# A SYSTEMIC INTERVENTION APPROACH TO RESEARCH ON COMPUTER-SUPPORTED COLLABORATIVE LEARNING

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## ABSTRACT

This paper presents a systemic intervention approach as a means to overcome the methodological challenges involved in research on Computer-Supported Collaborative Learning (CSCL). These challenges include how to choose between qualitative and quantitative analysis, and between predictive and descriptive studies. In addition, there is a lack of agreement in the research community regarding the appropriate methods and measures used to analyse several dimensions of the learning process, including the cognitive, motivational, social and technological aspects. The final challenge is a need for further research on how participants should engage in defining and re-defining learning purposes, interests and outcomes. The up-front focus of systemic intervention is regarding the process of making boundary judgments during an inquiry. Therefore, it facilitates questioning about whose views and what issues should be considered pertinent in an analysis. Definitions of improvement, the purpose of inquiry, the context of the application of methods, and participants' roles are all important in systemic intervention. The focus is on both the issues 'out there', and the identities and roles of the people (including the researcher) who frame those issues. In addition, the systemic intervention approach advocates methodological pluralism: mixing methods from different traditions (quantitative and qualitative; predictive and descriptive) to address the purposes of multiple stakeholders. In line with this focus on methodological pluralism, a design for CSCL research will be presented that includes the use of several methods drawn from other methodologies (Critical Systems Heuristics, Interactive Planning, Social Network Analysis, Formative and Summative Tests and Content Analysis). This methodological design will be used in future research to analyse and reflect on both a Colombian CSCL case study and the roles and identities of the individuals who participate in it.

Keywords: Computer-Supported Collaborative Learning, Critical Systems Thinking, Systemic Intervention, Methodological Design, Boundary Critique, Methodological Pluralism

## Introduction

Nowadays, the use of information and communication technologies (ICTs) to assist learning processes is on the increase. This usage has been considered a new educational paradigm called "Computer-Supported Collaborative Learning" (CSCL) (Lipponen, 2002; Lehtinen, 2003; Roberts, 2005; Stahl et al., 2006). The purpose behind the use of ICT in learning processes is to facilitate collaboration and thus improve learning by means of sharing and distributing knowledge (Lipponen, 2002).

This new educational paradigm has brought fresh theoretical and methodological challenges for researchers due to the complexity of analysing different factors in this type of learning process. The inclusion of computers to support interactions and facilitate collaborative activities generates new questions about the analysis of CSCL processes. For example, in addition to cognitive processes – the mental processes of thought (Jarvela et al., 2004; Strijbos et al., 2004a, b) – research has to consider peer influence and pressure; individual-group analysis; the nature of interactions and their influence on learning; the roles of tutors and teachers; students' attitudes; technological factors (computer access, ICT literacy and design of the virtual learning environment – VLE); and the school's context. Considering these factors in a coherent and reflective manner is a methodological challenge for CSCL research (Dillenbourg et al., 1996; Dillenbourg, 1999; Lipponen, 2002; Lehtinen, 2003; Jarvela et al., 2004; Kreijns et al., 2004; Reeves et al., 2004; Roberts, 2005; Daradoumis et al., 2006; De Laat et al., 2006a, b; Gallivan & Benbunan-Fich, 2005; Stahl et al., 2006; Suthers, 2006; Arbaugh et al., 2009, 2010). Furthermore, CSCL research is currently trying to address the need for new measurement tools to assess both learning processes and learning performance, taking into account the purpose of the learning activities in terms of the content and the type of skills promoted (Kreijns et al., 2003; Lethinen, 2003; Jarvela et al., 2004; Strijbos et al., 2004a; Roberts, 2005; Stahl et al., 2006; Bliuc et al., 2007; Pozzi et al., 2007; Strijbos & Fischer, 2007; Arbaugh et al., 2009).

Currently, CSCL researchers are proposing several different methodologies to analyse CSCL processes, such as the triangulation of quantitative methods (e.g. social network analysis, statistics, surveys) with qualitative methods (e.g. interviews, content analysis) (Dewiyanti et al., 2007; Finegold & Cooke, 2006; Hara et al., 2000; Lipponen et al., 2003; Cho et al., 2005, 2007; Daradoumis et al., 2006; De Laat & Lally, 2003; De Laat et al., 2006a). Also, some analysis of the *context* of CSCL activities has begun to be included alongside the analyses of processes (Arjava et al., 2007; Arnseth & Ludvigsen, 2006; Zhu, 2006; Nel & Wilkinson, 2006). Although these methodological developments are improving the way CSCL research is being undertaken, there is still a need for further critical reflection on appropriate methodologies (Chan & Van Aalst, 2004; Strijbos & Fischer, 2007, Gress et al., 2010), especially as very little *systemic* research has been undertaken into the current practice of CSCL and the scope for developing it in the future.

Taking into account these current methodological debates, this paper presents a proposal to overcome the methodological challenges that CSCL research is still facing. The proposal is based on a critical systems thinking (CST) perspective called "systemic intervention" (Midgley, 2000). Systemic intervention involves reflecting on boundary judgments (about who and what is or ought to be included, excluded or marginalised in the systemic analysis). It also involves methodological pluralism: the design of methods, drawing upon resources from across the spectrum of paradigms, to approach multiple questions regarding the problem to be analysed (Midgley, 1997, 2000). Applying a systemic intervention approach to CSCL processes offers some significant advantages compared with more traditional research approaches: CSCL researchers can integrate

multiple methods to aid reflection on CSCL processes; to analyse their outcomes; and to facilitate changes in the situations studied in order to improve learning.

This paper is organised as follows. The first section presents an introduction into the theoretical background of CSCL; a summary of the principal methodologies currently proposed in CSCL literature; and a discussion of the main methodological challenges in CSCL research. The second section presents the reasons why a Critical Systems Thinking approach can help to overcome the methodological challenges in CSCL research. In order to accomplish that, this section presents the basis of CST research. In this section the systemic intervention approach is also presented. Then, the third section presents the methodological design that we consider suitable to analyse CSCL processes, taking into account factors such as the context of application, the purpose of the learning process, and the participants' role. We conclude by discussing the implications of this approach for CSCL and CST research.

## CSCL research: Theory and methodology

This section has a threefold purpose. First, it presents the basic definition of CSCL and the main theoretical approaches. Second, it presents the current methodological designs used to analyse CSCL processes. And third, it presents the current methodological debates in CSCL research.

### What is CSCL? Theoretical background

Before we enter into discussions about the current methodological challenges in CSCL, we want to present the foundations of CSCL as a new field in education[1].

