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# Grounding and knowledge elaboration across cultural and geographical contexts: an exploratory case study

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## Highlights

- Intercultural collaboration across schools can lead to misunderstandings due to the over generalisation of one context to another.
- Grounding in interaction, aiming to overcome misunderstandings, leads to the recognition of the limits of situated knowledge.
- Constructive interaction in intercultural collaboration leads to reconceptualization of the knowledge domain.

## Abstract

In this paper, we investigate the processes by which groups of primary and secondary school students from two Francophone contexts (Guadeloupe and Québec) try to establish what has been mutually understood (grounding processes) with respect to shared tasks in geography and in literature. We identify the dynamic interplay of meaning-making in dialogue, the knowledge-building processes, and the types of contributions that are made. Analysed data include two videoconference interaction sequences (4 and 13 minutes) concerning Geothermal Energy and Traditional Folktales, with students at different educational levels. Findings show that interactive confrontation of alternative contexts, that differ in terms of geology (the way that geothermal energy is made) and the status of folktales (oral and written traditions) can lead to misunderstandings due to the overgeneralization of one context to another. Overcoming misunderstandings by grounding leads to the co-elaboration of knowledge on the object of study, the students own context, and the context that they are confronted with. The study emphasizes the importance of interaction strategies that support or inhibit further discussion to deepen reasoning, resolve potential conflict, and reach common knowledge. We discuss implications for the design of productive intercultural collaborative learning situations.

## Keywords

Computer Supported Collaborative Learning; Intercultural collaboration; Grounding processes; Constructive interactions; Interaction analysis.

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## 1. Introduction

Collaborative learning situations involve knowledge building when they encourage students to think and reason by confronting their ideas and points of view, formulating arguments, and receiving constructive criticism (Dillenbourg et al., 1995; Miyake, 1986; Webb, Troper, & Fall, 1995). However, productive collaborative learning requires interaction processes that sustain the co-elaboration of meaning and the knowledge to construct shared representations of the problem to be solved (Baker, 2015; Barron, 2003; Dillenbourg, 1999; Roschelle & Teasley, 1995). *Grounding* (Clark & Brennan, 1991; Clark & Schaefer, 1989) is the specific process by which learners attain and maintain mutual understanding in dialogue. By this process, learners establish a *joint-problem space*, namely a shared conceptual structure that develops within interactions (Teasley & Roschelle, 1993).

The present study concerns learning situations within which two groups of students living in different cultural and geographical areas (Guadeloupe and Québec) yet speaking the same language (French, of different dialectal varieties) collaborate via videoconferences for several weeks. The two groups investigate the same object of study (in one case, Geothermal Energy and in another, Traditional Folktales) in their contexts and collaborate with the other context on a given common problem (installation of a data centre in one of the two geothermal regions and writing a shared tale). By the term “context” here we mean the experiential world within which students acquire knowledge and develop competencies. Context refers to both the cultural background and the physical situation that influence interpretation and representation of a given object to be studied (Brown, Collins, & Duguid, 1989). This implies recognising the situated and embedded nature of learning (Lave, 1988), and that students are shaped by the context in which their education occurs. In our learning scenario, whilst the two groups have a common object of study in their respective contexts, the meaning of this is quite different in each case, because of specific geological, climatic, economic environments, and different regional heritages (Geertz, 1973; Schwartz, 2014). The common task, given its different meanings in the two different cultural, geographical areas, is designed to be favourable to the emergence of the students’ awareness regarding this contrast between the two contexts (Bourdeau et al., 2015; Forissier, Bourdeau, & Psyché, 2017; Forissier et al., 2014). The originality of such a learning situation is threefold: (i) the learning scenario is designed in order to put contextual knowledge in play in interaction; (ii) the collaborative learning scenario can lead to various degrees of misunderstanding if the students fail to grasp the gap between the two contexts; (iii) the scenario concerns the transfer and the co-construction of knowledge between students on the basis of confronting the two contexts.

Several studies in the field of Computer Supported Collaborative Learning<sup>1</sup> (CSCL) recognise that intercultural collaborative learning offers the opportunity to share knowledge forged in

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<sup>1</sup> “Computer Supported Collaborative Learning (CSCL) refers to collaborative learning that is facilitated or mediated by computers and networked devices. CSCL can occur *synchronously*, with learners interacting with each other in real time (e.g., a chat room), or *asynchronously*, with individual contributions stretched out over time (e.g., an e-mail exchange)” (Stahl, Koschmann, & Suthers, 2014, p. 479). In the CSCL situations that are analysed in the present paper, whole class groups of students collaborate across different countries, using video conferencing software.

situated contexts (e.g., cultural customs, ecological systems, astronomical and geographical phenomena) and gain better understanding (e.g., Anakwe & Christensen, 1999; Levin & Cohen, 1985; Popov et al., 2019; Uzuner, 2009; Vatrappu, 2008; Zhang, 2013). These studies broadly refer to the Individualist–Collectivist (I–C) dimension of Hofstede’s (1997) model of national culture to describe differences in culturally-based group work processes. The model helps to describe the extent to which a culture shapes a person’s dependence on the self or the group, and therefore the learner’s attitude towards common goals. However, here, we are interested in the emergence and evolution of contextual knowledge in interaction; and the way by which the confrontation in dialogue of alternative contexts (e.g., differences in cultural heritages and ecological phenomena) may be constructive and productive (Barron, 2003; Cohen, 1994), and may open the mind of students to other cultural, geographical contexts (Wegerif et al., 2019).

The aim of this exploratory study is therefore to analyse the students’ interactive processes across two cultural, geographical contexts as they co-elaborate knowledge and attempt to establish “what has been said has been mutually understood” (Clark & Brennan, 1991), in order to perform the common task. We define *understanding* as giving significance to a given object and analysing the relations of the given object to other aspects of the world (Lave, 1997). We recognize learning as an active process of acquisition of knowledge, through experiences and practices (Lave, 1988), and through social interactions (Stahl, 2005). This means that interaction, whether technology-mediated or not, constitutes a context itself, in which knowledge is discussed and develops, through culturally-related communication skills, as well as on the basis of prior representations and meanings. In this study, we focus on the latter point. We mobilise the interactions paradigm in collaborative learning research, including the concept of co-elaboration of knowledge in dialogue processes (Dillenbourg et al., 1995; Schwarz & Baker, 2017). This field of research particularly focuses on high-level cognitive processes involved in peer interaction such as elaborating, justifying, arguing, reasoning, and understanding each other (Baker, 2015; King, 2002). Our research question is: what are the interactive processes by which students in different contexts (cultural backgrounds and geographical situations) co-elaborate shared meanings and knowledge with respect to school-based problems? We also discuss the potential education value of our situations of study.

The paper is structured as follows. In Section 2, we provide a review of the literature on the co-elaboration of knowledge in collaborative learning and intercultural collaborative learning, including grounding process. We argue for our choice of the term context rather than that of culture and we describe our empirical study. In Section 3, we present the two experimentations that we implemented using a case study approach, and our qualitative method of interaction analysis. Our results are presented in Section 4, which examines two interaction sequences involving explicit grounding processes, which differ in terms of duration, educational levels, knowledge demands, and organisation of the groups. In Section 5, we discuss how the mutual understanding on the gap between contexts can be supported. Finally, in Section 6, we conclude with implications for the design of cross-cultural learning situations that are favourable to the development of students’ knowledge.

## 2. Research background

### 2.1. Knowledge elaboration in (intercultural) collaborative learning

In collaborative learning research, including Computer Supported Collaborative Learning (CSCL), the main challenge is to identify the conditions that optimize (or else hinder) collaborative work and learning, in order to design appropriate educational situations (Asterhan & Schwarz, 2010; Dillenbourg, 1999; Rummel & Spada, 2005). In effect, the aim of collaborative work situations is that the students learn, in the sense of discussing, co-elaborating and assimilating task-related conceptual understanding, and that they obtain the correct answer to the given problem (Baker, 2015). Bringing together people with different points of view is helpful for problem solving and deep understanding (Sawyer 2014). Knowledge about the common problem at hand develops further and further by negotiating different viewpoints and meanings in an interpretive process, and a shared understanding of the meanings is created as a result of this process (Arvaja, 2005; Stahl, 2004). However, the extent to which students learn and develop knowledge from collaborative activities depends on the quality of the dialogue peers engage in (Barron, 2003; Cohen, 1994; Hmelo-Silver, 2003; King, 2002).

The present study explores the co-elaboration of shared meanings and knowledge through dialogue between groups of students who come from two different cultural, geographical contexts yet speak the same language (French). Multiple studies have stressed the role of dialogue in learning scientific concepts (e.g., De Vries, Lund, & Baker, 2002; Nussbaum, Sinatra, & Poliquin, 2008; Roschelle, 1992). These studies aim at understanding epistemic dialogue in order to design learning environments that encourage students to engage in this type of dialogue. Epistemic dialogues are discursive activities (e.g., explanation, argumentation) that operate on knowledge and understanding, rather than on the execution of actions (Asterhan & Schwarz, 2009). For example, the study of De Vries, Lund, & Baker (2002) pointed out that the understanding of scientific notions can take place through the resolution of vocabulary ambiguities (i.e., rendering explicit meanings behind words). Other studies emphasize the importance of ideal – *constructive* – argumentative discourse, which is neither too consensual nor too conflictual (e.g., Asterhan, 2013, Baker, 1999; Weinberger & Fischer, 2006). Discourse that is over consensual does not provide elaborate explanations, and students do not critically examine others' ideas. Conflicting argumentation without concessions does not support the collaborative construction of new explanations. In the same way, previous studies have revealed some students' strategies that help others to restructure their knowledge and understanding (Chi, 2000; Webb, 1989). These interaction strategies are, for example, clarifying and reformulating explanations, encouraging others to rehearse information, and asking for more details, that assist students in bridging from their previous knowledge to new information (Barron, 2003).

Most of the studies on co-elaboration of knowledge through dialogue, and that are based on interaction analysis, do not really investigate the interplay between prior knowledge, knowledge co-construction and interaction processes. However, studies on intercultural collaborative learning have stressed the role of cultural background in students' engagement

in constructive interaction processes such as explanations, argumentation, and resolution of conflict. Various cultural factors may influence the way by which students from different cultures interact and argue with their peers (Weinberger et al., 2007). For example, the study of Zhu, Valcke, & Schellens (2009) compared Chinese and Flemish student's behaviours in a CSCL environment. The results showed that Chinese students exerted a higher level of critical thinking, elaboration, and self-regulation than Flemish students did, because the learning approach differed strongly from the conventional East Asian way of learning. The study of Weinberger et al. (2013) focuses on two cultures, in Finland and Germany, which are similar with respect to most of the cultural dimensions according to Hofstede (1997), but which differ with respect to conflict styles. This study analysed online discussions of several Finnish and German groups of three students. The results indicated that Finnish students integrated arguments of their partners into their own line of reasoning, whereas German students showed quicker consensus building that served continuation of discourse.

Studies on intercultural collaborative learning showed that collaborative problem solving may have different styles across cultures. But little attention has been paid to the extent to which interaction processes may be related to differences in representations and meanings of the common problem to be solved, due to contrasted cultural heritages or geographical situations. This is perhaps because the cultural background is often addressed in terms of its influence on students' behaviors in a given collaborative learning situation, namely task-related behaviour, conflict-related behaviour and type of communication style (Hofstede, 1997; Popov et al., 2019). However, some recent studies have pointed out that both the nature and the content of exchanges differ across cultures and affect collaboration and interaction processes (e.g., Gabelica & Popov, 2020; Salazar & Salas, 2013). For Cole & Engeström (1993), the concept of culture has more often been referred to as a whole or a uniform toolkit, and less in terms of the local experiences that people live according to both their social and physical environments.

In the present study we prefer to use the term context to refer to the multifaceted environment within which knowledge develops (Brown, Collins, & Duguid, 1989; Lave, 1988). This more distributed view of (culturally) distributed cognition considers that it is acquired through everyday interactions and is distributed in time. Learning involves the interplay between moment-to-moment interactions and more longitudinal timescales that are made relevant in the present moment of interaction (Ludvigsen et al., 2011). This means that students accumulate knowledge through social interactions by using prior experiential knowledge along other timescales than those of the *hic et nunc* of the present interaction. Thus, we propose that socio-cognitive conflicts and constructive interactions in distance learning may be based on a divergence of certain meanings expressed by groups of students from differing contexts. In the next section, we focus on the process of negotiation of meaning (or "grounding") in collaborative learning.

