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The visions and challenges of ICT for collaborative learning: A review of the literature

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Abstract

This report synthesises prominent issues found in the literature related to the use of Information and Communication Technologies (ICTs) in collaborative learning. It evaluates the most widely employed methodological approaches and reviews the most influential disciplines in the area of Computer-Supported Collaborative Learning (CSCL). The purpose of this evaluation is to identify gaps as well as opportunities in current research efforts to guide further investigation into the nature, theory and practice of CSCL. It is argued that there is a genuine need for cross-disciplinary research and a holistic methodological approach which will allow researchers to study technology-enhanced collaborative learning from multiple perspectives. Such an approach should incorporate social, cognitive and technological perspectives towards understanding real –as opposed to experimental– pedagogical contexts. This can help forward-thinking researches, educators, and designers find innovative solutions and practical ideas for addressing the challenges and capitalising the visions of ICT in education.

Introduction

Unquestionably the arrival of the Internet and other Information and Communication Technologies (ICTs) has leveraged the opportunities for communication, collaboration, and learning. The multimedia features of ICT and the fast worldwide access to information open up new opportunities for knowledge sharing and group work (Lehtinen, 2003; Dillenbourg, 1999). As a result there has been a growing interest on collaboration tools and educational technologies. Nevertheless, the successful application of ICT in education depends not only on the features and functionalities of the technology; above all it depends on the pedagogical approach used (Lehtinen, 2003;

Leidner & Jarvenpaa, 1995). Therefore the social and cognitive aspects of learning must be considered in addition to the technological ones (Garrison et al., 2000).

Research on the impact of ICT in education has attracted attention from various disciplines resulting in a multidisciplinary research area known as Computer-Supported Collaborative Learning (CSCL). In recent years, CSCL scholarship has been enriched both in terms of theory development and methodological approaches from a wide research community consisting of social scientists, computer scientists, psychologists and sociologists, linguists, anthropologists and managers of information systems amongst others. While this phenomenon offers appealing opportunities for innovative studies at the same time it presents specialists with many questions regarding which theories or approaches they could apply for gaining rich insights on a specific aspect of CSCL.

The aim of this literature review is to provide a critical analysis of the major methodological trends and the key literature that has contributed to our understanding of CSCL in an attempt to guide forward-thinking researchers towards systematic, holistic, and cross-disciplinary research designs. To achieve this aim the review addresses the following questions:

1. How has CSCL emerged and developed?
2. What are the primary benefits and challenges of CSCL?
3. Which disciplines have contributed to CSCL theory and practice?
4. What are the prominent methodological approaches used to study CSCL?
5. What research is needed to capitalise the benefits and meet the challenges of CSCL?

Most of the knowledge and research in CSCL derives from practitioner articles (Soller et al., 2005; Abramowicz et al., 2003; Milrad, 2002); books (Roberts, 2004; Dillenbourg, 1999); case studies (Dwyer & Suthers, 2005; Campos et al., 2001; Wasson & Morch, 2000) and theoretical/conceptual work (Grabinger et al., 2007; Kreijns & Kirschner, 2001; Garrison, et al., 2000). There are also several empirical investigations (Chou & Min, 2009; Carle et al., 2009; Piki et al., 2008; Bessagnet et al., 2005; Ocker &Yaverbaum, 2001).

Several online databases available through a university library system were consulted including JSTOR, ERIC, EBSCOhost Business Source Complete, and Science Direct. The majority of papers reviewed are published in journals (e.g. International Journal of Computer-Supported Collaborative Learning, Computers & Education, and MIS Quarterly) and conference proceedings. Google® Scholar was also used as a sup-

plementary source for searching the World Wide Web. Using these resources, a number of searches were conducted using a variety of search terms including, but not limited to: collaborative learning; CSCL; ICT in education; pedagogical models; technology-mediated learning; educational software; and collaborative technologies.

