Elementary Students' and Teacher's Interactions During Out-of-Classroom Activities

by

Bruno de Oliveira Jayme

Bachelor & Licentiate, Universidade Católica de Goiás, Brazil, 2001

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Supervisory Committee

Dr. Wolff-Michael Roth (Department of Curriculum and Instruction)

(Co) Supervisor

Dr. Nancy Turner (School of Environmental Studies)

(Co) Supervisor

Dr. Eileen Van der Flier-Keller (School of Earth and Ocean Sciences)

Departmental Member

Dr. David Zandvliet (Simon Fraser University)

External Member

Supervisory Committee

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_____
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_____
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ABSTRACT

Using interaction analysis and discourse analysis as a method of data analysis, I take a cultural-historical approach to explore teacher-student and student-student interactions during out-of-classroom science projects. The database is composed of my fieldnotes, videotaped science fieldtrips, and videotaped computer sessions where students worked collaboratively to produce science digital videos, highlighting their experiences during science fieldtrips. This thesis is formed by three studies I conducted with elementary students from a public school in British Columbia, Canada. These three independent and yet interrelated studies have implications for science learning and instruction in general. More specifically, this thesis contributes to the understanding of student-student and teacher-student interactions during collaborative work when they are engaged in science activities that occurred out of the classroom settings, such as fieldtrips and in the computer laboratory.

TABLE OF CONTENTS

LIST OF FIGURES

Acknowledgments

The completion of this thesis was only possible with the support of numerous professors, friends, students and teachers who kindly agreed to be part of my research. Wolff-Michael Roth warrants special mention because amongst all the "no-s" I received from others, he gave me the only "yes" I was looking for to enter in this endeavor. For that, I give him my admiration as a professor and researcher.

My sincere gratitude to,

The three most important women in my life: Marly, Marlene and Marianna that, despite the distance, provided me with emotional and occasionally financial support. I will never forget the innumerous late nights that we silently cried on the phone. More than love, what I feel for these three women cannot be expressed in English words. "Saudade," a word that exists only in my mother tongue, is what I feel for them every single day of my life.

Bruce, for his understanding, caring, and devotion. He has been both supportive and forgiving for the many times I was too busy in my own world, and did not take enough time and care for his world, which for the last three years, became my world too.

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The secretaries from the curriculum and instruction department and from the graduate studies department, who make the life of graduate students way easier.

The teacher, Mr. MacBeth (pseudonym) and the 25 students who welcomed me into their classroom. To maintain their anonymity, I cannot cite their names here, but I would like them to know that I am very grateful for their sharing time, joy and willingness to help me throughout. We had so much fun together, during our movie production.

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This positive energy that I call God that keep me sane, healthy and always put me in the right place, at the right time.

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***To Marly*,**

I was now so much bigger that I could not see myself anymore. As big as a landscape in the distance. I was in the distance. More perceptible in my ultimate mountains and in my most remote rivers. How can I say it, if not timidly like this: life is itself myself. Life is itself myself, and I don't understand what I say. And then I adore. (Clarice Lispector)

Chapter I – Introduction

> Studying science concepts in contexts involving out-of-classroom experiences of learners is consistent with the notion of humanizing and promoting meaningful learning in culturally and appropriate ways. (Koosimile, 2004, p. 483)

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This thesis is formed by three studies that explore teacher-student and student-student interactions during science out-of-classroom activities. Using interaction analysis and discourse analysis as method for data analyzes, I take a cultural-historical approach to understand how participants from elementary schools interact amongst themselves when they are engaged in collaborative work. Videotapes of science fieldtrips, videotaped computer sessions in which students worked collaboratively to produce short digital videos about their fieldtrips, and my fieldnotes form my database.

The main body of this thesis consists of three studies. The first study is concerned with the role of *egomorphism*, the tendency to ascribe to others, aspects and abilities of oneself, in the context of science lessons. I show how egomorphism functions as a hybrid language employed by science educators to mediate scientific concepts through a non-scientific language. In the second study, I investigate how interjections, such as "yuk," mediate students' interactions during science fieldtrips. The third study shows how monopolization of the mediational tools (e.g., computers and their components) emerges during collaborative work, when students are engaged in a video production about their experiences during science fieldtrips. These studies represent three different yet

interrelated aspects of how teacher and students interact amongst themselves during out-of-classroom science activities.

In this introductory chapter I articulate my personal motivations, in the form of a brief autobiography, for engaging in this research. I provide background on the interdisciplinary research project (NSERC-CRYSTAL), within which my study was situated. I present the definition of fieldtrips, which I use throughout this thesis and finally, I provide an outline of the three studies that constitute this thesis, and articulate how they are interrelated.

Autobiography

In 1997 I was a motivated and curious 17-year-old student when I was accepted at the Universidade Católica de Goiás (Catholic University of Goiás) as a full time student. There I pursued a bachelor's degree in biology and concomitantly a teaching certificate with a focus on environmental education. During my first year of studies I began my professional career as a researcher in biotechnology and medical genetics at two different molecular biology research centers in Brazil. As a result, I was left only with the unfortunate choice of having to set my teaching career aside for the first years of my university studies.

When I finally reached my last year of study I needed to take two courses to receive my teaching certificate: Practicum of Biology Teaching I and II. These courses gave me the opportunity to teach for over a year in public elementary and high schools in Brazil. Upon registering for my courses, I met Professor Yone Orcantina, who would

become my mentor during my practicum and who coincidently had been my science teacher in seventh grade.

I shared with Professor Orcantina my concerns about teaching and how I was intimidated by the idea of conducting science lessons with students of different ages, backgrounds, and so on. Professor Orcantina responded by suggesting that I try it for a week only, after which she guaranteed that once I started teaching I would never give it up. I returned to my genetics lab thinking how "silly" the Professor was and I decided to give it a chance. After all, it was my final year and the remaining two courses I needed to graduate.

Professor Orcantina was right. I commenced my first year of professional teaching in 2000 where I taught science and biology at a public school in my hometown Goiania. After graduating I was delighted to find a job as a part time seventh-grade teacher at a high school called *Colégio Didático* in an impoverished area of Brazil. To further supplement my income, I worked part time doing genetics research at a medical institute in the metropolitan area of the city. I held these two jobs until 2003 when I moved to Canada to pursue a master's degree in biology, with a focus on population genetics at the University of Victoria.

After almost a year in the graduate program, I found myself struggling in the genetics laboratory. It was a cold winter evening; I was alone and missing my warm classroom, my students, and their energy and enthusiasm. My mind was focused not on the test tube with DNA but elsewhere in another time in the past, when I was teaching in Brazil. It was there at *Colégio Didático* where my passion for teaching became grounded.

It was at that moment I realized I needed to leave my current program in population genetics and enter graduate studies in the field of education. After an exhaustive search I found myself drawn to a new master's program in science education under supervision of Wolff-Michael Roth, who gave me support and freedom to engage in the work I liked the most. I was no longer alone in a genetics laboratory; I became surrounded by youth learning science in the outdoors.

My passion for learning in the outdoors first began to develop when I taught seventh grade at the *Colégio Didático*. During science lessons I found myself struggling with material resources. Since it was a public school, students and teachers had to rely on government funding to acquire textbooks, notebooks, and other school materials. Funding for fieldtrips to local parks or museums was something that never existed in that school. My science lessons were directly affected by the lack of funding for the school and problems with science laboratories and computer rooms. For this reason, I decided to bring my students to where science really happened: in our daily lives. Numerous times we studied botany in my mom's backyard. Other times I would find the children learning concepts of physics and chemistry in my own kitchen, or having the opportunity to experience wildlife during visits to the local zoo. During our time outside the classroom I noticed that the students would interact with each other more often. They would laugh, take notes, and jump at every opportunity to touch their objects of study. Since they were learning in my own kitchen or my mom's backyard, I was able to become a part of the process and was left with a feeling of immense satisfaction. For these reasons I decided to focus my studies on how elementary students interact amongst themselves during out-of-

classroom experiences. And that is the reason I began my collaboration with the Pacific CRYSTAL project.

The Pacific CRYSTAL Project and my Contribution to the "Big Picture"

The Pacific CRYSTAL (Centre for Research in Youth, Science Teaching, and Learning)[1] is formed by directors, co-directors, an executive committee, and an international board for collaborative research in teaching and learning science, engineering, social sciences, and humanities at the University of Victoria, Simon Fraser University, Malaspina University-College, school districts in British Columbia, and non-governmental Canadian agencies. This is an ongoing project that aims to provide *authentic* science experiences to students (Roth, 1995). Broadly, the Pacific CRYSTAL project consists of three nodes concerned with scientific and technological teaching and learning. The first node explores authentic science opportunities for youth; the second is concerned with classroom-based studies of teaching, assessment and technological application; the third node investigates science programs in *lighthouse schools*.[2] My research was conducted within Node 1, which was designed to provide authentic science experiences to students and research how they learn in the process. Node 1 deals with different areas of expertise such as science fieldtrips, mathematics, and environmental

[1] The Pacific CRYSTAL project is funded by NSERC (Natural Sciences and Engineering Research Council of Canada).

[2] In the context of the Pacific CRYSTAL project a lighthouse school is a school that serves as a test site and leader in the development of pedagogies that promote science literacy. Lighthouse schools technically are part of Node 3.

education. My data were collected in the context of a lighthouse school (Blueberry Field Elementary School [pseudonym]) where I investigated how students and teachers from public schools interact amongst themselves during out-of-classroom science activities, when they have technology (e.g., camcorders and computers) mediating their science learning.

A giant funnel represents my conceptualization of the relationship between my project and Pacific CRYSTAL: Pacific CRYSTAL forms the large opening of the funnel (large scale) narrowing towards my individual research (Figure 1.1). As big as the Pacific CRYSTAL is, from my perspective we are only able to understand the big picture if we break it down into smaller pieces. Thus, through understanding these small parts, a better understanding of these parts as a whole can be constructed.

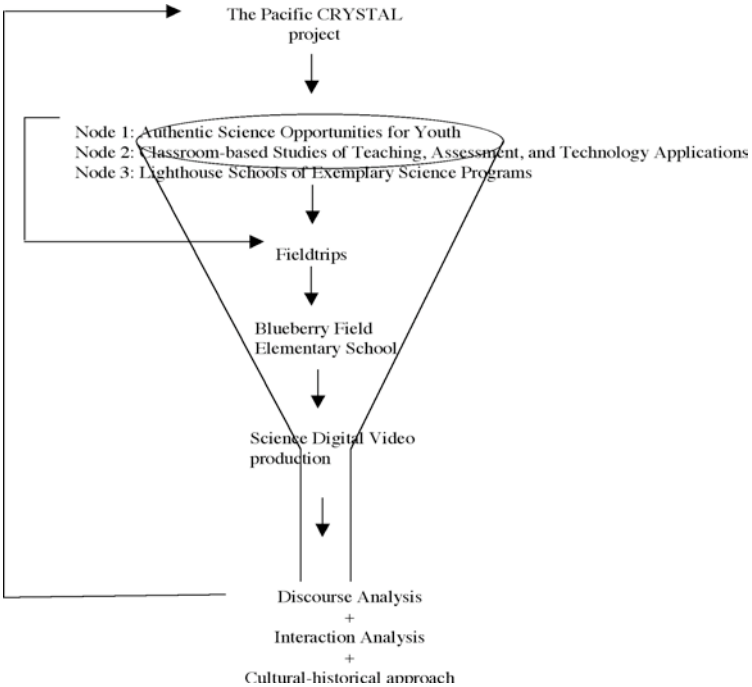

Figure 1.1. This diagram illustrates where my thesis fits within the Pacific CRYSTAL project as a whole. The Pacific CRYSTAL project consists of three nodes. My research deals with how elementary students

and teachers interact during science fieldtrips (Node 1). I conducted my fieldwork at Blueberry Field Elementary School where a group of 25 students engaged in the production of digital videos about their science fieldtrips. Using discourse analysis, interaction analysis and a cultural-historical approach I explored student-student and teacher-student interactions during out-of-classroom activities.

Definition of Fieldtrips

For the purpose of this thesis I borrow a definition of fieldtrips according to which a fieldtrip is "any journey taken under auspices of the school for educational purposes" (Prather, 1989, p. 10). In this context and as I articulate further in this thesis, due to the hands-on nature of fieldtrips, students interact with peers freely and communicate with each other through a more informal language, such as interjections, which are suited for the context in which students are embedded in (e.g., fieldtrips). Additionally, studies also agree on the benefits of learning science out-of-classroom because the outdoors is a more inspiring, appealing, and pleasant environment (Ramey-Gassert, 1997).

Outline of the Three Studies

The results of my research are presented in the form of independent yet interconnected three studies that focus on teacher's and students' interactions during out-of-classroom science activities (e.g., science fieldtrips and computer environment). In my first study, *"Egomorphism as simple words: Discursive pedagogical artifact in/for science education,"* I extend the anthropological term egomorphism (Milton, 2005) to the educational arena. Egomorphism denotes the fact that some speakers use a language suited to articulate their *selves* or *ego* to describe human understanding of non-human entities. I provide real examples extracted from my database to illustrate how science

educators mediate science concepts through the use of egomorphism. The episodes I present were collected during science fieldtrips and computer sessions. In this study, I conclude that egomorphism, which has not been used in education before, is a hybrid language (e.g., scientific and non-scientific) employed by educators that mediate students' understanding of natural phenomena. Such hybrid languages have been theorized to be necessary parts of learning process rather than issues (Roth, 2008).

My second study, *"'Don't say yuk, say hum,' an analysis of interjections as students' communicative, participative and cognitive practices during fieldtrips"* deals with the use of interjections during science fieldtrips and how they mediate students' interactions. Data for this study were collected during a daylong fieldtrip at a park in British Columbia where students had the opportunity to learn about the local environment (e.g., wetlands). In this study, I analyze how the interjection "yuk" mediates students' interactions during science fieldtrips. I conclude that interjections constitute communicative acts that signalize to the teacher and peers that the object of study was seen/heard, rather than exclusively an expression of student's feelings and emotions as the current literature suggests (e.g., Ameka, 1992; Wierzbick, 1992).

The third study in this thesis, *"Monopolization during computer collaborative work: The making of a science video project,"* explores monopolization of mediational tools within collaborative working groups. For this study I analyzed the interactions that occurred within groups of students when working collaboratively on the production of digital videos of the highlights of their science fieldtrips. More specifically, this study explores monopolization of mediational tools (e.g., computer and its components) during

collaborative work. I conclude that monopolization, which occurs within a collaborative working group, is not an attribute of individuals but is sustained through interactions amongst participants. Moreover, my analysis reveals that the physical arrangement of group members around the mediation tools provides a unique flow of information (e.g., students' mutual understanding) from the working groups to the computer.

Integration of the Three Studies

The core chapters of this thesis are formed by three studies written for publication in peer-reviewed journals and as such are oriented towards different audiences. Therefore, the structure of this thesis is not chronological or linear and does not read as a progression. These three studies are interrelated, because first they all deal with the same theme. For instance, as illustrated in Figure 1.2, throughout this thesis I articulate how students' and teacher's *language* mediate their *interactions* when they work collaboratively during *out-of-classroom* science projects in the presence of technology (e.g., camcorders and computers). Hence, my study starts from the moment that the groups of students are shooting their videos about their fieldtrip until the time that they are working collaboratively on editing their videos in the computer laboratory. Second, throughout my research I used the same theory, participants, and methods of data collection and analysis for all three studies. In other words, the use of interaction analysis and discourse analysis as method and a cultural-historical perspective to conduct data analysis, as well as the general significance of my findings to science and environmental education are what bring the individual chapters into cohesive focus. Collectively, these three studies have implications for science education in general and science teachers in

particular. For instance, they all address important issues related to how participants interact amongst themselves and with the tools that mediate their actions during out-of-classroom science activities.

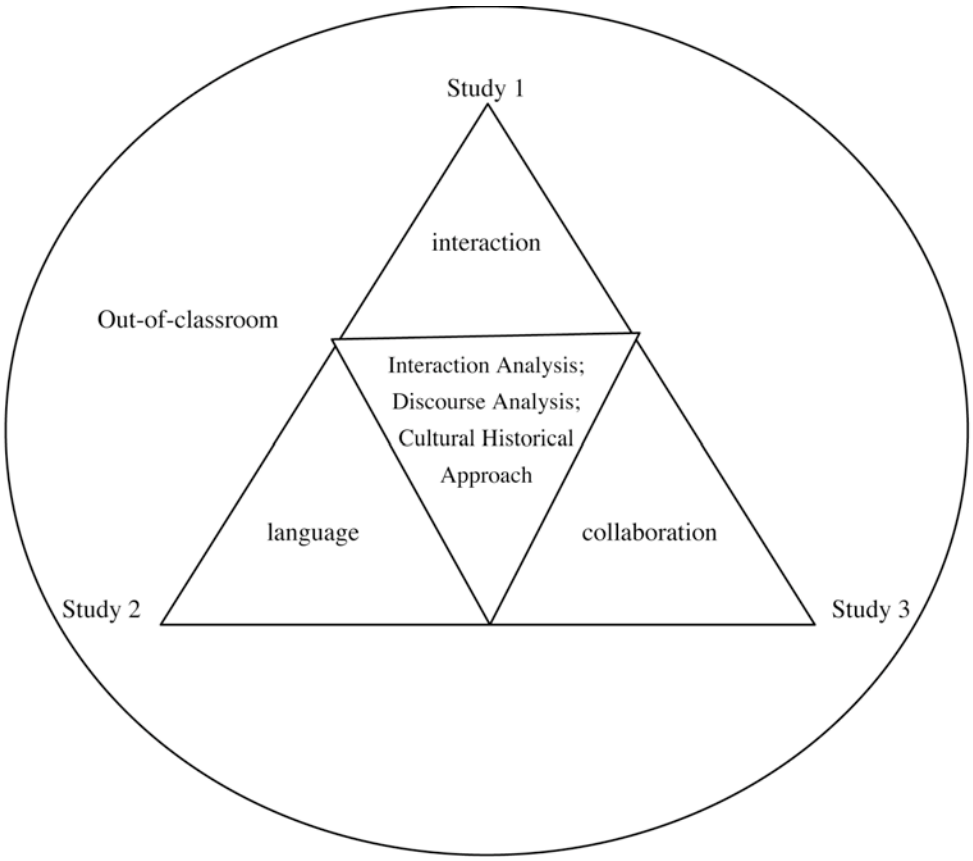

Figure 1.2. This diagram illustrates the three core chapters of this thesis and how they are interrelated. Study 1 extends the term egomorphism to the science education arena. Study 2 discusses the role of interjections during out-of-classroom activities and Study 3 explores monopolization of mediational tools during collaborative work in a computer environment. These three studies are interrelated first through their themes, because I articulate how through peer *collaboration*, students' and teacher's *language* mediate their *interactions* during *out-of-school science experiences*. Secondly, I use the same methodology and theoretical framework to collect and analyze the data, as well as the same research participants.

