and other (1%). Qualitative analyses used qualitative content analysis (3%), CA or DA (9%), grounded theory (8%), and IA (2%), and other methods (10%), and loosely defined (66%).

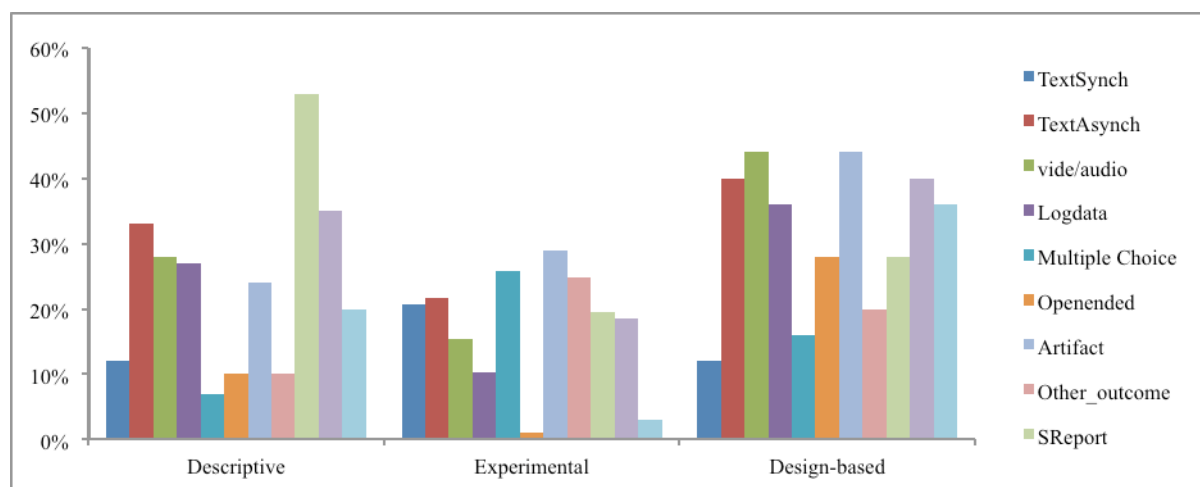


Figure 2. Data Collected in CSCL Research by Research Design (Data Types with Low Frequencies Omitted).

When researchers used quantitative analysis, they generally used inferential statistics. This was true even for studies that used code and count. The results of coding were subjected to inferential statistics in 69% of the cases. At the same time, there were also a sizable amount of studies that relied on descriptive statistics only. This occurred when researchers reported some descriptive statistics in the contexts of qualitative analyses (43%) or code and count (22%), but there were many studies whose analysis was solely descriptive. In the case of qualitative analyses, the use of established techniques such as CA or DA was less common and accounted for 32% of qualitative analyses conducted. The remaining qualitative analyses were *loosely defined* where descriptions of data were provided with examples. Loosely defined analyses were usually carried out after some initial quantitative analyses were conducted. For example, qualitative, in-depth descriptions of a subset of data were provided after quantitative analyses of the whole data set. However, about 15% of qualitative analyses were solely in the loosely defined category.

Analysis methods were strongly influenced by research design (see Figure 3). While experimental and descriptive studies relied more heavily on quantitative analysis (100% and 79%, each) than qualitative analyses (28% and 57% each), design-based studies relied more heavily on qualitative analyses (84%) than on quantitative analyses (68%). Use of multiple analysis methods was most common in design-based research with about half (52%) using both quantitative and qualitative analyses. Note, however, that this could have occurred because design-based studies collected more data than other studies and, as a result, had to use a range of methods to analyze the data.

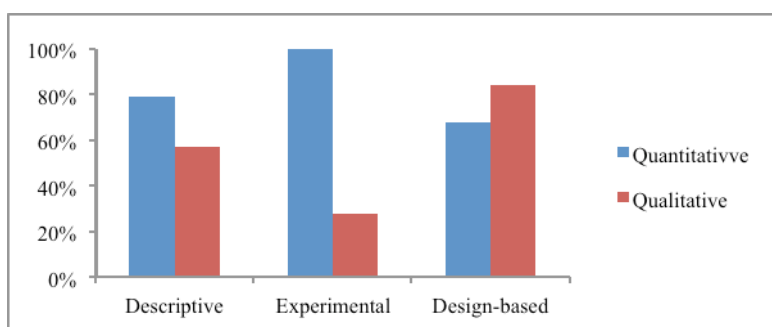


Figure 3. CSCL Research Design by Analysis Methods.