Conceptualising computer-supported collaborative learning

Although no single or unified definition of CSCL exists in the literature, a number of factors are attributed to effective learning processes including: active learning and construction of knowledge; teamwork; and problem-solving or learning-by-doing (Leidner & Jarvenpaa, 1995). From a theoretical viewpoint, the pedagogical model which embodies these attributes is the collaborative learning model. Collaborative learning (or Collaborativism) draws from the social-constructivist model of learning. Constructivism is based on the tenet that the role of teaching is not to transmit knowledge from the instructor to the learner; rather knowledge is constructed by the learner (Yaverbaum & Ocker, 1998). However, whereas constructivism assumes that learning occurs as an individual interacts with objects, the social-constructivist paradigm argues that individuals learn as they verify and improve their mental models through discussion, information sharing, and negotiating meanings with others (Grabinger et al., 2007; Santoro et al., 1999). Being exposed to alternative perspectives can challenge an individual's initial understanding and thus motivate learning. These benefits are of great importance to all levels of education, especially in higher education (Alavi, 1994).

As an offspring of social-constructivism, the major goal of collaborative learning is the construction of knowledge through interaction with others. When collaborative learning is 'supported by computers' then this social interaction is mediated by technology either fully (i.e. technology is the only channel/medium through which people interact) or partially (i.e. technology complements face-to-face interaction). A CSCL environment can be physical (such a classroom at a university, an office in an organization, a seminar room, a meeting room, etc); virtual (in which case learning takes place entirely through computers); or hybrid (Dwyer & Suthers, 2005; Qureshi & Vogel, 2001; Wasson & Morch, 2000). The effectiveness of the technology used will depend on how well the technology supports the underlying pedagogical approach and, most importantly, on how appropriate the chosen pedagogical approach is for the particular learning situation. This presents both pedagogical and technological implications for the successful application of ICT in education (Leidner & Jarvenpaa, 1995).

The term CSCL is used in a wide range of academic fields and even within the same discipline different authors use the term differently. This is partly due to the varied interpretations of concepts such as 'learning', 'collaboration', and 'computer support'. A common discussion in the literature involves the distinction between collaboration and cooperation. Some researchers use the terms interchangeably but it is important to understand the differences between them. While in cooperative learning students split the work, solve sub-tasks individually and then assemble the partial results into the final product, in collaborative learning all participants perform the tasks together to reach a common goal (Bouras et al., 2008; So & Kim, 2005). Collaborative learning emphasises engagement and participation, and provides more opportunities to exchange experiences and develop communication skills.

Depending on the situation CSCL may refer to a situation, process, task, system or mechanism through which people learn. A broad definition of 'collaborative learning' was provided by Dillenbourg (1999) and has been expanded here to accommodate the use of computer support resulting in the following definition: "Computer-Supported Collaborative Learning is the situation in which two or more people learn something together using technology".

Each element of this definition can be interpreted in manifold ways:

- "Two or more people" can be a pair, a small group, a class, or a community of learners.
- "Learning" may refer to attending a course, reading a book or course material, performing learning activities such as problem solving, or learning from lifelong work practice.
- "Together" may refer to diverse forms of interaction: face-to-face or computer-mediated communication (CMC); synchronous or asynchronous; frequent in time or not; short-term or longitudinal; cooperative or collaborative.

"Technology" may refer to any system, application, or tool which supports communication, collaboration and/or coordination between people including e-mails, audio and video-conferencing, knowledge repositories, social software (blogs, forums, wikis), shared online applications, virtual reality systems etc.

The emergence and growth of CSCL

A review of the literature reveals that multiple factors have contributed to the emergence of CSCL. Firstly, advances in ICT increased the opportunities for providing technological support for collaborative learning activities (Kreijns & Kirschner,

2001). The expansion of the Internet revolutionised the way learners acquire, create and exchange knowledge (Bessagnet et al., 2005). New educational tools also empower educators to create content, monitor student participation and facilitate the development of communities of learners (Haythornthwaite et al., 2000). Blended learning tools and techniques are increasingly employed in the curriculum to accommodate the diverse needs of learners and educators (Allan, 2007).