In this thesis, I describe and articulate three different phenomena (e.g., egomorphism, as a hybrid language that mediates teachers' talk about scientific concepts, interjections mediating students' interactions during science fieldtrips, and monopolization of the working tools within collaborative work). Even though my analyses focus on what I observed in one classroom throughout a school year, my findings are not taken to be isolated phenomena, because they are the concretization of real cultural-historical possibilities that participants may find themselves in.

Chapter II – Background

In this chapter, I first provide definitions of important terms used throughout this thesis. I then briefly introduce the school, the research participants, and how I engaged with them. I also describe how the data were collected and prepared for analysis. Finally, I describe the theoretical framework that guided my analysis and methods through the three studies. Likewise, validity is discussed to assure that my data analysis and overall research have met an expected quality standard for work of this nature.

Important Definitions

In this section I provide a brief explanation of important terms employed throughout, as this may be useful for the reading of the following three chapters.

Anthropomorphism: Is concerned with how people *represent* non-human animals by attributing (only) human characteristics to them.

Assertion: A statement resulting from the analysis of the data

Authentic science: The science carried out by scientists and researchers who work in a science laboratory or field.

Community of practice: A group of individuals that interact with each other sharing their ideas (Lave & Wenger, 1991).

Discourse: The term "discourse" has become common part in a variety of disciplines: critical theory, sociology, linguistics, philosophy, social psychology and many other fields. Discourse is a social practice including many forms of talking or writing constituting a cultural organization. For example, when I conducted analysis of participants' discourse, in fact, I described and articulated what my research participants made available to me in the form of verbal communication and non-verbal

communication. In my research, oral discourse is a crucial means of communication among students and teacher during the course of their activities, which reinforces my interest in the analysis of discourse.

Egomorphism: Denotes how one's self or ego understand the environment (e.g., animals and plants) based on personal previous relationship with it.

Participant observation: Is a set of research strategies, which aim to gain a close and intimate familiarity with a given group of individuals (e.g., a school or a classroom) and their practices through meticulous involvement with participants in their natural environment.

The Research Site: Blueberry Field Elementary School

The database of all the three studies that are presented in this thesis emerged from science fieldtrips and computer sessions that I videotaped during a six-month period[3] with the help of two research assistants[4] at Blueberry Field Elementary School (pseudonym). This school is one of the lighthouse schools for the CRYSTAL Project.

Blueberry Field Elementary School is located in an urban area of British Columbia. Its first one-room building was erected in 1893. Over the past ten years this public school experienced unprecedented growth and development. At the 100th

[3] I was a participant observer in the school for a school year (from September 2005 to June 2006). However, I videotaped the activities from November 23rd, 2005 to May 30th, 2006.

[4] I would like to thank Ian Stith and Giuliano Reis for their assistance in videotaping the fieldtrips as well as the computer sessions.

anniversary of the school, there were over 300 students housed in the school and seven portable classrooms situated on the playing field. Today, Blueberry Field Elementary School has 16 classes, from kindergarten to fifth grade. The first-class facilities on site include a gym, library, and computer lab for the 286 students and 31 staff members.

I negotiated my presence in the school directly with the school administration, Mr. MacBeth, and his students. The students were required to obtain written consent to participate in this study from their parents or legal guardians. Additionally, with the permission of Mr. MacBeth, I was able to observe the science lessons that took place in his classroom, videotape science fieldtrips, and conduct computer sessions where I tutored students throughout the digital science video production.

Research Participants

My first contact at the school was with Mr. MacBeth, to whom I was introduced by a colleague who had previously worked with in environmental education programs introduced me. Mr. MacBeth is a teacher concerned with the environment and has extensive experience in engaging his students in science fieldtrips.

During the data collection period of my research, I observed 25 students from Mr. MacBeth's classroom. Mr. MacBeth's students form a heterogeneous group, within a mixed classroom (fourth and fifth grades), with male and female students. For one of the students, English is not the first language. There were also two special needs students.

All 25 of Mr. MacBeth's students participated in my research. The teacher was responsible for organizing the fieldtrips, including the agenda and the goals of each activity. He did not participate in designing the video production *per se*, which included

the videotaping of the fieldtrips by the students and the movie edition during computer sessions. Furthermore, the teacher was not involved in the creation of the tutorial for movie edition (provided in the appendix section). The episodes I include in the following chapters are neither a reflection of the methods employed by the teacher, nor a reflection of his students' knowledge about science. Rather, my research is concerned with real situations that real people may find themselves in.

My Engagement with Mr. MacBeth's Students

This study was mediated through my engagement as a participant observer during Mr. MacBeth's science lessons inside and outside the classroom environment. From our first encounter onwards, I expressed to Mr. MacBeth my personal interest in media, such as computer and production of short movies. More specifically, I was interested in helping his students to create science digital videos, with the highlights of their fieldtrips. Mr. MacBeth was not only willing to open his classroom to me, but he was also personally interested in research conducted on science fieldtrips. Hence he agreed to have me observing his science lessons and videotaping any science activity that would happen outside the school. He also allowed me to conduct computer sessions in which I would coach his students throughout the production of their digital videos.

My initial idea in the beginning of this project, was to capture students' own experiences during their science fieldtrips through the use of video cameras. That was my starting point for collecting the data that would be the basis of my study. Therefore, I designed a pilot project with only two students, before expanding it to the classroom as a whole.

For the pilot project, the students were brought to the field, where they had a chance to learn about the life cycle of the local salmon, and the relation of salmon to the First Nation people from British Columbia, Canada. At that time, I randomly chose two students and asked them to videotape 30 minutes of their daylong fieldtrip. The reason for my request was that I was interested in understanding their feelings about their out-of-school experiences. However, as the project unfolded, and through my deeper understanding of human interactions, I learned that it is impossible to get into people's mind. In other words, I cannot know what students feel about their fieldtrips unless they express their feelings about it. Discursive approaches taught me that all that people make available to one another is talk (and nonverbal signs); this is what I had available too, and I learned that this is what I needed to focus on. Hence, instead of trying to analyze *what* students felt about their science fieldtrips, I focused my research on how participants interacted when engaged in such activities.

Data Collection

Videotaping was the primary data source for the development of this study, followed my fieldnotes as secondary source. However, in agreement with the teacher, I did not videotape his classroom science lessons, hence my fieldnotes constitute my only data source for this learning context. Mr. MacBeth did want me to videotape all the science projects that happened outside the classrooms, as well as any other activity arranged by myself, for example, the computer sessions where students worked collaboratively to create up to three minutes of science digital videos.

Getting ready for a fieldtrip

Mr. MacBeth usually prepared the students for the fieldtrips during their regular class time. In other words, he worked with the students to explore the topic of the fieldtrip in advance. They did homework and readings about the various subjects they would encounter in the field. For example, if their out-of-school activity was a visit to a lake where students would observe the local environment, they would first undertake research about the lake or develop small projects about it in class. In this way, the students had a sense of what to expect when they were exploring the outdoors.

Additionally, during the fieldtrips the students were supposed to work collaboratively, and therefore they were grouped together (two to five individuals per group[5]) beforehand. In this way, each student could be aware of who he or she would be working with, during the fieldtrip. Every group of students received one camcorder and they were requested to videotape a total of 30 minutes of the highlights of their experience in the outdoors. Since most of the students had never had a chance to work with camcorders before, I brought video cameras to the school the day before the fieldtrips. In this way, the students practiced in advance the basic steps of capturing images, such as start/stop recording, zoom in/out, and so on.

[5] The number of students per group depended on the number of camcorders I had available the day of the fieldtrip.

The day of the fieldtrips

On the day of the fieldtrips, each group of students was asked to videotape up to 30 minutes of whatever they thought was interesting about their fieldtrip. Also, each group of students received a booklet that had been previously elaborated upon by the teacher. The students were expected to fill these booklets out with information about their findings during the out-of-school activity. The booklet contained questions about the local environment, figures that they were supposed to identify at the site, and information about the local environment. An example of a booklet that was given by the teacher to each group of students is contained in the appendix section.

In addition to the booklets, each group received a short questionnaire I created, in which they were asked to enter information about their working group, such as the number of the camera[6] that they were using, their names, and how the group decided on what to videotape.

After the fieldtrips

After each fieldtrip, the same groups of students were reunited in the computer laboratory. Using an Apple software package (iMovie™) for movie editing, they were asked to edit their 30 minutes of footage to form a three-minute video. Since none of the students had any experience using this software, the computer sessions were conducted as follows:

[6] Numbering the camcorders was a strategy I used to keep track of the videos produced by the students and the groups. In this way, each group had its own corresponding camera.

(a) The groups of students gathered around the computer (one computer per group);
(b) On the white board, I wrote detailed instructions about the software, and I personally guided the groups through the software.
(c) An iMovie™ tutorial elaborated by myself was given to each student, for consultation as needed. An example of the tutorial is provided in the appendix section.

Data Preparation

I used a digital camcorder to record the entire video production, which included the students videotaping their fieldtrips and the time they spent editing their videos in the computer room. Once the video had been made, my first step was to create a "content list," where, right after the data collection, I made any pertinent annotation and explication of events about the videos. In so doing, my memory was still "fresh" about the events that had happened during the data collection.

My content list was indexed by the time stamp for each videotape. Each consisted of a heading that gave identifying information, followed by a rough summary listing of events as they occurred on the tape. The content list was useful in providing me with a quick overview of the data corpus, for locating particular sequences and issues, and as a basis for doing full transcripts of particularly interesting segments.

The use of the camcorder for data collection allowed me to play the recorded material on the computer. I used iMovie™ version 3.0.3, a free software package for Apple computers, to watch the video frame-by-frame. The software allows playing videos back and forth as needed. This same software also facilitated playing the movie during transcribing. To avoid fully transcribing all 25 videotapes, I designed a coding

system (an Excel™ spreadsheet containing the number of the tape, the date on which it was recorded, the name of the research assistant who was responsible to videotape, and a brief description of its contents). This spreadsheet helped me to find the phenomena I was studying in any one of the 25 videotapes, which corresponded to 25 hours of video.

To facilitate the data analysis, I produced smaller (one to two minute) episodes of selected parts from the total hours of recorded material, exporting these episodes into QuickTime™. Then, each QuickTime™ short episode was transcribed verbatim, including pauses and verbal descriptions of nonverbal actions when necessary. The short videos and their respective transcripts were entered into the database, which also contained my fieldnotes. These materials helped me to better understand teacher and students' interactions during the unfolding of the project.

Additionally, the use of still images was helpful when I needed to evidence specific body movements. For example, as discussed in chapter 5, still images were isolated and extracted from the videos to produce the visual representation of the gestures of the students that would accompany each vignette that I produced for analytic purposes. I used a function of iMovie™ that allowed me to capture a particular frame of the video as it played, and then pasted this image to Adobe PhotoShop™ 7.0 and prepared it for insertion into the text file.

Theoretical Framework

This thesis is about interactions (including verbal and non-verbal communication) of elementary teachers and students during out-of-classroom science projects, taking into account the context in which these interactions happened, as well as the tools that

mediated their interactions. Hence, my studies are based on an assumption that in human interaction, the subjects, the mediational tools, the division of labor, and the context where participants' interactions happened, constitute different aspects of the same activity system, which I articulate further in this section.

In this context, my general orientation throughout my data analysis focus on understanding student-student and teacher-student interactions as these are mediated by several analytically different but interacting units (e.g., division of labor within the collaborative working groups, computer setting, fieldtrip settings as well as the mediational tools). More so, the role of these numerous units vary from one context to another (e.g., computer laboratory and the fieldtrip), and at various stages of the project development. In other words, in both stages of development (outside or inside the school) of this project, all units are known as mediators of students and teacher's interactions. As they are interrelated within a dynamic system, these units cannot be understood in isolation or in a static way, because they are part of the context in which those actions took place.

In addition, to understand student-student and teacher-student interactions within the context in which these interactions happened, the three core chapters of this thesis are based on the assumption that the work done in a conversation is a social construction (Erickson, 1982). Social for the purpose of this thesis is based on the concepts of social action relationship employed by Max Weber (1978): "A social relationship may be said to exist when several people reciprocally adjust their behavior to each other with respect to the meaning which they give to it, and when this reciprocal adjustment determines the

form which it takes" (p. 32). That is, actions take into consideration the reactions of other individuals, considering the context that the participants are part of. Hence, in my research, the students' and teacher's interactions analyzed here are meaningful only within the context in which they happened. For instance, in my study about interjections, I point out that the interjections are just meaningful when bounded to the context in which they were uttered. Therefore the interjections are seen as communicative acts, rather than the expression of people's emotions. For example, if I take Weber's perspective of social actions, the interjections are the students' reactions upon their peers' actions, hence they are social actions in themselves.

As I am interested in understanding students' and teacher's interactions within the cultural, institutional and historical context where such interactions happen, the theoretical framework I used throughout is based on the concept of the cultural-historical activity theory (CHAT) (Leont'ev, 1981). This theory was developed from the founding work of Lev Vygotsky, and its fundamental concept is that human beings do not act directly towards the object of their actions but they rely on tools and division of labor. For instance, in my research, the students produce their digital videos relying on their peers and the technology that mediate their interactions. In other words, CHAT is based on the principles of dialectic-materialism, in the sense that humans are part of a dialectic relationship between subject (humans themselves) as biological units and their own human culture (object). Hence, I have chosen CHAT as my theoretical framework, because the structure of an activity system, for example, allows me to take into consideration the context in which actions take place. Such approach helped me to avoid

assumptions about what goes on inside students' and teacher's heads, because actions are social, historical and situated in the context in which they happen.

Cultural-historical activity theory takes "activity" as its smallest unit of analysis (Leont'ev, 1981). Therefore, everything that an activity, like producing a science digital video, implies—students working with their peers, working with tools (e.g., camcorders, computers)—cannot be understood apart from the community, society, and culture within which they are embedded in.

More so, CHAT allowed me to outline students and teacher in a certain activity as subjects with a particular objective. In other words, CHAT gave me the chance to analyze the science fieldtrips and the computer laboratory context as a series of actions directed towards some object, such as videotaping the local environment or editing digital videos. Furthermore, in CHAT, any action is understood as a transitive relation between subject and its object of activity, which is mediated by the units (e.g., division of labor and tools) that are constitutive of the particular activity (Figure 2.1). That is, cultural-historical activity theory is based on the relation between units in an activity system. Each part of a system can only be understood in relation to all other parts—all parts are interdependent. Therefore, a change in one entity leads to a change in the whole system. As a hypothetical example, if I take a collaborative working group of students out in the field, videotaping the highlights of their fieldtrips as my unit of analysis, the breakdown of a camera (tool), would transform the object of activity from producing a science digital video to sending the camera away to be fixed.

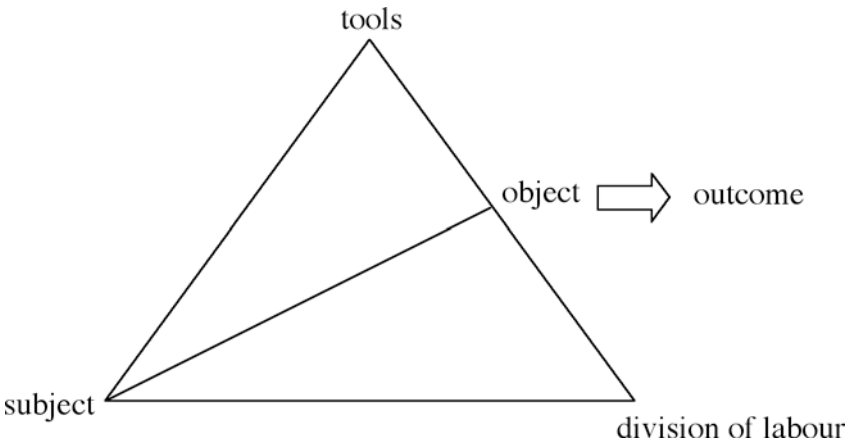

Figure 2.1. Cultural-historical activity theory (activity system) adapted from Engeström (1987).

