A Systematic Review of the Quantification of Qualitative Data in the Proceedings of International Conferences of CSCL from 2005 to 2017

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Abstract: In computer-supported collaborative learning (CSCL), verbal and non-verbal behaviors among group members are often examined to help investigate how people in groups interact and learn. Analytic methods used on language data that involve a certain degree of quantification are not rare. This study examines the quantification of qualitative data that involves some form of language use in articles included in the proceedings of international conferences on CSCL from 2005 to 2017. The goal of this systematic review is to identify gaps in methodological effort of quantifying human interactions and communication in terms of research contexts, levels of analysis, and time points of assessment. In synthesizing information on these three aspects, we hope to identify trends over the years and encourage more effort in less researched areas.

Introduction

The interaction and communication between individuals who work in collaborative groups are key aspects in CSCL and is often times under investigation by researchers in the field. As CSCL grows and attracts effort from multidisciplinary fields, it presents the community with promising developments and tensions (Borge & Mercier, 2018). Previous effort has been made to review some key aspects of CSCL field to provide insights into the characters of CSCL and further into future paths. Those studies helped to reveal CSCL's membership (Hoadley, 2005), methodological approaches and theoretical frameworks (Jeong, Hmelo-Silver, & Yu, 2013), and similar issues in fields related to CSCL such as educational and instructional technology (Hrastinski & Keller, 2007). Research in CSCL produces large amount of qualitative data and has used methods of quantification to identify patterns and themes in interviews, student speech in naturalistic settings, online discourse, and other qualitative data forms, as well as to understand relationships in data and make predictions on learning behaviors and outcomes. Chi (1997) proposed a method of content analysis to quantify quantitative data; from then on, there have been other methods used for the same purpose, such as thematic analysis, open coding, social network analysis, as well as automatic analysis based on Natural Language Processing. However, we do not yet know how researchers in the community of CSCL, as identified by having work published in international conferences of CSCL proceedings, apply methods to quantify human interactions over the years, and how prevalent these different types of methods are in the CSCL conference community, what learning contexts we tend to prioritize, and to what extent we examine collaborative learning processes over time.

In this paper, we begin the process of examining our community's existing practices and trends by examining where the data being quantified was collected, which indicates where the researchers examined phenomena associated with learning; at what level(s) researchers analyzed language use; and how many time points assessments were administered. We believe an understanding of the contexts and participants is critical to a comprehensive view on the types of learning that has been under investigation and to reveling gaps in research. Thus, we ask the following research questions: (RQ1) In what contexts have data of group processes been quantified and how have they changed from 2005 to 2017; (RQ2) What are the levels of analysis that have been examined in when quantifying group process data and how they changed from 2005 to 2017? 3; (RQ3) How many times were assessments carried out and how has this aspect changed from 2005 to 2017?

Methods

Selection criteria

We examined CSCL conference proceedings from 2005 to 2017. Inclusion criteria were as follows: (1) articles had to be five or more pages long; (2) the data sources included some form of language use, i.e., text-based language, spoken language, or body language; (3) the analysis of the data should involve some type of quantification, from frequency counts to statistical comparisons or mathematically aided machine automation, e.g. natural language processing.

Data collection and coding

The first author read through the methods section and findings of all conference papers that were over five pages to check for inclusion or exclusion. In total 30.51 % of all papers (180/599) met our criteria; 29/65 articles in 2017, 25/57 in 2015, 31/69 in 2013, 32/71 in 2011, 24/93 in 2009, 19/144 in 2007, and 20/100 in 2005. Information from methods sections was extracted on (1) research contexts, (2) level of analysis, and (3) number of assessment time-points.

Research contexts refer to the settings where the selected research was carried out; due to its variety, the first round of analysis focused on extracting keywords on these three dimensions with minimal interpretation; in the second round of analysis, categorization was based on the following codes. *Classroom*: studies in K-16 classrooms, including face-to-face courses or hybrid courses where only part of the learning activity was carried out online; these classrooms may or may not be technology-enhanced, depending on the research design. *Technology implemented in classroom*: studies with focus on technologies such as online systems incorporated in K-16 classrooms. *Lab*: studies were carried out in computer laboratories. *Technology implemented in informal learning (online)*: studies that extracted data from educational online technologies that were used outside of classrooms. *Informal learning (offline)*: studies in physical informal learning environments such as after school clubs, museums, and summer camps. *Informal learning (online)*: studies that extracted data from online communities that are not designed for educational purposes, such as forums where interest groups interact online. *Online classroom*: studies were carried out in completely online classes, including both those offered within degree programs and massive online open courses. *Classroom and lab*: studies were carried out in both classrooms and labs. *Company*: studies were carried out in company settings, such as corporate training sessions. *Email list*: studies that extracted data from emails in email lists. *N/A* refers to unspecified cases.