### Theoretical Frameworks and Research Methodologies

CSCL research was guided by various theoretical frameworks with the most common being constructivism (32%), followed by socio-cultural theories (19%), social psychology (16%), other (14%), atheoretical (11%), information processing (10%), and socio-cognitive theories (4%). Note that there were quite a number of atheoretical investigations motivated by practical concerns. At the same time, a small portion of the papers (14%) drew from multiple theoretical frameworks, reflecting the diverse theoretical heritage of CSCL.

Theoretical frameworks had a strong influence on all aspects of the investigations. It first influenced research design (see Figure 4). Experimental studies were strongly guided by constructivism and social psychology theories, whereas descriptive and design-based studies were strongly guided by constructivism and socio-cultural theories. Theoretical frameworks similarly influenced research settings so that laboratory studies were most strongly associated with constructivism and social psychology framework, while classroom studies were strongly associated with constructivism and socio-cultural theories.

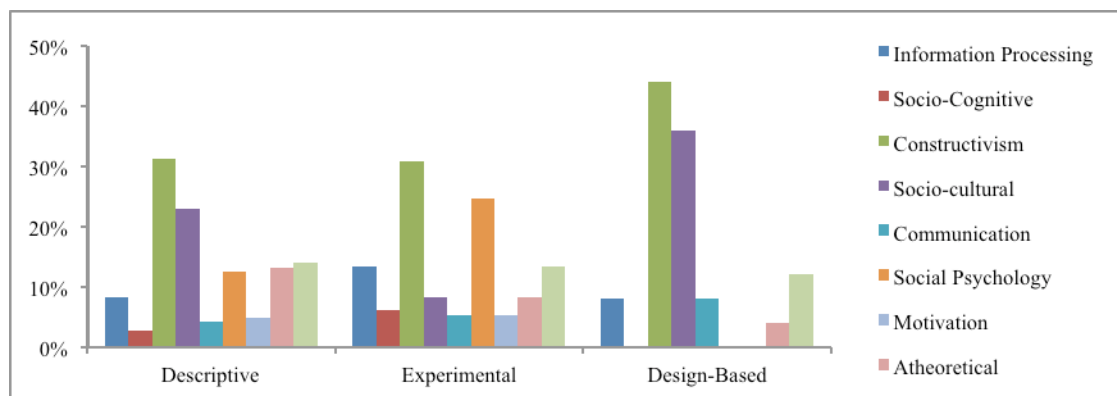


Figure 4. CSCL Research Designs by Theoretical Frameworks.

Theoretical frameworks also influenced kinds of data collected. Video/audio data and artifacts were most likely to be collected in studies with a socio-cultural framework (44% and 32% each), whereas self-report data were most likely to be collected in studies with a social psychology framework (79%). Theoretical frameworks also influenced analysis methods (Figure 5). Although quantitative analysis was less common in studies with socio-cultural frameworks (64%), quantitative analyses were actively used in studies with all theoretical frameworks. Theoretical frameworks influenced use of qualitative analysis methods more heavily. Studies from information processing and social psychology framework were least likely to carry out qualitative analyses (15% and 21% each), whereas studies from socio-cultural framework were most likely to carry out qualitative analyses (82%).

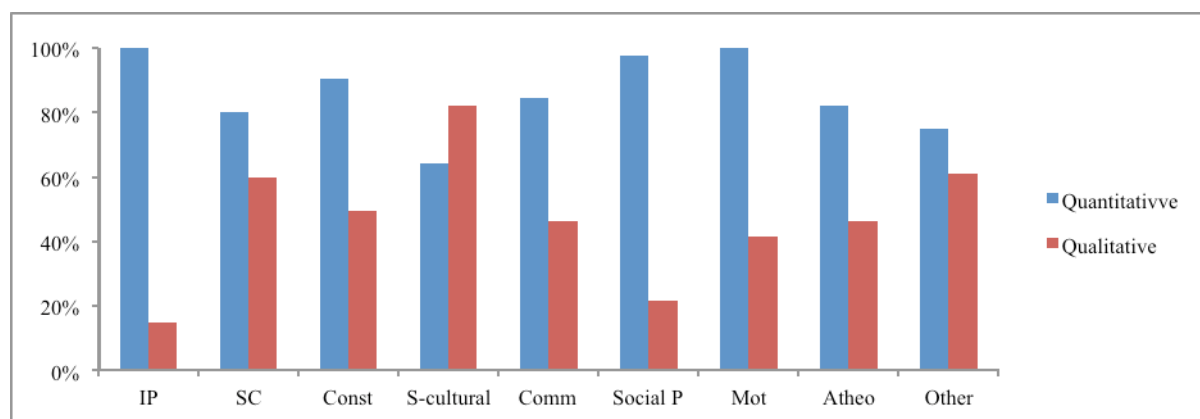


Figure 5. Theoretical Frameworks by Analysis Methods (IP: Information Processing; SC: Socio-Cognitive; Const.: Constructivism; S-cultural: Socio-cultural; Comm: Communication; Social P: Social Psychology; Mot: Motivation; Atheo: Atheoretical).