## 2.2. Learning by grounding

One fundamental aspect of interactional work during collaborative learning is that students simultaneously manage their own effort to understand the common problem and try to understand what others understand (Baker, 2003; Barron, 2003; Dillenbourg, 1999; Dillenbourg et al., 1995). Collaboration is “a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem” (Roschelle & Teasley, 1995, p. 70). The establishment of this *joint-problem space* (Roschelle, 1992; Teasley & Roschelle, 1993) is crucial for problem-solving and learning (Barron, 2003). In addition, collaborative problem-solving particularly concerns the meanings of scientific concepts underlying the task domain (Baker 2016; Baker et al. 1999). Therefore, for collaboration and learning to take place, it is necessary that students understand not only what the others say, but also the meanings that others attribute to the concepts discussed (Baker, 2015).

In Language Sciences, *grounding* is the interactive process by which people try to establish that which has been said is mutually understood (Clark & Brennan, 1991; Clark & Schaefer, 1989; Clark & Wilkes-Gibbs, 1986). The grounding process contributes to construct and maintain the *common ground*, the set of mutual understanding, knowledge, beliefs, assumptions, and presuppositions. The common ground refers to shared, and often agreed upon, meanings of utterances (Baker, 2015). The grounding process by nature is collaborative because it requires effort by both participants to achieve common ground (Clark & Schaefer, 1989). But this collaborative effort depends on the reasons for needing given information and can vary with the type of collaborators’ objectives (Baker et al., 1999; Clark & Wilkes-Gibbs, 1986).

Research carried out within the “interactions paradigm” in collaborative learning (Dillenbourg, 1999; Dillenbourg et al., 1995) has widely recognised grounding as central to the interplay between individuals. Grounding is apprehended as a negotiation process where the various levels of mutual understanding between learners constitute various objects of negotiation in dialogue (Baker et al., 1999; Kerbrat-Orecchioni, 1990; Roulet, 1992). Here, negotiation does not necessarily refer to the conflict, disagreement, or opposition of ideas, but rather refers to the negotiation of meaning of what is said. Through such *meaning-making*, peer interactions can be constructive and lead to the co-elaboration of new meanings and knowledge (Baker, 1999; 2016). The notion of constructive interaction is defined here as new understanding co-constructed in an iterative fashion (Miyake, 1986). It can produce learning gains beyond the interaction itself, e.g., when constructive interaction leads to individual knowledge restructuring (Schwarz & Baker, 2017).

Learning by grounding has been mainly studied in small groups situated in one particular context whilst investigating knowledge elaboration in the task domain. However, previous studies have pointed out that effective communication is more difficult to achieve in intercultural conversations than in intracultural ones (Li, 1999). The language capacity is not the main barrier (Gass & Varonis, 1985). Chen (1996) pointed out that a main reason is that intercultural interlocutors differ more in background knowledge than intracultural



interlocutors. Due to their differences in their culturally shared knowledge, intercultural interlocutors are often less successful in managing interaction than intracultural ones (Gumperz & Robert, 1991). However, effective communication does not only depend on the quantity of prior common ground among people, rather it relies on how the grounding process occurs in interaction and how people actively participate in the conversation (Clark & Brennan, 1991). This means that some types of collaboration between interlocutors (e.g., when speakers and listeners engage in explanations rather than just presenting information) may foster the construction of shared knowledge on the basis of prior contextual knowledge (Aguilera & Li, 2009; Li, 1999).

Previous studies emphasize the existence of grounding (negotiation of meaning) in multicultural learning environments and the importance of supporting it (e.g., Convertino et al., 2007; Popov et al., 2019; Vatapru, 2008). Again, little attention has been paid to how the common ground is established in interaction. For example, the study of Zhu (2012) investigates if there are cultural differences in the level of student knowledge construction through online discussions. Flemish and Chinese students were required to create wiki documents to explain the main concepts on a given theme in educational science (e.g., constructivism). The results showed that both groups contributed a majority of messages that were at a low level of knowledge construction (sharing and comparing information), and to a lesser extent, messages that were at a high level of knowledge construction (negotiation of meaning). Flemish students posted more messages that supported the exploration of dissonance or inconsistency among ideas, concepts and statements (prerequisite for negotiation of meaning). However, the study does not investigate the process of negotiation of meaning itself. The study of Korsager & Slotta (2015) explores how students from four countries (Canada, China, Sweden, and Norway) developed explanations about a scientific issue (climate change) which implies contextual (cultural and geographical) variability. The analysis focused on how the scientific concepts evolved throughout the collaboration of 6 weeks' duration. It showed that students built connections between new and prior knowledge, and they expanded over time their understanding towards a more coherent one. The authors recognised the need for further investigations concerning the quality of peer interactions that support students to develop more global perspectives and understanding.

### ***2.3. The present study***

In collaborative interaction, some degree of mutual understanding between students can already exist, having been attained through the integration of the students into a common cultural, geographical context, or due to their previous interactions (Baker et al., 1999; Barron, 2003). But the common ground also needs to be augmented and maintained during the interaction itself, in order to take into account new aspects of the common situation. The aim of this study is to explore the *micro* moments of collaborative interaction when diverse contextual knowledge is discussed to perform a common task. We want to understand what happens if learners collaborate, exchange across different contexts (cultural background and geographical situation) and have to confront them with respect to a given knowledge domain. In other words, what are the interactive processes by which students in different contexts co-

elaborate shared meanings and knowledge on a given object or problem that has a different meaning (cultural/geographical) in the two contexts?

To do this, we recognize the multiplicity of both timescales and trajectories of participation in learning (Ludvigsen et al., 2011). In this sense, we consider moments of grounding as events favourable to the development of knowledge through dialogue and that is linked to a past and future events within which prior knowledge has evolved. These *micro* moments of interaction constitute local social contexts within which students take part, and where their heterogeneous backgrounds are involved and structure their participation in the particular context of interaction (Dillenbourg & Traum, 2006; Dreier, 1999; Lave, 1988).

The study concerns learning situations via videoconferences, and it is known that such a medium influences grounding processes (Clark & Brennan, 1991). For example, it sometime requires high “costs” (in terms of cognitive-linguistic effort) in order to perform actions such as reformulating utterances and managing speaker change. It also limits the perception of gestural cues. But, *a contrario*, videoconferences are close to face-to-face conversations in the sense that they respect constraints such as visibility, audibility and co-temporality, which reduce the collaborative effort to coordinate the content of what is said. The limitations of the learning situation will be discussed in Section 5 below.

### **3. Method**

#### ***3.1. Data collection***

##### *3.1.1. The TEEC project*

The interaction data analysed here was collected within the framework of the TEEC project (*Technologies Educatives pour l'Enseignement en Contextes* – Educational Technologies for Contextual Teaching) financed by both the French National Research Council (Agence Nationale de la Recherche) and the *Fonds de recherche du Québec, Société et culture* (FRQSC). One of the aims of this project was to design learning scenarios based on the confrontation of cultural and geographical contexts (Anjou et al., 2017; Bourdeau et al., 2015; Forissier et al., 2014).

The TEEC project was carried out within a Design-Based Research (DBR) approach (Brown, 1992) in that it aimed to design authentic educational situations in collaboration with directly concerned social actors (teachers and their students), in order to both understand and improve those situations. The methodological approach is iterative insofar as it integrate cycles of design (i.e., experimentations), evaluation and revision of pedagogical designs, including the evaluation of the teachers' and students' appropriation of them. Typically, the approach provides a rich, complex and 'ecologically valid' set of data upon which to refine the theory underlying the design (Collins, Joseph, & Bielaczyc, 2004). The DBR methodology is also well-recognized for its relevance to the design of innovative educational technologies (Bourdeau, 2017; Sandoval & Bell, 2004). In the TEEC project, the learning situations were co-designed by international (France, Paris region and Guadeloupe; Canada, Montréal) groups

of teachers and researchers, in accordance within national curricula (for example, in the teaching domains of geography and in French language and literature).

The TEEC project involves five cycles of experimentation, each involving collective work over several weeks between students living in two countries (Guadeloupe and Québec). The five experimentations were carried out in various academic disciplines (e.g., Earth Sciences, literature, etc.) and on different educational levels. For each experimentation, the learning scenario was designed on the basis of three principles: (1) choose an object of study which maximizes the gap between the two contexts; (2) choose an object of study which is observable in the students' environments (e.g., via field investigation); (3) propose moments of synchronous exchanges (using videoconferencing via the Internet). On a given object of study (e.g., Geothermal Energy), the two groups of students investigated the same concepts (e.g., Geothermal Energy functioning). Groups either met together virtually or, at times, were divided into teams (two to four students) in each context. Over several sessions, students met via videoconference to discuss their field investigation with the mirror group. They summarized and shared their findings and what they had learned. All exchanges between students were recorded.

### *3.1.2. Two case studies*

The DBR approach offered the opportunity to improve the educational situation and the learning scenarios, by means of the evaluation of each cycle of experimentation and their revision. We observed that the first experimentations did not lead to collaboration between students (Baker, 2015) since they were not asked explicitly to produce something in common (for example, a common solution in the form of a text). In that case, grounding, or shared meaning-making — our principal object of study — would be unlikely to occur. Therefore, the two last experimentations of the TEEC project, studied here, involved a single-shared production throughout the meeting sessions, in order to satisfy this minimal condition for collaborative learning, i.e., a shared task focus and common production (Baker et al., 1999; Dillenbourg et al., 1995). We selected these two experimentations for a case study analysis (see Table 1) given that they involved rich sequences of grounding resulting from the interactive confrontation of (geographical/cultural) contexts.

*Table 1. Two experimentations for a double case study.*

<b>Experimentation</b>	<b>Experimentation 1</b>	<b>Experimentation 2</b>
Academic discipline	Earth Science	French language literature
Study object	Geothermal Energy	Traditional Folktales
Educational level	Secondary school (14-15 years old)	Elementary school (8-9 years old)

Gap between the two contexts (Guadeloupe and Québec)	The production of geothermal energy depends on the geological, climatic, economic, industrial and political context. There is volcanic activity in Guadeloupe, but not in Québec.	Traditional folktales reflect regional heritage. They follow different structure patterns according to the source language (e.g., linguistic expressions, onomatopoeia). The same characters (e.g., the wily fox) appear in several folktales in the Guadeloupe mostly oral tradition, but not in Québec (mostly written tales).
Common production	Investigate the geothermal potential of the two regions and make a joint recommendation for the fictive installation of a data center in one of the two regions.	Investigate one folktale per region and write a common tale which takes elements from the two regional folktales.
Team division	No	Yes (5 teams). Each pair of mirroring teams works on one component of the tales (e.g., characters, lexicon).
Total of video-recorded sessions	4	5
Period of collection	November 2017 to March 2018	April to May 2018

For the purposes of clarifying the double-case study, we provide a brief description of the two contexts (Guadeloupe and Québec). As Table 1 illustrates, each domain of study comprised a major contextual gap. The first experimentation on Geothermal Energy involved an exchange between secondary school students. Class groups were not divided into teams, and the videoconferences lasted approximately 50 minutes. In Guadeloupe, since it is a volcanic island located in a subduction zone, a geothermal power plant uses the heat of the groundwater. This exploitation produces about 8% of the local demand for electricity. This “high-energy geothermy” uses fluids with temperatures exceeding 150°C. It generally concerns significant drilling to depths which are greater than 1000 metres. In Québec, the bedrock mainly consists of ancient Precambrian rock from the Canadian Shield, which does not allow for the production of electricity. There, the geothermal heat is used to regulate the temperature in homes and buildings (heating, air-conditioning). This “low temperature geothermics” operates in the first tens of metres below the ground surface (less than 200 meters), where the temperatures are between 10 and 30° C, and it uses a heat pump (Anjou, 2018).