Level of analysis indicates whether the analysis was conducted at the level of the individual, dyad, group, or community. At *individual* level, data was extracted from individuals; research addressed the question(s) at the individual level; please note that even in cases where students worked in groups, but if the researchers used individual data to answer questions concerning individual learners, those studies analyzed data at the individual level and fell under this category. At *dyad* level, data was extracted from dyads; research addressed the question(s) at the group level. At *group* level, data was extracted from groups with three people or more; research addressed the question(s) at the group level; in some studies where students worked in groups, but if the researchers analyzed for individual learning, those studies were not included in this category. At *community* level, data was extracted from a community of learners both online and offline from cases where researchers considered the whole classroom as community to online communities; research addressed the question(s) at the community level. At *multiple* levels, data was extracted from two or more levels from above categories; research addressed the question(s) at multiple levels. *N/A* refers to unspecified cases.

Assessment and time point refers to how many times the researchers administered assessment and an approximate description of whether the interval is long or short to see whether they are looking at learning over time. Between the first and last time points, short intervals are less than half semester and long intervals are more than half semester. Cases where there was no information concerning assessment were coded as *N/A*. The possible codes for our database of papers included "1TP," "2TP (long)," "2TP (short)," "5TP," or "N/A."

Results

Context

The five most common contexts were classrooms (47.31%), technology implemented in classrooms (12.90%), technology implemented in informal learning (online) (7.53%), informal learning (offline) (6.99%), and labs (11.29%). We examined the frequency of these contexts as settings for studies over time to look for trends. Figure 1 shows the frequencies of each category from 2005 to 2017. Classroom setting shows an upward trend, increasing from 6 cases in 2005 and 2006 to around 18 in 2013, 2015, and 2017. Technology implemented in informal learning (online) does not appear in 2015 and 2017, and the laboratory setting shows a slight upward trend.

Level of analysis

As would be expected, the articles that studied groups and dyads account for the most, 81(45%) and 42(23%) respectively, followed by 20 papers (11%) studying individuals and 16 (9%) examining communities. Only 10 studies (6%) examined collaborative learning at multiple levels. Eleven studies did not report relevant information. We also examined trends of different categories over the years from 2005 to 2017 (Figure 2). While there are fluctuations in number of studies on groups, dyads, and communities, the general representations remain stable, with groups being the most represented, then dyads, and communities being the least represented of the

three. With the exception of 2017, the number of studies examining at the level of individual shows an increasing trend. Overall, the number of articles that examined multiple levels of analysis is the least represented of all the categories over time, with the exception of 2017.
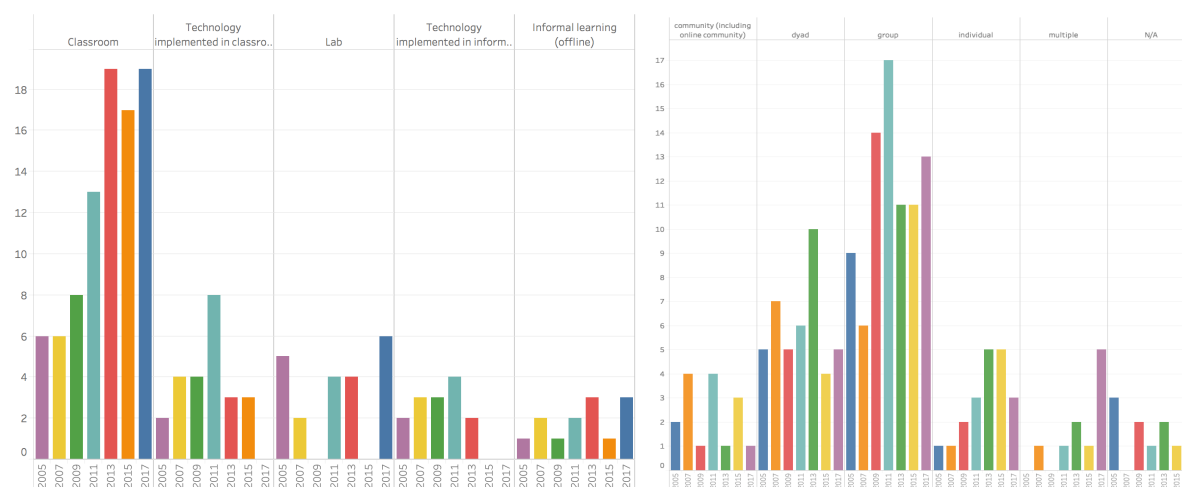

Figure 1. Changes of the most frequent five categories in contexts over the years from 2005 to 2017 (left).
Figure 2. Changes in the number of papers for different levels of analysis from 2005 to 2017 (right).