In an activity system the subject is a person or group of people that acts toward a specific object. Without an object there is no activity. For example, science digital videos are the overall object of activity for students and teacher (subject) in the context of the computer laboratory and science fieldtrips. Their division of labor, and tools always mediates the relation between students and teacher and the object of their activity. In the science digital video project, the videos produced by students in a DVD format are the outcomes of activity that is itself mediated by: division of labor (collaborative working groups) and tools (camcorder, computers). The units of an activity are not still entities but can change as the context changes (Nardi, 1996), and this aspect of the cultural-historical approach is evident throughout my research.

The concepts of CHAT and the perspective of social action developed by Weber (1978), which I have discussed previously in this section, allowed me to understand how students and teacher interacted during science fieldtrips as well as during the computer sessions, and how their interactions vary according to those environments. As an example

of the fact that discourse is bounded to its context, and that the language mediates participants' interactions, I present in chapter 3 a study about egomorphism, where I extend this term to the field of science education. In this case, teachers employ a language that is appropriate for the context (fieldtrips), since teachers may use their *selves* to articulate science concepts with the students. The episodes I present in chapter 3 illustrate egomorphism, which I identify as a hybrid language (scientific and non-scientific language), mediating teacher-students interactions when they act towards a specific object (e.g., their object of study). Such hybrid language mediates students' understanding of scientific concepts during science lessons.

I present another example of how students' interactions vary according to the context in which they occur in chapter 4, a study about the role of interjections during science fieldtrips. There, I argue that during out-of-school experiences, students use interjections more often than within the school setting and that students' (subject) actions are mediated through their language, in this case, through interjections. Additionally I point out that such interjections are the evidence of student's attentiveness to the task at hand and a form of communication that is bound to the context in which it occurred.

Cultural-historical activity theory also helped me to understand teacher's and students' interactions throughout the entire project, when they had to share a number of tools or artifacts, such as the camcorder, the computer, the utensils they used to collect and study their biological samples, and even their language. Such tools or artifacts mediated their interactions during the science fieldtrips as well as during the computer laboratory. More so, when the students worked together to achieve their goal, which was

to produce digital videos with the highlights of their science fieldtrips, they indeed shared their tasks, such as videotaping (since they had available just one camcorder per group) and editing the video in the computer laboratory. In sharing their tools and the work, the students finally achieved their goal, which was to produce digital videos, which represents the outcome of their science project. In chapter 5 I exemplify how tools mediate students' interactions during the production of science digital videos. I present episodes that illustrate collaborative working groups gathering around the computer sharing their tasks and their tools. In this study, I articulate the path of students' mutual understandings within working groups. Such mutual understandings goes from the group itself, to one specific student (the one who sits closer to the tools [computer and its components]), then is processed into the computer to be further finalized in a DVD format, which is the outcome of the group task.

In the next sections I describe the methods (e.g. interaction analysis and discourse analysis) I used to analyze the episodes that comprise my database, also articulating the reasons for following such methods. Finally I discuss the credibility of qualitative methods of research.

Interaction Analysis: A Collaborative Method

I began my data analysis by reviewing my data sources collaboratively with my research group, which was composed of nine other graduate students, and in cooperation with my supervisor (Wolff-Michael Roth). During these meetings, I set up interaction analysis sessions (Jordan & Henderson, 1995), which form an interdisciplinary, collective method to investigate the interactions of human beings (e.g., teacher and students) with

each other (e.g., talk, nonverbal communication) and with the objects in their environment (e.g., camcorders and computers) within the context in which such interactions happen. More so, interaction analysis is a reflexive form of analysis in which my research group and me not only analyzed students' and teacher's interactions, but we did it collaboratively.

During our group meetings, which were video-recorded, I attempted to keep my work, to the largest extent possible, free from predetermined categories or assertions about the data. I expected such categories or assertions to emerge out of our deepening understanding of the participants' interactions. Hence, I developed my categories or assertions together with my research group as our group analysis developed. During our meetings, the videos were stopped whenever a participant found something (e.g., an event) worthy to remark. The event was reviewed as often as necessary so that each tentative assertion could be fully explored by all members of our research group. Through the multiple replaying the videos, improved levels of students' and teacher's interactions were explored. As my categories and assertions developed, so did my analytic approach, which allowed me to explore verbal and non-verbal communication depending on my research claim. During our meetings, several assertions were produced. I then returned to the data to attempt to revise them.

In the second and further meetings for collective analysis, additional themes were explored in the same manner as above. I subsequently refined the assertions through the writing process and revising the data back and forth.

Transcriptions

As a particular video segment emerged as significant during our meetings, I expanded my content lists into transcriptions. My transcriptions were more or less rich in details depending on the nature of my research claims, and this is noticeable throughout my three studies. The transcriptions presented in chapter 3 are less rich in details than those in chapters 4 and 5. In the study presented in chapter 3, where I expand the concepts of egomorphism to the field of science education, body movements of participants, for example, are irrelevant. In chapters 4 and 5, I am interested in how interjections mediate students' talk during science fieldtrips and monopolization of the mediational tools during collaborative work, respectively. Hence nonverbal communication, such as changes in body position, gaze, gesture, and so on, are useful to the understanding of teacher and students' interaction.

Why interaction analysis?

I chose interaction analysis as a method for analyzing my videos because of its nature (collaborative work). When I first started my data analysis I was a novice in this type of research, and interaction analysis is best learned by doing it collaboratively (Jordan & Henderson, 1995). Hence, as part of my apprenticeship, I was gradually socialized into an ongoing community of practice where I increasingly participated in the work of analysis, of the activities studied. Additionally, collective analysis, such as interaction analysis is a powerful tool for neutralizing preconceived notions on the part of individual researchers. The collaborative viewing of data, minimizes the tendency

researchers have to see what they are conditioned to see. We are alsoconfronted with different ways of seeing it. Thus, I ascertained that my analysis met the highest scholarly standards.

Discourse Analysis: The Context Matters

In conjunction with interaction analysis, throughout the three studies that form this thesis, I used *discourse analysis* (Edwards & Potter, 1992) as an analytical tool for interpreting the videotaped fieldtrips as well as the videotaped computer sessions that I conducted with the students. Discourse analysis as an analytical tool (e.g., Roth & Alexander, 1997); help me to understand teacher and students' interactions during their science out-of-classroom activities.

Discourse is indeed a central part of our lives, and what we do with others is always mediated through some kind of communication. Hence, discourse itself is related to social interactions, including different forms of talking, writing, or performing actions. Based on this premise discourse both in the classroom and in out-of-classroom activities becomes an important tool that mediates communication amongst teacher and students. Therefore, analyzing discourse that happens during science lessons is useful in understanding how teacher and students interact amongst themselves, hence, contributing to the understanding of teaching and learning in different settings (e.g., computer laboratory and fieldtrips).

In this context, discourse analysis is an approach to the understanding of such natural talk, writing, or actions performed, in the context that such events happen. Such approach was first developed by the sociologists Gilbert and Mulkay (1984) to study

scientists' talk during discussion about biochemistry issues. Later, one of Mulkay's post-graduate students, Jonathan Potter, who had a psychology background, used discourse analysis to examine issues within social psychology. Nowadays, discourse analysis draws from methods in a wide range of fields, such as anthropology, philosophy, and sociology.

Discourse analysis, is the study of language in use, in the sense that language, in the same manner of CHAT, cannot be understood apart from the context in which it is used, thus the researcher must be able to understand the context. Hence, the object of analysis is hardly a single sentence. Instead, larger texts and video recordings, provide major data, which is focused on speaker's hesitations, repetitions, incomplete utters, and so on. In the case of my research, these discourse features are indeed relevant and are in fact the focus of my study. In this scenario, the analysis of discourse I conducted throughout the three core chapters made available to me the ways in which discourse is central of students' and teacher's interactions.

In practice, the process of discourse analysis could be generally split into different stages that are not sequential steps but phases (Potter & Wetherell, 1987):

Setting assertions: My assertions were generated during the collaborative viewing of videotapes accompanied by respective transcripts, which happened during our research group meetings. These meetings were always recorded, which gave me opportunity to refer to the videos as many times as needed. Having no pre-determined categories or assertions, throughout the viewing of the videos, I gave priority to discourse as it happened in the videos (I described and articulated only what is shown in videos). My

assertions were refined as we watched and discussed the events that appeared in the videos as well as through my writings process.

Sample size: The sample size depended on the specific assertion or category. The success of a discourse study is not dependent on the sample size (e.g., length of video). For example, the videos I analyzed throughout are less than a minute long.

Collection of records and documents: By collecting documents from many sources, it is possible to build up a more accurate description of the way participants' linguistic practices are organized compared to one source alone. Therefore, I made sure that I videotaped as many groups of students working collaboratively as possible. For example, there were computer sessions in which the camera was capturing the computer lab as a whole. Other sessions, the camcorder was focused in one single group. I also made sure I videotaped groups of five individuals, groups of two individuals and so on. Finally, I also videotaped the interviews that I conducted with the students after the conclusion of their science video projects. By doing that, I expanded my understanding of how participants interacted in the way they did.

Transcription: The content of my transcripts depended on what I intended to articulate. In general, the ratio of video time to transcription time was about one to ten. Which means that ten minutes of video took about one hour to transcribe. However, this ratio also depended on the detail of the transcription.

Coding: As an example of coding, in chapter 3, my transcripts were coded in a way that I could separate my excerpts into two different categories: (a) episodes illustrating egomorphism, and (b) episodes illustrating anthropomorphism. In doing so, I

could easily identify the phenomena of study. In chapter 4, I coded the interjections in two categories: (a) interjections that were uttered inside the computer laboratory, and (b) interjections that were uttered during the fieldtrips. In this way, I was able to affirm that during the science fieldtrips, students uttered more interjections than during the activities that happened inside the computer laboratory. In chapter 5, a coding system helped me to identify verbal and non-verbal communication employed by participants when they were working collaboratively in the computer room. The goal of coding, therefore, is not to find results but to compress the large body of discourse into manageable parts.

Analysis: During my data analysis, I did a lot of careful reading and re-readings of the transcripts and watched the videos over and over again (videos about our collaborative research group meetings and the ones that referred to the assertions I was investigating). While watching the videos and reading the transcriptions, I searched for patterns in both inconsistency and regularity of events. For example, in my study about egomorphism, I searched for the same phenomenon repeated in different videotaped fieldtrips.

Validation: For validation of the discourse analysis I conducted, I followed two main techniques: (a) coherence, which is concerned with how the discourse fits together; and (b) participants' orientation: through the interviews I conducted with students, I could also access their views about the project as a whole.

Theoretical principles of discourse analysis

The approach that I took through my three studies is concerned with social interactions amongst teacher and students. Such an approach has three fundamental principles (Potter, 2003).

Discourse is action-oriented: Discourse analysis is concerned with actions, hence, discourse itself is just meaningful when it is socially, culturally and historically bounded to the context in which it happens. Therefore, discourse analysis is about uncovering what is hidden in people's actions.

Discourse is situated: Discourse is a social action. The concern with the occasioning of speech is related with the concern with action; actions do not hang in space, but are responses to other actions, and they in turn set the environment for new actions to happen. For example, greetings follow greetings, acceptances follow invitations, and so on.

Why discourse analysis?

I had decided for discourse analysis as method of analysis, first because I approached fieldwork without any pre-categorization of students' and teacher's discourses. Second because it allows me to understand *how* what research participants say is supported in a way that it becomes uncontroversial rather than just focusing on *wha*t is being said. The fact that I was able to describe how participants interact during their science fieldtrips when engaged in collaborative work, for example, allows me to

point out that discourse analysis is a powerful method for environmental education research.

Why interaction analysis and discourse analysis "partnership"?

I have decided to use interaction analysis in conjunction with discourse analysis as method to analyze teacher-student and student-student interaction during out-of-classroom projects, because both interaction and discourse analysis are based on the assumption that human interactions are grounded in social environment (Jordan & Henderson, 1995). That is, learning is not located in the students' heads; rather it is situated in their interactions.

Having a cultural-historical perspective, this thesis as a whole is not about specifically egomorphism, interjections, nor monopolization. My writings are about real situations that elementary science students and science teachers may find themselves in during out-of-classroom activities. Hence, the three studies that form this thesis are about interactions of students and teachers during science fieldtrips, and discourse analysis helps me to understand such interactions.

Credibility of qualitative research

The use of camcorders for data collection is a powerful resource to ascertain credibility of qualitative research. Videotaping, gave me the chance to play over and over again events that happened in the past, and the chance to re-examine it as much as I needed. Hence, I took recourse to the video as a final authority. The use of videos allowed direct observation of the data. Video permits me to fill up gaps between what the

teacher and students say they perform and what they really perform. It also provides me with optimal data when I am interested in what "really" happened during my research participant's social interactions. Watching the videos collaboratively is a powerful strategy, because it neutralizes preconceived notions on the part of the researcher. Additionally, inferences about what is happening on the videotape pertaining to what participants think (unless they say what they think) are not relevant in both interaction and discourse analysis.

The fact that I did all my transcriptions myself, allowed me to gain to substantive analytic insights during transcription. What has emerged from watching the videos over and over allowed me to extend and detail my transcription, which guided me throughout the deeper understanding of my data.

Finally, to further establish the credibility of qualitative research, I used several techniques from fourth-generation evaluation (Guba & Lincoln, 1989), such as:

Prolonged engagement: To avoid data misunderstanding, involvement with research participants is recommended. Thus, I spent several hours with the students at the school and I participated in five science related fieldtrips, four non-science out-of-classroom activities, and conducted 15 computer sessions (45 minutes each).

Persistent observation: To identity features of teacher and students' interactions that are relevant to the research claims, consistent observations are suggested. Thus, the recordings that composes my dataset amount to over 25 hours, from different activities the students were engaged in.

Peer debriefing: To facilitate testing research claims and to set next research steps, discussion with peers are suggested. In this sense, the use of interaction analysis provided me with the opportunities to exercise this practice.

Progressive subjectivity: To avoid the situation in which the researcher finds only what he or she expected to find. This was also effectuated through interaction analysis sessions with our research group, as articulated earlier.

Chapter III – Egomorphism in simple words: Discursive pedagogical artifact in/for science education

In the present chapter, I expand the concept of *egomorphism* to the field of science education. Egomorphism determines that humans understand their environment through their own personal experience (i.e., this understanding is achieved by *perceiving* human characteristics *in* non-human entities), and that the speaker's *self* or *ego* (in the general, rather than the Freudian sense) is the focus point for such understanding (Milton, 2005). I point out that in the classroom egomorphism is associated with the fact that teachers use a language to articulate his or her self or ego to understand their object of study (e.g., animals and plants). In so doing, teachers open the opportunity for students to perceive their own selves and egos in their object of study as well. Hence, I claim that egomorphism in the classroom is an appropriate term to use to refer to the fact that humans understand non-human animals through individuals' own personal experience in the sense that we, as human beings, understand our environment (e.g., non human creatures), based on our selves or ego. In other words, the understanding of non-human animals by humans is based on the perception that they (animals) are "like me" rather than "human like" (Milton, 2005). I conclude by asserting that egomorphism mediates learning by constructing a hybrid language (scientific and non-scientific) that is appropriate to the science education context in which participants may find themselves.

According to Milton (2005), who first created the term, egomorphism is different from anthropomorphism, another anthropological term, which is concerned with how people *represent* their environment by *attributing* human characteristics *to* it. Hence, anthropomorphism from this perspective is merely the personification of animals or plants, which is in opposition to the egomorphism perspective that implies that people

understand their environment by *perceiving* human characteristics *in* it. This point of view I articulate further in this chapter. More so, I illustrate the differences between these two terms, presenting episodes extracted from my database that exemplify how egomorphism employed by teachers, during science lessons, mediates students' understanding of scientific concepts through a non-scientific language.

I conclude that egomorphism is a discursive pedagogical device employed by science teachers that allows students to relate to their object of study (e.g., animals and plants). I start by pointing out what is found in the literature about anthropomorphism during science lessons, then articulate its difference from egomorphism, and explain why the second term is appropriate in the cases I present.

Anthropomorphism During Science Lessons

The field of studies about anthropomorphism of non-human entities (e.g., animals and plants) during science lessons is considerable (e.g., Zohar & Ginossar, 1998). In the literature, anthropomorphism is defined as the tendency to attribute to non-human beings not only life but also feelings and human characteristics (Piaget, 1929). For instance, teachers use anthropomorphism both consciously and unconsciously during their lessons; and anthropomorphic language is common amongst both students and teachers. Despite the controversies about the use of anthropomorphism during lessons in the sense of whether it should or should not be used in the field of science, most studies argue that the use of anthropomorphism is indeed natural amongst students and teachers and it mediates student's learning of scientific concepts (Kallery & Psillos, 2004). Moreover, "the use of anthropomorphism does not imply prevalence of anthropomorphic reasoning in high

school students, since most of them can distinguish between anthropomorphic and factual explanations" (p. 292). The fact that in previous studies there is still a debate about the use (or not) of anthropomorphism in science lessons, I suggest in the following sections that these non-scientific languages (e.g., personification of animals and plants), may be the students' way to articulate scientific talk about the environment.

Egomorphism vs. Anthropomorphism

In this section, I articulate the differences between egomorphism and anthropomorphism, and argue that egomorphism, in the field of science education, is an appropriate term to refer to how teachers and students understand their object of study by perceiving (only) human characteristics in their object of study. Thus, I start by pointing one situation in which anthropomorphism can be a misleading term.