Secondly, ICTs inspired the restructuring of learning environments by allowing new modes of learning and instruction. On one hand, this shifted the teachers' role from being in the centre of instruction to becoming moderators or facilitators in the learning process. On the other hand, it has empowered students to become active participants rather than passive observers which in turn shifted the focus from individualistic towards collaborative learning (de Freitas & Neumann, 2009; Milrad, 2002). This two-fold shift encouraged scholars to investigate how ICT can facilitate learning activities such as exploration, problem solving, conflict resolution and argumentation. It is argued that these activities trigger specific cognitive mechanisms (such as knowledge elicitation, higher-order critical thinking, metacognition and self-regulation) which are found to be beneficial for learning (So and Kin, 2005; Lehtinen, 2003; Dillenbourg, 1999). It is no surprise then that during the last two decades research on the use of ICT in education is explicitly considering the possibilities of the technology to enable social interaction both amongst students and between teachers and students (Chou & Min, 2009; Kreijns & Kirschner, 2001).

Thirdly, the increasing use of project teams in businesses and organisations was another reason which promoted research in CSCL. In fact, CSCL has grown out of wider research into Computer-Supported Collaborative Work (CSCW) (Santoro et al., 1999). Due to the technological advancements at the turn of the century, there has been an increase in the soft skills graduates should have. As Alavi (1994, p.159) argues: "Individuals need to learn at higher rates of effectiveness and efficiency than even before because of rapidly growing bodies of relevant information and the escalation of knowledge and skill requirements for most jobs." This statement is more relevant today than it was almost 15 years ago, and presents the need for continuous development and research in collaborative learning.

The thrust for constant improvement and lifelong learning alongside the fast-changing business needs, the increased competition, globalisation and the evolution of ICT have contributed to the emergence of CSCL. At the same time, they have generated both challenges and opportunities for prospective endeavours. There are discussed next.

The visions and benefits of ICT for collaborative learning

When research in the area of CSCL first begun the possibilities were glorified. Researchers and practitioners were talking about the level of flexibility and the enormous amount of cost reductions institutions and individuals would gain by using video-conferencing and groupware systems instead of conventional ways of learning. The main vision was –and maybe still is– that in the future people will collaborate as easily with someone far away as they would with someone in the same room (Robey et al., 2000). E-collaboration technologies allow people to bring diverse skills on collective ventures that eliminate the barriers of time, distance and resources (Bessagnet et al., 2005). Yet ICT is not designed to replace face-to-face interaction; it is designed to supplement it by allowing people to communicate anytime, anywhere. Collaborative technologies offer functionalities for coordination of group work, tools for recording progress and giving feedback, libraries of solutions and best practices, as well as meta-information (i.e. date, author, and sequence of contributions). They also support interactions through various channels (i.e. audio, video, text-based) (McConnell, 2000; Majchrzak et al., 2000).

The standardisation and increasing adoption of these technologies has vastly affected the way people choose to communicate, learn and work. The Internet and online tutorials offer a more expansive world to explore compared to traditional lectures. This gives students the freedom and flexibility to learn at their own pace and they may find it easier to concentrate and learn than following a teacher's thought process during a lecture (Anderson, 2004).

In addition to the above benefits, CSCL inherently shares the benefits of collaborative learning. From a social point of view, collaborative learning is superior to individualistic learning because it enables positive changes in interpersonal attitudes and promotes student participation and a sense of community. Collaborative learning activities allow students to practice their communication and listening skills and explore multiple perspectives from people with different cultural, academic or professional backgrounds (Stacey, 1999).

From a cognitive/psychological viewpoint collaborative learning is associated with increased personal achievement. Learners can develop critical thinking through evaluating, reflecting, and arguing for or against different viewpoints (Fung, 2004). They also tend to demonstrate higher-level reasoning, greater diversity of ideas, and more creativity when they are actively learning in groups rather than when they are learning individually or competitively (Alavi & Leidner, 2001; Alavi et al., 1995). CSCL

also inspires lifelong learning, which seems to be the key to success in forthcoming years (Abramowicz et al., 2003).