The second experimentation compared traditional folktales and involved elementary school children in both regions (Table 1). Groups were divided into teams of four students in each context, and the videoconferences lasted approximately 15 minutes per team (the teams met one by one during the same videoconference). Folktales are both universal objects (i.e., they provide answers to the big questions that humans face, such as fairness and death) and singular objects (i.e., they reflect a given cultural, historical context). In Guadeloupe, traditional folktales are closely linked to colonial history and resulting social relationships, namely the power relationships between, on the one hand “the little people” who are the slaves and on the other, the white, slave owners. Recurring themes in Guadeloupean tales are

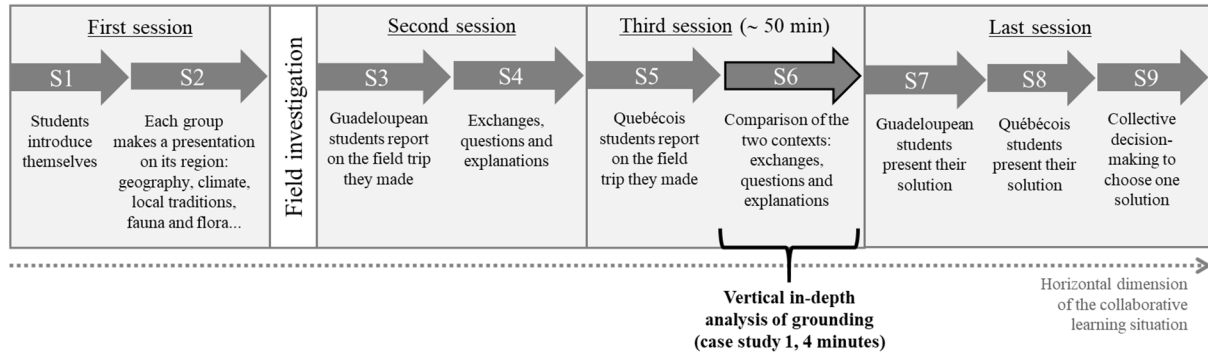
ruse and resourcefulness as a set of non-conforming acts towards the dominant system. Québec tales are mostly written, and they are influenced by the Judeo-Christian tradition (i.e., the difference between good and evil). Therefore, Antilles (of which Guadeloupe) folktales and Québec folktales relate the social issues that are considered as major in each region, and that are transmitted from one generation to the next. But another important difference concerns the way by which moral issues and traditions are addressed in the two regional folktales. In Québec, moral issues are addressed through stories that include characters known only in one specific story or legend. For example, the legend of *Rose La Tulipe* illustrates the cultural norms of the 18<sup>th</sup> century and narrates the story of a young girl, already engaged to a man, who accepts to dance with a handsome stranger (the devil incarnated) despite the advice of both a priest and her father. According to the different versions of the tale, the devil takes the girl with him to hell, or the girl dies few years later. However, the *La Tulipe* characters (Rose and her father), the handsome stranger and the priest are only known in the story of *Rose La Tulipe*. In Guadeloupe, moral issues are more addressed through emblematic characters (humans and animals) who symbolize resilience towards the dominant system, and who appear in various stories which result from a long oral tradition. *Compère Lapin* (Fellow Rabbit) is the emblematic character who symbolises resourcefulness. He is part of a cycle of tales that involve him and his alter ego, *Compère Zamba*, who symbolizes brute force and who is duped by the “weak and oppressed” *Compère Lapin* (Chartofylaka et al., 2018). To resume, in Québec, specific folktales are well-known, while in Guadeloupe it is rather the characters recurring across many folktales, deriving from a strong oral tradition, who are widely known across all levels of society.

The learners were not initially informed of these differences, our approach being based on the principle that the discovery of differences in interaction, leading to more or less intense interactive work on the level of grounding, would enable each group to extend its own knowledge and to understand the specificities of its own context.

### *3.1.3. Selection of sequences involving grounding*

For the two experimentations, the videos were viewed several times. Each working session was divided into interaction sequences. An interaction sequence can be defined as a block of exchanges that are connected by a strong semantic or pragmatic coherence, about the same topic or focusing on the same task (Kerbrat-Orecchioni, 1990). For each session, interaction sequences were identified considering the instructions given to students and the task performed for the session. Figure 1 broadly maps out the chronology of the working sessions and divisions into interaction sequences throughout each experimentation.

### Experimentation 1 Geothermal Energy



### Experimentation 2 Traditional Folktales

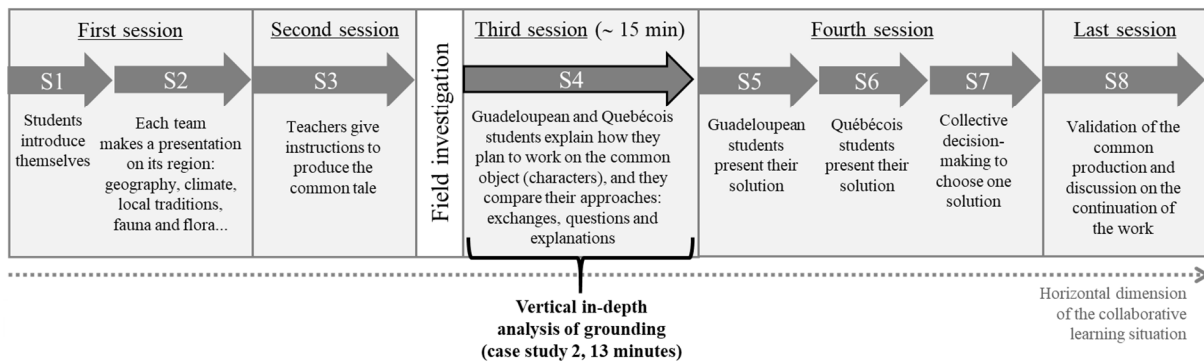


Figure 1. Chronology of sessions, interaction sequences and selection of micro moment of grounding in each experimentation.

For the two experimentations, we identified vertical micro moments of grounding throughout the sequential ordering of social interaction (Ludvigsen et al., 2011). According to Clark & Schaefer (1989), grounding is a *ubiquitous* process in conversation; it occurs in all interactive exchanges, usually *implicitly*. In the present case, we focus on *explicit grounding moments*, i.e. those where one or more speakers explicitly state that a misunderstanding may have occurred and engage in interactive work in order to *repair* it. Whilst in conversation analysis, reparation can concern a variety of “problems” that arise, in speaking and listening and understanding (Schegloff, Jefferson, & Sacks, 1977), we focus on the latter here, i.e. the repair of problems in mutual understanding, grounding. Therefore, sequences involving (explicit) grounding<sup>2</sup> were identified considering three indicators related to our theoretical framework and research questions (Derry et al., 2010). The first indicator is the existence of interactive exchanges between the two groups of students. Some interaction sequences were only the presentation of information between groups, without any real discussion between students (e.g., S2 in Figure 1). The second indicator is the existence of questions (requests for more information, clarification) followed by explanations and argumentation, reflecting a certain degree of negotiation of meaning of what is said (Baker, 1999; 2016), or reflecting misunderstanding (Clark & Brennan, 1991). Some discussion consisted of questions followed by short sharing of information without meaning-making between students. The third indicator is the negotiation of meaning involving contextual knowledge and the comparison between two contexts (use of personal pronouns such as “we” and “you”).

<sup>2</sup> Henceforth, all references to grounding are to be understood as explicit grounding.

As can be seen in Figure 1, sequences involving grounding mainly occurred in the middle sessions of the collaborative work, when students described and compared their contexts. In this paper, we focus on two sequences with grounding, one per experimentation. These particular sequences were the ones with the most indicators in the two experimentations. For the Geothermal Energy experimentation, we focus on a sequence of 4 minutes (S6 in Figure 1, case study 1) occurring during the third session, where students compare their respective geothermal contexts after each group had presented its field trip. For the Traditional Folktales experimentation, we focus on a sequence of 13 minutes (S6 in Figure 1, case study 2) occurring during the third session, where teams compared their methods for working on their common object (in our case, the mirroring teams worked on the folktales characters). In the next section, we present how the two sequences with grounding were analysed.

### **3.2. Data analysis**

#### *3.2.1. Transcription and coding of speakers*

We systematically transcribed the two sequences with grounding whilst considering overlapping speech and paraverbal elements such as pauses in speeches, tone of voice, and laughter (Kerbrat-Orecchioni, 1990). We also paid attention to how the students were positioned with respect to the camera and the microphone. We numbered speech turns (chronologically from 1 to x) and annotated the timeline of the video (minutes and seconds corresponding to the start of the turn). Then, we assigned a code to the speaker as follows:

- G<sub>x</sub> or Q<sub>x</sub>: a student from Guadeloupe (“G”) or Québec (“Q”) (1 to x).
- Tut.G or Tut.Q: tutor (teacher or researcher) from Guadeloupe or Québec.
- Sev.G or Sev.Q: several or all students from Guadeloupe or Québec speaking at the same time.

#### *3.2.2. Coding of the interactive and epistemic dimensions*

Our coding scheme considers the superposition of two dimensions involved in the grounding process, the interactive dimension and the epistemic dimension (e.g., Asterhan, 2013; Weinberger & Fischer, 2006).

The interactive dimension accounts for the process of mutual understanding, i.e., the way in which participants interact and negotiate the meaning of what is said. According to the literature, there are various degrees of disagreement and various degrees of negotiation of the meaning of knowledge in peer interaction (Baker, 2003). It includes the evocation of arguments as well as other forms of interaction revealing the reinforcement and the maintenance of shared knowledge (grounding process) such as acceptance, explanation, and clarification (De Vries, Lund, & Baker, 2002). Table 2 presents codes for the interactive dimension.

Table 2. Coding of the interactive dimension.

Code	Definition	Example
UNDER	Speaker expresses understanding	<i>Well, that's what I have understood.</i>
AGREE	Speaker agrees	<i>Yes, it makes sense what you say.</i>
ARGUE	Speaker argues an idea or a notion	<i>It depends if the character is popular.</i>
EXPLAIN	Speaker explains or clarifies a notion	<i>We use geothermal energy to heat houses.</i>
QUESTION	Speaker asks a question	<i>Do you understand what a heat pump is?</i>
DISAGREE	Speaker disagrees	<i>Me, I do not agree.</i>
MISUNDER	Speaker expresses a lack of understanding	<i>We don't really understand.</i>

The epistemic dimension accounts for knowledge involved in interaction. It is analysable through the topic, the scientific notion, or the concept that is discussed in interaction. Codes for this dimension are unique for each experimentation, each session, and each interaction sequence. For each sequence with grounding, we have identified as precisely as possible the evolution of knowledge involved in interaction through different phases. Furthermore, we distinguish acontextual knowledge from contextual (Québec or Guadeloupe) knowledge. Acontextual knowledge is knowledge that does not refer to a specific context, such as “the functioning of a heat pump”. Contextual knowledge is knowledge that involves contextual (cultural or geographical) particularities such as “in Québec, the water in the heat pump is about 12 degrees”.

### 3.3. Summary

We selected two sequences with grounding from two experimentations for case analysis. The two sequences were viewed several times and discussed among the co-authors of the paper. Then, the sequences were fully transcribed and examined inductively through qualitative interaction analysis. For each turn of speech, we annotated the timeline, the speaker, the utterances, the interactive dimension (Table 2) and the epistemic dimension (knowledge involved). An overview of the grounding processes was also illustrated with a chart. The transcripts of the interaction were translated (by the authors) from French to English for the case studies.

## 4. Results

### 4.1. Case study 1: from heat pump functioning to heat sources of Geothermal Energy

We present the analysis of an interaction sequence from the Geothermal Energy experimentation. The sequence shows the evolution of a discussion on the functioning of a heat pump leading to the understanding of the various sources of heat involved in geothermal energy. In the Geothermal Energy experimentation, the learning scenario asked the students (in secondary school) to investigate the geothermal potential of Guadeloupe and Québec in order to make a joint recommendation for where, Guadeloupe or Québec, it would be best to



install a data centre, given that servers require consistent temperatures and often cooling, which in turn requires energy sources. The learning scenario is based on the following gap between the two geographical situations. In Québec, geothermal energy uses the temperature of water a few meters underground to heat or cool homes or enclosed spaces, depending on the season. Heat pumps extract water from the groundwater table and transfer it directly to the home. In Guadeloupe, a geothermal power plant located in the town of “Bouillante” (whose name in fact means “Boiling”) that operates with a groundwater depth of 1500 meters and at a temperature of 250° Celsius. This is possible due to the volcanic activity in the region. The power plant generates electricity for the national power grid.

The sequence that we present took place during the third session of the experimentation and its duration is approximately 4 minutes. There are four students in Québec (Q1 to Q4) and 11 in Guadeloupe (G1 to G11). Figure 2 shows the position of students in front of the camera.



Figure 2. Position of students in front of the camera (Geothermal Energy experimentation), Québec on the left, Guadeloupe on the right.

Prior to the exchanges, the Québécois students presented the field trip they made to the Montreal Biodôme (natural ecosystem), which uses Geothermal heating. The Québécois students highlighted the functioning of a heat pump. It should be specified that the Guadeloupean students also took a field trip to the Bouillante geothermal power plant near the Soufriere Hills Volcano. A few days earlier, during the second session of the experiment, the Guadeloupean students presented their field trip to the Québécois students. This did not involve overt manifestation of misunderstanding.

The interaction sequence involving (explicit) grounding is presented and discussed below. The process of mutual understanding of the different sources of heat of Geothermal Energy can be divided into six phases, according to the knowledge under co-elaboration.