In the previous section I articulate that anthropomorphism is the attribution of human characteristics to non-human things (Piaget, 1929). That is, anthropomorphism attributes characteristics that belong *only* to humans to non-human things (Asquith, 1997). Based on such definitions of anthropomorphism, and to articulate the problems with it, I take as an example a chicken to show how anthropomorphism can be a misleading term. We can say that a chicken, like humans has two eyes and walks on two legs, which are human features. Hence, I am giving human characteristics to that animal. This can be seen as anthropomorphism. However, having two eyes and walking on two legs is not an exclusively human characteristic. Chimpanzees also have two eyes and sometimes walk on two legs; ostriches have two eyes and walk on two legs. If this is the case, it does not fit in the anthropomorphism definition, which is the attribution of

exclusively human characteristics to animals. Another way of understanding the chicken illustration is the fact that one can switch the order of the sentence. Because I also can say that a human, like a chicken, has two eyes and walks on two legs, it is not obviously anthropomorphism because here, I am giving humans chicken characteristics, which again is not a characteristic that belongs only to the chicken, neither only to humans.

In this sense anthropomorphism assumes that "human-ness" is the main point of reference to understand non-human things, by attributing exclusively human characteristics to them (Milton, 2005). However, based on the example I provided above, the characteristics that people attribute to animals are features that do not belong only to humans, therefore, anthropomorphism (according to its definition) is not an appropriate term in these cases.

In addition, when pet (e.g., dog) owners for example, attribute feelings and mindedness[7] to their dogs. This attribution of feelings and emotions to animals is a product only of the researchers' assumptions (Milton, 2005). Hence, according to this argument, anthropomorphism can only ever be a metaphoric device, and never a mechanism for understanding what non-human animals are thought to be really like.

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[7] Previous studies on human and dog interactions have noted that dogs have a mind. "Mind, in this view, is possessed by individuals and is an indirectly accessible interior place whose physiological home is the brain wherein its reason, intelligence, and personality reside. Mind, then, is taken to be in some way a play of inner representations (symbols, mental images, pictures) looked upon by a dog" (Laurier, Maze, & Lundin, 2006, p. 3). However, when I interact with my dog, for example, and interpret its behavior towards me as loving, caring, I do not necessarily relate the dog's behavior to human behavior in general.

Since the example I provided above do not fit in the concepts of Asquith, anthropomorphism, Milton suggests that egomorphism is an appropriate term, because it is based on the assumption that people's personal experiences rather than human-ness are the primary points of reference for understanding both human and non-human things. To exemplify how an individual's personal experience is related to how we understand animals, thus characterizing egomorphism, I use the relationship between my dog and myself as an example.

I have a very well trained dog called Isabela. One day, I had a friend over and while we were sitting on the couch and chatting, Isabela left her bed that is in my bedroom, walked across the apartment, sat right in front of us, and stared at me. I said to my friend that I had to bring Isabela outside, because she needed to eliminate. My friend asked me back how I knew that the dog needed to eliminate. I replied to my friend saying: "I just know." However, there is a reason that I knew that Isabela needed to eliminate and it is due to my personal experience with that dog. This means that I have lived that same moment before with Isabela, becoming almost like a *déjà vu*, in which the action of Isabela sitting in front of me and staring at me (meaning that is time to eliminate) became a routine for myself and for the dog. But only for myself, since I am Isabela's master and have to deal with her on a daily basis. On the contrary, if Isabela had crossed the apartment and instead of sitting in front of us, had passed us by and eliminated on the floor, one who had never seen Isabela before, would figure out right a way that someone needed to bring the dog outside to eliminate. This example shows that

I understand my dog, through my own personal experience with it, hence characterizing this illustration as egomorphism in the sense presented by Milton.

I use the previous example of my dog to illustrate the fact that egomorphism is seen as the understanding of the environment (e.g., non-human animals) based on people's own personal experience. Now, extending the concept of egomorphism to the science education arena, I present two other examples of egomorphism happening during two different science lessons. In the first example I articulate another aspect of egomorphism, which is concerned with how people understand non-human animals based on the assumption that the animals are "like me." In this sense, the speaker articulates his or her self or ego, characterizing egomorphism, rather than what anthropomorphism implies, that animals are human-like. In this first example, the teacher, using a hybrid language (e.g., egomorphism), introduces the students to concepts of conservationism towards animals. In the second example, I present another situation to illustrate egomorphism mediating teacher's talk about animal behavior.

Findings

Egomorphism employed by teachers during science lessons is a discursive device available to them that mediates their communication with their students. Studies have shown that personification of inanimate objects happens freely and naturally in the classroom, especially during science lessons, on both the teacher's and the student's side (Hughes, 1973). Therefore this study contributes to the understanding of such phenomenon. As specified in chapter 2, following the principles of interaction analysis (Jordan & Henderson, 1995) and discourse analysis (Edwards & Potter, 1992) I take a

cultural-historical approach (Vygotsky, 1978) to conduct the analyses of the following episodes.

Egomorphism mediating discussion about marine environment conservation

Here, Kelly, a public school science educator is giving an introductory speech to grade four students, at a local public school in British Columbia. During this talk, the learners are getting ready for a science project where they would have contact with the local marine environment. In the following, Kelly refers to the marine animals:

01 They are other ***living creatures just like you and I*** are living
02 creatures so you wanna treat them like you would somebody else
03 who's your ***friend.***

In this episode, Kelly introduces students, concepts of conservationism towards animals by asking the student to treat the marine animals as they would treat one of their friends. Kelly explains that those animals should be handled gently and treated with the same respect as any other living creature—whether it is human or otherwise. At a first glance, the teacher's language might be considered an example of anthropomorphism because in saying "they are other living creatures just like you and I" (turn 01) the instructor compares the marine animals to human beings. Yet, this is not the case of anthropomorphism, because Kelly is indeed comparing the marine animals to humans (living creatures just like you and I [turn 01]), however being a living creature obviously is not property or an exclusively human characteristic. For example, my dog Isabela, chickens, plants are all living creatures. Therefore what Kelly said cannot truly be anthropomorphism, because according to its definition, anthropomorphism is the

attribution of human characteristics (that belong only to humans) to non-human animals. Thus, if it is not anthropomorphism, egomorphism is an appropriate theoretical concept to use.

In Kelly's speech, it is noticeable that there are two different "social" groups. Elementary students form the first group and the marine animals form the second group. What Kelly does is to compare these two different groups by putting them all together in the same group. Kelly says that these animals should be treated as the students' friends, which means that if before the animals that were once a part of only the marine animals' group, now these same animals are part of the group of students. Since marine animals and elementary students are part of the same social group, it opens the possibility for students to understand these animals as they understand their classmates or their friends (turn 03), as someone like themselves, that belong to the same group, which is a group of elementary students. In this sense the marine animals that Kelly talks about are like human, not "human-like" or human forms (Milton, 2005). More so, in the last episode by comparing "living creatures" to "you and I" (turn 01), Kelly creates both the possibilities for learners to see themselves in the animals, and the possibility for students to experience a social relationship with the same animals (since now, they are all parts of the same social group).

Kelly, as a science educator, is aware that other animals are not human beings, although she compares them to humans when she says, "living creatures, just *like* you and I" and "somebody else who's your friend." By saying this, Kelly shows that like them (the students and herself), the creatures are also living beings deserving care and respect.

In the second and third turns, "you wanna treat them like you would somebody else who's your friend," Kelly relates the marine animals to the students. In so doing, she makes familiar to the students the animals by comparing them (animals) to their friends (students). In other words, if the students were able to recognize their friends, they would be able to recognize the animals as their friends as well, since now they are the same, "just like you" (turn 01). Kelly tells students that the marine animals are living beings and like them (students and the teacher), are part of the environment.

Kelly articulates what we might consider students' selves or egos and her own self to describe human understandings of animals. This is exemplified in turn 01 where she uses the pronouns "you" and "I." When Kelly compares animals to humans, using a student's self (e.g., you) and her self (e.g., I) to describe to the students how fragile marine animals can be, and how gently they should be handled, she clearly separates *her* self from her *students'* selves. Instead of saying: they are other living creatures just like *us,* Kelly says: "they are other living creatures just like *you and I*." We cannot ever know *why* she says it in this way, but in separating her *self* from her students she creates the possibility for the students to explore their own *selves* in their object of study (e.g. marine animals). For the present purposes and consistent with discourse analysis, I am interested in the function that Kelly's expressions have in the particular context in which she speaks. Furthermore the students' *selves* are projected into animals (by Kelly). In this way, the possibility is created for the students to understand animals as they understand *themselves* or *their own* friends on the basis of their own perception that they (marine

animals) are “like them” (students themselves) rather than human-like. This illustrates the concepts of egomorphism.

In the example, therefore, Kelly employs egomorphism, which I identify as a hybrid language that relates the students to their object of study (e.g., the marine animals). During science lessons, such hybrid language mediates teachers’ interaction with their students, whose primary language is that of the everyday world rather than the one used in scientific publications. In Kelly’s example, this language underscores the fact that the animals can be harmed if not handled carefully, being not immune to actions performed by others.

In the following section, I present a second example of egomorphism as it has occurred during a science lesson within the school setting. In this study I have identified the occurrence of egomorphism not just in animal related discussion but also in plant related discussion. Hence, my next episode exemplifies science educators employing this hybrid language when articulating other scientific topics, such as plant physiology.

Egomorphism mediating discussion about plant physiology

In the culture of science education, the role of teaching in mediating students’ understanding of ecology for conservation purposes is a part of teachers’ speech during their science lessons (Gallant, 1981). Additionally, science teachers have to deal with students from different backgrounds—i.e., they bring their own understandings about surrounding phenomena into the classroom. This means that these students have their own language (usually non-scientific) to articulate their ideas about the topics covered in science lessons. To illustrate this point, I present example of a teacher employing

egomorphism when introducing concepts of plant physiology to students. This episode illustrates the phenomenon of egomorphism as it could happen in any classroom or during any science fieldtrip.

Back at the school, the same group of students who were engaged in a previous fieldtrip is now gathered around their computers in the computer laboratory. As part of their science project, they were required to videotape the fieldtrip and to further produce a short video with the highlights of their out-of-school experience using software for movie edition. Before they start working on their video, their teacher (Mr. MacBeth) recounts with them what they saw during their out-of-school activity:

1	Mr.MacBeth	***You remind*** standing at the river, what kind of plants were
2		all around us? Yes. *((one student rises up his hands to*
3		*answer teacher's question))*
4	Mark	Trees.
5	Mr.MacBeth	Lots of big high trees. And ***you*** know what kind of trees?
6		(0.1) Yes Sarah?
7	Sarah	Um, ceda-, evergreen trees.
8	Mr.MacBeth	Evergreen trees, yep, and? There is another kind of tree
9		too.
10	Sarah	Oh!
11	Paul	Garry Oaks?
12	Mr.MacBeth	***I don't think*** that was oaks right down by the water,
13		because we were
14		right by the edge of the river (0.1) And the edge of the
15		river
➔ 16		Garry-oaks *don't like* to have their *toes* in the river.

In this episode, as Mr. MacBeth is talking to a group of students, he uses a personal pronoun (you) to refer to the whole group when he affirms: "*you* remind standing at the river" (turn 01). This pronoun uttered by the teacher can have two different meanings: (a) *you* can refer to every student as an individual or (b) *you* can refer to the group as a whole. In other words, the same pronoun can be singular or plural, depending on the context. However in this example it relates to the plurality of students. Singular or plural pronoun, when the teacher says "you" he opens the opportunity for each student in the classroom to consider their own selves in the teacher's speech. Second the teacher opens up the opportunity to anyone as an individual to answer the question he is about to ask.

When the teacher utters the word *remind*—although the use of this word is not grammatically correct in this sentence—he creates the possibility for the student to give him feedback about the fieldtrip (e.g., through remembering the time they were standing by the river during the fieldtrip). As the teacher had previously used the pronoun *you*, giving students the chance to consider their own selves, and now, in uttering the word "remind," the students have the possibility to articulate their own experience in whatever the teacher is about to say. Hence, the words *you remind* are related to the individual's self experience even though the teacher talks to a group of students. In addition, the question the teacher is anticipating in uttering, "remind," refers to something that happened in the past, therefore the students have to recall that event in particular.

In advance, Mr. MacBeth formulates for students that a question is going to be asked, and the way he accomplished that is through cueing the students with "standing at

the river" (turn 01). In so saying, the teacher refers to some event that happened in the past when they were *standing at the river,* and the specific event the teacher is asking the students to recall (to remind). Hence, from that moment on, the discussion they have is concerned with some event that happened in the past. When the teacher utters "you remind standing by the river," Mr. MacBeth mediates students' feedback, because in so saying, he gives the students the opportunity to remember on the excursion and go back to that specific site and time. In doing so, the teacher also constrains students' answers or actions because he is putting a previous experience in context, that is, he asks the students to remember a specific event that happened in a specific time.

Right after the teacher's anticipation of his inquiry, he asks the students what kinds of plants were around them (turns 01 and 02). After Mr. MacBeth asked this question, one of the students, Mark, immediately rises up his hand to answer the teacher's question. Mr. MacBeth then says, "yes," giving Mark the opportunity to complete the question–answer adjacency turn. Mark takes this opportunity by saying that trees were the kind of plants they saw when they were by the river (turn 04). The teacher confirms the student's answer saying that they did indeed see lots of "big high trees" there, then the teacher asks, "And *you* know what kind of trees?" (turn 05). At this point of their interaction, Mr. MacBeth once again uses the personal pronoun (you) when he refers to the student, giving Mark, the opportunity to consider his own self about his experience. In other words, the teacher could have said "and *yourself* (Mark) or *yourselves* (if he was talking to the group of students as a whole), know what kind of trees?"

After a short pause the teacher says, “yes Sarah” thereby giving the named student the opportunity to answer the question (turn 06). Sarah starts articulating that the big trees by the river were “ceda-.” Noticeably, she did not finish saying the type of the tree she saw by the river, instead she immediately changes her answer to evergreen trees (turn 07). After Sarah’s answer, Mr. MacBeth confirmed it, saying that evergreen trees were indeed a kind of tree that they saw when they were standing by the river. Although that was not yet the answer the teacher was “waiting for.” The teacher kept instigating the students on the same subject, allowing us to hear that he wanted a specific answer. In a correct or an incorrect manner, the question was already answered. If the student had given the teacher the wrong answer, he could have said that that was wrong answer and said what the right answer was and finally changed the subject. The fact that the teacher was waiting for the right answer is also articulated in his use of the conjunction followed by the word “and?” meaning that what Sarah had said was a right answer but not a complete one. Then, he said that there was another kind of tree (turn 08 and 09).

In response to the teacher, Sarah utters an interjection “oh!” (turn 10). After that, another student, Paul, hesitatingly answers the teacher with a question: “Garry oaks?” (turn 11). Mr. MacBeth answers Paul’s question saying that *he does not think* that the oaks are kind of trees that they could find by the water, because since they were right on the edge of the river, and the Garry oaks, according to Mr. MacBeth are a kind of trees that does not like to have their *toes* in the river (turns 12, 13 and 14). Here, the teacher compares the roots of the trees to toes.

The fact that the teacher perceives a human characteristic (e.g., toes) in the plant could be seen as anthropomorphism, in which however, anthropomorphism is the attribution of (only) human characteristics to non-human things. Since having toes is a characteristic that does not belong only to humans, for example, there are in the nature, other animals (e.g., dogs, chimpanzees, chickens) that also have toes, this example cannot be treated as anthropomorphism. I therefore suggest that egomorphism is an appropriate term, because here, the teacher is not just using characteristics that are not exclusive to humans in the plants, but he is also sharing with the students his own perception of what toes are, and what they represent for the plant. Although we could never know what the teacher's feeling are, in uttering that the Garry oaks do not like to have their toes into the water, this could be the teacher's personal experience be reproduced onto that plant. If this is the case, egomorphism is an appropriate term to use. This is noticeable right before his usage of the word toes, when he says "I don't think" (turn 12). In uttering, "I don't think" he gives the opportunity for his listeners to expect that what he is going to utter next is referred to his own opinion of the subject. In other words, the teacher is articulating what that specific subject means for him. Otherwise, the teacher would be only using a metaphoric device and not opening opportunities for students to understand what those plants are thought to be really like.

In the last excerpt, Mr. MacBeth uses a hybrid language, which I identify as egomorphism. It is a hybrid language in the sense that the teacher articulates scientific concepts through a non-scientific language. More specifically, Mr. MacBeth explains plant physiology and the water requirements of different trees. For instance, there are

some kinds of plants, such as the Garry-oaks, that do not need as much water to survive, thus they are not frequently found next to rivers, or any other water sources. In other words, in this final example, the teacher substitutes the word roots for the word toes to mediate students' understanding about a natural phenomenon.

Conclusion

My interest in investigating the role of egomorphism in the field of science education is due to the fact that in the anthropology arena, research has shown that people's attitudes towards animals are influenced by their particular physical and behavioral characteristics—like their beauty and rarity (Kellert, 1993; Wandersee & Schussler, 2001). Likewise, the fact that children like animals has been associated to their "similarity" to humans in appearance and behavior (Katcher & Wilkins, 1993; Ward et al., 1998). Explanations are offered for these attitudes toward animals: for example, children would be fascinated by their mobility (Kinchin, 1999) and ability of communicating, thus perceiving animals as individuals (Schneekloth, 1989). Based on the fact that students' interest about animals is linked to how they see animals as *humans* with mobility, feelings, and so on, I investigate how egomorphism mediates communication between teachers and students during science lessons. In this chapter I provided the reader with a background of egomorphism, highlighting the fact that students bring to the school their own way of articulating scientific phenomena. Additionally, I articulated how humans understand animals through their own *selves*.