Moreover, CSCL is based on the premise that technology can facilitate collaboration which in turn promotes interactive learning and sustained critical discourse. Many scholars argue that ICT holds promising opportunities for the next generation of educational tools (Abramowicz et al., 2003; Kreijns & Kirschner, 2001). The integration of social software and Web 2.0 tools in education opens up novel arenas for CSCL. Weblogs (blogs), file-sharing systems, and wikis are increasingly embedded in the curriculum and are expected to increase collaboration readiness and active participation of learners (Cress & Kimmerle, 2008). Especially since people familiarise with the technology from a young age, its use becomes more and more ubiquitous requiring less effort to use it. As people become progressively more comfortable with using technology, the visions of ICT are becoming more prominent.

The challenges of ICT for collaborative learning

Alongside the benefits, CSCL is a complex phenomenon and many challenges still remain to be addressed (Bessagnet et al., 2005; Lehtinen, 2003). To begin with, there is an escalating need for improving educational practices and preparing graduates for the modern economy. Universities are constantly challenged to equip graduates with the skills necessary for effective participation in groups (Abramowicz et al., 2003). To prepare graduates for this demanding business world the curriculum needs to include learning tasks that prompt critical thinking and problem solving. These goals require a pedagogical approach which emphasizes on learning from hands-on experience and group work (Grabinger et al., 2007). There is also a genuine need for sharing best practices and raising awareness of successful and sustainable solutions amongst practitioners (Stansfield et al., 2008).

Despite the vast technological progress field observations report low degrees of collaboration and learning performances indicating that contemporary CSCL environments do not completely fulfil the expectations of educators and learners (Kreijns & Kirschner, 2001). From a psychological point of view, the unwillingness to collaborate is not surprising since knowledge sharing is often perceived as loss of power. As a result learners may withhold knowledge that would otherwise be shared with peers. Therefore competitive assessment strategies should be avoided as they may disable effective learning (Leidner & Jarvenpaa, 1995).

Learners may also be reluctant to collaborate due to lack of trust or incentives (Qureshi & Zigurs, 2001; Olson and Olson, 2000; Furst et al., 1999). Furthermore, contributing to a forum discussion or posting something on a blog is often associated with additional time and effort which may disengage students. Motivation plays a key role in the success of collaboration practices. Learners will participate if they are given the right incentives and optimal conditions such as small groups to work with (Leidner & Jarvenpaa, 1995). Providing timely feedback and using group awareness tools can also be useful for re-engaging the students (Kimmerle & Cress, 2008; Kreijns & Kirschner, 2001).

The fact that group members might have diverse backgrounds or different cultural and communication norms may hinder the grounding process, that is, the interactive process through which students establish mutual understanding or common ground (Schoonenboom, 2008; Cramton, 2002; Cramton, 2001). Even though exchanging ideas with people from different perspectives can be beneficial, researchers have pointed out difficulties regarding conflict resolution (Wulf et al., 2001; Qureshi & Vogel, 2001; Greenspan et al., 2000).

In addition, human-to-human interaction is more likely to be 'mediated' by technology than being strictly face-to-face. People manage to communicate using different 'media' but each medium inflicts more or less effort to coordinate each others' actions and establish a common ground (Clark & Brennan, 1991). Table 1 shows some communication media and their associated constraints.

Table 1. Communication media and their associated constraints for communication (adopted from Clark and Brennan, 1991)

	Communication medium							
Constraint	Face-to-face communication	Telephone	Video-conferencing	Instant messaging	Answering machine	e-mail	letter	
Co-presence	✓							
Visibility	✓		✓					
Audibility	✓	✓	✓		✓			
Contemporality	✓	✓	✓	✓				
Simultaneity	✓	✓	✓	✓				
Sequentiality	✓	✓	✓					
Reviewability				✓	✓	✓	✓	
Revisability						✓		✓