Assessment time point

The majority of papers in our sample (116/64.09%) did not provide an analysis of collaborative processes at different time points. Of those that provided an analysis of collaborative processes at different time points, 44 papers (24.31%) included only two time points; these were primarily pre- and post- tests administered at the beginning and end of the study over a short period. Articles with two time points of assessments show an increasing trend from 2013 to 2017. Followed afterwards are those with one time point of assessment (15/8.29%), which usually had pretests. Notably, the number of assessments administered to measure change over half semester is extremely low. Five studies had pre- and post- tests to measure change over half semester from 2009 to 2017, and only one study administered more than two assessments; they measured collaborative processes at five time points that spanned over 11 weeks.

Discussion

This study examines the studies that quantified language that occurs during collaboration in the conference proceedings of CSCL from 2005 to 2017, as seen representative of the overall effort made in CSCL community. Being a first step to illustrate the effort, this study focuses on the research contexts, level of analysis, and assessment time points in the selection of articles.

In terms of research contexts, findings showed a dominance of research conducted in classroom settings over other types of learning environments. Researchers in learning have emphasized the importance of conducting research in naturalistic settings (Barab & Squrie, 2004), which offers a possible explanation for the majority of studies that quantifies human interaction and communication in real classrooms. Nonetheless, our findings show that there is a context gap since there are other types of naturalistic learning environments that show potential in offering various learning opportunities which learners might not be able to get from formal classrooms. According to Enyedy and Stevens (2014, p. 207), the collaborative learning in informal learning sites could be as much different as they differ from formal schooling; to them, the difference is "striking". Though there are collaborative learning activities in those formal learning environments and most of the studies were conducted there, those activities would have less impact on the collaborative learning than other informal, collaborative learning contexts where learners work as groups Thus, to have a fuller and more in-depth understanding of collaborative learning, more research is needed in underrepresented contexts (i.e., informal and professional work spaces) as well as between contexts (i.e., between classroom and informal contexts, between classroom and work contexts, etc.). Increasing representation of different learning contexts will help learning scientists gain a richer, deeper understanding of how people enact collaborative learning and learn to collaborate.

Findings on levels of analysis shows that the majority of selected articles are focused on dyad or group level, which causes little surprise. However, researchers in the CSCL community have called for effort to address collaborative learning at multiple levels (Borge & Mercier, 2018; Stahl, 2013; Strijbos, 2011; Zhao & Frank,

2003). The findings indicate more effort needs to be exerted to address this multi-level analytic needs to further investigate collaborative learning as it happens across individuals, dyads, small groups, and communities. The need for studies on individuals and small groups is inherent in learning from sociocultural perspective (see more on "internalization" from Vygotsky, 1978, p. 56), and the research on learning communities not only offers opportunities to examine learning phenomena and knowledge dissemination, retention, and transfer at the larger scale. The multi-level research could also benefit other effort in education research, such as design-based implementation research (Fishman, Penuel, Allen, & Cheng, 2013).

Equally important is the need to include more studies conducted at the community level. The low representation of such studies is problematic, given that people organize their learning around the social communities to which they belong and the process of learning and membership in a community of practice are inseparable (Lave & Wenger, 1991). Thus, more research in CSCL is needed that operationalizes interactions within a community or at multiple levels that include the community. Such research would has the potential to generate innovative insights and contribute to the field.

Lastly, findings on the assessment of collaborative processes highlights how little research has measured learning of content or changes in processes over time. While our community values the close examination of language that occurs during collaboration, the measurement of learning and process changes over time gives critical information on learning progressions and provides more in-depth analysis of the effectiveness of some interventions. However, our findings show that in most cases, no assessment was administered, and even for those pre- and post-tests, most of them were measuring learning in a short time and thus did not consider knowledge retention or the actual development of competence. The lack of assessments might be a result of practical complexities, restrictions in conducting research, or a lack of measurements that are of high reliability and validity, but this current status nevertheless creates an urgent need to develop measurements in the field of CSCL. The quantification on human interactions unlocks potential for learning analytics to exploit process data, which could be used for measurement in connecting the interpretation of process and outcome data and thus help fill this gap.

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