The purpose of this chapter is to extend the term egomorphism to the science education field. This new term, created by Milton (2005), which so far has solely been

used in the field of anthropology, is concerned with how a speaker articulates his/her own self or ego towards the understanding of non-human beings. In the educational arena, egomorphism mediates teachers' and students' interactions during science lessons. More specifically, egomorphism mediates the canonical science and everyday language and experiences during out-of-classroom science activities. Additionally, I point out that egomorphism in science education is indeed a hybrid language (i.e., non-scientific and scientific) that teachers employ when they articulate scientific concepts with their students in a way that it is accessible to everyone in class. If this is the case, I conclude that egomorphism is an appropriate term to use since teachers may use their *selves* to articulate science concepts to students.

I used two genuine examples extracted from my database to illustrate my findings in which egomorphism is employed by science educators when they articulate different science topics with their students during science fieldtrips, as well as inside the school setting. The first episode presented illustrates a teacher employing egomorphism to articulate concepts of conservationism towards marine animals with her students. Here, the science educator puts students and animals at the same social group (humans), in so doing, the educator gave the students the chance to understand those animals in the sense that they (animals) are like humans, not human-like. The second episode happened within the school setting, while the teacher articulated concepts of plant physiology. Here, the teacher used a human characteristic, which does not belong only to humans, to give students the chance to understand what the roots of the plants are really like.

Without doubt, students bring to the school their own way of understanding the world surrounding them (e.g., natural phenomena) and sometimes they attempt to describe it using their own everyday life-world language. Studies have identified that what children bring to the classroom are in fact their own way of seeing and explaining their surroundings based on the context they are embedded in (Gilbert & Watts, 1983). In this scenario, science educators have the challenge of bringing to the students scientific knowledge in a manner that it is intelligible to everyone in the class. In other words, teachers during their lessons use scientific and non-scientific language to communicate with their students.

When this non-scientific language meets the scientific language a hybrid language is created. One form this hybrid language may take is *egomorphism*, a language that is appropriate to science lessons, representing a mix of the two realities (inside and outside the classroom). Literature has often ignored the teacher's contribution to the occurrence of such events. After all, their discourses must be intelligible to their students—this would be different if they were talking to other science teachers or adults. In this way, instructors deploy this hybrid language as a strategy to make their object of study familiar to their students.

During an informal conversation with Mr. MacBeth, he affirms that he uses a more expedient vocabulary, which is "more appropriate to the age of students" and having learned this from a fieldtrip specialist. In reviewing my episodes and based on the teacher's conversation with me, we learn that there is a hybrid language *(egomorphism)* that has been transferred from the fieldtrip settings to the classroom settings. This hybrid

language in the educational arena may have been produced during science fieldtrips and reproduced onto students in the classroom setting. *Egomorphism* is indeed a new concept in science education and there may be benefits to investigate the phenomenon at a deeper level.

Chapter IV – “Don’t say yuk, say uhm.” An analysis of interjections as student’s communicative, participative and cognitive practices during science fieldtrips

In this chapter I present evidence for and discuss the role of students' interjections in their discourse and participation in activities that unfold in the context of science fieldtrips. My analysis reveals that, contrary to the common approach to interjections found in the literature, interjections are complete communicative acts that reify students' cognitive engagement and participation in the instructional activities. Moreover, these interjections provide teachers and analysts with concrete evidence of students' attentiveness to the tasks at hand, thus presenting educational potential, both for instruction design and interaction between students and teachers, as well as for assessment purposes.

The interjections I analyze next, as communicative acts, function as tools for the mediation of interactions that go on amongst learners and educators. They all occurred during a science fieldtrip, for which the objective, as identified by the teacher, was to give students opportunities to learn about the salmon life cycle and the relationship between salmon and the First Nations people from British Columbia. The salmon migrate from the ocean to their natal river to reproduce, and they die about a week after spawning. Most salmon species spawn only once during their lifetime and the decomposing bodies help to fertilize the stream (Boyer, Roth, & Lee, 2003).

During spawning season the Blue River Park[8] is bustling with school groups and local residents of all ages. One cannot help but remember the salmon in autumn as seen in this park, for (as the students so aptly point out) the stench of rotting fish is palpable.

[8] Pseudonym.

Despite this, the park is a very important site where schools bring their students to contemplate and learn about the local environment as well as the First Nations culture.

On the day of this fieldtrip I gave two students one camcorder and I asked them to videotape their fieldtrip. During the time they recorded, I captured their interaction with a second camcorder, which provided me with substantial material that helped me to understand how their conversation mediated their learning and participation in the activities. At one point in their conversation, one student says to another:

(01) Student: If you see a dead fish don't say **yuk,** say **uhm.**

In preparation for the fieldtrip, the day before in the school I explained to the students how this project would be conducted in the park and what they would be seeing by the river. At that time, the teacher also mentioned the strong smell of dead fish that they might have to deal with during the activity. Yet the teacher articulated and made clear to students how important the salmon is to First Nations people, hence students were told that if some of them were to see a dead fish, they should not demonstrate disgust, they should not say "yuk" but "uhm." This same way of articulating how the students should react to the dead fish when in the park was repeated by one of the students during the out-of-school activity (line 01).

In line 01, the student's comment about the dead fish is therefore a reproduction of a sentence the teacher previously had articulated in the classroom. We notice that the interjection *yuk* simply was to be substituted by the interjection *uhm*. This was in fact the guideline provided by the teacher: the students were to substitute one (verbal) re-action for another. The interjection *yuk* is part of the students vocabulary and is culturally

interpreted and understood as signifying disgust. Thus, by instructing students to use a different interjection when faced with smelly dead fish, the teacher proposed a different reaction to what the students were seeing and smelling. The contention was that it would be disrespectful to address or react to the fish with disgust (even though it may actually be disgusting to them). Thus, a more *neutral* interjection was proposed as a suitable substitute.

However, I cannot say what the student, when repeating the teacher's instruction (line 01), feels or thinks. My interpretations as an analyst are limited to what is communicatively and bodily made available at that moment. That is, the student instructs her peer to say *uhm* instead of *yuk*, and the reproduction of this instruction does not necessarily imply that the student believes that *yuk* is inappropriate to describe the object of study (e.g., the dead salmon), whereas *uhm* is a suitable word for that moment. It is, in any case, quite evident that the student is attentive to the teacher's instructions, so much so that she repeats the exact instructions to her friend a day after they were first uttered by the teacher.

Of particular interest in this study is the fact that the utterance of the sentence in line 01 already inherently acknowledges the potential of interjections as communicative acts. Why is it necessary to replace *yuk* by *uhm* when seeing a dead fish? Within the social and cultural context in which this sentence was produced and later reproduced, the interjections are considered not only as simply expressions of feelings or "mental or emotional" states, as they are sometimes referred to in the literature, but as legitimate forms of communication that carry meaning that are socially and culturally associated to

them. The action of consciously replacing *yuk* by *uhm* when faced with a dead fish entails a change of attitude that requires the students to pay attention to their reactions to what they may see, smell, or touch during their fieldtrip and also to *communicate* and *interact* differently; students are asked to do more than substitute words (or interjections in this case)—they are asked to remember the importance of salmon for First Nations people and to respect it.

Interjections in the Literature

Most studies on interjections consider them to be linguistic/verbal expressions of human emotions (Bloomfield, 1984; Padley, 1976; Wilkins, 1992), thus expressing the mental states or mental acts (Ameka, 1992; Goffman, 1981) of an individual. Within this perspective, *yuk* in line 01 could be interpreted as an interjection that refers to the speaker's mental state or mental act associated with disgust. The interjection *yuk* has in its semantic field the component *I feel something*, and if we narrow its signification within this framework, its component becomes *I feel disgusted* (Wierzbicka, 1992). Similarly, *uhm* also has the component *I feel something,* although this can be interpreted differently *depending on the context* (e.g., *I feel pleasure, I feel excitement*). Some studies classify interjections based on their functions (Jackobson, 1960; Lyons, 1977). According to these classifications, interjections refer to the exact nature of the mental state or mental act: (a) expressing emotions (emotive interjections), (b) expressing desire (volitive interjections), or (c) expressing cognition (cognitive interjections). However, according to the cultural-historical perspective I employ here, these classifications are not possible without a cultural and social analysis, which also takes into consideration the full

meaning potential of interjections as communicative acts, instead of pre-established representations of states of mind.

For instance, the interjection *yuk* can represent a feeling of disgust within a particular culture (English speakers). However it does not present the same meaning in other languages; in fact, in my mother tongue (Brazilian Portuguese), *yuk* simply does not exist. Previous studies have already pointed out that interjections may contain sounds that are not found in other words (Fidelholtz, 1979; Montes, 1999) or other languages. For example, Portuguese, English, and Q'eqchi' Maya (Kockelman, 2003) all have different interjections that are associated to feelings of disgust—"eco!" "yuk!" and "chix!" respectively—with different sounds and spellings[9]. That the interjections present meanings that are *culturally* associated to them is not what I question here; instead, I question the presuppositions inherent in the classifications of interjections as different states of mind that (a) analysts and interacting participants alike are able to "read" someone's mind through their utterances, and (b) that the meanings associated to interjections are fixed and immutable, and therefore they can be indisputably interpreted as representing a particular feeling, emotion, or cognitive status, irrespective of the (cultural, social, historical, personal) context within which the interjection is used.

[9] The function of *yuk* is culturally related to disgust in all those languages, although there are studies that make a distinction between the interjection *yuk* and the feeling of disgust (Haiman, 1989). According to Haiman, *yuk* would carry the components feel/want/do something, while disgust would carry the components say/want/say something. However, I would like to emphasize that I do not support this view, for reasons I have presented elsewhere.

Therefore, in this chapter I analyze interjections as communicative acts, in the sense in which McNeill (1985) considers language as action. That is, speech and accompanying nonverbal aspects of language are not seen as translations of the speaker's thoughts, but as action, the speaker's taking up a position in a world of significations. This approach radically changes the interpretations of interjections: They are no longer understood uniquely as expressions of feelings or emotions that can be attributed to people in diverse situations, but as communicative actions that have their own meaning arising from the cultural and social interaction within which they were performed. Moreover, interjections are a class of words that encode the attitudes of the speaker and his/hers communicative actions (Kockelman, 2003) and are bounded to the context of his/her speech. Therefore, the role of interjections in communication and the meanings associated to them depend on the context of speech and the context within which they are spoken, and as part of the speaker's communicative act, interjections can and in fact do carry meanings that go beyond the mere expression of feelings, emotions, or states of mind.

In this scenario, I discuss how interjections mediate students' interactions within the context of out-of-classroom activities. Since interjections are not meaningless utterances, I analyze their occurrence as communicative acts (McNeill, 1985) that are only meaningful within their communicative context (Wood, 2006).

Data Analysis

In the previous session I articulate my argument for rejecting a traditional view of interjections. Here, I explore the role of a specific interjection, "yuk," during students'

participation and interaction in activities that took place during a science fieldtrip. This particular interjection was the only one that was *exclusively* uttered outside of the classroom. That is, other interjections were used both within and outside of the classroom, but *yuk* appears in my dataset during the fieldtrips only. As specified elsewhere (chapter 2), I take a cultural-historical approach (Vygotsky, 1978) and I follow the principles of interaction analysis (Jordan & Henderson, 1995) and discourse analysis (Edwards & Potter, 1992) to conduct the analysis of the episodes.

Adjective(ing) an Interjection: Students' Communicative and Cognitive Engagement in the Activity

The following excerpts happened during a fieldtrip to White Bear Park[10], another popular site for school fieldtrips in British Columbia, and it shows interactions amongst group of students working collaboratively during their out-of-school experience. This daylong fieldtrip was planned by the teacher to provide students with the opportunity to learn about their local environment (e.g., wetlands).

The day before the fieldtrip, students were divided into groups (five individuals in each group) and each group was given a booklet. The booklets contained information about the kind of wildlife that may be observed during the fieldtrip as well as questions, pictures to be colored in, and blank spaces to include additional information from resources around the park. At the beginning of the episode, five students are gathered around a bench on a dock by the lake, where they are collecting water and animal

[10] Pseudonym.

samples using different kinds of nets and containers. In this context the following interaction happened amongst the students.[11]

Episode 1:

```
01 Jack:   Kelly, I've asked Nikki, [and, Norah
           ((Kelly approaches her group with a net full of algae, Jack
           turns his body towards her))
02 Nikki:                          [Didn't you already have it?
03 Jack:   No, I didn't
04 Pat:    <<p>[Oh, that's nasty!>
           ((Kelly drops the net on the bench where they were working))
```

[11] The following transcription notations are used:

01 – numbers on the leftmost column represent each turn at talk by different individuals;

Jack – names are pseudonyms used to identify the interacting participants;

, – commas represent pauses;

((*screaming and giggling*)) – italicized text within double parentheses presents a verbal description of actions enacted simultaneously with the speech reported on each turn of talk;

[Didn't you – square brackets on consecutive turns at talk mark overlap speech;

so:rry – colon in the middle of a word represents an elongation of the pronunciation of the phoneme preceding it;

<<p> oh that's nasty> – text within angle brackets and preceded by the letter p within angle brackets represents speech uttered in a lower volume;

<↑a:w> – text within angle brackets and preceded by an arrow pointing upwards represents speech uttered in a higher volume;

! ? – exclamation and interrogation marks are used to represent exclamations and questions, respectively.

05 Nikki: [I didn't have it

06 Pat: <<p> uhm [Ke:lly>

07 Nikki: [Ok you guys, where is this <↑A:[W>

08 ? [<↑a:w>

((*screaming and giggling*))

09 Jack: Nice!

10 Nikki: Yuk! Get the oh the yuk stuff out

11 Kelly: So:rry!

12 Nikki: That is just dis<↑gus>ting

When this conversation took place, Jack was looking for a sampling container that he had lost and asking other group members if they have seen it. In turn 01, Jack reports to Kelly that he had asked other group members about the whereabouts of his lost container. But by uttering "Kelly," Jack also announces Kelly's arrival at the site, thus including her in the group's interactions, not only by directing his speech to her, but also by updating her on previous conversations that unfolded within the group. Moreover, Jack also makes explicit that he is talking to Kelly (i.e., Kelly is his audience), which helps disambiguate his action, alerting other group members to the fact that even though they may already have heard Jack's asking Nikki and Norah about his container, he is now reporting this to the benefit of someone else, who presumably does not know about it yet.

Even though in turn 01 Jack explicitly refers to Kelly when talking, in turn 02 another group member (Nikki) reacts to Jack's comment. Nikki asks a question to Jack about the status of his (lost) container. Jack replies by confirming that he still does not have (i.e., found) his container (turn 03), and Nikki volunteers that she does not have it

either (turn 05). Meanwhile, Kelly continues approaching the bench and drops her net onto it, an action that provokes an immediate reaction from Pat (turn 04). Pat's utterance "oh, that's nasty" is a characterization of what is in Kelly's net. This is the first direct reference to the object that Kelly captured in her net (algae); hence at this moment, she introduces the object to the group. This introduction, however, is already framed in terms of a characteristic of this object: its nastiness. This characterization, as I show below, reappears in the conversation and, eventually, it will transcend its role of a characteristic (that is, an adjective) of the object to become a noun that defines the object in the absence of its proper scientific name (i.e., algae), which the students do not employ here.

Although Nikki (turn 05) continues talking to Jack, she eventually turns towards the entire group (turn 07) and acknowledges the net on the bench and its content, through the use of an interjection ("aw"). Here, not only does Nikki react to the presence of the object, but she also makes this reaction available to others through her vocalization of the interjection. The communicative role of this interjection is intensified by its abruptness, braking off the previous sentence being uttered. In this sense, the interjection marks a shift of focus: the conversation is now centered on the object inside Kelly's net.

Continuing to focus on the algae, in turn 10 Nikki articulates her interpretation of the object, again through the use of an interjection (*yuk*), which is immediately followed by an alternative use of the same interjection. The first use of *yuk* communicates Nikki's characterization of the object and how she engages with it; that is, she concurs with Pat (turn 04) in attributing nastiness as a defining property of this object. *Yuk* signifies (for English speakers, at least) disgust; as an interjection, therefore, *yuk* may indeed expresses

the reaction (emotion, feeling) to the object that is the referent of both Nikki's gaze and speech. But here, this interjection communicates Nikki's interpretation of the object to her peers, and ratifies the previous characterization of the object (turn 04). In this sense, the interjection is more than an expression of emotion: it embodies Nikki's cognitive being at the moment, her interaction with the object and her peers. That is, the interjection communicates Nikki's engagement and understanding of the object to her peers, thus making her cognitive effort concretely available in the situation; Nikki's evaluation and description (both cognitive processes) of the object is reified by means of the interjection.

The second time Nikki uses the term *yuk* it is articulated as an adjective to the object, but in a way that is constitutive of the object per se; that is, *yuk* here identifies the object. The *yuk stuff* is now synonymous with and a direct signifier (in semiotic terms) to the object in Kelly's net. In the absence of an appropriate scientific name for the object, the student resorted to the use of one of its adjectives (its "yuk" property) to name it. Thus, when Nikki says "yuk" (turn 10) she not only acknowledges the contents of Kelly's net and defines it (as the "yuk stuff" [turn 10]), transforming an interjection into an adjective and further on into a noun, but she also demonstrates her attentiveness to the object of study and her engagement in the activity (that is, her *cognitive being at the moment*). The *yuk stuff* was the object of study inasmuch as the students were required to collect samples from the lake, and Kelly's net contained a sample collected from the lake water. Even though Nikki did not use the proper scientific name of the object (algae), she engaged with it by evaluating, characterizing and defining it.