A prevalent debate in the literature refers to choosing between face-to-face and computer-mediated collaboration. Some researchers argue that teams can thrive despite physical distance (Robey et al., 2000) while others believe that distance matters and that face-to-face teams outperform virtual teams (Olson and Olson, 2000; Jarvenpaa and Leidner, 1999). Some researchers claim that teams begin to lose their identity and emotional character as they move away from face-to-face interaction (Cummings et al., 2002). Moreover, face-to-face meetings have a lot of side discussions and interactions which are difficult to deliver online. According to Olson and Olson (2000, p.140) "There are characteristics of face-to-face human interactions, particularly the space-time contexts in which such interactions take place, that the emerging technologies are either pragmatically or logically incapable of replicating". However, researchers have recently developed mechanisms to compensate for the lack of contextual cues and create a feeling of 'social presence' in computer-mediated interactions. Examples include using a shared information space (Piki et al., 2008), a graphical shared workspace (Overdijk & van Diggelen, 2008) or a structured discussion format (Schoonenboom, 2008).

There is also the contemporary belief that ICT enables better face-to-face meetings. Although some researchers consider this as a paradox it is becoming increasingly true. Technology is used as an enabler rather than a replacement of human interaction. Researchers suggest that "the richness of communication technology media may reduce many of the problems associated with virtual team interaction" (Furst et al., 1999, p.252) and that "if more flexible tools for problem-solving and decision-making are made available, the collaborative technology could be adapted to a greater extent" (Qureshi & Vogel, 2001, p.9). Others yet suggest that "successful virtualisation does not depend on the degree of technological sophistication. It's how the tools are used that matters" (Qureshi & Zigurs, 2001, p.85). Hence, in addition to the technology, we need to consider the human side, that is, how students appropriate the capabilities (or affordances) offered by the technology. However, this is not straightforward since not only the way students use a tool is often unexpected, it also influences their level of satisfaction with the technology (Dwyer & Suthers 2006; Overdijk & van Diggelen, 2008). Consequently, exploring the social and cognitive dimensions of CSCL is a complex process and future research should address this.

The lack of appropriate training is another source of discouragement for technology use. In addition, the tools that are more appropriate for a certain learning task are often not the same with the ones that students feel comfortable with. Selecting the most natural and effective tools taking into consideration the task at hand and the individuals involved is a common pedagogical problem (Kock et al, 2007). Lastly, the

proliferation of social tools adds new challenges for curriculum design and planning (de Freitas & Neumann, 2009).

Following the review of the literature, it seems that the centre of attention is on which form of interaction outperforms the other. It is however crucial to realise that the arguments used against CMC (such as lack of trust, conflicts, cultural differences and language issues) may also hinder collocated groups of people who share the same culture and background, who know each other for a long time, and have worked together in previous projects. These issues are somehow embedded in human nature and they are inherently built into collaborative encounters. Hence the focus should not be on those aspects that technology cannot entirely support; rather it should be on finding innovative ways to merge the benefits of ICT with the benefits of face-to-face interactions in order to create a truly efficient collaborative setting. This will be an important step towards the next generation of collaborative technologies.

Table 2 categorises the key benefits and challenges of CSCL into social, cognitive and technological ones. This classification is neither unique nor absolute (since these three dimensions are interrelated); it simply points out the essentiality of considering the linked effects between social, cognitive and technological aspects in the wider pedagogical context.

Table 2. The visions and challenges inherent in CSCL

	Visions / Benefits	Challenges
Social	• Social and interpersonal skills • Communication and listening skills • Student participation • Communities of learners • Coordination of joint activities • Co-construction of knowledge • Synergy effects • Exploration of diverse perspectives	• Changing business needs • More expectations from graduates • Sharing best practices and sustainable solutions • Diverse backgrounds • Establishment of common ground • Unwillingness for knowledge sharing • Lack of incentives • Development of trust • Conflict resolution • Issues of power

(continued)

Table 2. ***(continue)***

	Visions / Benefits	Challenges
Technological	• Flexibility • Easier creation, access to and sharing of information • No time or space restrictions • Fast information processing. • Social software • Easier to give and receive feedback • Monitoring student participation • Variety of media to choose from	• Extra effort and time to contribute • Media constraints • Lack of training • Appropriateness of ICT for the learning task