#### *Phase 1 (heat pump functioning: mutual understanding)*

The first phase of the sequence (from 22:52 to 23:59) concerned the mutual understanding of how a heat pump works. The knowledge discussed is acontextual and does not specifically refer to one or the other context. It begins with the Québécois tutor who asks if the Guadeloupean students have understood the presentation of the heat pump functioning (line number, N=001). A Guadeloupean student (G4) answers that his group has understood (N=004). But when a Québécois student asks him to clarify (N=007), G4 changes his mind

and does not take the risk of giving a poor explanation (N=009). Some Guadeloupean students take the opportunity to say that they did not really understand the functioning of the heat pump (N=014). A classmate (G11), who thinks she has understood, gives explanations to her group (N=015). She is not completely sure she is right (N=019), but a Québécois student (Q1) encourages her to continue (N=022). Q1 supports Guadeloupean students in the shared understanding of what a heat pump does (N=025 to N=029).

Dialogue during phase 1:

N=001 [Tut.Q]: In Guadeloupe do you understand what a heat pump is and how it works?

N=004 [G4]: Yes, we understand.

N=007 [Q1]: Can you explain it?

N=009 [G4]: ((tilts the head forwards)).

N=014 [G11]: Me and G7 we don't understand.

N=015 [G6]: There is a pump and they said it pumps water under the ground...rather high because with the heat of the sun I think it's warmer at the top ((gestures with the hands)).

N=018 [G11]: ((laughter)).

N=019 [G6]: Well that's what I understood eh!

N=022 [Q1]: Yes, that's good! Yes, yes, it makes sense what you say!

N=025 [G11]: Ok, and it's hot, and it goes through the pipes, and it goes in the house?

N=027 [G4]: Yes.

N=028 [G6]: Yes.

N=029 [Q1]: Yes, that's it, that's what a heat pump does!

*Phase 2 (temperature of the water in the pump: poor understanding)*

In the second phase (from 24:02 to 24:43), student G11 asks G6 a question on the temperature of the water inside the heat pump (N=031). This request concerns the Québécois context. In fact, G11 requests two types of information: the nature of the fluid inside the pump, and the temperature of the fluid (N=038). G6 does not know the answer (N=039). Guadeloupean students only ask Québécois students about the nature of the fluid inside the pump (N=041 and N=042). The latter responds to them that it is water (N=049 and N=050). Guadeloupe students manifest the comprehension of the information (N=051 and N=052), but G11 extrapolates the answer and reaches the hasty conclusion that the water is cold when it arrives in the pump (N=053). Despite the manifestation of understanding, the two groups do not mutually clarify at which temperature the water is pumped. G11, at least, continues to believe that the water is cold at first (N=053).

Dialogue during phase 2:

N=036 [G11]: ((to G14)) And in the pump, at first, the water is cold?

N=037 [G6]: What?

N=038 [G11]: ((to G14)) At first, the water, if there is water in the pump, is cold and then they heat it?

N=039 [G6]: Uh...!

N=041 [G11]: Is there water in the pump?

N=042 [G9]: Or another fluid?

N=049 [Q1]: It's water.

N=050 [Q2]: Yes, it's water.

N=051 [Sev.Q]: ((head-nodding))

N=052 [G6]: It's water, ok.

N=053 [G11]: ((to G14)) OK, so at first it is cold and then they heat it.

*Phase 3 (heat pump in the Guadeloupe geothermal plant: mutual understanding)*

The third phase of the sequence (from 24:53 to 25:38) begins with the Québécois tutor who encourages the discussion and asks if there is a heat pump in the Geothermal power plant in Guadeloupe (N=055). The discussion therefore moves to the Guadeloupean context. At first, the Guadeloupean students give opposing answers (N=059 to N=062). Then, student G6 provides an explanation that everyone can agree on (N=063 to N=67). Student Q1 says that she understands there is no heat pump in the Guadeloupean station (N=070).

Dialogue during phase 3:

N=055 [Tut.Q]: Is there a heat pump in your geothermal energy station?

N=059 [G11]: Uh...

N=060 [G4]: Yes.

N=061 [G6]: No.

N=062 [G7]: No, no!

N=063 [G6]: No because we do not use geothermal energy to heat houses like you do... here, it is a big station which aims to generate electricity.

N=066 [G4]: For everyone.

N=067 [G11]: For everyone, and then it distributes electricity to each house ((gestures with the hands)).

N=070 [Q1]: ((to Tut.Q)) OK, so, there is no heat pump.

*Phase 4 (similar system in the Guadeloupe geothermal plant: explanation)*

The fourth phase of the sequence (from 25:39 to 25:58) again begins with the Québécois tutor who asks if there is a mechanism similar to the heat pump in Guadeloupe (N=071). Two Guadeloupean students explain that water is extracted with a borehole, and the water turns into steam upon the ascent (N=072 to N=074). The explanations are not followed by a manifestation of understanding on the Québec side, but rather provoke a question about the extraction of steam (next phase).

Dialogue during phase 4:

N=071 [Tut.Q]: To convert the heat to electricity, is there a mechanism like the heat pump?

N=072 [G6]: It is done with a borehole.

N=073 [G4]: When we extract water from the borehole after it goes directly into a kind of thing, and after it is mixed with something.

N=074 [G6]: Yes, because it is steam.

*Phase 5 (extraction of steam: misunderstanding)*

The fifth phase of the sequence (from 26:01 to 26:16) concerns the mutual understanding of why it is steam that is extracted in Guadeloupe. It begins with a Québécois student (Q2) who asks if steam is extracted “directly” (N=076). The use of the word “directly” appears three times (N=080 and N=085) which indicates that the student does not understand why the water turns “naturally” into steam. In fact, this is because in Guadeloupe the geothermal power plant operates with groundwater at a temperature (250° C) higher than the boiling temperature of

water at the ground surface (100° C). The Guadeloupean students did not perceive the lack of understanding of Québécois students and provided several irrelevant answers, focusing on how the steam is extracted by a kind of pump (N=078 to N=084), while Q2 wanted to know why the water turns into steam. The misunderstanding follows the non-clarification of the question of water temperature that was mentioned in phase 2. The resolution of the misunderstanding lies in the contribution of student Q1 who finally understands that water turns into steam because it is already hot (N=086).

Dialogue during phase 5:

N=076 [Q2]: So, you take the steam directly?  
N=077 [G3]: We pump it, we pump it!  
N=078 [G6]: ((to her group)) Because of the pressure of the steam, no?  
N=079 [G7]: ((to his group)) The water rises directly to our fingers?  
N=080 [Q2]: ((gestures with the hands)) Uh... they take the steam directly?  
N=081 [G3]: We pump it!  
N=082 [G4]: We pump it!  
N=083 [G11]: There is a pump! ((gestures with the hands))  
N=084 [Sev.G]: There is pressure!  
N=085 [Q2]: ((to itself)) They take the steam directly?  
N=086 [Q1]: Yeah yes! Because the water is already hot!

*Phase 6 (heat in the ground vs. heat in the water: resolution)*

The understanding of student Q1 turns the discussion towards mutual agreement and understanding that water does not come from the same source in the two geothermal contexts (Guadeloupe and Québec). The last phase of the sequence (from 26:18 to 26:35) begins with student Q3 who summarizes what she has understood concerning the difference between the two systems (N=087). Student Q1 agrees with her (N=089), as do several Guadeloupean students (N=090 to N=093). It should be mentioned that the mutual understanding, expressed by student Q2 (N=094), is not really correct. In the two Geothermal Energy systems, the heat comes from water from a groundwater table, but in the Guadeloupean system the extraction is deeper, and the water is hotter than in the Québécois system. That is why the students use the comparison between “heat in ground” and “heat in water”. However, the misunderstanding between the two groups is repaired and the students’ knowledge evolves in the sense that they understand that geothermal energy can use various sources of heat according to the geological context.

Dialogue during phase 6:

N=087 [Q3]: Basically, the big difference between you and us it's, for us, the heat is in the ground, for you, the heat is in the water.  
N=089 [Q1]: Yes, for us, it is in the ground, for you, it is in the water.  
N=090 [G7]: That is!  
N=091 [G11]: That's right!  
N=092 [Q3]: That's right?  
N=093 [G4]: Yes, that's correct!  
N=094 [Q2]: We are geniuses, congratulations to us ((applause)).

Figure 3 summarises the above analysis of the interaction sequence and the process of grounding which come from the third session of the Geothermal Energy experimentation.

Acontextual	Québécois context			Guadeloupean context				
Epistemic Dimension	Epistemic Dimension	Interactive Dimension			Interactive Dimension			Epistemic Dimension
		Tut.Q	Sev.Q	Q	G	Sev.G	Tut.G	
	Heat pump functioning		QUESTION			UNDER MISUNDER		Mutual understanding ①
				AGREE		EXPLAIN		
	Temperature of the water in the pump			EXPLAIN		QUESTION		Poor understanding ②
						UNDER		
			QUESTION			EXPLAIN	Heat pump in the Guadeloupe geothermal plant	Mutual understanding ③
				UNDER				
			QUESTION			EXPLAIN	Similar system in the Guadeloupe geothermal plant	Explanation ④
			QUESTION			EXPLAIN QUESTION	Extraction of steam	Misunderstanding ⑤
				MISUNDER		EXPLAIN		
				UNDER				
	Heat in the ground vs. Heat in the water		EXPLAIN			AGREE	Heat in the ground vs. Heat in the water	Resolution ⑥
				UNDER				

Tut.Q/Tut.G = tutor from Quebec/Guadeloupe; Sev.Q/Sev.G = several or all students from Quebec/Guadeloupe; Q/G = a student from Quebec/Guadeloupe

Figure 3. Interaction sequence with grounding in the Geothermal Energy experimentation (case study 1).

The figure 3 summarizes the evolution of knowledge (epistemic dimension) supported by the interactive processes (interactive dimension) throughout the six phases of dialogue (circled numbers). As we see, the discussion concerns at first the object of study (heat pump functioning) and does not refer to the contexts (acontextual). Then, the discussion concerns the comparison of the two Geothermal contexts (Québécois context then Guadeloupean context) following a contextual question from several Guadeloupe students (underlined “QUESTION”). We see a poor understanding in the Guadeloupe side (starred symbol marked “UNDER”) that reappears after a few speech turns and provokes a misunderstanding in the Québec side (arrow between circle 2 and circle 5). The resolution of the conflict is based on explanations from both sides, and the expression of common agreement and understanding of the gap between the two contexts (heat in the ground vs. heat in the water).

#### 4.2. Case study 2: from characters in the tale to characters across tales

We now present the analysis of a sequence that comes from the Traditional Folktales experimentation. The sequence shows how a discussion on looking for information on characters in a folktale book evolved to the understanding that characters can be a type of cultural heritage that transcends storybooks. In the Traditional Folktales experimentation, the learning scenario asked elementary school students to write a common tale taking elements from two regional folktales, *Compère Lapin et Compère Zamba* (Fellow Rabbit and Fellow Zamba) from Guadeloupe and *Rose Latulipe* (Rose the Tulip) from Québec. The pedagogical objective is to exploit tales from two different cultural contexts to enrich the students' knowledge of the object "tale" itself. In each region, students are divided into teams. Each pair of mirror teams work on one component of the tales (e.g. characters, vocabulary and collocations, and narrative discourse). In the two countries, traditional folktales are of a different nature and follow different structural patterns. The learning scenario is based on the following gap between the two cultural contexts (see above). Antilles tales are based on a strong oral tradition in the region. Tales are transmitted orally (through a storyteller) and are transformed according to the context in which the story is told (traditional and cultural events, celebrations). Antilles folktales are always built around a "moral" to the story, and moral issues are addressed through emblematic characters that (re)appear across different stories. Depending on the story, some personality traits of the characters are more or less emphasized. Such characteristics do not exist in the studied Québec tale. The character of Rose La Tulipe only appears in the unique *Rose La Tulipe* folktale, despite a few different versions of the end (the "moral") of the story.

The sequence that we present concerns mirroring teams number 2 and takes place during the third session of the experimentation. Its duration is about 13 minutes. There are four students in each mirroring team (Q1 to Q4 and G1 to G4). Together, they must create the characters of the common tale from the characters of the two regional folktales. The instruction for the session is to discuss ways of collecting data on characters in the tales. Each team has prepared solutions and students are asked to discuss their solutions. Figure 4 shows the position of students in front of the camera.



Figure 4. Position of students in front of the camera (Traditional Folktales experimentation): Québec on the left, Guadeloupe on the right.

The interaction sequence with grounding is presented and discussed below. The process of mutual understanding of Guadeloupe characters are well-known across stories can be divided into seven phases, according to the co-elaborated knowledge.