It is important to notice here that Nikki's two different uses of the interjection *yuk* are unproblematically understood by her peers, so much so that Kelly's reaction to Nikki's speech is to apologize (insofar as she was the one who brought the offending object to the group's attention) by uttering "sorry" (turn 11). This is further evidence for the communicative and interactive roles of the interjections in this situation.

Finally, Nikki articulates that the object "is just disgusting" (turn 12). The referent of "that," however, could be either the *yuk stuff* inside Kelly's net or Kelly's action of dropping the net on the bench. The particular referent remains unspecified in this situation, but the use of *disgusting* is coherent with the previous adjectives imparted on the object (or the action): *nasty* and *yuk*.

Therefore, my analysis demonstrates that the interjection *yuk* uttered by the student at that particular moment in the activity played an important role in facilitating the communication and interaction between individuals in the group, and it also provided a means by which the student's cognitive engagement in the activity was reified both to her peers and to the analyst as well. Considering interjections as communicative actions allows for a different interpretation of students' interactions with objects of study and with each other, which may be disregarded by teachers and analysts when interpreting students' participation and engagement in instructional activities.

I Say Yuk, You Say Yuk: Interjections Establishing Membership

The next episode happened during the same fieldtrip, just a few moments after Episode 1. Most of the students were working in groups, but one student, Laila, was by herself on the dock. The other students gathered around the teacher to collect additional

instruments for collecting water samples. Laila was bent over the water when I approached her and asked what she would collect next.

Episode 2:

```
01 Bruno:  What are you gonna collect now?
02 Laila:  Insects
03 Bruno:  Yu[k!
04 Laila:    [or not insects Uhm. Inve- O(:)h [I don't know
05 Bruno:                                     [Inverte-brates?
06 Laila:  Yeah! That's what I mea↑nt
07 Bruno:  uhun
08 Laila:  Not insects
09 Bruno:  All insects are invertebrates?
10 Laila:  <<p> No, I I actually didn't say inse↓cts>
11 Bruno:  A↑HN?
12 Laila:  <<p> I meant invertebrates, not insects
           ((she brings up the net from the water))
13 Laila:  Yuk! Yu:↑k! That's disgusting!>
```

My introductory question in this episode (turn 1), not only function as a conversation initiation, but it also alerted Laila of my presence. She acknowledges it by replying to my question, and thus accepting my invitation to talk, saying that she is collecting insects (turn 02). Although I am a biologist by training and have experience with different forms of living creatures, I am not particularly fond of insects. Thus, my reply to Laila's statement in turn 2 is "yuk" (turn 03). My use of this interjection at the beginning of our conversation opens up the possibility of maintaining an informal

conversation, where uttering interjections is acceptable and intelligible. As a biologist and educator I probably would have avoided the use of this interjection to refer to the object of study during a formal science lesson. Here, however, insofar as Laila and I are out in the field, in a more informal environment, our conversation happens more freely and I felt more comfortable using *yuk*. At this point of our interaction, because of the informal nature of the fieldtrip and of the format the interaction between Laila and I took place, I make use of language that I might not otherwise use in a scientific or an academic context, for example. Therefore, when I say *yuk* I am providing the possibility for Laila to say *yuk* as well, that is, to use the same form of communication as I did. Indeed, she does use this interjection later on.

My use of *yuk* also prompts Laila to correct her previous answer (turn 04). She says that she is not collecting insects, but something else that she does not fully articulate. However, the first syllables of the word are enough for me to provide an alternative to what I presumed Laila wanted to say: invertebrates (turn 05). She confirms in turn 06 that that was indeed what she meant. Then, I immediately acknowledge her answer with another interjection (turn 07), which functions here as an affirmative noun (similar to *yes* for example) and leaves space for Laila to take the next turn in the conversation. Laila acknowledges this and takes up the next turn (turn 08), repeating that she is not collecting insects. I then ask her if all insects are invertebrates (turn 09). Although she acknowledges my question she does not answer it; instead, once again, she affirms that she did not say insects (turn 10).

At this point in our conversation I use another interjection ("ahn?" [turn 11]), which functions to prompt Laila to repeat what she had said previously. Although I had heard what she had said previously, her utterance did not answer my question. Thus, instead of repeating my question to her, I simply make use of an interjection to communicate to her that I am still waiting for her answer. However, Laila still avoids answering my question, and with a softer voice, she says that she meant invertebrates, not insects (turn 12). This actually corresponds to an accurate and communicatively and socially acceptable response to the interrogative interjection I used previously; Laila repeats what she had said before, which is the expected reaction to someone's articulation (however poorly articulated it may be) of have missed what the interlocutor said (similarly to "what?" or, more politely, "pardon me?").

After saying that, she brings out from the water the net she was using to collect her samples and, looking to the net, she says "yuk" twice (turn 13), immediately complementing it with "that's disgusting." In this particular situation, Laila is not only identifying what is in her net as disgusting, but she is also taking advantage of a possibility that I had provided earlier when I first used *yuk*. That is, Laila accepts my invitation to talk *informally*, making use of interjections as legitimate words to express culturally and in this case situated meanings.

There is another aspect of the use the interjection *yuk* here: when I first use it, I am not only establishing the informal character of my conversation with Laila, but I am also using it as a *password* that may grant me access to Laila's group. That is, by saying *yuk* for the first time, I am *signing in* my membership in Laila's sociocultural and age

group. Fifth graders in particular and children in general communicate through interjections quite often, as I can attest from the various instances in which the students in my database make use of interjections. When I say *yuk* I am in fact using a language that is closer to the language that the students speak. Thus, at that moment, Laila and I are speaking the same language. Just like parents may change the way in which they talk to their toddlers and to their work colleagues, in my interactions with Laila, I used language that I would not use in other circumstances, with other interlocutors.

Thus, my analysis of Episode 2 shows how interjections mediate interaction within a particular cultural group, even and especially if the interacting participants do not belong to the same social group (*e.g.*, science instructor and students). This illustrates how interjections can be an example of the use of language and discourse as culturally and socially specific to achieve membership in a particular social or cultural group.

Yuk: Interjections as stance

In the previous sections I articulate two uses of the interjection *yuk* and how it mediates interactions amongst students, their objects of study, and other interacting participants (teacher, instructor). Next, I articulate how the same interjection can be used as a case of stance (Goodwin, 2007), when a member in the group takes position in relation to a particular situation. Episode 3 occurred near the end of the same fieldtrip of Episodes 1 and 2, as groups of students were filling out their booklets with information they had collected throughout the activity. One of the students, Jack, pulls a net full of samples out of the water and sets it down on the bench where his fellow group members were seated.

Episode 3:

```
01 Jack:   Here comes people Oh my Go(:)d!
           ((giggles in the background))
02 Kelly:  ↑Oh my Go(:)d!
03 Norah:  Jack, don't do th[at
04 Kelly:                   [You're just mess[y!
           ((giggling))
05 Nikki:                   [Uhm!
           ((giggles in the background))
06 Pat:    N↑ICE! Yu(:)k! Yuk! Yuk! Yuk! Yu[k!
           ((giggles in the background))
```

As this episode starts, Jack approaches his group with a net full of samples, and warns his peers about the object he is carrying: "Here comes people. Oh my God!" (turn 01). Jack's comments provoke laughter from the other group members. The group has already had an experience with the *nasty* nature of the things that came from the lake (e.g., in Episode 1, when Kelly brought a net full of algae to the bench around which the students were assembled). Thus, Jack's utterances also function here to alert his peers of the *nastiness* (a characteristic this group had used to identify the material collected) of what was on his net. The awe inspired by the contents of Jack's net is also made available through Kelly's words, after looking into the net. In a high pitched voice she says: "oh my God!" (turn 02), repeating and reinforcing Jack's previous exclamation.

In turn 03, Norah says "Jack, don't do that." As the only thing Jack is actually doing is placing his net on the bench, we can interpret Norah's request as a disapproval of Jack's bringing the net to the bench ("don't do that," therefore, refers to Jack's action,

and the negative particle in imperative form allows the interpretation of disapproval.) Kelly also utters her disapproval by stating that Jack is messy (turn 04). Pat, however, in turn 06, reacts quite differently: She exclaims "nice" and uses the interjection *yuk* repeatedly. In this situation, Pat diverges from her peers and, contrary to the reactions of Kelly and Norah, she seems to *celebrate* the nastiness of Jack's actions. The very same object that inspired awe from Kelly and disapproval from Norah is greeted by Pat with the word *nice*. The interjections in this situation are used as emphasis to the stance that Pat is taking within the group. That is, Pat positions herself within the group in direct opposition to the stance other members took in relation to the object in Jack's net and to Jack's actions. Even though the meaning of *yuk* may still be associated to the nastiness of the algae (what is within Jack's net), the role this interjection plays in this interaction is quite different than in the previous episodes. Here, the interjection is an exclamation that functions to establish stance (c.f., Goodwin, 2007) in the situation. The repeated exclamations of this interjection share characteristics with social and cultural acknowledged and established practices that enable us (the ones who share in this culture) to recognize them as "cheering" (for example, as when, during a birthday celebration, the name of the person whose birthday is being celebrated is repeated many times, as an incentive to do something, such as blow the candles, or simply to cheer this person in his/her special day). Therefore, we may interpret Pat's repeated exclamations of "yuk!" as cheering the referent to this interjection; that is, the samples in the net that Jack brought and laid on the bench.

Of particular interest, here, however, is not so much the fact that the interjections are used as a celebration, but the fact that they are used as a celebration of something nasty, which has provoked quite opposite reactions from other group members. Even Jack, when approaching the bench with the net full of samples from the lake, warned his peers that he was bringing it in. His warning can be historically understood, given the previous reactions that similar samples have provoked in his group mates (Episode 1). That is, Jack's words of warning refer to his peers' previous negative reactions to the *nastiness* of the objects in the net. But Pat does not react in the expected and by now usual way. In a formal school setting, Pat's reaction would more likely than not be met with an admonition from the teacher, as it would be considered disruptive. In Episode 3, however, Pat's reaction is not curtailed by formal rules of classroom interaction, because the students are engaged in a different activity, a fieldtrip, where the rules of conduct are acknowledged to be different than those at school. Thus, within this new setting, with different rules, Pat was able to express herself and stand in opposition to her peers towards the object of study. This stance is achieved mainly through the use of her interjection in yet a different manner, that this time conferred them (the interjections) a role of cheering and celebrating the very characteristics of the object that were repudiated by the others (i.e., its *nastiness* and *messiness*).

Discussion

It has been suggested that interjections present meanings that are bounded to the context of the activity (Kockelman, 2003). Others view interjections as expressions of an individual's own experiences and emotions; and claim that interjections have the function

of expressing people's mental states (Ameka, 1992). From my analysis of the use of interjection by the students during a fieldtrip, I concur with Kockelman (2003), as the interjections indeed carry different meanings and achieve different communicative tasks depending on the cultural and situated context in which they were used. However, I have also shown that, instead of expressing students' mental states, interjections can function as communicative acts that mediate interaction between peers, and, most importantly, reify the students' engagement and *cognitively being* in the activity. Communicative acts accomplish certain functions, which operate at the level of learned social interaction in and through which the speakers (e.g. students) convey their participation in the activity and communicate their understanding with other students, teachers, and in reference to the material at hand (i.e., the object of study).

In addition, I have also articulated three different aspects of the use of interjections, which render different functions to them that go beyond the expression of mental states or emotions, as often stated in the literature. First, students use interjections to describe the object of study, thus facilitating communication and interaction. The interjections may assume the role of nouns and adjectives, which describe and characterize the object of study. Moreover, through this description and characterization of the object, the students also communicate their engagement in the activity, that is, their focus on the task. Second, interjections can guarantee membership in different socio-cultural groups. In other words, the use of interjections by one speaker opens the possibility for other speaker(s) to use the same interjection, thereby establishing common grounds for communication and interaction. For example, when I talked to a student

using interjections, the interjections became a communicative tool that afforded me to recognize and accept as legitimate the particular way in which this student often communicates with her peers, but that is usually considered improper within regular classroom discourses. Third, the use of interjections allows students to position themselves within the group, either in accordance with or in divergence from the other group members' stances. Interjections may function to make explicit students' personal stances in relation to what may have become "the rule," that is, behaviors and opinions that are accepted within the group as the usual and perhaps most legitimate ones.

Students may not be prepared to fully articulate their engagement with the objects of study, their personal opinions (especially when these latter differ from the general common opinion within the group), and their interest in the activity through argumentation that is considered from an adult point of view as the most appropriate manner to communicate. In fact, children usually are more "economical" in their dialogues, making use of a variety of slang, expressions, and interjections to communicate with their peers. This, however, does not mean they have nothing to say; quite the contrary, interjections, as I have demonstrated here, may play various different roles in students' interactions with each other and with the objects of study, which may give important clues to teachers and adults who endeavor to talk to these children as for how to understand what the children are trying to say.

What about fieldtrips?

In the previous episodes, the analysis of how an interjection meditates interaction amongst participants need to be considered within the context into which it occurred, that

is, during a science fieldtrip. Due to the hands-on nature of the fieldtrip, students, being "unsupervised," have more autonomy, which is also evident on their speech, when they freely communicate to each other and use more informal language, which is suited for the specific circumstance. Thus, during fieldtrips, students are not as concerned about the rules of conduct (and the possible breeching of these that may be caused by their choice of language and behavior), which are typical for the classroom, such as, for example, the use of "appropriate" language. Rather, in out-of-classroom activities such as fieldtrips, students make use of a language that is their own, the language they commonly use amongst themselves, to converse with their peers. There is the presupposition that everyone in the group already understands what they are talking about (Roth & Middleton, 2006), but even given the particular case of the use of interjections, which have until recently being considered as mere adjuncts to communication, expressing solely internal psychological states and having ephemeral impact on the overall conversation and interaction, one can see that the communication between students is not only intelligible but accomplishes quite a lot in terms of their understanding each other, and communicating to each other meanings they make of the objects of study to which they orient themselves during the out-of-school activities. The particular characteristics of the fieldtrip afford students the possibility of using their own language to interact and make sense of the world around them, resorting to the use of words and terms (e.g., interjections) that they may be requested to avoid within the formal classroom environment. Whereas the specific learning opportunities that are also afforded by such an alternative to regular, in-the-classroom schoolwork still need to be further

investigated, my analysis in this study points already to some advantages of out-of-school activities over traditional classroom tasks, the most prominent of them all being the autonomy and freedom the students enjoy that is evident in their choice of language and attitudes within their work group, and which permits us (the adults, teachers, outsiders to these students' particular culture) to grasp some of their worldviews and ways of being, linguistically, cognitively, and bodily.

Chapter V – Monopolization during computer collaborative work: The making of science videos projects

In this chapter, I articulate how monopolization of mediational tools (e.g., computer and its components) is the outcome of students' interactions during computer collaborative work (CCW). My analysis reveals that the physical arrangement of computer environments affects participants' social interaction (i.e., peer collective work). I point out that the physical arrangement shapes not only different levels of individual participation (Roth, McGinn, Woszczyna, & Boutonné, 1999), but also a unique flow of information (i.e., students' mutual understandings about the task at hand) within the working groups. In addition, I introduce a diagram that illustrates the path of students' mutual understandings within CCW.

According to the Merriam-Webster Collegiate Dictionary, monopolization occurs when one person (or a group of people) assumes complete possession or control over an object or a conversation. Extending this definition to the classroom, I identify *monopolization in CCW* as a situation where an individual in a group of students controls an activity that is intended to be conducted collaboratively. In this case, the individual's actions are mediated by his or her close access to the mediational tools—i.e., one student has a longer period of time in contact with the mediational tools than other group members. To exemplify the phenomenon of study, I present episodes of a computer session where groups of four and five students worked together towards the completion of a science project using computers as a mediational tool.

The following excerpt illustrates monopolization in CCW groups where a group of grade five students work in the computer laboratory. In this episode the students share one single computer and their goal is to complete a science digital video project about a

fieldtrip they videotaped a few weeks before this computer session. At this point of their interaction, they already have selected the segments of footage that would be included into their final video clip. Hence, as a next step of the video production, the students articulate the transitions that should be added in between scenes:

	01	Maria:	Wait we have to fade out. Remember? Let's put fade out there.
➔	**02**	**Avril:**	<<p>Can I do something?>
	03	Tara:	No, we do^n't
	04	Maria:	Yeah we do, remember we wanted fade out?
	05	Tara:	Oh yeah, fade ↓out.
➔	**06**	**Avril:**	<<p>Can I do something?<p>

In this excerpt, Maria (a group member) asks Tara (another member of the same group) to wait since there is one transition effect to be added ("Wait, we have to fade out" [turn 01]). Maria also indicates that they had decided what the effect would be prior to this part of their conversation ("Remember?" [turn 01]). Using an imperative sentence, Maria seems to determine their next action ("Lets put"[turn 01]). Avril (another student in the group) expresses willingness to contribute to the project by posing a question to Tara (who sits right in front of the computer): "Can I do something?" [turn 02]. Avril shows the intention of doing something herself when she utters the personal pronoun "I." Tara, instead of answering Avril's request, replies negatively to Maria's suggestion of adding the transition (i.e., fade out): "No, we don't [have to fade out]" [turn 03]. Maria articulates their apparent prior commitment to fading out: "Yeah, we do, remember we wanted fade-out?" [turn 04]. Tara now seems to recollect their agreement: "Oh yeah, fade out" [turn 05]. Once again, Avril repeats her former request: "can I do something" [turn

06], evidencing that she had not received an answer or reaction to whatever she had requested.