The need for cross-disciplinary research into CSCL

Nowadays, notions such as blended learning (Allan, 2007; Sommaruga & De Angelis, 2008), e-Learning 2.0 (Cress & Kimmerle, 2008; Boulakfouf & Zampunieris, 2008; Clarke et al., 2008), virtual collaboration (Majchrzak et al., 2005; Qureshi & Vogel, 2001), distance education (Garrison et al., 2004; Haythornthwaite et al., 2000; Wasson & Morch, 2000; McConnell, 2000), and new ways of working (Wynarczyk, 2005) are in the centre of attention. As a result, many researchers and practitioners are exploring the norms and behaviours in collaborative learning situations with a view to inform the design of useful and usable tools to support these endeavours. Various disciplines have contributed to CSCL literature including sociology, anthropology and linguistics, management science and information systems, psychology and education science amongst others. Some influential contributions are discussed next.

Education and Learning

The application of ICT in education reflects –either purposely or unintentionally– a pedagogical model (Leidner & Jarvenpaa, 1995). Therefore the literature on education is a natural place to search for inspiration when studying CSCL. There is a continuum of pedagogical paradigms ranging from behavioural theories (Skinner's Stimulus-Response theory) to social learning theory (Bandura) to constructivism and social-constructivism. Other widely studied frameworks include the cognitive information theory and the socio-cultural approach (Grabinger et al., 2007). Recently, Dillenburg and Hong (2008) emphasized the need for a new pedagogy that integrates individual, group, and class learning. Using wide-ranging learning activities can trig-

ger different cognitive mechanisms which is beneficial for learners (Dillenburg, 1999).

Maryam Alavi and others have studied virtual collaboration and its effects on learning (Alavi, 1994; Alavi & Leidner, 2001; Alavi et al., 1995). Recent work in communities of practice and organisational learning drawing from the theory of situated learning (Wenger, 1998) has also been applied to study CSCL. Collaborative learning is increasingly used in organisational development literature with many organisations claiming to be 'learning organisations' (Brown & Duguid, 1991). Using ICTs organisations bring together experts with varied skills and knowledge, from different disciplines and countries, to work together on joint ventures. Learning is intrinsic in such endeavours; it is both a key element and the outcome of the process. While working together people can learn with, and from, each other and they can later apply this knowledge in future projects.

Sociology and anthropology

Since computer networks link people they inevitably become part of their social networks and should therefore be studied through a social lens. A large community of researchers is employing ethnography (which originates in sociology and anthropology) to develop a thorough understanding of current practices as the basis for the design of computer systems (Rosenberg et al., 2005; Luff et al., 2000; Simonsen and Kensing, 1997).

Sociolinguistics and social anthropology have also influenced our understanding of patterns of communication and communicative strategies. Muriel Saville-Troike (1982) presents a framework of cultural competence influenced by the work of Dell Hymes and others in the field of sociolinguistics. Kjeld Schmidt and others have used the concept of 'articulation work' found in sociology (Strauss' theory of action) to analyse the activities needed when several individuals' work is mutually dependent (Schmidt, 1998). The importance of 'situated action' was also influential in the CSCL community. The concept was introduced by Lucy Suchman (1994) who argues that all actions should be understood in their respective context. Other scholars also argue for the importance of studying social phenomena in their contexts of use (Rosenberg, 2000; Orlikowski et al., 1995; Kendon, 1990).

Management Science

Within management science there have been diverse contributions on organisational and strategic aspects. Wanda Orlikowski's well-known articles on the use of Lotus

Notes focus on the interplay between groupware use and organisational change (Orlikowski, 1995; Orlikowski, 1992). A lot of research is also done in Group Support Systems (GSS) designed specifically to support collaborative tasks such as brainstorming and decision making (Qureshi & Vogel, 2001). Other aspects studied within the organizational sciences include the social shaping of technology (Overdijk & van Diggelen, 2008). DeSanctis and Poole (1994) use adaptive structuration theory to explain how groups in organizations bring technology into action through appropriation of the rules and resources provided by the technology.