The use of information and communication technologies (ICT) in the field of education is vast. Different forms of ICT have been designed to support education. Table 1 identifies different types of learning-oriented uses of ICT in education including CSCL. This figure is based on previous descriptions of Virtual Learning Environments (VLEs) presented by Harasim et al. (1995), Sharda et al. (2004), UNESCO (2004), Alexander (2006), and Allan (2002). As the table shows, CSCL shares some common features with those other forms of VLE, including asynchronic learning networks (ALN), virtual reality (VR) environments, and virtual or distance learning (VL-DL).

| | **Different aspects for comparing learning environments** | | | |
|---|---|---|---|---|
| **Learning Environments** | **Place** | **Time** | **Collaboration?** | **Type of "learning content"** |
| **Traditional** | Same | Same | Almost never | Curriculum based |
| **VL-DL** | Different | Different | No | Curriculum based |
| **VR** | Same or different | Same or different | No | Learning by playing |
| **ALN** | Different | Different | Yes | Curriculum based or |

[1] For more theoretical discussions regarding CSCL see Barros & Córdoba (2011)..

| | | | | |
|---|---|---|---|---|
| | | | | others (topics or interest) |
| **CSCL** | Different | Same | Yes | Curriculum based |

**Table 1. Comparison between CSCL, LN, VL, VR and Traditional Learning**

Having shown CSCL in a general educational and technological perspective it is necessary to define CSCL. The term "Computer-Supported Collaborative Learning (CSCL)" was proposed to refer to a new educational paradigm where the use of ICT to support collaborative learning was fundamental (Roberts, 2005). Generally speaking, CSCL means the inclusion of technical artefacts to mediate and support peer interactions with the purpose of enhancing collaborative learning (Stahl et al., 2006).

CSCL is focused on how collaborative learning supported by technology can enhance peer interaction and work in groups, and how collaboration and technology facilitate sharing and distribution of knowledge and expertise among community members (Lipponen, 2002; Kreijns et al., 2003). To achieve this, CSCL can be built through three levels of social infrastructure. According to Bielaczyc (2001) these layers are composed of 1) a cultural level (the philosophy and norms); 2) an activity level (practices), and 3) a tool level (technology). To Lipponen (2002) these layers have similar meaning but they are called organisational, pedagogical and technical challenges.

The synergies between these levels aim to meet the purpose of enhancing collaborative learning through the use of ICT. It follows that the pedagogical base of CSCL is collaborative learning. According to Dillenbourg (1999), collaborative learning is "a process by which individuals build knowledge, skills or attitudes occurring as the result of group interaction while solving a shared task or problem". At the heart of collaborative learning is the need for analysing learning as a social and active process: the learners play an active role in constructing their knowledge, where interaction is important to understand each other and to generate a common language to perform a task (Dillenbourg et al., 1996; Webb & Mastergeorge, 2003; Salkind, 2004). This assumption of active and social learning is based on socio-constructivism and socio-culturalism from Piaget and Vygotsky (and their disciples). These terms are explained below.

Although Piaget acknowledged the relevance of social factors, he emphasised the child's contribution to thinking and cognition. That is to say, Piaget focused on what the child does (explore, discover, rediscover) while he/she interacts with the environment, and how the child expresses (describes, explains) his/her cognition to the environment. From Piaget's point of view, it is important to put the children into a context that enables them to explore different structures of the physical world so they can construct from that physical interaction, abstract concepts. Therefore, the focus is on the children's construction of the reality (Hergenhahn & Olson, 1997). For example, children can play with marbles, and then construct abstractions about how "carrying" the marbles can be added. After that process, children can construct more abstractions based on their previous knowledge (Newman & Newman, 2007).

In contrast to Piaget, and from a socio-cultural perspective, Vygotsky argues that development can only be understood within a social-historical framework. Vygotsky

emphasised the contribution of the child's culture. Therefore, Vygotsky's perspective points out that cognition emerges from social interactions and the use of cultural tools (technologies, language, beliefs, social relationships, patterned of customs, values, etc.) which are gradually internalised. Activities are socially constructed and have cultural meaning and value. So, culture is seen as a promoter of cognitive structuring or shaping. For example, for Vygotsky it is important that children interact with peers and adults so that they can generate knowledge (Salkind, 2004).

Both Piaget and Vygotsky argue that language and thought play important roles in cognition. In other words, how a child comprehends and assimilates things and thus prepares him/herself to face future events is critical (Ertmer & Newby, 1993; Hergenhahn and Olson, 1997; Webb & Mastergeorge, 2003; Salkind, 2004; Newman & Newman, 2007).

Both the Piagetian and Vygotskian perspectives embody constructivist and social views of learning. First, the learners play an active role in constructing their knowledge. Second, learning is considered a social process, where interaction helps individuals generate a common language concerning the performance of a task as well as understanding between them (Dillenbourg et al., 1996; Webb & Mastergeorge, 2003). For example, in Piaget's constructivism, children interact with each other in pursuing the construction of their individual knowledge. This interaction can generate conflicts between different approaches to the construction of knowledge in groups. Nevertheless, interaction helps children understand each other, solve their cognitive conflicts, and actively construct their knowledge (Salkind, 2004). In the case of Vygotsky, he presents the "zone of proximal development": that is, a zone which shows the difference between what a child can achieve independently and what he/she can achieve with help of a more capable peer. With the help of a more-skilled person, a process of negotiation and transformation enables the less-competent person carry out a task or solve a problem (Webb & Mastergeorge, 2003).

These two perspectives are building blocks to enable better conceptualisation of collaborative learning because they establish the need for learning as a social process where the learner has an active role as he/she interacts. While the socio-cognitive approach focuses on individual development in the context of social interaction, the socio-cultural approach focuses on social activity, from which individual mental functioning develops (Salkind, 2004; Dillenbourg, 1999). Although these two perspectives differ, they are both necessary for an improved and richer understanding of the social dimension(s) of learning (Lipponen et al., 2003; De Laat & Lally, 2003, 2005).

The technological basis of CSCL is the design of Virtual Learning Environments (VLE) to support collaborative learning activities. Those VLEs have a structure that consists of:

- Knowledge – all the necessary information to learn
- Collaboration – real and virtual groups
- Consultation – the teachers or tutors who give the right direction for learning

- Experimentation – the practical work of the students in the VLE
- Personal space – all user-related information (Kreijns et al., 2003).

This structure is supported by several technological tools, such as email, discussion forums, chat rooms, personal profiles, notes, etc. (Sheremetov & Guzmán, 2002).

Taking into account the theoretical background of CSCL, the next step is to present current methodological approaches and challenges to the analysis of CSCL processes.