In this episode[12], one student (Tara) sits closer to the computer than the other two (Avril and Maria), which in part may explain why Maria and Avril talk to Tara to get things done. Nevertheless, Tara monopolizes the tool for that time and Avril is not granted the permission she asks to participate in that activity at that moment. Additionally, the other group members also perpetuate the group dynamic by allowing Tara to behave in that manner. (At no moment was it specified by group members or the instructor what every student's level of participation would be.) Ultimately, one can learn from this episode that monopolization is not an attribute of individuals, but rather a feature that can emerge in and through social interaction in collaborative work situations. This aspect of monopolization of available resources I articulate further in this chapter, but, first I present a brief review of literature on computer collaborative work and dynamics of group work in computer environments. My intention here is not to overload the reader with an exhaustive and extensive literature review; rather I provide some definitions I use throughout and provide a brief background on the field to situate my study amongst previous research.

[12] There are two other members in this group who are not consulted by any other group members, these two students later on engage in parallel conversation.

Background on Computer Collaborative Work

In the last two decades, due to the rising number of computers in our society, educators increasingly have incorporated computer technology into their classroom (Gilles, 2003). However, because of the constraints of the use of computers in schools, such as the number of machines available per student and the fact that students can learn from their peers (Roberts & McInnereny, 2004), teachers who prefer using such technology during their lessons sometimes ask their students to work collaboratively.

For the purpose of this study, the term computer collaborative work (CCW) is used throughout and refers to the students' communities of practice in computer environments. These communities of practice presuppose learning and knowing as associated with social interaction of peers (Lave & Wenger, 1991). For instance, I identify the group of students engaged in this science digital video project, as communities of practice. I identify them in this way because their division of labor characterizes these working groups.

Aside from the constraints that teachers may sometimes find in computer environments (i.e., number of students per computer), peer collaboration during computer sessions becomes an appealing concept, because it opens the possibility for peers to learn *with* and *from* their classmates (Hwang, Roth, & Pozzer-Ardenghi, 2005). However, in the previous episode, I demonstrate that in a CCW only two students (in a group of five) might conduct the activity by themselves with less participation of other members. For example, in the previous episode, Tara and Maria conducted the activity that was

supposed to be constructed collaboratively. Acting in this way, Tara and Maria left Avril with no answers when she requested twice to participate in that activity.

Research suggests that in CCW, work ownership and control of the working tools are supposed to shift amongst group members to make collaboration more democratic (Blatchord et al., 2003), That is, when students work together sharing one computer, they should take turns with the machine and articulate their own understandings about the activity to achieve the group goal. Within their working groups, students talk about the activity at hand. In so doing, students make available for each other their own understandings about the activity itself. Therefore, while interacting with peers, the students coordinate their talk such that they construct a joint (a common) understanding of the activity they are engaged in.

In this context, during CCW, the individual understandings (opinion/information) of each member of the group will be processed into the computer as a common understanding of the group as a whole. The results of this processed common understanding should fulfill each individual's desire within the group. To achieve such common understanding, it is expected not just by educators but also by the learners themselves that when peers work collaboratively using a computer as a mediational tool, they will interact in a way in which every individual will have an opportunity to articulate their own understandings about the subject of study (Roth, McGinn, Woszczyna, & Boutonné, 1999). However, as I articulate further in this chapter, work ownership and mediational tools shifting amongst group members, which is supposed to happen to create a more democratic environment, do not always take place in CCW. On the

contrary, only one individual within the group monopolizes the mediational tools. Such monopolization can compromise students' social interactions. If this is the case, monopolization of the mediational tools during CCW becomes an important issue that has not been yet addressed in the literature.

The purpose of this study therefore is to explore the issue of monopolization of mediational tools during CCW activities. More specifically, I am interested in how computers, as central tools in collaborative work mediate monopolization within working groups.

The Meaning of Collaborative Work

Due to the fact that instruction involving CCW is part of the daily life in schools, research on this subject flourished mostly in the nineties – due to the "boom" of technology in schools, along with other interests in a variety of related curricular structures such as small group learning (Roth & Bowen, 1995), cooperative work (Slavin, 1991), and learning communities (Holmes Group, 1990). However, the current literature remains uncertain of the differences of some terminologies, such as cooperative and collaborative (Dillenbourg, 1999; Roberts & McInnereny, 2004). Moreover, the terminology for working and learning groups is also unclear (Dillenbourg et al., 1996; Graham & Misanchuk, 2004). Hence, for the present study, I use the term *collaborative work* to define a group of students working together to achieve a certain pre-determined task, under the supervision of an instructor or a teacher. Aside from the differences in terminology as well as problems that may occur during CCW, research traditions all agree that working in groups is worthwhile.

Monopolization and Group Dynamics in Computer Setting

Although studies have demonstrated the benefits of collaborative work in computer environments (Calderón, Hertz-Lazarowitz, & Slavin, 1998), setting students to work in groups using computer does not mean that collaboration will happen. In theory, CCW groups should involve children as co-learners (Zajac & Hartup, 1997), not just one child helping another (Blatchord et al., 2003), or one single individual controlling all the decisions for the group. If this is the case, CCW may not fulfill teachers' and students' expectations.

One of the problems that may affect CCW groups is how students engage in a particular task at hand (Johnson & Johnson, 1999), which means that the students involved in group work should understand how they are expected to work together, for example, taking turns with the working tools. Additionally, students are not always taught the social skills necessary for collaborative work (Johnson & Johnson, 1987). The social skills that mediate communication amongst peers include: listening to each other during group discussion, acknowledging other's ideas and considering their ideas, stating ideas freely, and resolving conflicts democratically (Johnson et al., 1997).

In addition to problems that educators and learners may find during collaborative work, such as group structure, social skills, and grouping size and composition (Egan, 1997; Johnson & Johnson, 1999), other studies on group dynamics during computer sessions have identified that (a) in face-to-face interaction during computer sessions, teachers might observe a low level of discourse amongst participants and; (b) due to different backgrounds of the students involved in the activity, they may experience

confusion when facing different kinds of technology (e.g., computers) and even anxiety about the working group itself (Miller, Trimbur, & Wilkes, 1994). More so, the constraints mentioned above can be increased by a number of factors such as, the number of students/computers, the layout of the computer room, and how students are arranged around the machine (physical arrangement). If this is the case, it is likely that students may manage the mediational tools differently. For instance, if not monitored by a teacher or an instructor, a certain individual within a CCW group may take charge of processing the common understandings of the whole group into the computer for a longer period of time than others, thus increasing the possibilities of monopolization of mediational tools.

Most noticeably, amongst all these issues mentioned above, the facts that some peers may monopolize the mediational tools more frequently than others and that such monopolization is the outcome of peers' interaction have not been yet addressed. Hence, this study begins to fill a gap in the literature.

Aside from the constraints of CCW, research has suggested that the use of computers in education can positively affect teaching and learning in elementary schools (Norris, Smolka, & Soloway, 2000). It is often accepted that collaborative work environments, such as CCW, are more democratic media for educational exchanges than conventional learning environments.

From a cultural-historical perspective, much of the interactions and peer collaboration that happen in CCW are mediated by a computer (Staarman, Aarnoutse, & Verhoeven, 2003), hence, as tools in human activity, computers constitute central moments of thinking and cannot be seen apart from the cultural-historical determined

forms of activity in which human subjects participate. Thus computers mediate the group's thinking inasmuch as thinking mediates the use of the computer tools, thus these two modalities cannot be understood apart from each other.

In this context, this study contributes to an understanding of the diversity of the problems that occur when students work in groups in a computer setting. The five CCW groups I videotaped during 15 computer sessions provided me with substantial and unique material to understand students' interactions when they share their mediational tools.

Findings

Previous studies observing CCW groups focused on group size, peer skills applied to technology and computer environment settings. However, they have not yet addressed some aspects of monopolization of the mediational tools (e.g., computer), such as how monopolization emerges during CCW groups as well as the path of students' common understandings of the task at hand within a CCW group.

In the following sections, I illustrate monopolization of mediational tools within CCW using episodes extracted from my database. I shall present my findings in the form of two assertions: *(a) the path of students' common understandings within CCW groups is influenced by the physical arrangement of students around the mediational tools*. In this assertion, I first describe the physical arrangement of students around the computer, that is the positioning of the students in relation to the machine as well as in relation to their peers. Second, I demonstrate the path of student's common understanding of the working groups, suggesting a diagram that represents the path of such common

understanding, that goes from the CCW groups to the computer. *(b) Monopolization of mediational tools as an outcome of students' social interaction*. In this assertion, I articulate that monopolization of mediational tools that occurs within a CCW is an outcome of students' social interaction. Along with these students' social interactions, I articulate how emblem gestures[13], physical contact and verbal communication mediate monopolization of mediational tools in CCW groups.

As specify elsewhere (chapter 2), I follow the principles of interaction analysis (Jordan & Henderson, 1995), discourse analysis (Edwards & Potter, 1992) and a cultural-historical approach (Vygostky, 1978) to conduct the analyses of the next episodes. These episodes illustrate a group of five students interacting during a science activity in the computer laboratory. Although there were four other groups working in the room, I decided to use the interactions of one solitary group to exemplify the phenomenon under study. Even though I present episodes of a single working group, my findings should not be taken as an isolated phenomenon. On the contrary, these participants are the concrete realization of possibilities available to all others in similar environments.

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[13] McNeill (2000) uses the OK sign to exemplify emblem gestures –made by forming a circle with the forefinger and thumb in contact at their tips, while the rest of the fingers extend outward, which can be made with speech or not. The emblem gesture, like a word, is constrained to assume a certain "phonological" shape. The same concept is applied to the gesture of holding index finger towards mouth implying silence.

Assertion I - The path of students' common understandings within CCW groups is influenced by the physical arrangement of students around the mediational tools

A few weeks after the science fieldtrips, where the students had a chance to videotape up to 30 minutes highlighting their experience outside the school environment, their teacher and myself brought them to the computer laboratory in their school. There, I requested them to get together with their former groups (i.e., the same ones that worked together during the fieldtrip), to edit a final version of their video using software for movie edition (iMovie™).

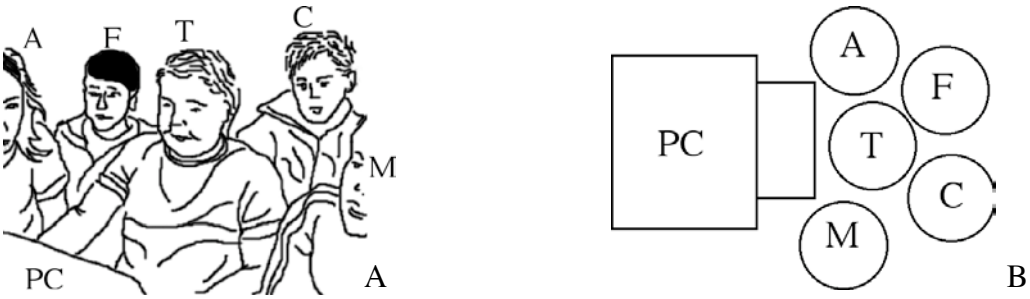

Figure 5.1a. Physical arrangement of a CCW group (PC- Computer, A-Avril, F-Fernando, T-Tara, C-Casey, M-Maria) working towards the completion of a science digital video project. Bird eye view detailing student's (circles) positions in relation to each other and in relation to the computer (PC).

A group of five students physically arranged themselves in front of a computer (PC) as shown in Figure 5.1a. Noticeably, some students are seated closer to the machine, a fact that may have provided them with easier access to its components, while others are seated slightly further away, a fact that may have made difficult their access to the computer. Additionally, I use symbols and bird's eye view, Figure 5.1b to detail the

positioning of students within this CCW group, where the circles represent the students and the rectangles represent the computer.

As illustrated in Figure 5.1a, Tara (T) seats herself directly in front of the computer screen (PC), while all the other students are arranged around her. Maria (M) and Avril (A) seat on Tara's right and left side respectively, while Fernando (F) and Casey (C) seat behind Tara, as detailed in Figure 5.1b. Given their proximity, Tara, Maria and Avril could possibly reach the machine more easily than Casey and Fernando, who are seated further back, away from the computer, and behind Tara, Maria, and Avril.

As articulated in this chapter, during collaborative work, students have chances to talk to each other, and articulate their own understandings about the activity at hand. When a computer mediates students' interactions, the working group arrives at a common understanding (the group ideas agreed upon about the work at hand), therefore, these common understandings become the information that will be processed into the computer. It was indeed observed in the CCW group that I introduced in Figures 5.1a and 5.1b that throughout this computer session, group members articulated their own understandings about the task at hand. Through their shared understandings, this same group achieved a common understanding that was satisfactory to every individual in the group. This mutual understanding was further processed into the computer, by only one individual within that CCW group.

For instance, as illustrated in the diagram (Figure 5.2), the five members from this CCW group (Tara, Maria, Fernando, Casey, and Avril) articulated their individual understandings about the activity they were engaged in. They arrived at a mutual

understanding that represents the agreed ideas of the group as whole. Since Tara was the student who seated closer to the computer, she is in charge to input all the agreed ideas of the group into the computer. Therefore, the students' common understandings, which in the diagram (Figure 5.2) are represented by the black arrows, first have to go through one single student (e.g. Tara), to further be processed into the machine. Finally, students' common understandings leave the computer (as an outcome of their activity) in a digital movie format, which is the group's final product.

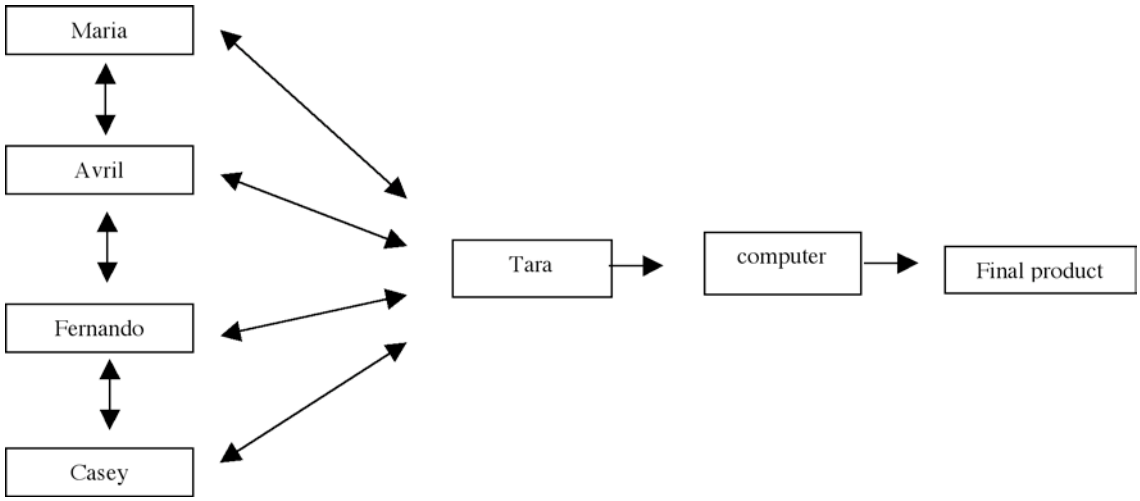

Figure 5.2. Diagram illustrating students engaged in CCW groups. The information or student's common understandings (represented as black arrows) that needs to be processed in the computer first has to "go through" Tara before being finalized into the computer. The individual in charge of processing the information into the machine is the student directly in front and closest to the computer.

In summary, student's physical arrangement around the computer supported a unique path of student's common understandings from the working groups to the computer. That is, before being processed into the computer, the group's common

understanding has to go through a single student (normally, the one who seats closer to the computer).

The physical arrangement of the students around the computer may have facilitated the monopolization of the mediational tools (e.g., mouse, computer screen and keyboard) by one of the group members. For instance, the fact that Tara was positioned closer to the computer than the other members gave her opportunity to input students' common understanding of her group into the computer, and may have helped her to manage the computer throughout the whole computer session.

In addition, my study is grounded on the assumption that every student within a working group is responsible for making the situation what it is and the outcome of their collective project depends on how they interact with each other. Hence, the fact that Tara was in charge of processing the students' common understanding of her group into the computer may have facilitated the occurrence of monopolization of the mediational tools. Therefore, in the next assertion I articulate the fact that monopolization of the mediational tools is a result of students' social interaction. I use examples of students working collaboratively to illustrate that body movements, emblem gestures, physical contact and verbal communication can contribute to monopolization of mediational tools within CCW groups.

Assertion II – Monopolization of mediational tools as an outcome of students' social interaction

Throughout the unfolding of the computer sessions, students' talk about the activity itself was coordinated by the close physical presence of the computer and its

components such as the computer screen, keyboard, and mouse. The physical arrangement of students around the computer as shown in Figure 5.1a and 5.1b allowed their interaction with each other through verbal and nonverbal communication (pointing to the computer screen and touching peers, for example), and these communication features represent important attributes of scientific talk (Goodwin, 1986), contributing to the sense-making in classroom conversation. Therefore, in this section I describe how verbal and nonverbal communication can contribute to the monopolization of resources within CCW.