*Phase 1 (collect information in the text of the tale: mutual understanding)*

The first phase of the sequence (from 02:18 to 04:53) concerns the mutual understanding of the possibility of collecting information on characters directly in the book of tales proposed to the students. The option discussed is acontextual and does not refer specifically to one or the other context. It begins with a Guadeloupean student (G1) who explains such a possibility (line number, N=001). Supported by their tutor (N=003 and N=010), the Québécois students express the same idea (N=008 and N=011). Therefore, the two teams agree with each other (N=023).

Dialogue during phase 1:

N=001 [G1]: How do we collect information? ((reads his sheet)) We have several solutions. First, we can read the text and underline the information.

N=003 [Tut.Q]: And you? Does anyone want to speak? What do you plan to do first?

N=008 [Q4]: Me, I want to describe the characters.

N=010 [Tut.Q]: Would you read the text several times?

N=011 [Q2]: We would read the text several times and underline the relevant words.

((problem with the video))

N=023 [G1]: We agree.

*Phase 2 (collect information in other tales: false acceptance)*

The second phase of the sequence (from 04:54 to 07:09) concerns mutual understanding of the suggestion to collect information on characters in other books of tales. Again, the option discussed is acontextual. Again, a Guadeloupean student (G1) raises such a possibility (N=025), probably because, as explained above, the same characters appear in adapted forms across several tales in Guadeloupe. One Québécois student does not understand why it is relevant to search for information in other books (N=030). Driven by the tutor (N=031), the Québécois students do not discuss their misunderstanding, but rather disagree with the proposal (N=036). The Guadeloupean tutor encourages her students to defend their proposal (N=040). The Guadeloupean students (N=041) proposal is then accepted by the Québécois students (N=043) thanks to — again — the guidance of their tutor (N=042). However, the argument of the Guadeloupean students is not explored by the two teams, including the possibility of collecting information on the characters' age, personality, physical and moral portraits. The discussion therefore remains focused on acontextual knowledge, rather than moving on to the differences between the two contexts. As we will see, the non-exploration of why it is possible to find such information in other tales will lead to another conflict based on the current unresolved misunderstanding.

Dialogue during phase 2:

N=025 [G1]: ((reads his sheet)) To better describe the characters, we can also look in other story books.

N=029 [Tut.Q]: Do you think it is a good idea?

N=030 [Q1]: I don't understand the point. We only have one book, why look in other books?

N=031 [Tut.Q]: You don't understand? Tell them that you will focus on that book.

N=036 [Q3]: We will focus on the book.

N=040 [Tut.G]: Why do you plan to look in other tales?

N=041 [G1]: The aim is to understand the characters of the tale. Maybe this tale will give us some information, but there are other tales with the same characters, and we will have more information on their age, their personality, their physical, and moral portraits.

N=042 [Tut.Q]: Do you think it is a good idea? You can tell them it is a good idea.

N=043 [Q2]: OK, it is a good idea.

*Phase 3 (collecting information from story book pictures: mutual acceptance)*

In the third phase of the sequence (from 07:15 to 08:30) the Québécois tutor asks his students to propose another solution to collect information on characters in the book of tales (N=044). Two Québécois students (Q3 and Q4) suggest looking at the pictures (N=047 and N=053) and Guadeloupe students agree (N=063). Again, the solution discussed is acontextual and can concern all books with pictures.

Dialogue during phase 3:

N=044 [Tut.Q]: ((to Québécois students)) What else are you going to do?

N=047 [Q3]: Look at the pictures.

N=050 [Tut.Q]: Then?

N=053 [Q4]: We can find information.

((problem with the video))

N=063 [G1]: OK. We agree.

*Phase 4 (manipulate information on characters: pseudo agreement)*

The fourth phase of the sequence (from 08:34 to 10:41) begins with a Guadeloupean student (G1) who turns the discussion to methods for manipulating (classifying) information on characters. Again, the discussion does not involve a specific context. G1 proposes making tables, and again he emphasizes the various types of information that can be found on the characters (N=065). The two teams agree on several proposals such as making tables, mind maps, and drawing the characters (N=066 to N=079). But the mutual agreement does not entirely satisfy the Guadeloupean students who wonder how the Québécois students will organize information on the morality of characters (N=077 and N=082). The pseudo (partial) agreement follows the false acceptance in phase 2, and the discussion moves on the collection of information on morality on characters (next phase).

Dialogue during phase 4:

N=065 [G1]: ((reads his sheet)) We can make tables with all the characters. Each time we find a character we will insert its personality, age, moral, and physical characteristics. We describe if the character is good or bad in the story, if it is a malicious one or the one who is duped.



N=066 [Tut.Q]: ((to Québec students)) Do you sometimes make tables?

N=067 [Q1]: We do mind maps. It is rather like tables or diagrams (...).

N=075 [G2]: We can also draw the physical characteristics.

N=077 [G1]: It can help us shape the characters.

N=079 [Q2]: Yes, it's a good idea. We will have a visual description of what they look like.

N=082 [G1]: We agree, it describes their physical aspects. But in the text, we will find words about these characters that will describe their morals, and we will put it on the table, no?

#### *Phase 5 (collecting information on character morality: conflict)*

The fifth phase of the sequence (from 10:51 to 14:00) concerns argumentation on how to collect information on character morality. It begins with the Québécois tutor who highlights the previous question-comment of the Guadeloupean student about drawing moral qualities (N=083). Such an option involves the specificities of the Guadeloupean tales (and their characters), even if it is not clearly mentioned in the discussion. Once again, Québécois students focus on information that exists in the tale book (N=085), whereas Guadeloupean students think it is possible to obtain information from other sources (N=091). The students do not perceive the gap between their two cultural contexts. In Guadeloupe, folktales are more embedded in traditional culture than in Québec, and characters are very widely known, representing what is good or bad in society. That is why the Guadeloupean student G1 says: "We have heard about the characters. We know at least their moral portrait." (N=096). The misunderstanding provokes disagreement and argumentation on both sides (N=093 to N=098). The resolution of the conflict lies in the Québécois tutor intervening (next phase).

#### Dialogue during phase 5:

N=083 [Tut.Q]: ((to Québécois students)) The drawing, it helps for the physical aspects, but not for the morals?

N=085 [Q2]: We can have a look in the paragraph, in the text, where it talks about the character, and write the qualities next to the drawing.

N=091 [G1]: We would like to know, we can find qualities in the text, but can you tell us more precisely where are you going to find the qualities? Can you find the qualities elsewhere than in the text?

N=093 [Q2]: Uh... no we can't. I don't really think we'll find information elsewhere.

N=096 [G1]: I don't agree. It is not only in the text. We can look up the characters on the internet; we will find information. We can look up other tales as well. We have heard about the characters. We know at least their moral portrait.

N=097 [Q2]: Well, we can certainly find the characters if there is a storybook with pictures, but if not, maybe the paragraph will help.

N=098 [Q4]: But we can't find qualities using pictures.

#### *Phase 6 (presence of characters in other tales or not: mutual agreement)*

The sixth phase of the sequence (from 14:01 to 14:39) shows the Québécois tutor trying to guide the students towards the comprehension of the difference between Guadeloupean and Québécois characters, i.e., their presence (or not) in other stories (N=101). In the discussion, the two contexts are intertwined. Supported by their tutor, the Québécois students argue for such a difference, which shows they are beginning to understand it (N=102 to N=111). The Guadeloupean students agree with the Québécois students' interpretation (N=112).

### Dialogue during phase 6:

N=101 [Tut.Q]: ((to Québécois students)) Do you think that you will find information on the internet about your characters' personality? Do you think your characters are in other books?

N=102 [Q2]: No. They are only in this text.

N=105 [Tut.Q]: Yes, that's good.

N=106 [Q2]: But maybe the characters are only in this text. We can't find them elsewhere.

N=107 [Q4]: But it depends on whether characters are widely-known<sup>3</sup> or not.

N=110 [Tut.Q]: Yes. If they are not widely-known, they will just be in this book.

N=111 [Q4]: Yes. If they are not widely-known, we will not find them on the Internet.

N=112 [G1]: We agree.

### *Phase 7 (Tales and characters as cultural heritage: resolution)*

The mutual agreement turns the discussion towards the mutual understanding that tales are embedded in cultural contexts and that they may be different because of these various contexts. The last phase of the sequence (from 14:40 to 15:08) begins with the student G1 who summarizes what he has understood concerning the various origins of traditional tales (N=114). The student Q1 agrees with him (N=115), and the two teams, at that point, reach a consensus and shared knowledge (N=116). The misunderstanding between the two teams is repaired and knowledge evolves in the sense that students understand that folktale characters are not known in the same way in different regions of the world. The end of the sequence brings the session to a close. It is time for the Québécois students to leave the videoconference and the two teams say goodbye.

### Dialogue during phase 7:

N=114 [G1]: In fact, it depends on where the characters come from! Because you have characters from your own stories from Québec! But we don't have the same stories in Guadeloupe, so we won't have the same characters.

N=115 [Q1]: Yes. Our characters will probably differ from yours. We can't really find them on the Internet because they are not widely known.

N=116 [G1]: Yes, okay.

Figure 5 illustrates a summary of the analysis of the interaction sequence discussed above, and the process of grounding which come from the third session of the Traditional Folktales experimentation.

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<sup>3</sup> The original French word used was "populaire". This does not quite mean "popular" in English (in the sense of well appreciated), but rather "what pertains to the people", anyone and everyone.

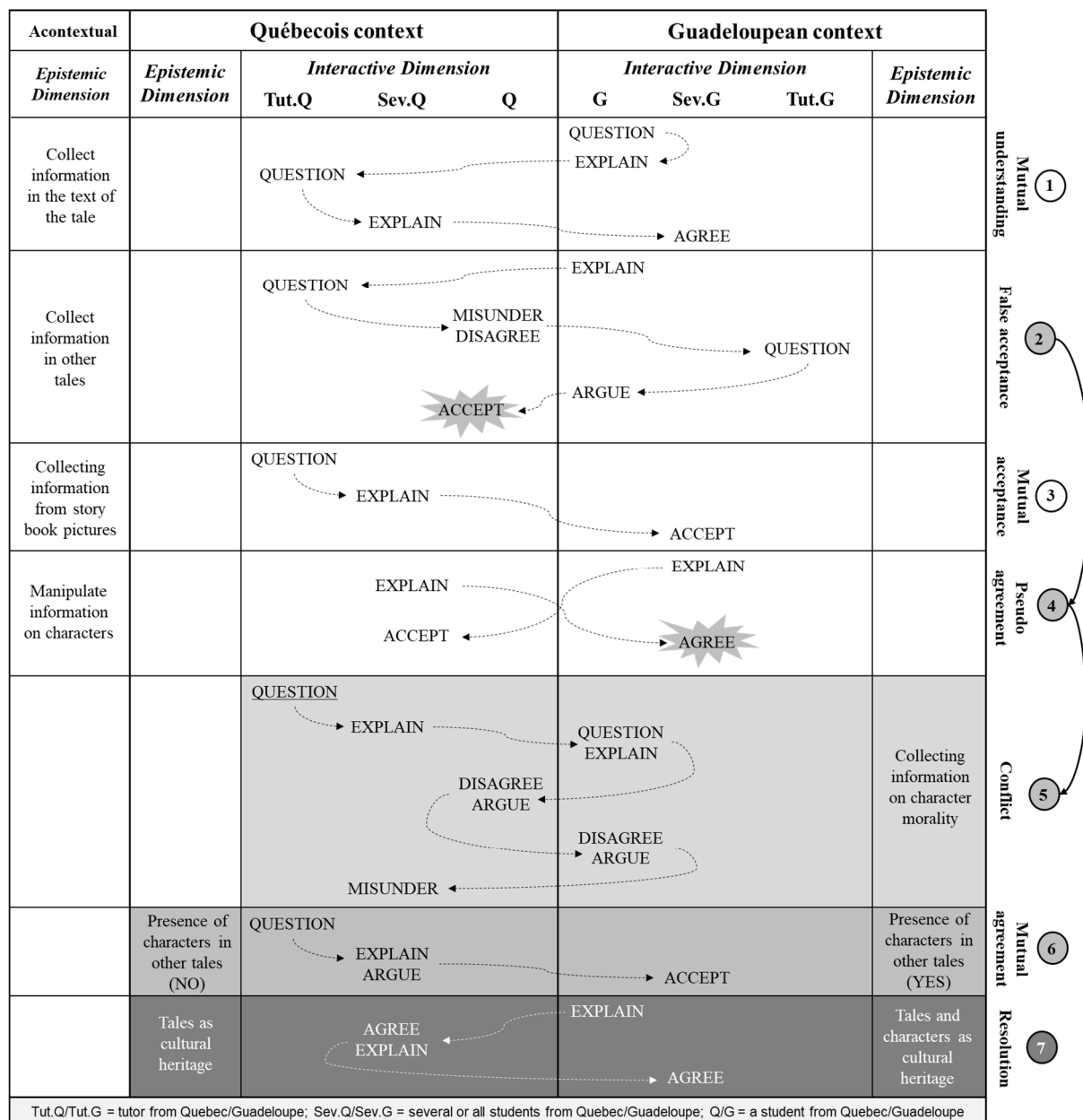


Figure 5. Interaction sequence with grounding in the Traditional Folktales experimentation (case study 2).