## CSCL methodology: Approaches and challenges

This section presents a summary of methodological approaches used in CSCL research, the focus of CSCL research, and the main challenges that CSCL researchers have to face.

*Focus of CSCL research:*
The CSCL research focus has been on two different kinds of effects: the effects *of* CSCL and effects *with* CSCL. The former refers to the analysis of certain variables (perceived learning – what students believe they have learned, learning outcomes) before and after a CSCL activity. This focus is on the individual level and is supported by experimental research design. Here, the objective is to determine evidence of knowledge creation and motivational aspects of CSCL processes. In this regard, perceptions concerning CSCL activities, attitudes towards teamwork, technology use, and learning activities and engagement have been the variables taken into account to evaluate their effects on CSCL processes. 'Effects with CSCL' refer to the analysis of the classroom and social conditions of learning. This focus is on participation and is supported by 'real world contexts', so ecological research is the basis of this approach. Here, the main focus is on the analysis of interactions to see patterns and the evolution of interactions (Dillenbourg, 1999; Chan & Van Aalst, 2004; Strijbos et al., 2004a, b, c; Strijbos & Fischer, 2007).

*Methodological approaches, methods and challenges:*
*The tension between qualitative and quantitative approaches is the first challenge*
In the field of CSCL[2] some researchers have presented their vision of the current methodological practices (Lipponen, 2002; Kreijns et al., 2003; Strijbos et al., 2004a; Arnseth & Ludvigsen, 2006; De Laat et al., 2006b). They describe three general methodological approaches and their respective chosen methods: quantitative, qualitative, and mixed method approaches.

Quantitative research: With these focus of attention on CSCL research, researchers in the CSCL field have chosen different methodological designs to analyse CSCL processes. There are some researchers that are dedicated to quantitative research. Experimental

[2] CSCL, Asynchronic Learning Network (ALN), and blended learning have similarities not only in the way that they use ICT to support learning activities, but also in their methodological approaches and challenges. For example, Bliuc et al. (2007) point out that the majority of studies in blended learning research use survey and comparative studies or descriptive case studies. A few of those studies take a holistic perspective.

design is required in this kind of research to analyse the impact of certain variables on CSCL processes.

This experimental design is supported by the use of statistics testing in order to validate hypotheses and frequency statistics for comparisons. Surveys (questionnaires) with different sets of questions regarding learning perception, attitudes toward learning activities, teamwork or technology use, is the main method used in this type of research (Dewiyanti et al., 2007; Finegold & Cooke, 2006). Another method used in quantitative research is Content Analysis (CA), which is applied to make descriptive statistics. CA refers to the analysis of the content of the students' messages posted in the VLE, using different coding schema to organize messages (Hara et al, 2000; Lipponen et al., 2003; Hurme & Jarvela, 2005). Social Network Analysis (SNA) has also been used in quantitative studies to describe patterns in interactions during CSCL processes with different measures for relational data (who is talking to whom) (Cho et al., 2005, 2007; Daradoumis et al., 2006; De Laat & Lally, 2003; De Laat et al., 2006a). Although in minor proportion, all of these methods are complemented in some research with tests and final grades of courses to evaluate the impact of certain variables on learning performance (Suthers et al., 2003; Yuan & Gay, 2006).

Qualitative research: Although quantitative research can give information regarding some dimensions of CSCL processes, other researchers point out the need for qualitative research to give more information from a situated perspective of the collaboration process, making as few as possible a priori expectations. Here, the objective is to describe and interpret CSCL processes taking into account situational factors. Ethnographical and discourse analysis methods are typical for analysing participation and situated activities (Dillenbourg, 1999; Chan & Van Aalst, 2004; Strijbos et al., 2004a; Strijbos & Fischer, 2007).

CA also is used in this kind of research approach, taking advantage of the coding schema and the students' contributions. Another method used in this type of research is interviews (with different approaches from closed to open interviews). Interviews are used to depict attitudes and perceptions about CSCL processes and to determine a specific vision from the participants on some phenomena regarding contextual factors (De Laat & Lally, 2003, 2005; De Laat et al., 2006a; Pozzi et al., 2007).

The previous description regarding qualitative and quantitative research brings the first challenge in CSCL research: the dichotomy between qualitative and quantitative. On the one hand, qualitative research is focused on situational descriptions of factors with as few as possible a priori expectations. On the other hand, quantitative research is focused on statistical measurements of the impact of systematic variations of instruction on different kinds of process (cognitive, metacognitive, social, and motivational). In the same vein, a related challenge is that of the conflict between retrospective and prospective analysis (Strijbos et al., 2004a). Retrospective analysis is descriptive in nature and can be seen as a series of anecdotes that document a learning situation. Prospective is predictive in nature, based on a series of hypotheses to be tested. However, both analyses are not considered the most appropriate for CSCL research. The reason is that CSCL research

requires a long term study, with conceptual questions (rather than technological), that allows theory to be linked with practice and for consideration of the results (Reeves et al., 2004).

*Mixed and hybrid methods and the second challenge*

From these two perspectives emerges the second challenge: CSCL research needs to focus on mixing methods to enable a deeper understanding. It is also needed to document the creation of this fusion, allowing researchers to learn from documented experiences (Strijbos & Fischer, 2007). Along the same lines, Dillenbourg (1999), Lipponen (2002), Lehtinen (2003), Chan and Van Aalst (2004), Levy (2004), Roberts (2005), Suthers, 2006, De Laat et al. (2006a, b), and Gress et al. (2010) state that CSCL research lacks integrated analysis (that made by a mixture of methods that can capture several dimensions of processes). This challenge has brought a new perspective in the analysis of CSCL processes: mixed and hybrid methods.

Mixed methods: In addition to traditional quantitative and qualitative analyses, some CSCL researchers have found the need to generate mixed methods to capture more elements of the CSCL process that they want to analyse. In general terms, mixed methods refer to the use of two or more methods and a triangulation procedure (the process of comparing the same type of information from different sources or methods) to integrate the results (Lipponen, 2002; Strijbos & Fischer, 2007). Typically in CSCL research, content analysis or SNA with surveys (Lee et al., 2003; Daradoumis et al., 2006), or SNA with CA (Lipponen, 2000; Hakkarainen & Palonen, 2003) have been used within the mixed methods strategies. Other possible strategies found in CSCL literature include SNA, tests and surveys (Martínez et al., 2003; Cho et al., 2005, 2007) or SNA, CA and interviews (De Laat et al., 2006a).