Information Systems

Socio-technical frameworks are used to explore knowledge sharing in teams (Belanger & Allport, 2007), distant education (Garrison et al., 2004; Haythornthwaite et al., 2000; Wasson & Morch, 2000; McConnell, 2000) and the introduction of computer conferencing in education (Garrison et al., 2000). Jonathan Grudin's articles on the challenges of computer systems to support collaborative initiatives were very influential in this respect (Grudin, 1994; Grudin, 1988). Research in the field of Human-Computer Interaction (HCI) has also extensively contributed to CSCL. Moreover, forthcoming conferences and publications are influenced by innovative technology trends such as the use of social software and Web 2.0 tools in education.

Psychology

Social psychology is concerned with human-to-human interaction. Kiesler was one of the first to study the different psychological effects of CMC (Kiesler et al., 1988). Key theoretical figures such as the psycholinguists Karl Buehler and Herbert Clark have shown how important the coordination of actions is for any joint effort. Communication is a joint activity and therefore both social and cognitive issues should be considered when examining communicative behaviour. Clark's theory of common ground (Clark, 1996) draws from speech act theory, theories of discourse and dialogue and theories of social interaction (Goffman, 1983). Only by bridging these two camps –the social and cognitive– one can really provide adequate support for effective communication in technology-mediated situations (Clark and Brennan, 1991; Clark and Schaefer, 1989).

Another influential theory is activity theory which was inspired by a developmental psychology theory on children's development and learning (Vygotsky). It was first introduced in the HCI area, but has substantially contributed in many research fields including CSCL (Kuutti, 1995; Engeström, 2008).

The need for a holistic research methodology

Understanding the characteristics, perceptions and expectations of those using the technology plays a crucial role in successful design and application of ICT. To gain this understanding one needs to employ the right methodological framework.

Current research into CSCL can be broadly categorised in the positivist and the interpretivist approaches. Positivist research studies (such as experimental or laboratory-based studies) are based mostly on quantitative data collected from a representative portion of the population in an attempt to test some hypotheses, infer causal relationships or create generalisable rules. Positivist studies contrast technology-mediated settings with face-to-face settings or focus on the causal effects between particular features of groupware and user performance, critical thinking, or productivity (Yaverbaum & Ocker, 1998; Nunamaker et al., 1997).

Interpretivist research studies such as ethnography, on the other hand, explore natural settings in depth in an attempt to generate rich insights and make sense of the contextual aspects that affect the acceptance of collaborative technologies (Qureshi & Vogel, 2001). Ethnographic, field and workplace studies explore a social context and attempt to understand what people do, when, with whom, how, and why. These aspects cannot be replicated in an experimental or laboratory environment (Rosenberg, 2000). Some researchers argue that since the results of interpretive research are context-specific it is not easy to apply them across other fields and domains or use them to generate suggestions and recommendations. However, the purpose of interpretive studies is not to generalise across all situations but to understand what happens in the specific context (Simonsen & Kensing, 1997).

Precision vs. contextual realism

The limitation of past research is mostly due to the dominant methodological paradigm which falls within the positivist-reductionist-analytic paradigm. This paradigm permits very precise measurements, manipulation and control of variables which allows researchers to test key hypotheses and/or infer causal relationships between variables. However, this precision is achieved at a high cost. Experimental studies ignore considerable amounts of 'contextual realism' and cannot be easily generalised in real world situations since only a small subset of the relevant variables are considered while all other aspects (which would normally affect people in their everyday contexts) are ignored or held constant. The majority of empirical studies ask students to perform artificial tasks with often unrealistic time limits. Many studies also seem to put rigour over relevance (Lee, 1999) resulting in pilot-type (quasi) experimental

research designs or small-scale pioneer projects with extraordinary resources and participants. Positivist approaches are limited by their analytic focus, temporal scope, and failure to treat groups in context (Arrow et al., 2000).