The figure 5 summarises the evolution of knowledge (epistemic dimension) supported by the interactive processes (interactive dimension) throughout the seven phases of dialogue (circled numbers). As can be seen, the discussion concerns at first the object of study (collecting information on the tales characters) and does not refer to the contexts (acontextual). The students discuss several solutions (collect information in the text, collect information in other tales, etc.) which provokes a lack of understanding due to the gap between the two contexts which is not perceived at first. It leads to false acceptance and pseudo agreement (starred symbols marked “ACCEPT” and “AGREE”). Then, the discussion concerns the specificities of the Guadeloupe folktale characters, and their moral portray, following a question from the Québec tutor (underlined “QUESTION”) that revives the misunderstanding and creates verbal conflict, namely argumentation (arrows between circles 2, 4 and 5). The mutual agreement that characters can appear in other tales or not lies again on a question from the Québec tutor

which helps Québec students to argue. The resolution of the conflict lies on explanations on both sides, and the expression of common agreement of the gap between the two contexts (folktales characters constitutes cultural heritage in Guadeloupe, but not in Québec).

#### ***4.3. Summary of the analysis: grounding processes in the two cases***

In the two case studies, the grounding process is broadly structured as follows: (i) the two contexts discuss a scientific notion (e.g., heat pump functioning) or a solution (e.g., collect information in the text of the tale); (ii) the two contexts manifest mutual agreement or understanding, but it is a false agreement or poor understanding due to each context which applies its own understanding to the other context; (iii) the unresolved underlying misunderstanding appears in interaction. The grounding process supports students to extend their knowledge of their own context, because they identify some of the limits (e.g., “*We do not use geothermal energy to heat homes like you do*”, “*We can’t really find characters on the Internet because they are not popular*”). At the same time, the students acquire knowledge of the alternative context (e.g., “*Because [your] water is already hot*”, “*You have characters from your own stories from Québec*”). Finally, the students extend their knowledge of the object of study itself (e.g., heat pump functioning, the existence of morals in some tale characters) and their knowledge of the discipline studied (e.g., Geothermal Energy does not use heat pump systematically, Folktales can be found elsewhere other than in books of tales). Thus, both types of prior knowledge (contextual and acontextual) are intertwined in the grounding process, and students synchronize, moment-by-moment, these two types of prior knowledge to perform the common task.

In the first case study (Geothermal Energy) the grounding process do not involve disagreement and argumentation. Students who do not spontaneously understand the issues at stake express themselves as the exchanges progress. In the discussions, we observe a type of mutual support within the groups and between the groups, where students dare to ask further explanations and where others support them in the process of developing new knowledge. This is the case when the Québécois student Q1 repeatedly encourages the Guadeloupean students (*Yes, that’s good!*). The students are broadly engaged and cohesive in the comprehension of new knowledge (e.g., applause at the end of the sequence) despite a moment of poor synchronization on the gap between the two contexts (the transformation of water into steam). The students’ strategies of interaction supported the process of formulating explanations and clarifications (on both sides) to help other students to repair imperfect mental models, to construct more elaborate conceptualizations and to develop a better awareness of what they do not understand.

In the second case study (Traditional Folktales) the grounding process involves socio-cognitive conflict, namely argumentation and divergent positions. Several times, the Guadeloupean students propose the idea of collecting information on the morality of the characters. Claims and counterclaims exist not because of divergent opinions, but rather because of the non-perception of the gap between the two contexts. The argumentative attacks and defenses, due to an underlying misunderstanding, provoke incoherent conversations where students advocate and repeat their own positions without elaboration or justification

(e.g., the Guadeloupean student, G1, who, several times, focuses on the moral information of tale's characters). This leads to pseudo agreement, without genuine grounding, in which students may never develop new knowledge.

## **5. Discussion**

Collaborative learning is aimed at getting the students to work together on a common problem, discuss and build knowledge together, and of course, develop together (Baker, 2015; Dillenbourg, 1999). However, learning outcomes are highly related to the interaction process that fosters mutual understanding and co-elaboration of knowledge, such as the exchange of information, explanations, clarification, and negotiation of meaning (Baker, 2016; Barron, 2003; Cohen, 1994; Hmelo-Silver, 2003). Furthermore, the rise of technologies for Computer Supported Collaborative Learning (CSCL) has made new collaborations among students from different cultural, geographical contexts possible (Popov et al., 2019; Zhang, 2013). These specific collaborative learning situations offer the opportunity to share culturally diverse knowledge (Vatrapu, 2008; Uzuner, 2009). However, in these situations, the common object of study and the knowledge discussed in interactions are likely to have different meanings as they have been conceptualized in situated contexts (Geertz, 1973; Lave, 1997; Salazar & Salas, 2013; Stahl, 2005). This study examined two cases where students from different cultural and geographical contexts who speak the same language (French) interact and co-elaborate knowledge in specific domains (French Linguistics and Earth Science) to perform a common task. We analyse micro-moments of interaction, meeting points between students prior knowledge and knowledge discussed for the “future” of students’ common project, and where new knowledge is co-created and learning can occur (Dreier, 1999; Ludvigsen et al., 2011). The analysis focused on how the two groups of students share knowledge, grasp the gap between the two contexts on a given object of study, and reach mutual understanding (grounding processes). The two cases examined are distinct in terms of academic discipline, the nature of shared knowledge, students’ educational level, and duration.

Our findings indicate that interactive confrontation of alternative contexts can lead to misunderstandings that relate to the application of one group of students’ own context to another context. In other words, misunderstandings are due to over generalisation of one context to another. Furthermore, overcoming misunderstandings by grounding in interaction can lead to the recognition of the limits of situated knowledge, extension of knowledge to other contexts and the reconceptualization of the knowledge domain. Finally, the grounding process involves that students engage in various forms of more or less constructive interactions. In the first case study (Geothermal Energy), students tried to reach a high level of collaboration and were engaged in active participation, encouragement, and inclusion of ideas. In the second case study (Regional Folktales), the discussion was more conflictual, and students were engaged in the defense of their own ideas. Our exploratory case study highlights four important points regarding collaborative learning situations across cultural and geographical contexts.

Firstly, the extent to which students engage in constructive interactions depends on the way by which the meaning of the common object of study has been shaped by the cultural, historical, physical context within which students learnt this object. Our study follows earlier studies that highlight the importance to design learning environments and collaboration scenarios that integrate differences between cultures (Popov et al., 2019; Uzuner, 2009; Weinberger et al., 2013; Zhang, 2013). These previous studies emphasize the importance of supporting the interactive dimension, namely, how to act and interact in intercultural collaborative learning. For example, Popov et al. (2019) showed that an interculturally-enriched collaboration script (IECS) for culturally heterogeneous groups of students is favourable to knowledge sharing. The script encouraged students from an individualist culture to share ideas and information as much as possible, and students from a collectivist culture to feel free to disagree with their partners. However, our study suggests the importance of paying attention to the epistemic dimension as well, namely what students say about the concepts and solutions. This means that negotiation of the meaning of culturally embedded knowledge (that we preferred to call contextual knowledge in this study) must be rather considered as a potential source of misunderstanding and disagreement in intercultural collaborative learning. Furthermore, collaboration across cultural and geographical contexts may be productive of new knowledge if students *really* understand each other, and not only share knowledge. Future studies may pay attention on the interplay between how students from different cultures collaborate to build knowledge (i.e., way of negotiating knowledge due to cultural norms) and the different meanings that the object of the collaboration can have due to different cultural backgrounds.

Secondly, the mutual understanding of the gap between the contexts must be supported on the micro scale of the interaction. The situation of interaction must help students to identify the contextual nature of the misunderstanding or disagreement. Then, the situation of interaction must allow students to coordinate their knowledge and negotiate their own conceptions (Baker et al., 1999) to ensure that the common ground is updated moment-by-moment as the discussion progresses (Clark & Schaefer, 1989). We can cite interaction strategies that support meaning-making. For example, learners may be guided to give in-depth explanations and to clarify the words they use and the notions they evoke. When these strategies occur spontaneously (e.g., as we observed in the Geothermal Energy experimentation), they must be detected and fostered if necessary. Previous studies have pointed out that co-elaboration of knowledge can be guided by the instructor and is influenced by the learning situation. For example, teachers can improve the quality and the depth of the discussion by asking students to provide feedback for each other's suggestions and to give clear and precise explanations rather than quick answers (Webb, 2009). In the same idea, teachers can guide learners to generate high-level questions about the object of study (e.g., *How ... is similar to ...?*) to help students monitor their own and each others' understanding (King, 2002). Thus, our study would need to be extended by a deeper analysis of the tutors' strategies. These strategies have not been addressed explicitly in the TEEC project. The tutors (teachers or researchers) acted by "instinct", sometimes to resolve the situation of misunderstanding and sometimes to avoid discussions that may provoke confusion, which is not favourable to deepen the students'

representations of concepts. Tutors also had to manage constraints of time, Internet connections, and the organisation of students in front of the camera.

Concerning the learning situation, the videoconference is a media where students visualise who is speaking, and where gestures and gaze can be used as a complementary channel to express some information (Clark & Brennan, 1991). But groups with too many people are not favourable for all the interlocutors to express their understanding or request for clarification, because large groups are less structured. In our study, we observed situations where students in front of the screen relayed information to those at the back of the class who did not hear well (e.g., Geothermal Energy experimentation, large group in Guadeloupe). We observed small teams where only one student was holding the microphone and spoke for its entire team (e.g., Traditional Folktales experimentation). Furthermore, we observed that sometimes, the time allowed for the session was not enough for students to deepen the concepts. Our observations corroborate the literature. Effective collaborative learning depends on many conditions, including group heterogeneity, time (e.g., to reason, to produce answer) and the opportunity given to children to interact with others in the class (Dillenbourg, 1999). Several methods can be used to structure the interaction according to the constraints of the learning situation (King, 2007). For example, the discussion can be punctuated by moments of common agreement where students summarise the common statement. Future studies are needed to investigate collaboration processes within groups, and the effective participation of each student in each group should be analysed in more detail. We only investigated the interaction between the two groups, and we did not evaluate why some students were more engaged than others in the collaboration. Furthermore, there is a large body of research in CSCL which must be considered in order to investigate the role of collaboration tools such as videoconferencing, text messaging, and forums, etc. and the organization of group work.

Thirdly, and following the second point, the mutual understanding of the contrast between the contexts must be supported on the meso-scale of the collaborative learning project. Before the discussions, students can be prepared for the collaborative task. For example, the study of Aguilera & Li (2009) compared intercultural dyads that received 15 minutes training on grounding to control groups that received no training. The results show that the trained groups were better at grounding. For listeners, the training session conveyed the message that it was acceptable if they did not fully understand the first time, and it raised their ability to ask question. For speakers, the requests to repeat or clarify information influenced them to present their statements more clearly. In a similar vein, after the discussions, each group can engage in reflective activities. One useful method for the construction of shared knowledge and representations is collective allo-confrontation (Mollo & Falzon, 2004). For example, the teacher selects video records of crucial moments of grounding (pseudo-agreement, poor understanding) and the group verbalises the activity of the group and discusses the interaction processes. It helps to go back to the notions that were not understood during the interaction. Future studies are needed to explore what were the meaningful changes in students' knowledge throughout the collaborative learning situation.

Finally, the extent to which students share a common language influences the interaction strategies and the methods used to support grounding across cultural and geographical contexts. At first sight, it is rather easy to think that language constitutes a barrier to grounding. Even when second-language speakers have sufficient language capacities to participate in a conversation, intercultural communication may be not successful in terms of the quantity of information transmitted (Chen, 1996; Gass & Varonis, 1985). Miscommunication in intercultural conversation is a result of several factors such as ignorance of conversational rules, lack of linguistic knowledge, and conversation style differences (Li, 1999). But *a contrario*, we should not believe that sharing a language (albeit of different dialectical varieties) necessarily implies that mutual understanding will be easier to reach. Our study emphasises the idea that the bigger is the gap between the two contexts, the more students will have to make a collaborative effort to establish a common ground, even if they speak same language. Similarly, words may have different meanings across regions who speak the same language but have different cultural heritages (e.g., metropolitan France and French west indies). However, we can think that the resolution of the socio-cognitive conflict will be different (maybe more difficult?) if there is a misunderstanding about the meaning of concepts, and that in addition the students do not speak the same language. One question that can be investigated in further studies is how the common ground is established between regions that are somewhat close in terms of cultural heritage and geographical situations, but do not speak same language. For example, Geothermy in English-speaking Canada is similar to Geothermy in Québec, and Guadeloupe and Dominica are two volcanic islands in the Caribbean region, whilst they differ in terms of their official languages (French and English). Other studies are also needed to investigate to what extent intercomprehension in intercultural collaborative learning relies on modes of communication, the spoken language, and the differences in meanings.