Hybrid methodology: From mixed methods, it can be seen that some researchers maintain a quantitative or qualitative approach by combining methods typically used in those approaches. For example, the use of SNA and surveys to generate statistics testing that shows a quantitative approach or the use of CA and interviews to analyse some situational factors from the messages, showing a qualitative approach. However, other CSCL researchers have combined methods from different research approaches, which is called hybrid methodology (Lipponen, 2002; Strijbos & Fischer, 2007). For example, the use of interviews with surveys and SNA is a sample of hybrid methodology with qualitative and quantitative perspectives together in the analysis of a CSCL process (Boyle, 2005; Zemel et al., 2007).

Although these new approaches have tried to overcome the current challenge, researchers recognise the need to develop integrated analysis to generate a deeper understanding of the CSCL process within a coherent and reflective theoretical perspective (Chan & Van Aalst, 2004; Strijbos & Fischer, 2007, Gress et al., 2010).

*Other approaches in CSCL methodology, and the third and fourth challenges*

Despite the fact that qualitative research has paid attention to describing and interpreting CSCL processes, whilst taking into account situational factors, in recent years researchers

have been discussing the need to include some methods for the analysis of context, learning objectives and conditions as the main focus of their research (Daradoumis et al., 2006; Arjava et al., 2007; Arnseth & Ludvigsen, 2006; Zhu, 2006; Nel & Wilkinson, 2006, De Laat et al., 2006a, b; Pozzi et al., 2007). These discussions are based on two more challenges in CSCL research. These challenges refer to the lack of clarity about:

- the context and how to measure it (Strijbos & Fischer, 2007)
- the relation of individual with group behaviours in CSCL processes (Gallivan and Benbunan-Fich, 2005; Dimitracopoulou, 2005; Strijbos & Fischer, 2007). Chan and Van Aalst (2004) state that individuals and not groups are those who learn, but we need to consider the influence of the group on individual leaning, and the influence of the individual on the group dynamic.

Some researchers have proposed a number of methods to approach these issues. Arjava et al. (2007) have included the analysis of CA and surveys, taking into account messages concerning particular aspects of the task, group work or technology use that allow the evaluation of contextual factors between individual and group levels in terms of perceptions towards CSCL activities. In doing so, researchers present a contextual analysis based on tasks, teamwork and perceptions towards technology.

Another attempt to approach those challenges is proposed by Lipponen et al. (2004). They present the idea of taking into account several dimensions of the CSCL process (cognition, metacognition – the self-control and self-monitoring of the learning process –, participation, and motivation), questioning the purpose of the learning activities, analysing social practices from individual and group perspectives, and working in collaboration with practitioners. However, they do not make explicit the manner in which to approach these methodologically. They propose the idea of a developmental research, besides traditional approaches, but without considering the guidelines or methods to approach it.

In the same way, Strijbos et al. (2004b) present the need for a systematic approach. So, they present a framework that takes into account critical elements that affect interactions: establishing expected interactions, learning objectives, and learning activities. A similar view is presented by Kirschner et al. (2004).

Gress et al. (2010) also highlight the need for developing methods to evaluate individual and group products. So, they propose trace data to capture the information about the process without interruptions. However, they point out the need for a methodological approach for the analysis of data for research purposes.

De Laat et al. (2006a) include a type of interview model called Critical Event Recall (CER). CER is an interview where the interviewer presents some events (in this case a summary of Content Analysis) to allow a participant to recall those events and talk about them. The purpose of using this method in their research was to answer the question "why they are talking as they do?" So CER helps to discuss contextual factors.

Arnseth & Ludvigsen (2006) present a study of what they call a "dialogic approach". They point out that what they call the "systemic approach" generates models of how specific features of technological systems affect the collaboration, reasoning, functions, contents, and structures of discourse (with interdependences between those variables). Instead, they prefer to focus on how the meaning and functions of discourse, tools, and knowledge are constituted in social practices. Social interaction is the centre of analytical attention and not only an intermediary between cognitive and external contextual variables: to determine what students and teachers actually do, and specific institutional arrangements. Therefore, the idea is to analyse the everyday practices and the discourse within those practices (institutional practices or context). The way to apply the analysis is by examining the sequential unfolding of activities along different time scales.

Previous proposals have been considered as attempts to overcome the contextual and individual-group challenges. However, researchers have still presented the need for generating a vision of what it is wanted in the case of CSCL designed activities (Nel & Wilkinson, 2006), of developing methods that take into account not only what is said in both cognitive and social terms (Kreijns et al., 2004), but also what happens (Pozzi et al., 2007) and what happened before the CSCL project (Gress et al., 2010), and of taking into account "the context" (Strijbos & Fischer, 2007).

*Assessment of learning and the fifth and sixth challenges*

The previous proposals of Lipponen et al. (2004) and Arnseth & Ludvigsen (2006) take into consideration the need for linking research and practice. However, Dillenbourg et al. (1996), Lehtinen (2003), Chan and Van Aalst (2004), Strijbos et al. (2004a), and Stahl et al. (2006) have described another challenge that is related to this gap between research and practice: the lack of attention placed on the learning perspective of CSCL. In other words, the gap between the instruction and learning goal on the one hand, and methods to approach the CSCL processes on the other hand. CSCL research has focused on perceived learning – asking questions to students regarding their perception about whether or not they have learned –, analyses of social interactions, and design of virtual learning environments (Strijbos et al., 2004a).

A related challenge is the need to create different approaches to assess processes and products in relation to learning processes, where theories of collaborative learning can be taken into account in the assessment (a coherence between learning, collaboration and assessment should be promoted) (Chan & Van Aalst, 2004).

So, there is a need to examine both advances in knowledge and social interactions in CSCL research (Chan & Van Aalst, 2004). Here, the conflict between analysing how learners collaborate and how much they have learned is highlighted. However, there is no complete description of how learning outcomes are related to different strategies of instruction or computer use (Strijbos et al., 2004a).

Regarding this issue, Chan and Van Aalst (2004) present a proposal to overcome these challenges with the idea of generating new assessment tasks such as self-questioning (cognition and metacognition), learning diary or portfolio assessment (progress of own

learning) to evaluate the process and content of the CSCL activities. Thus, records of instruction, process and outcome can be obtained. However, Gress et al. (2010) point out the over reliance on self report measures that assess the individual with reference to the individual, and the individual with reference to the group.

In relation to the link between research and practice, Levy (2004) highlights the need for a critical reflection and a vision of experiential learning in the process of investigating CSCL. Here, the role of researchers, teachers, and other possible participants of the CSCL process should be considered, not only the role of the students (Strijbos et al., 2004a). This reflection implies a discussion about learning purposes in a broad perspective, and considering the relevant participants (Levy, 2004; Dimitracopoulou, 2005; Strijbos & Fischer, 2007).