In contrast, ethnographic, longitudinal research emphasizes the importance of understanding ICT in its 'context of use' (Alavi & Leidner, 2001; Rosenberg, 2000; Luff et al., 2000). Capturing this contextual realism entails research in a real-life setting. In exploratory studies the researcher gets immersed in the field trying to capture these unique, unexpected, complex patterns found in everyday natural contexts (Belanger & Allport, 2007; Majchrzak et al., 2000).

Controlled vs. complex/dynamic/adaptive setting

Behavioural norms and patterns emerge in a natural way which cannot be replicated in an isolated, 'controlled' laboratory experiment. Contemporary research lacks empirical data that explore the dynamics and complexities in technology-enhanced collaborative environments. When exploring such settings it is essential to treat groups as complex, dynamic and active systems comprising of people, tasks, tools, and the environment (McGrath, 1997).

Furthermore, most experimental designs are conducted on a one-shot or short-term basis. Participants are brought together for a limited time span, are asked to work with others whom probably have never met before –and probably will never meet again in the future– and are given a precise set of tasks to complete in an isolated setting. Such endeavours do not take into account the fact that in real life, people often participate in more than one group, build their relationships based on previous experiences, and adapt to the work demand. Laboratory groups have neither history nor future; participants have neither commitment nor expectations from the group. Nevertheless, short-term experimental studies have been far more popular than longitudinal ones mostly for practical reasons.

Longitudinal studies are extremely costly in time and resources and demographic effects are often difficult to unravel. Still, if we want to arrive at a complete and rich understanding of real-life groups we need to study them in their workplace with all the complexity that comes with it (Arrow et al., 2000). With the exception of work done in the socio-technical tradition little attention is paid in theoretical construal or empirical research on the interaction of groups with their embedding contexts. Moreover, some of the existing literature appears to be mainly descriptive.

Techno-centric vs. holistic

Recently, the amount of journal articles and books addressing the problems of ICT in education has grown immensely. However, many contributions have a technological focus while research on students' experiences and expectations, and the importance of social relationships in teamwork lags behind (Egea, 2006). Therefore, it is essential to adopt a holistic approach which collectively focuses on the social, cognitive and contextual aspects of human-to-human collaboration in addition to the technological facets (Majchrzak et al., 2000; Arrow et al., 2000).

Systematic investigation

Sociologists almost never compare their field work with that of a predecessor (Burawoy, 2003). Future research should provide more systematic empirical investigation into what affects group dynamics and learning practices in real-life settings. Researchers should contrast their results and research methods with similar studies. Systematic empirical research should involve cross-disciplinary research combining theory with practice. This will enable scholars to develop novel theoretical frameworks for better understanding the complex nature of CSCL. This can also guide system analysts and designers to develop more context-specific systems and applications.

Synopsis

Improving the effectiveness of collaborative technologies in education will require aligning the design of learning environments with the new business trends, and the technological and pedagogical visions we are trying to achieve. This implies a need to consider the linked effects between the social, cognitive and technological dimensions of pedagogical situations. The aim of this literature review was to evaluate the most influential theoretical frameworks and methodological approaches used in the area of CSCL and can serve as the basis for future research efforts.

Technology-enhanced collaborative learning is a complex phenomenon and there is a genuine need to find ways to harvest the benefits of ICT and most importantly, improve the learning experience for learners and educators alike. Recently, the opportunities for exploring this phenomenon have increased. First of all, technologies such as video-conferencing, which first appeared more than 20 years ago, have matured considerably and have become more accessible allowing learners and educators to realise their full potential. Secondly, many revolutionary tools and application have

been recently commercialised (BETT, 2009). Thirdly, alongside businesses, universities have also started to acquire these technologies. More importantly, many universities are now integrating their systems and forming academic alliances in an attempt to share best practices and capitalise the benefits of collaborative learning.

Furthermore, international research bodies are funding innovative interdisciplinary research thus encouraging ICT experts (computer scientists, software designers, system developers) to join forces with specialists on human nature (psychologists, sociologists, linguists) and management experts (human resource specialists, managers, leaders, entrepreneurs) in order to target this complex issue from different perspectives. Promising opportunities exist to bridge these contributions and reach at least some of the visions of ICT for collaborative learning.

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