## **6. Conclusion**

The research presented in this article focused on the processes by which students from two cultural, geographical contexts (French Antilles and French-speaking Canada) investigated the same object of study (e.g., Geothermal Energy, and Regional Folktales), collaborate via videoconferences, reach mutual understanding (grounding process) and develop new knowledge and “meta-knowledge” (in the sense of realizing the limits of one’s own knowledge). The study shows that the verbal confrontation of students from two diverse cultural contexts provokes misunderstanding which result from an overgeneralisation of one context to another. Reparation of misunderstandings can be constructive in terms of cultural knowledge sharing, understanding the limits of students’ own context, and better understanding of scientific notions or concepts as a result of the process of grounding. This study highlights the importance of interaction strategies that support the step-by-step achievement of mutual understanding. It is important that students recognise misunderstandings, negotiate the meaning of what is said, clarify their explanations cooperatively, and express common agreement to ensure that they share the same representation of concepts forged in situated contexts. The study also emphasises positive aspects of grounding processes on knowledge across cultural contexts. These are strategies



that encourage students to engage in further explanations, to deepen ideas, and to grasp the gap between the two contexts by themselves.

The study suggests that teachers, researchers, and designers of intercultural collaborative learning situations should offer guidance, with respect to task instructions and the way that students should engage in constructive interaction (e.g., with respect to argumentation) in order to foster productive collaboration. In intercultural collaboration, misunderstandings not only concern linguistic backgrounds, or differences in communication styles, but also what might be termed a *knowledge space*, which includes both contextual and acontextual knowledge. A lack of synchronization of contextual knowledge, a poor common ground, can lead to conflict or disengagement to collaborate. This study stresses the importance of paying attention to the misunderstandings that could result from the gap between different contexts, and the learning potential of the interactive processes by which such misunderstandings are addressed collectively.

Several implications for the design of productive intercultural collaborative learning situations emerge from the research described here. The learning scenario must be designed in such a way that it supports the explicit discussion of contexts, their differences and similarities. A shared task with a common production between students from different contexts is a necessary condition for collaboration with learning potential relating to grounding. In this case, anticipating the differences between the two contexts could help to design appropriate common tasks that would favour the emergence of confrontation of contexts in interaction (e.g., Anjou et al., 2017; Forissier et al., 2014).

Teachers-researchers could use strategies for structuring or “scripting” the interaction (Kollar, Fischer, & Hesse, 2006), supporting the negotiation of concepts and the grounding process (i.e., the *meaning-making*). This would imply that teachers need to be trained in these methods and tools, and that the interaction situation is favourable to their use (e.g., moments where students summarize their common statement). Several factors that affect the quality of the negotiation of meaning have been identified in this study, namely the size of the groups of students, the medium of collaboration, and the time dedicated to verbal exchanges. It is important that each student can express their incomprehension, their disagreement, and negotiate their representation if necessary. Finally, interaction situations can be followed by group reflection sessions, which may support/trigger learners’ awareness of their own and others’ past activity (i.e., their previous interaction), encouraging description and evaluation of it. In some cases, the group reflection session supports a new or continued process of negotiation of meaning that did not necessarily occur in the previous interaction that is the object of students’ reflection (Baker et al., 2020). This would imply recording the interaction, as a learning resource, and organizing sessions where students in each context can identify and comment on keys moments of misunderstanding that were due to the gap between the two contexts. It also implies teachers training teachers in the preparation and management of such reflection sessions.

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## References

- Anakwe, U.P., & Christensen, E.W. (1999). Distance learning and cultural diversity: Potential users' perspective. *The International Journal of Organizational Analysis*, 7(3), 224–243. <https://doi.org/10.1108/eb028901>
- Anjou, C. (2018). Modélisations de contextes pour l'apprentissage par effets de contextes: un exemple sur le sujet de la géothermie. *Contextes et didactiques*, 11. <https://doi.org/10.4000/ced.992>
- Anjou, C., Forissier, T., Bourdeau, J., Mazabraud, Y., Nkambou, R., & Fournier, F. (2017). Elaborating the Context Calculator: A Design Experiment in Geothermy. *Lecture Notes in Computer Science*, 513–526. [https://doi.org/10.1007/978-3-319-57837-8\\_42](https://doi.org/10.1007/978-3-319-57837-8_42)
- Aguilera, L., & Li, H.Z. (2009). Grounding as a facilitator in Anglo-Canadian and Mainland Chinese conversations. *Asian Journal of Social Psychology*, 12(3), 163–172. <https://doi.org/10.1111/j.1467-839x.2009.01282.x>
- Arvaja, M. (2005). *Collaborative knowledge construction in authentic school contexts*. Research reports 14. University of Jyväskylä: Institution for Educational Research.
- Asterhan, C.S. (2013). Epistemic and interpersonal dimensions of peer argumentation. Affective learning together. In M.J. Baker, J. Andriessen & S. Jarvela (Eds), *Affective learning together* (pp 251–272). New York, NY: Routledge.
- Asterhan, C.S., & Schwarz, B.B. (2009). Argumentation and explanation in conceptual change: Indications from protocol analyses of peer-to-peer dialog. *Cognitive science*, 33(3), 374–400. <https://doi.org/10.1111/j.1551-6709.2009.01017.x>
- Asterhan, C.S., & Schwarz, B.B. (2010). Online moderation of synchronous e-argumentation. *International Journal of Computer-Supported Collaborative Learning*, 5(3), 259–282. <https://doi.org/10.1007/s11412-010-9088-2>
- Baker, M.J. (1999). Argumentation and Constructive Interaction. In J. Andriessen & P. Coirier (Eds.), *Foundations of Argumentative text processing* (pp. 179–202). Amsterdam; Amsterdam University press.
- Baker, M.J. (2003). Computer-mediated argumentative interactions for the co-elaboration of scientific notions. In J. Andriessen, M.J. Baker & D. Suthers (Eds.), *Arguing to Learn: Confronting Cognitions in Computer-Supported Collaborative Learning environments* (pp. 47–78). Dordrecht: Kluwer Academic Publishers. [https://doi.org/10.1007/978-94-017-0781-7\\_3](https://doi.org/10.1007/978-94-017-0781-7_3)
- Baker, M.J. (2015). Collaboration in collaborative learning. *Interaction Studies*, 16(3), 451–473. <https://doi.org/10.1075/is.16.3.05bak>
- Baker, M.J. (2016). The negotiation of meaning in epistemic situations. *International Journal of Artificial Intelligence in Education*, 26(1), 133–149. <https://doi.org/10.1007/s40593-015-0050-3>

- Baker, M.J., Détienne, F., Mougnot, C., Corvin, T., & Pennington, M. (2020). Argumentation, Eureka and emotion: An analysis of group projects in creative design training. *Learning, Culture and Social Interaction*, 26. <https://doi.org/10.1016/j.lcsi.2020.100436>
- Baker, M.J., Hansen, T., Joiner, R., & Traum, D. (1999). The role of grounding in collaborative learning tasks. In P. Dillenbourg (Ed.), *Collaborative learning: cognitive and computational approaches* (pp. 31–63). Oxford: Elsevier Science.
- Barron, B. (2003). When smart groups fail. *The journal of the learning sciences*, 12(3), 307–359. [https://doi.org/10.1207/s15327809jls1203\\_1](https://doi.org/10.1207/s15327809jls1203_1)
- Bourdeau, J. (2017). The DBR methodology for the study of context in learning. *Lecture Notes in Computer Science*, 541–553. [https://doi.org/10.1007/978-3-319-57837-8\\_44](https://doi.org/10.1007/978-3-319-57837-8_44)
- Bourdeau, J., Forissier, T., Mazabraud, Y., & Nkambou, R. (2015). Web-based context-aware science learning. In *Proceedings of the 24th International Conference on World Wide Web* (pp. 1415–1418). <https://doi.org/10.1145/2740908.2743048>
- Brown, A.L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The journal of the learning sciences*, 2(2), 141–178. [https://doi.org/10.1207/s15327809jls0202\\_2](https://doi.org/10.1207/s15327809jls0202_2)
- Brown, J.S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational researcher*, 18(1), 32–42. <https://doi.org/10.3102/0013189x018001032>
- Chartofylaka, L., Anciaux, F., Candau, O.S., Jeannot-Fourcaud, B., Carignan, I., & Saint-Pierre, A. (2018). Il était une fois des contes en contextes: retour sur une expérimentation au primaire en Guadeloupe et au Québec. *Contextes et didactiques*, 11. <https://doi.org/10.4000/ced.1014>
- Chi, M.T.H. (2000). Self-explaining expository texts: The dual processes of generating inferences and repairing mental models. In R. Glaser (Ed.), *Advances in instructional psychology: Educational design and cognitive science* (pp. 161–238). Hillsdale, NJ: Erlbaum.
- Chen, L. (1996). Cognitive complexity, situational influences, and topic selection in intracultural and intercultural dyadic interactions. *Communication Reports*, 9(1), 1–12. <https://doi.org/10.1080/08934219609367630>
- Clark, H.H., & Brennan, S. (1991). Grounding in communication. In L.B. Resnick, J.M. Levine & S.D. Teasley (Eds.), *Perspectives on Socially Shared Cognition* (pp. 127–149). Washington DC: American Psychological Association. <https://doi.org/10.1037/10096-006>
- Clark, H.H., & Schaefer, E.F. (1989). Contributing to Discourse. *Cognitive Science*, 13(2), 259–294. [https://doi.org/10.1207/s15516709cog1302\\_7](https://doi.org/10.1207/s15516709cog1302_7)
- Clark, H.H., & Wilkes-Gibbs, D. (1986). Referring as a collaborative process. *Cognition*, 22(1), 1–39. [https://doi.org/10.1016/0010-0277\(86\)90010-7](https://doi.org/10.1016/0010-0277(86)90010-7)

- Cohen, E.G. (1994). Restructuring the classroom: Conditions for productive small groups. *Review of Educational Research*, 64(1), 1–35.  
<https://doi.org/10.3102/00346543064001001>
- Cole, M., & Engeström, Y. (1993). A cultural-historical approach to distributed cognition. In G. Salomon (Ed.), *Distributed cognitions: Psychological and educational considerations* (pp. 1–46). New York: Cambridge University Press.
- Collins, A., Joseph, D., & Bielaczyc, K. (2004). Design-research: theoretical and methodological issues. *The Journal of the Learning Sciences*, 13(1), 15–42.  
[https://doi.org/10.1207/s15327809jls1301\\_2](https://doi.org/10.1207/s15327809jls1301_2)
- Convertino, G., Zhang, Y., Asti, B., Rosson, M.B., & Mohammed, S. (2007). Board-based collaboration in cross-cultural pairs. In T. Ishida, S.R. Fussell, & P.T.J.M. Vossen (Eds.), *Lecture Notes in Computer Science*, 4568 (pp. 321–334). Heidelberg, Germany: Springer Berlin. [https://doi.org/10.1007/978-3-540-74000-1\\_24](https://doi.org/10.1007/978-3-540-74000-1_24)
- Derry, S.J., Pea, R.D., Barron, B., Engle, R.A., Erickson, F., Goldman, R., ... & Sherin, B.L. (2010). Conducting video research in the learning sciences: Guidance on selection, analysis, technology, and ethics. *The Journal of the Learning Sciences*, 19(1), 3–53.  
<https://doi.org/10.1080/10508400903452884>
- De Vries, E., Lund, K., & Baker, M.J. (2002). Computer-mediated epistemic dialogue: Explanation and argumentation as vehicles for understanding scientific notions. *The journal of the learning sciences*, 11(1), 63–103.  
[https://doi.org/10.1207/s15327809jls1101\\_3](https://doi.org/10.1207/s15327809jls1101_3)
- Dillenbourg, P. (1999). *Collaborative learning: cognitive and computational approaches*. Oxford: Elsevier Science.
- Dillenbourg, P., Baker, M.J., Blaye, A., & O'Malley, C. (1995) The evolution of research on collaborative learning. In E. Spada & P. Reimann (Eds), *Learning in Humans and Machine: Towards an interdisciplinary learning science* (pp. 189–211). Oxford: Elsevier.
- Dillenbourg, P., & Traum, D. (2006). Sharing solutions: Persistence and grounding in multimodal collaborative problem solving. *The Journal of the Learning Sciences*, 15(1), 121–151. [https://doi.org/10.1207/s15327809jls1501\\_9](https://doi.org/10.1207/s15327809jls1501_9)
- Dreier, O. (1999). Personal trajectories of participation across contexts of social practice. *Outlines. Critical practice studies*, 1(1), 5–32.
- Forissier, T., Bourdeau, J., Mazabraud, Y., & Nkambou, R. (2014). Computing the context effect for science learning. In P. Brézillon & A.J. Gonzalez (Eds.), *Context in Computing* (pp. 255–269). New York: Springer. [https://doi.org/10.1007/978-1-4939-1887-4\\_17](https://doi.org/10.1007/978-1-4939-1887-4_17)
- Forissier, T., Bourdeau, J., & Psyché, V. (2017). Quand les contextes se comparent et se parlent. *Contextes et Didactiques*, 10. <https://doi.org/10.4000/ced.954>