**Summary**

Taking into account previous descriptions about methodological approaches and challenges in CSCL research, Table 2 presents a summary of the current challenges in CSCL research. It is important to state that, although some of the approaches help to understand the way CSCL researchers have worked on those challenges, there is still a need to propose new alternatives. Specifically, there is a need to approach CSCL with critical reflection about the learning purpose, vision of what is desired, notions of the context, and a development of integrated analysis to generate a deep understanding of the process and outcomes.

| **Challenge discussed and worked on in CSCL research** | **Current challenge** |
|---|---|
| 1. Qualitative vs. quantitative perspective<br>Prospective vs. retrospective perspectives | Development of integrated analysis to generate a deep understanding of CSCL process. |
| 2. Mixed and hybrid methods | |
| 3. Context | Analysis of the context, with the inclusion of a vision and a historic perspective (what happened before CSCL) |
| 4. Individual vs. group levels | |
| 5. Learning perspective vs. social or technological perspectives | Critical reflection about the roles, process and outcomes, and learning purposes. |
| 6. Assessment of product and process | |

**Table 2. Summary of current challenges in CSCL research**

The next section presents the basis of the Critical Systems Thinking (CST) perspective and the systemic intervention approach within the CST research context that could be appropriate to overcome CSCL methodological challenges, taking into account the identified needs.

## CST and Systemic Intervention

Critical Systems Thinking (CST) is a research approach to systems practice that was first developed in the 1980s. It emerged from the systems and management field[3] with two main foundations: the argument for methodological pluralism proposed by Jackson and Keys (1984) and the need to be critical of the boundaries made by planners (who and what is considered included and excluded within a system) proposed by Ulrich (1983). CST has centred its debate and contributions on three themes: critical awareness, improvement, and methodological pluralism (Flood and Jackson, 1991; Midgley, 1996; Flood and Romm, 1996; Jackson, 2000; Midgley, 2000). According to Midgley (1996) those themes mean:

- Critical awareness: to examine taken-for-granted assumptions, recognising that a system is a construct that defines the limits of the knowledge in any problem situation analysed.
- Improvement: to ensure that research is focused on "improvement", defined temporarily and locally, and taking issues of power into account.
- Methodological pluralism: to use a variety of research methods in a theoretically coherent manner, becoming aware of their strengths and weaknesses, to address a corresponding variety of issues.

Critical Systems Thinking and its three themes have been approached from different perspectives. All of them place a particular emphasis on the way they identify and work the three themes.[4] In the following we will focus on the description of one of those approaches, which is called "systemic intervention". In doing so, we are also going to explain why this approach has been selected as the basis of the methodological design to help to overcome CSCL challenges.

### Systemic Intervention (SI)

Systemic intervention (SI) was proposed by Midgley (1997, 2000). Midgley defines systemic intervention as a purposeful action by an agent[5] to create change in relation to reflection on boundaries. This definition involves, in general terms, a cycle composed by:

[3] Systems is a vast research field with some "principles" such as emergence (properties that stem from the interactions between the parts of a system), synergy (the "all" is more than the sum of the parts), and the idea of a boundary, which is discussed in the paper.

[4] If the reader is interested in other CST approaches described and widely discussed in literature, there are some journal papers and books that can help, for instance: System of Systems Methodologies – SOSM (Jackson & Keys, 1984; Jackson, 1987); Total Systems Intervention – TSI (Flood & Jackson, 1991; Jackson, 1999, 2000); Diversity Management – TSI II (Flood, 1995; Flood & Romm, 1996); Critical Systems Practice – CSP (Jackson, 2003); Critical Pluralism (Mingers, 1997a, b, 2003); Critical Appreciation – Discordant Pluralism (Gregory, 1996); Pragmatic Pluralism (Taket & White, 1996, 1997, 2000; White & Taket, 1997a, b); and Deep Complementarism (Ulrich, 2003; Ulrich & Reynolds, 2010).

[5] Here, agent is defined as a single human being or an identifiable group of human beings in interaction (family, team, organization) that have purposes ascribed to them.

- Critique – about exploring different possible boundary judgements and choosing between them.
- Judgement – the idea is to judge which theories and methods might be most appropriate. So creative design of methods, with its questions, is used. Consequently, the idea of this "creative design of methods" is to understand the problem situation in terms of a series of systemically interrelated research questions, each of which might need to be addressed using a different method, or part of a method. An alternative way to see this approach is to think in terms of "multi-layered" intervention, where methods have to be responsive to different "levels" of analysis (Boyd et al., 2007). Furthermore, creative design of methods allows mixing methods from different paradigms to address these research questions. The set of questions may evolve as events unfold and understanding of the situation develops. The method(s) that emerge from this perspective is different from the sum of its parts. So a synthesis is needed that allows each individual research question to be addressed as part of a whole systems of questions, the result is a synergic use of the method (Midgley, 2000).
- Action – the implementation of methods used to create improvement[6] (Midgley, 1997; 2000).

This approach is based on the idea of making boundary judgments[7]. In doing so, Midgley based his proposal on the ideas of Churchman (1970) and Ulrich (1983) regarding boundary critique. This refers to the process of exploring who and what is or should be included or excluded (Midgley, 2000). In addition to the categories of inclusion and exclusion, Midgley (2000) proposes an analysis of marginalisation. To Midgley, the notion of marginalisation is important. There are situations where particular stakeholders and issues are marginalised (neither fully included nor excluded from the system) and subjected to strong labelling and ritual treatment. Regarding this issue Foote et al. (2007) commented, "Midgley (2000) talks about marginalized people and issues being made 'sacred' and 'profane' to indicate the potency of the valuing or devaluing that they are subject to" (p. 647).

Therefore, the basic idea of boundary critique is to reflect on different possible boundaries to challenge taken for granted assumptions regarding issues, values relating to judgement on these issues, and people (including the identities and roles of agents such as researchers and participants) included in, marginalised by, or excluded from a social design. Reflection on the problem situation or social design should be considered in terms of what is, ought to be, and how the "ought to" might be realised (Midgley & Ochoa-Arias, 2001).

Midgley (2000) proposes three types of interrelated questions to be addressed during systemic intervention (p. 229-230):

[6]Improvement is defined by Midgley (1996b): to ensure that research is focused on "improvement", (action for the better) defined temporarily and locally, taking issues of power into account.