## Discussion

In this paper, we conducted a detailed examination of empirical CSCL research published in seven leading journals of the field during 2005-2008. The analyses showed that the typical methodology adopted in empirical CSCL investigations is a descriptive design with quantitative analyses of self-report/questionnaire data in classroom settings. Although these may characterize the most typical CSCL empirical investigations, CSCL methodology is far from monolithic. Design-based research, although still comprising a minority of studies, has gained a respectable footing in CSCL research. Researchers are also actively experimenting with existing methodologies as they carry out experiments in classroom settings, collect many kinds of data, and increasingly analyze them both quantitatively and qualitatively. In the past, characterization of research methodology often relied on simplistic distinctions such as quantitative and qualitative and/or experimental and descriptive distinctions (Hew, Kale, & Kim, 2007; Hrastinski & Keller, 2007). Rather than relying such a general

characterization, this study examined research methodology in more detail along four dimensions of research methodology: design, setting, data, and analyses and identified some of the recent trends in CSCL research. Through these analyses, this study was able to provide a more detailed picture of CSCL methodologies currently practiced in the field. Reflecting its multi-disciplinary mission, CSCL is characterized by multiple methodological approaches. The complexity of the research methodology currently practiced in CSCL suggests a need to develop more sophisticated understanding of research methodologies beyond the exiting dichotomies of quantitative and qualitative methods. In addition, this study showed that theoretical framework strongly influenced all aspects of research methodologies, suggesting that researchers need to be more mindful of the influences and biases of one's theoretical frameworks when they plan and carry out research.

Despite the recent methodological developments in the field, there are a number of areas where more sophisticated methodological understanding and practices are needed. First, the field needs to be more principled in its applications of design-based research. Researchers often did not distinguish design as a research goal from design as a research methodology. In addition, even when design research was used to refer to the research method or strategies, its application was often name in only (Jeong & Hmelo-Silver, 2010). Second, unprecedented amounts of "content" data are being generated online in the form of synchronous and asynchronous messages and various online artifacts. The advancement of the field greatly depends on how well these rich sources of data can be utilized, and much of the field's current analytic efforts is directed toward honing analytic methodologies related to analyzing these types of data, as can be seen in the topics of recent methodology papers (Baker, Andriessen, Lund, van Amelsvoort, & Quignard, 2007; de Wever, Schellens, Valcke, & van Keer, 2006). So far, analyses of these content data have been mostly conducted through coding and counting or qualitative analyses. Such methods are time-consuming and not well suited to large-scale analyses, however. Automating the process of code and count is being explored (Rosé, 2008), but the field needs to explore additional ways to analyze these data efficiently as well as meaningfully. The yearning for meaning research outcomes that goes beyond "merely significant" results is reflected in the increasing role of qualitative methodology. However, qualitative analyses often present barriers for many researchers who are new to them. It is often unclear which qualitative methods to choose among the diverse qualitative research methods such as discourse analysis and conversational analysis. The analytic techniques are not always transparent either. These factors contribute to shallow applications of qualitative methodology. Qualitative research methods need to be better communicated to the community in order to ensure more fluent and appropriate practices. Third, the mixed-method approach is becoming increasingly prevalent in CSCL research. There are concerns that the epistemological commitments of some of these methodologies are too disparate for true multi-method analyses to be possible. Epistemological issues are not necessarily present in all forms of mixed-method research. Still, researchers need to be aware of the differences in epistemological and theoretical frameworks and find ways to achieve productive multi-vocality (Suthers, et al., 2011). Fourth, in this paper, we attempted to contextualize research methodology within theoretical frameworks and captured some of its influences. In a similar fashion, we need to understand what may be the influence of research methodologies (as well as theoretical framework) on research findings. We need to understand whether and how adoption of certain methodology obscures certain aspects of the phenomena while increasing sensitivity to others. The results of this study should help researchers enhance their understanding of current practices of CSCL research methodologies as well as develop common conceptual frameworks for discussing different methodologies and bridging diverse research traditions.

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