- Gabelica, C., & Popov, V. (2020). "One Size Does Not Fit All": Revisiting Team Feedback Theories From a Cultural Dimensions Perspective. *Group & Organization Management*, 45(2), 252–309. <https://doi.org/10.1177/1059601120910859>
- Gass, S.M., & Varonis, E.M. (1985). Variation in native speaker speech modification to non-native speakers. *Studies in Second Language Acquisition*, 7(1), 37–57. <https://doi.org/10.1017/s0272263100005143>
- Geertz, C. (1973). *The Interpretation of Cultures: Selected Essays*. New York: Basic Books.
- Gumperz, J., & Roberts, C. (1991). Understanding in intercultural encounters. In J. Blommaert & J. Verschueren (Eds.), *The pragmatics of intercultural and international communication* (pp. 51–90). Amsterdam: Benjamins. <https://doi.org/10.1075/pbns.6.3.05gum>
- Hmelo-Silver, C.E. (2003). Analyzing collaborative knowledge construction: Multiple methods for integrated understanding. *Computers & Education*, 41(4), 397–420. <https://doi.org/10.1016/j.compedu.2003.07.001>
- Hofstede, G. (1997). *Culture and Organisations: Software of the Mind: Intercultural Cooperation and its importance for Survival*. McGraw-Hill.
- Kerbrat-Orecchioni, C. (1990). *Les Interactions Verbales : Tome 1*. Paris: Armand-Colin.
- Kollar, I., Fischer, F., & Hesse, F.W. (2006). Computer-supported collaboration scripts - a conceptual analysis. *Educational Psychology Review*, 18(2), 159–185. <https://doi.org/10.1007/s10648-006-9007-2>
- Korsager, M., & Slotta, J.D. (2015). International Peer Collaboration to Learn about Global Climate Changes. *International Journal of Environmental and Science Education*, 10(5), 717–736.
- King, A. (2002). Structuring peer interaction to promote high-level cognitive processing. *Theory into practice*, 41(1), 33–39. [https://doi.org/10.1207/s15430421tip4101\\_6](https://doi.org/10.1207/s15430421tip4101_6)
- King, A. (2007). Scripting collaborative learning processes: A cognitive perspective. In F. Fischer, I. Kollar, H. Mandl, & J. Haake (Eds.), *Scripting computer-supported collaborative learning: Cognitive, computational and educational perspectives* (pp. 13–37). New York: Springer. [https://doi.org/10.1007/978-0-387-36949-5\\_2](https://doi.org/10.1007/978-0-387-36949-5_2)
- Lave, J. (1988). *Cognition in practice: Mind, mathematics and culture in everyday life*. Cambridge University Press.
- Lave, J. (1997). The culture of acquisition and the practice of understanding. In D. Kirshner & J.A. Whitson (Eds.), *Situated cognition: Social, semiotic, and psychological perspectives* (pp. 63–82). Mahwah: Lawrence Erlbaum Associates.
- Levin, J., & Cohen, M. (1985). The world as an international science laboratory: Electronic networks for science instruction and problem solving. *Journal of Computers in Mathematics and Science Teaching*, 4, 33–35.

- Li, H.Z. (1999). Grounding and information communication in intercultural and intracultural dyadic discourse. *Discourse Processes*, 28(3), 195–215. <https://doi.org/10.1080/01638539909545081>
- Ludvigsen, S., Rasmussen, I., Krange, I., Moen, A., & Middleton, D. (2011). Intersecting trajectories of participation. In S.R. Ludvigsen, A. Lund, I. Rasmussen, & R. Säljö (Eds.), *Learning across sites: New tools, infrastructures and practices* (pp. 105–121). New York: Routledge.
- Miyake, N. (1986). Constructive Interaction and the Iterative Process of Understanding. *Cognitive Science*, 10(2), 151–177. [https://doi.org/10.1207/s15516709cog1002\\_2](https://doi.org/10.1207/s15516709cog1002_2)
- Mollo, V., & Falzon, P. (2004). Auto-and allo-confrontation as tools for reflective activities. *Applied ergonomics*, 35(6), 531–540. <https://doi.org/10.1016/j.apergo.2004.06.003>
- Nussbaum, E.M., Sinatra, G.M. & Poliquin, A. (2008). Role of epistemic beliefs and scientific argumentation in science learning. *International Journal of Science Education*, 30(15), 1977–1999. <https://doi.org/10.1080/09500690701545919>
- Popov, V., Biemans, H.J., Fortuin, K.P., van Vliet, A.J., Erkens, G., Mulder, M., ... & Li, Y. (2019). Effects of an interculturally enriched collaboration script on student attitudes, behavior, and learning performance in a CSCL environment. *Learning, Culture and Social Interaction*, 21, 100–123. <https://doi.org/10.1016/j.lcsi.2019.02.004>
- Roschelle, J. (1992). Learning by collaborating: Convergent conceptual change. *The Journal of the Learning Sciences*, 2(3), 235–276. [https://doi.org/10.1207/s15327809jls0203\\_1](https://doi.org/10.1207/s15327809jls0203_1)
- Roschelle, J., & Teasley, S.D. (1995). The Construction of Shared Knowledge in Collaborative Problem Solving. In C. O'Malley (Ed.), *Computer Supported Collaborative Learning* (pp. 69–100). Berlin: Springer-Verlag. [https://doi.org/10.1007/978-3-642-85098-1\\_5](https://doi.org/10.1007/978-3-642-85098-1_5)
- Roulet, E. (1992). On the Structure of Conversation as Negotiation. In H. Parret & J. Verschueren (Eds.), *(On) Searle on Conversation* (pp. 91–100). Amsterdam: John Benjamins.
- Rummel, N., & Spada, H. (2005). Learning to Collaborate: An Instructional Approach to Promoting Collaborative Problem Solving in Computer-Mediated Settings. *Journal of the Learning Sciences*, 14(2), 201–241. [https://doi.org/10.1207/s15327809jls1402\\_2](https://doi.org/10.1207/s15327809jls1402_2)
- Salazar, M., & Salas, E. (2013). Reflections of cross-cultural collaboration science. *Journal of Organizational Behavior*, 34(6), 910–917. <https://doi.org/10.1002/job.1881>
- Sandoval, W., & Bell, P. (2004). Design-Based Research Methods for Studying Learning in Context: Introduction. *Educational Psychologist*, 39(4), 199–201. [https://doi.org/10.1207/s15326985ep3904\\_1](https://doi.org/10.1207/s15326985ep3904_1)
- Sawyer, K. (2014). *The Cambridge Handbook of The Learning Sciences* (2nd ed.). New York: Cambridge University Press. <https://doi.org/10.1017/cbo9781139519526>

- Schegloff, E.A., Jefferson, G., & Sacks, H. (1977). The Preference for Self-Correction in the Organisation of Repair in Conversation. *Language*, 53(2), 361–382.  
<https://doi.org/10.2307/413107>
- Schwarz, B.B., & Baker, M.J. (2017). *Dialogue, argumentation and education: History, theory and practice*. Cambridge University Press.  
<https://doi.org/10.1017/9781316493960>
- Schwartz, S.H. (2014). Rethinking the concept and measurement of societal culture in light of empirical findings. *Journal of cross-cultural Psychology*, 45(1), 5–13.  
<https://doi.org/10.1177/0022022113490830>
- Stahl, G. (2004). Building collaborative knowing. Elements of a social theory of CSCL. In J.W. Strijbos, P.A. Kirschner, R.L. Martens & P. Dillenbourg (Eds.), *What we know about CSCL and implementing it in higher education* (Vol. 3, pp. 53–85). Norwell, MA: Kluwer Academic Publishers. [https://doi.org/10.1007/1-4020-7921-4\\_3](https://doi.org/10.1007/1-4020-7921-4_3)
- Stahl, G. (2005). Group cognition in computer-assisted collaborative learning. *Journal of Computer Assisted Learning*, 21(2), 79–90. <https://doi.org/10.1111/j.1365-2729.2005.00115.x>
- Stahl, G., Koschmann, T., & Suthers, D. (2014). Computer-supported Collaborative Learning. In R.K. Sawyer (Ed.), *The Cambridge handbook of the Learning Sciences* (pp. 479–500). Cambridge: Cambridge University Press.  
<https://doi.org/10.1017/cbo9781139519526.029>
- Teasley, S.D., & Roschelle, J. (1993). Constructing a joint problem space: The computer as a tool for sharing knowledge. In S.P. Lajoie & S.J. Derry (Eds.), *Computers as cognitive tools* (pp. 229–258). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Uzuner, S. (2009). Questions of culture in distance learning: A research review. *The International Review of Research in Open and Distance Learning*, 10(3), 1–11.  
<https://doi.org/10.19173/irrodl.v10i3.690>
- Vatrapu, R. (2008). Cultural considerations in computer supported collaborative learning. *Research and Practice in Technology Enhanced Learning*, 3(2), 159–201.  
<https://doi.org/10.1142/s1793206808000501>
- Webb, N.M. (1989). Peer interaction and learning in small groups. *International journal of Educational research*, 13(1), 21–39. [https://doi.org/10.1016/0883-0355\(89\)90014-1](https://doi.org/10.1016/0883-0355(89)90014-1)
- Webb, N.M. (2009). The teacher's role in promoting collaborative dialogue in the classroom. *British Journal of Educational Psychology*, 79(1), 1–28.  
<https://doi.org/10.1348/000709908x380772>
- Webb, N.M., Troper, J.D., & Fall, R. (1995). Constructive activity and learning in collaborative small groups. *Journal of Educational Psychology*, 87(3), 406–423.  
<https://doi.org/10.1037/0022-0663.87.3.406>



- Weinberger, A., Clark, D.B., Häkkinen, P., Tamura, Y., & Fischer, F. (2007). Argumentative knowledge construction in online learning environments in and across different cultures: A collaboration script perspective. *Research in Comparative and International Education*, 2(1), 68–79. <https://doi.org/10.2304/rcie.2007.2.1.68>
- Weinberger, A., & Fischer, F. (2006). A framework to analyze argumentative knowledge construction in computer-supported collaborative learning. *Computers & education*, 46(1), 71–95. <https://doi.org/10.1016/j.compedu.2005.04.003>
- Weinberger, A., Marttunen, M., Laurinen, L., & Stegmann, K. (2013). Inducing socio-cognitive conflict in Finnish and German groups of online learners by CSCL script. *International Journal of Computer-Supported Collaborative Learning*, 8(3), 333–349. <https://doi.org/10.1007/s11412-013-9173-4>
- Wegerif, R., Doney, J., Richards, A., Mansour, N., Larkin, S., & Jamison, I. (2019). Exploring the ontological dimension of dialogic education through an evaluation of the impact of Internet mediated dialogue across cultural difference. *Learning, culture and social interaction*, 20, 80–89. <https://doi.org/10.1016/j.lcsi.2017.10.003>
- Zhang, J. (2013). Collaboration, technology, and culture. International Handbook of Collaborative Learning. In C.E. Hmelo-Silver, C.A. Chinn, A.M. O'Donnell & C. Chan (Eds.), *The International Handbook of Collaborative Learning* (pp. 495–508). Philadelphia, PA: Taylor & Francis. <https://doi.org/10.4324/9780203837290.ch28>
- Zhu, C. (2012). Student Satisfaction, Performance, and Knowledge Construction in Online Collaborative Learning. *Educational Technology & Society*, 15(1), 127–136.
- Zhu, C., Valcke, M., & Schellens, T. (2009). Cultural differences in the perception of a social-constructivist e-learning environment. *British Journal of Educational Technology*, 40(1), 164–168. <https://doi.org/10.1111/j.1467-8535.2008.00879.x>