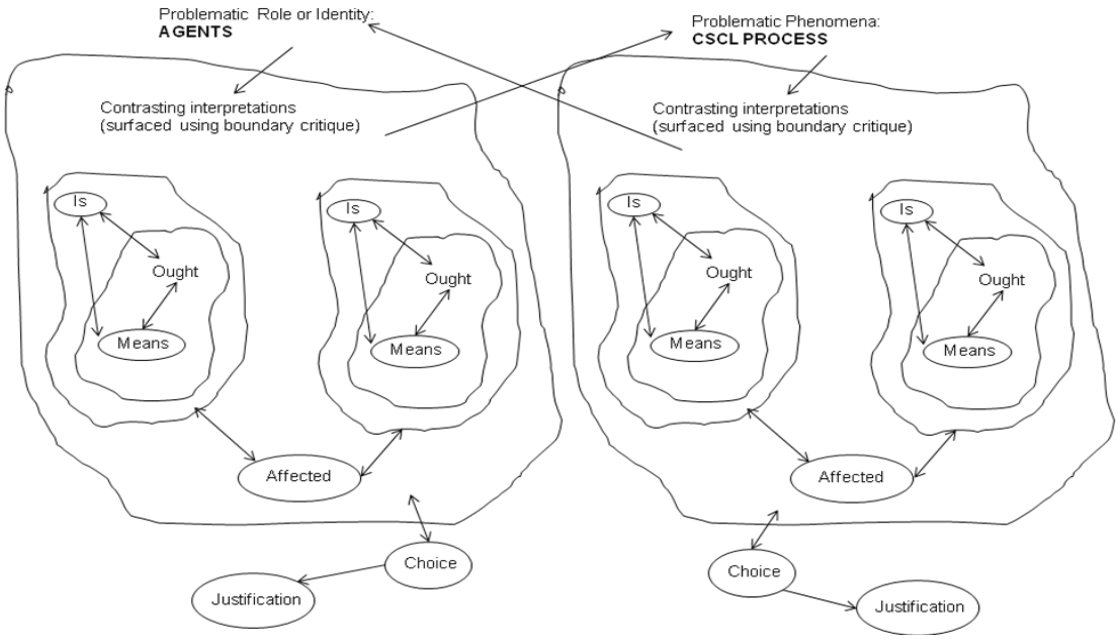
[7] In proposing systemic intervention approaches based on the idea of making boundary judgements, Midgley abandons the idea of the 4 implicit validity statements inherent in any sentence intended for communication (according to the theory of the communication acts of Habermas).

- Boundary questions, leading to the design of methods for defining issues
- Issues related questions, leading to the design of methods for addressing the issues already defined
- Knowledge related questions, enabling exploration of relations between agents and intellectual resources.

The process means these type of questions are answered can be explained as a cycle. This cycle is presented by Midgley and Ochoa-Arias (2001) using two sides as main parts of the analysis: agents and process. The general view of the cycle is detailed as follows (See Figure 1):

- Processes side: We can start with the identification of problematic phenomena. Here, we can find some contrasting interpretations of the problematic phenomena by using boundary critique.
- After some initial reflection of two or more contrasting interpretations, it is possible to choose between them before cycling back into the reflections. Here, the methods for the chosen interpretation are described. Choices have to be justified in dialogue with others.
- So far, learning about the interpretation may occur, resulting in changes to it, new interpretations, a switch to another interpretation, or a conclusion from the intervention (the phenomenon has ceased or a new phenomenon has substituted the previous one).
- Agents' side: During the process of identification of problematic phenomena and their interpretations, the role and identity of the agents also appear as problematic. So, interpretations regarding roles and identities have to be discussed.
- After some initial reflections (as in b), a choice between interpretations can be made. This can lead to transforming the role or identity of the agents. Justifications of the choices made have to be provided.
- The process of questioning roles and identities also helps identify problematic phenomena. So, the main cycle can be closed.

**Figure 1. Systemic intervention (adapted from Midgley & Ochoa-Arias, 2001, p. 643)**




Among the strengths of this approach we can find that systemic intervention brings together the emphasis of methodological pluralism with the theory of boundary critique which makes explicit the need to explore issues of inclusion, exclusion, and marginalization (Foote et al., 2007; Midgley et al., 2007). Besides, it is not only focusing on boundary critique, but also in learning from that process through critical reflection on both process and outcome. Furthermore, in this approach there is no blind defence of a singular philosophical position, but a call for process philosophy – where primacy is granted to analyses of "the process of bringing knowledge into being" instead of accepting a 'foundational' theory of knowledge (Midgley, 2000, p. 78). Lastly, its fundamental concern is for the well-being of people, and in particular those who, for one reason or another, are all too frequently marginalized within communities and societies. In this respect, values, ethics, aesthetics, emotions, and passions are all as crucial dimensions to the process of judgment about what constitutes improvement, as facts and figures and concepts (Bawden, 2003).

However, Mingers (2006) offers some criticisms that need to be answered. He says that Midgley's process philosophy does not work because "It is impossible to theorize about anything without there being a 'thing' to theorize about" (p. 93). He claims that Midgley denies the existence of a real world. Also, according to Mingers, Midgley does not answer the question, are all boundaries simply constructs of the observer? Finally, Mingers says that the whole process is unhelpful in practice because we can make infinite boundary judgements.

Regarding those critiques, it is important to highlight that Midgley (2000) does not deny the existence of agents or a real world. His view is that it is perfectly legitimate to talk of these things, but our knowledge of them is constructed via the process of bounding. It is therefore important to switch analytical primacy from 'content analyses' (analyses that focus on phenomena in the world, including the identities and roles of agents observing those phenomena) to the analysis of how those phenomena are bounded (or 'framed').

Also, when Mingers talks about the 'problem' of never ending boundary judgements, he fails to recognize that any process of making boundary judgements is basically a value clarification process rather than a hopeless quest for comprehensiveness, as Ulrich & Reynolds (2010) have explained. So, despite the claim that nothing should, *in principle*, be excluded from analysis, the inevitable, practical move to action limits critical reflection and makes choice between boundaries inevitable (Midgley & Ochoa-Arias, 2001). In every systemic intervention there is a need for decision making on when and how to end critical reflection in order to move to action, which is a topic that Ulrich (1983) has written about at length.

### Justification of Systemic Intervention as the chosen approach

According to the first section, CSCL research has the challenge of analysing CSCL processes with an integrated perspective in terms of several methods that can help explain different dimensions of the learning process and critical reflection regarding the participants' roles, CSCL purposes, and the notion of the context. According to the second section, CST focuses its attention on critical reflection, methodological pluralism and improvement, but different CST approaches have different ways of dealing with those issues. In the case of systemic intervention, this perspective has the advantage of making an emphasis on both methodological pluralism and boundary critique. Because of that, Systemic intervention helps us understand how we can analyse a CSCL process. First, the idea of defining agents (and in a wider sense stakeholders) of the process (designers, students, researchers, and teachers) and the object (the process itself) can be useful in CSCL research. In so doing, we can ask whom and what can be considered pertinent in the analysis as a way to question the purpose of the inquiry and roles of the participants. Second, we can analyse aspects as the context of the application and the identity of participants (including the unit of analysis). Third, we can use the notion of creative design of the methods to approach the different dimensions (cognition, metacognition, social, motivational, and technological) of the CSCL process. In so doing, the creation of methods that can answer different questions of the CSCL process is the means to overcome the lack of hybrid methods and integrated analysis. Besides, the need for including different types of research (qualitative/quantitative, retrospective/prospective, and summative/formative) is advisable. And finally, Systemic Intervention also aims at generating changes in the situation studied, so the learning process and performance can be improved, according to purposes pursued. All of these reasons support the fact that CSCL could be analysed in a reflective and coherent manner with a systemic intervention perspective.

Having stated why Systemic Intervention is an appropriate approach to overcome the CSCL research challenges, the next step is to formulate a systemic intervention in terms of interrelated questions about CSCL and the agents involved (or to be involved).

## Methodological design: Questions and methods for SI in CSCL research

This section presents the methodological design, based on systemic intervention, to overcome the challenges involved in research on CSCL.

To take advantage of systemic intervention, in other words to take advantage of an exploration of different possible boundary judgments, a creative design of methods with its questions to be answered is required. Table 3 presents the summary regarding the boundary questions concerning the agents, stakeholders, and issues to be considered in a CSCL research process within the systemic intervention framework. .

Regarding the questions and methods presented in the table, there are several aspects to be explained in order to identify the creative design of methods in this proposal. First, the CSCL process analysis can be focused on both issues to be considered and the identities and roles of the people who frame those issues. So, there are questions related to each of those aspects. In relation to this aspect, it is important to recognise that the process of making boundary judgements about issues and identities and roles of the agents can be seen as an ongoing reflection throughout the change process.

Second, there are several dimensions for considering the process of CSCL: Learning purpose, cognitive and metacognitive aspects, social, motivational, and technological dimensions. These dimensions refer to the main theoretical discussions presented in CSCL research (Barros & Córdoba, 2011).

Third, we try to present the questions in a generic form. In other words, they are questions about CSCL processes in terms of the systemic intervention approach, although in practice there is a need to consider specific questions according to the situation analysed. Besides, on the one hand, Table 3 presents some generic boundary questions and knowledge related questions based on the proposals made by Mingers (1997b), Reynolds (2001), Midgley (2000) and Midgley et al. (2007). On the other hand, as a result of answering the questions of Table 3, a particular set of questions about the issue related questions in terms of the details and implementation of a CSCL process can be generated. Thus, Table 3 and its new set of questions, can together help us develop a deeper understanding of CSCL processes.

| | **Boundary questions – CSCL (Questions: Q, Methods: M)** |
|---|---|
| **Agents – Stakeholders** | Who should be the agents?<br>Who should be the stakeholders?<br>Are they groups or individuals?<br>What are their roles?<br>What are their purposes in this intervention?<br>What are their values and interests?<br>What kind of knowledge do the agents and stakeholders have?<br>Are they accountable regarding their decisions?<br>Do they participate in an open dialogue about the intervention?<br>How could we support answers for these questions in a broader perspective to generate a deeper understanding of the CSCL process? |

| | |
|---|---|
| **Issues** | What are the purposes of this intervention?<br>What are the dimensions of this CSCL process?<br>What is the notion of improvement for this intervention?<br>What kind of knowledge and skills should be promoted in this CSCL process?<br>Who decides the inclusion of the type of knowledge to be promoted?<br>What kind of considerations have to be taken into account regarding the context of the application of CSCL activities (i.e. technological access, different socio-economical levels of participants, class dynamics)?<br>How could we support answers for these questions in a broader perspective to generate a deeper understanding of the CSCL process? |
| **Methods for exploring agents, stakeholders, and issues** | CSH, Interactive Planning (IP), School documents (curriculum, mission, and vision), workshops, interviews |

**Table 3. Summary of possible boundary questions and methods (agents, stakeholders and issues to be considered) in systemic intervention**

Table 3 presents generic questions and methods regarding reflections about the boundaries in CSCL processes. The first set of questions concerns the basis of the learning process in terms of purposes, agents, stakeholders, values, and agents' notions for improvement. There are also questions regarding those issues to be considered (dimensions of learning, knowledge to be promoted). The type of knowledge that the agents have is also questioned. These refer to boundary questions so we can identify issues and people to be included in the discussion about the learning process and organise a vision of the CSCL process itself. Furthermore, the context takes into account making explicit the question about what issues are out of the scope of the CSCL process or activities. To address this set of questions some methods can be useful: Critical Systems Heuristics (CSH) (Ulrich, 1983), Interactive Planning (Ackoff, 1981), and interviews based on school documents (mission, vision, and curriculum). The following explains how these methods work in the framework of this systemic intervention.

Because we need to answer boundary questions concerning CSCL process and agents, CSH is one framework that suits this purpose. CSH is a framework to support the process of making boundary judgements (Ulrich, 1983).

The basic idea behind CSH is to support people in the process of identifying and examining boundary judgements, finding options to those judgements, and reflecting on, debating and challenging those boundary judgments (Ulrich, 2005). In order to do that, CSH has developed a systemic categorisation of boundary issues. There are four basic boundary issues, each of which leads to three types of boundary problem. Accordingly, CSH proposes a conceptual framework of twelve boundary categories – questions (Ulrich, 2005). The four boundary issues are (Ulrich & Reynolds, 2010):

- sources of motivation – where a sense of purposefulness and principle values come from

- sources of power/control – where the necessary resources and power are located
- sources of knowledge – where sufficient expertise and experience is assumed to be available
- sources of legitimacy – where social and legal approval is assumed to reside.

The three boundary problems are (Ulrich & Reynolds, 2010):

- social group or role (stakeholder)
- role-specific concern (what is at stake)
- key problem (a stakeholding issue).

CSH has two main purposes: to analyse situations (for personal understanding and by engaging with people to discuss different perspectives) and to allow people to challenge the boundaries of others (Midgley, 2000; Ulrich & Reynolds, 2010). This conceptual framework helps uncover the purposes, values, interests of the participants, to question the issues that are being considered and identify those that ought to be considered. So, it is a framework that can be helpful in the methodological design of CSCL inquiries.

A synergy between CSH and other methods can be useful in the exploration of boundary questions. In this regard, the proposal is to use Interactive Planning (IP) (Ackoff, 1981) because IP is based on participative, continuous, and holistic principles of planning on one hand, and the purpose of designing a desirable future and the invention of ways to bring it about, on the other hand. So, planning should be a matter of coordination and integration of different levels of the organisation, with participants of every level, and with the vision of continuous planning. This synergy between CSH and IP was first proposed by Cohen and Midgley (1994) and has been tried in several interventions (see Midgley et al., 1998; Midgley, 2000).

According to Ackoff (1981), this methodology has five phases. First, the idea is to formulate the mess or the situation that face the organisation, with threads and opportunities, making a reference projection (extrapolation of corporate performance from its recent past into the future assuming no significant changes of either the organisation or its environment). Second, the idea is to specify the ends to be pursued, making a desirable idealised design, so the organisation has a vision of the future to work towards. This idealised design requires three properties: a) it must be technologically feasible (the design must not incorporate any technology that is not currently known to be usable); b) operationally viable (the system designed must be capable of surviving if it were brought into existence); c) capable of learning and adaptation (the system designed must be capable of changing to meet new circumstances). This phase also involves the formulation of both, unconstrained and constrained designs (the constrained design is developed because some systems belong to a supra-system so these systems can constrain the system being designed).

Third, it is the creation phase and selection of the methods to reach the desirable future. In this stage, the ways to reach the desirable future are invented (the idea is to close the gaps between the reference scenario and the idealised redesign of the system).

Fourth, it is the organisation of the resource planning phase ("what", "when", and "how" questions regarding materials, supplies, energy, services, facilities, equipment, personnel, and money). And fifth comes the phase of implementation and control (who is to do what, when, and where; and how the system is going to be controlled), which it is needed to consider these phases as an interactive planning cycle.

In the CSCL process there is a need to approach purposes of learning activities from a broader perspective. IP, in addition to CSH, can help in facilitating discussions regarding the desirable future. This aspect is addressed specifically in the second phase (idealised design). In this phase, participants have to discuss a desirable future taking into account three conditions: the idealised design has to be technologically feasible, viable, and adaptable. Therefore, CSH and IP can deal with boundary questions in the "is" and "ought to be" form, in the case of the CSCL process and its purposes.

In the task of defining issues, school documents are also welcome. School documents such as curriculum, mission statements, vision, and philosophy of education can help establish the broader context where the CSCL processes are designed. They also help understand possible values, interests and purposes of the system concerned.

CSH, IP, and the analysis of school documents should be discussed in workshops and interviews designed accordingly to promote participation concerning confidentiality, participants' roles, organisational design for workshops (for instance, small groups), and the question regarding who should be involved. The interviews and workshops have the objective of taking participants' viewpoints regarding their roles, interests, purposes and perspectives about the CSCL process and therefore, to facilitate the process of making boundary judgements. Here it is important to highlight the question of who ought to be included or excluded, and who is about to be marginalised in these workshops and interviews (Midgley, 2000). Consequently, since we are in the process of making boundary judgements, none of these questions should be out ofconsideration , although the need for action will make choices between the boundaries studied inevitable (Midgley & Ochoa-Arias, 2001).

Having reflected on purposes, improvement, roles, values, and issues during the boundary questions, the next step is to focus on the issue-related questions. However, several aspects need to be highlighted. First, it is important to recognise that the boundary questions should be promoted through the CSCL process, to keep in mind issues included, excluded or marginalised. Second, there are several dimensions considering the process of CSCL: learning purpose, cognitive and metacognitive aspects[8], and social,

[8] Regarding the dimension "cognitive and metacognitive", it is necessary to investigate the methodological approach from the content's field (knowledge or skill to be promoted such as science, mathematics, history, among others) to include its discussions in the CSCL process. For instance, if the content is science, it is necessary to explore theoretical and methodological design from science education and also from CSCL.

motivational, and technological dimensions. These dimensions refer to the main theoretical discussions presented in CSCL research and should be seen as interdependent[9] (Hakkarainen & Palonen, 2003; Kreijns et al., 2004; Sharda et al., 2004; Strijbos et al., 2004b; De Laat et al., 2006; Pozzi et al., 2007; Barros & Córdoba, 2011). Third, the context of application should be mentioned explicitly to take into account questions regarding factors of the process that are being or are going to be excluded or included and reflect on that. Fourth, as was previously identified, the issue-related questions are the result of reflecting on the boundary questions. So, discussion on those boundary questions in Table 3 it is needed, and then generation of a set of questions to follow the ongoing CSCL research process.

After making boundary and issue-related questions during the CSCL process, the intervention is concluded when the phenomenon has ceased or a new phenomenon has substituted the previous one. As a result of the intervention, learning about the CSCL process and the roles and identities of the agents should be achieved.

## Final considerations

The previous section presented the design of methods to approach a CSCL process based on the boundary critique process from a systemic intervention perspective. Some traditional methods from the CSCL field have been proposed in addition to some methods from the systems thinking field in the framework of systemic intervention.

Systemic Intervention allows approaching CSCL research with the emphasis of methodological pluralism and the theory of boundary critique, altogether. In doing that:

- SI allows approaching different levels of CSCL research (organisational, pedagogical, and technological) with the inclusion of different methods (including CSH and Interactive Planning)
- Methodological challenges related to reflection, participants' roles, and the context of application can be overcome with this approach..

The novelty in this methodological design consists of the process of boundary judgment based on the systemic intervention perspective and the inclusion of an Interactive Planning perspective, united with different methods from traditional CSCL processes.. This proposal is useful to consider CSCL as an on-going learning process where questions regarding who and what is excluded, included or marginalised are relevant.

However, this approach works under two assumptions, which can result in possible limitations:

- Knowledge regarding issues and methods is needed to approach this kind of intervention. So, a heterogeneous group of agents is needed to address different

[9] For example, factors in the motivational dimension can affect and be affected by factors in the social dimension (group composition, evolution of interactions, etc.) (Hakkarainen & Palonen, 2003; Kreijns et al., 2004; Strijbos et al., 2004b; De Laat et al., 2006; Pozzi et al., 2007; Barros & Córdoba, 2011).

phases and dimensions of the CSCL process in the systemic intervention. In this respect, questions regarding who should be included and what is the purpose of the intervention become important because answering those questions can accordingly help address the intervention.

- The engagement of stakeholders is needed to approach this kind of intervention in order to identify, discuss and address the issues in the CSCL process. Therefore, as none of the issues can be out of consideration, the engagement of stakeholders should be considered in the boundary critique process. In this way, at least systemic intervention can guarantee reflections on engagement and make decisions according to the results of those considerations.

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