My findings uncover four different ways of students' social interaction that contribute to monopolization of the mediational tools, thus, the foregoing description shows that body and verbal communication play a central role in providing/inhibiting the access to the computer input/output devices. Hence, in this section I articulate these four types of interactions to finally conclude that the monopolization that may happen within CCW groups is an outcome of these four types of interactions (or a combination of them).

Body movements as a way of collecting information from peers

During CCW, the computer represents a common focal point that can be touched, pointed to, as well as referred to through verbal communication. Such behaviors facilitate and support interaction amongst students (Roth, Woszczyna, & Smith, 1996). However, as I articulate in this section, the physical arrangement of group members around the computer and how they move their bodies within their working groups may interfere in the group social interaction. In other words, depending on the way individuals move their bodies in front of the computer, students can constrain peer participation in the activity

by blocking their peer's vision of the computer screen, which may contribute for decreasing their participation in the actions that may be happening in the computer screen. Additionally, body movements of peers during collaborative work are evidence of students collecting information from other members, which means that they articulate their individual understanding to achieve a common understanding of the group. This aspect of body movements I exemplify next.

Figure 5.3 illustrates a CCW group formed by the close presence of the mediational tool in relation to the group members. In this example the one student, Tara (T), seats directly in front of the computer, while other four group members seat around her. Wherever Tara may turn her body, she either faces the computer screen or the other students. In this way, Tara might physically block the vision of Casey (C) and Fernando (F), who are other group members sitting behind her, thus further back from the computer.

It is illustrated in Figure 5.3a that Casey is sitting away from the computer in relation to Tara and Maria. If he needs to reach any of the computer components he may find several situational difficulties, because of his location in relation to the computer and to his colleagues. Figure 5.3b illustrates Tara turning her body towards Casey. In so doing, three different things happen: (a) it demonstrates that Tara is aware of Casey's presence, a fact that is evident because she talks to him, (b) Tara talks to the other peers, collecting information to process into the computer, and (c) when Tara turns her body towards Casey, she may block Fernando's vision of the computer screen, who is also sitting behind her. If this is the case, Fernando may have his participation limited by

Tara's body. Figure 5.3c illustrates the same thing happening, but this time, the student who may has the vision blocked is Casey, because Tara now, turns her body towards Fernando. When this body movement happens, it increased the interaction that Tara has with the computer, while Fernando's and Casey's continued participation of the events on the screen is decreased.

Tara's frequent changing body position frequently in the group, exemplifies her autonomy upon her colleagues, because, in doing that, she is mostly collecting information from her peers to be processed into the computer. Tara's autonomy within her group may be explained by her closer contact with the computer than her colleagues. I cannot presume that Tara moves her body consciously to block her peer's contact with the computer, but my findings reveals that in doing so, she may limit other's participation in the event that may occur in the computer screen at that moment.

Figure 5.3. In CCW groups, physical movements of its members may interfere in peer participation.

In summary, body movement of students within CCW groups demonstrates their awareness of other group members. In my previous example, Tara's body movements are evidence of this awareness; more so, it demonstrates that she collects information from her peers. In this way, during CCW one student may turn his/her body towards different peers, talk to them, articulate their own individual understandings to achieve a common understanding that represents the group's agreed ideas that will be finalized in the

machine. As I previously articulated, the one student who is in charge of processing the common understanding of the group into the machine is likely the one student who monopolizes the mediational tools.

Previous studies had demonstrated that during lessons, the fact that students use gestures and talk at the same time is important to peers to develop science talk (Roth, Woszczyna, & Smith, 1996). It was observed in the CCW groups I followed that verbal and non-verbal communication mediated students' social interactions throughout their activity in front of the computer. Along with these students' social interactions, I articulate in the following sections how emblem gestures, physical contact and verbal communication mediate monopolization of available tools in CCW groups.

Emblem gestures

Emblem gestures are gestures in which the principal function is to carry out certain social activities. They are complete speech acts, but the speech acts they perform are restricted to certain functions only. For example, they make promises, swear oaths, etc. They can be used to salute, command, request, reply to some challenge, insult, threaten, seek protection, express contempt or fear, and so on (McNeill, 1999). Thumbs up means good, thumbs down means bad, index finger held towards mouth means silence; these are all examples of emblem gestures.

In this context, I present the next episode that exemplify the fact that emblem gestures, such as holding index finger towards mouth, can mediate monopolization of working tools within CCW groups. The next excerpt illustrates two students articulating their understandings about the videos that have been displayed on the computer screen.

At this point in the computer session, the groups have finished uploading the videos into the computer, and they are now selecting only the clips that will be used for their final product, which is a science digital video in a DVD format.

Figure 5.4. Tara points her index finger towards her mouth (emblem gesture) asking the other students in her group to be quiet.

	01	Maria:	We can have it(.) We can have all the clips,
	02		because it's like [two (3.0)
	03	Tara	[There ***((points index finger***
	04		***to the screen))***
	05	Maria:	two…
	06	Tara:	I know
	07	Maria:	Two minutes [and
	08	Tara:	[<<p>**Sh!**> ***((holding index finger***
→	09		***to mouth – emblem gesture))***
	10	Maria:	[twenty five seconds ↓
			(53.0)

In this excerpt, Maria says that they can have all the clips uploaded into the computer—they have already used as much time as they are allowed for their final product (turns 01 and 02). However, Maria does not finish her sentence because, Tara

cuts off her speech saying “there” (turn 03) while pointing her (Tara’s) index finger to the computer screen. In so doing, whatever Tara showed Maria was being displayed on the computer screen. Maria now finishes her sentence saying “two” (turn 05), meaning that they can have all the videos uploaded into their final product because all the videos they have are already two minutes in length (they were supposed to edit 2 to 3 minutes from the 30 minutes of their footage).

Tara agrees with Maria when she affirms that she knows that they can use the clips suggested by Maria (turn 06). Then, yet referring to the length of their video clips, Maria says “two minutes and” (turn 07), but once again Tara interrupts Maria’s talk with a request for silence, which she accomplishes in a very particular way. She cuts short Maria’s talk with two physical actions. First, she points her index finger towards the computer screen, (action repeated for the second time) and then she rises up the same finger towards her lips, which is an emblem gesture signifying silence. In so doing, Tara makes available for Maria that she should be in silence at that moment. The emblem gesture used by Tara is illustrated in Figure 5.4, which details Tara with her index finger held towards her mouth. At this moment, Tara did not say a single word besides the interjection *sh!*. However, because of Tara’s emblem gesture, Maria not even finished what she was previously saying. Instead of working on choosing the clips that would be part of their final video as Maria was suggesting in the beginning of this episode, Tara gazes at the computer screen and take no action for a period of 53 seconds. Tara’s action (emblem gesture followed by her gazing at the computer screen) mark the end of the discussion on the topic because they do not talk about Maria’s suggestion when she said;

"We can have all the clips" (turn 01). At this point in their interaction, Maria had her participation regulated by Tara, because she interrupts Maria's speech twice as demonstrated in turns 03 and 08.

From this episode I conclude that students manage not to be interrupted while taking actions—and they can accomplish this through an emblem gesture, such as holding index finger towards mouth, meaning silence. In this way one student can manage to be in charge of group member's participation in the activity. Additionally, this previous episode illustrates that participants in a CCW group act in certain ways because other members allow him or her to act in that way. For instance, this episode could have ended differently if instead of just accepting Tara's request, Maria had insisted in debating about the length of their video clips.

Physical contact

In CCW, monopolization of mediational tools is a result of social interaction of group members. In the previous section I articulate how body movements and emblem gestures mediate monopolization of available tools within CCW. Next I present another episode of group interaction that illustrates how physical contact amongst group members may also mediates monopolization within CCW. The following episode happened towards the end of this computer session when Tara and Maria were discussing the final steps of their video production.

Figure 5.5. Tara pushes Maria's hands away from the computer (PC) when she tries to reach its mouse.

01	Tara:	↑No::
02	Maria:	I am j^ust doing something.
03	Tara:	Maria, ↑no:↓:

Tara seats right in front of the computer screen, and Maria seats on her left side. Maria (M), without saying a word, reaches for the mouse of the computer with her right hand. Then, Tara (T) looks at her and says "no" (turn 01). Maria argues with her, claiming that she was just doing something (turn 02), and, for a second time, Maria reaches for the computer. However, Tara interrupts Maria's action with a physical contact. Tara pushes Maria's hands away from the machine. This physical contact between the two students is detailed in Figure 5.5, where Maria's action (reaching for the mouse) is interrupted by Tara's hand. Tara's action is followed by her saying " Maria, no" (turn 03). After having her participation inhibited twice by Tara, Maria does not react to her imposition, allowing Tara to use the computer at this point in their interaction.

In summary, monopolization of mediational tools is an outcome of students' social interaction and physical contact that may happen amongst group members, and it is an example of social interaction that mediates such monopolization. Finally, I present the

next episode to illustrate that verbal communication also mediates monopolization of mediational tools during CCW.

Verbal Communication

In this next excerpt, the CCW group discusses the transitions to be used in between clips in their final product. Tara is still seated in front of the computer while Maria is at her left side. They discuss about the kinds of transitions available for them in the movie edition software, when a third student, Casey asks if he could help them.

➔	01	Casey:	<<p>Can I help?>
	02	Maria:	Almost done.
	03	Tara:	Oh, it is done.
	04	Maria:	Let's just see it.
	05	Maria:	There
	06	Tara:	Yea(.)h.
➔	07	Casey:	<<p>Let me. Let me help?>
➔	08	Tara:	Casey, you guys a(.)re.

Casey, who seats behind Maria and Tara, asks them (with a very low pitch in his voice) if he can help (turn 01). In uttering that, he makes available for his peers his presence in the group and he declares his intention of getting involved more directly with the activity. Neither Maria, nor Tara acknowledges his presence or his request to help. Maria does not reply immediately to him, instead, she tells Tara that they are almost done (turn 02). Then, Tara agrees with Maria when she affirms that they are done (turn 03). Maria invites Tara to watch the video (turn 04). Then, she shows Tara the video: "there"

(turn 05). Tara acknowledges when Maria showed her the video: "yeah" (turn 06). In saying that, Tara indicates to Maria that she understands both Maria's request for watching the video and the presence of the video on the computer screen.

For the second time, Casey articulates his intention of helping by producing another low-pitch utterance: "Let me. Let me help" (turn 07). Tara finally acknowledges Casey's presence in the group as well as his request to help by replying to him: "Casey, you guys are" (turn 08). Even though it is Casey who makes the two requests, Tara talks to him as if he was voicing the desire of participation of a larger "unsatisfied" group, when she uses the personal plural pronoun *you* follow by the verb *are*: "you are already helping" (turn 08). In the first case, Casey puts the question in a manner that evokes the idea of an "offer" to help. In the second case, he is asking for permission to help, thus reinforcing his willingness to contribute—originally expressed in turn 01—and his desire to do so. Tara refers to the whole group when she utters, "you guys are." Here, no matter what the other members are doing, or how much they had contributed to the work until that moment, Tara's response is dismissive in that it affirms that whatever they wanted to do is actually being done—i.e., there is no reason for doing something different (they are already helping).

In this session, I am conveying how through their verbal communication, peers' social interaction mediates monopolization of the mediational tools within CCW. In this last episode, one of the group members is asking permission his peers to do the work that was supposed to be done collaboratively. Additionally, the entire group dynamics creates the situation and division of labor in the way it is, because every single individual accepts

that Tara uses herself the computer for the entire computer session. When Casey asked permission to the peer who seats closer to the computer (Tara), he empowers her control over the computer.

Discussion

In this chapter, I first describe the physical arrangement of CCW groups around the mediational tools and how this physical arrangement supports a unique path of students' common understanding that travels from the working groups to one single student (the one who is seated closer to the machine) to be processed into the computer, to finally leave the computer in a digital video format. Second, I articulate that monopolization of mediational tools that may happen in CCW is an outcome of students' social interactions, in the sense that only one student has (perceptual, agential) access to the computer, whereas others are limited in their levels of access, willingly the actions of one single student (e.g., Tara), therefore have contributed to what I call in this chapter monopolization of mediational tools.

Specialists in CCW have identified a number of factors that can constrain group dynamics in computer environments, such as a low level of discourse amongst peers. Additionally, studies have pointed out that confusion and anxiety from the student's part, that can be generated by a number of factors, for example, the number of students in the groups and the layout of the computer setting (Miller, Trimbur, & Wilkes 1994; Webb, Ender, & Lewis, 1986). However little is yet known about monopolization of the mediational tools in CCW, hence, my study contributes to the literature as well as to the understanding of the diverse problems that can occur when students are working

collaboratively sharing their working tools. In this chapter I explore some aspects of monopolization of mediational tools during CCW. Specifically I investigated student's social interactions within CCW and how their interactions mediate such monopolization.

In general, teachers tend to place value on activities in which students work together to accomplish shared learning goals and to arrive at the solution of a given task. If this is the case, the understandings of every single student within the group meet others students' understandings and at this point they have to negotiate their ideas, assumed to be common ideas/understandings of the group as a whole. Additionally, I grounded my study on the assumptions that when students are working collaboratively, every individual within the working groups is responsible for making the situation what it is, depending on how they interact with each other. Thus, in this chapter, I used episodes of students' interaction in a computer environment to exemplify the fact that monopolization within CCW is dependent on student's social interactions.

Having a cultural-historical perspective to conduct the data analyses of the presented episodes, I explored my findings in the form of two assertions: *(I) the path of students' common understandings within CCW groups is influenced by the physical arrangement of students around the mediational tools*. In this assertion I described the physical arrangement of CCW around their mediational tools. I argued that the physical arrangement supports not only different levels of individual participation but also a unique flow of students' common understandings that goes from the group of students to one individual within that group (the one sitting closer to the computer), who processes it into the computer, and it finally leaves the machine as a final product, which in the case

of this study was a science digital video. *(II) Monopolization of mediational tools as an outcome of students' social interaction*. In this assertion I articulated that monopolization of mediation tools that may occur in CCW is a result of participants' social interactions.

In this study I identify four types of students' social interactions: (a) *Body movements, as a way of collecting information from peers*, where the students who have easier access to the tools may block other member's vision through their body movements, which is akin to what Roth, Woszczyna, and Smith (1996) had found in previous studies. However, my study adds that the same student who blocks peers' vision is likely the one who is in charge of collecting information from his/her peers, and processing this information (student's mutual understandings) into the computer. (b) *Emblem gestures*, where, one single student can manage to be in charge of the working tools by employing gestures that signify silence, for example, holding index finger towards mouth. (c) *Physical contact*, where one single individual manages to monopolize the mediational tools by physically pushing peers away from the tools. (d) *Verbal communication*, where one group member may exclude peers from participating in the activity at hand, by silently denying their access to the computer. In this context, my analyses revealed that monopolization of working tools is not an attribute of individuals, but rather a feature that can emerge in and through social participation in collaborative work situations.

Previous research on collaborative work in computer environments has shown that the computer facilitates group discussion by providing a common focal point that can be touched and pointed to (Roth, Woszczyna, & Smith, 1996). My study indeed confirms

this aspect of CCW. However, I also found that the computer environment may constrain the possibilities for learning of those who do not have direct access to the computer. The fact that some students might had been excluded from the activity can be a result of the physical arrangement of the students around the machine, determining unequal levels of peers' involvement in the activity. In other words, students' engagement in the activity depends on their position within the group and their distance to the artifacts, which is akin to what Roth, McGinn, Woszczyna, and Boutonné (1999) had previously described. For instance, it was observed that the students who are sitting behind and further away from the computer engage less actively, thus enrolling in parallel activities, such as conversation with members of other groups. That is, group members that are seated together, their physical arrangement can constrain their communication (Roth, McGinn, Woszczyna, & Boutonné, 1999).

In my study it was noticeable that the students who were sitting further away from the computer engaged less actively, engaging in parallel conversation with other group members, which confirms previous studies on the subject. Such behavior may be a result of peer exclusion while the person sitting closer to the machine manipulate the computer components, which was suggested by Roth, Woszczyna, and Smith (1996).

In CCW, the individual on the keyboard can be assisted by other members of the group through verbal and nonverbal communication (Roth, Woszczyna, & Smith, 1996). However, in the groups I followed, the students who sat closer to the computer, took over the activity and did most of the work that was supposed to be done collaboratively. My findings are akin to the Roth, McGinn, Woszczyna, and Boutonné (1999) study because

in the example I provide in this study, one student (the one closer to the computer) dominated the computer for a noticeable period of time, while group members sitting further back away from the computer engaged in off-task activity.

Previous studies had demonstrated that group size could affect students' participation during CCW (Johnson & Johnson, 1999; Roth, Woszczyna, & Smith, 1996). These studies detailed that in collaborative groups in which the number of individuals exceeds four members, some individuals may be excluded from the actions that may happen on the screen due to the physical arrangement of participants, which is akin to my findings. Additionally, I point out that there are other social interactions such as body movements blocking peers' vision, emblem gestures and verbal communication amongst participants that might contribute to this exclusion of peers, as I articulate in my second assertion.

My findings reveal that the constraint of computer settings is contradictory to what Kaput (1992) had described, who argues that the computer work environment indeed gives students opportunities to interact more often and freely to each other than the formal classroom settings. However, the physical arrangement of the working group members can represent a constraint on peers' interaction in the sense that they may have different access to the mediational tools, which can lead to the monopolization of these tools by some.

Additionally, previous studies have articulated that when groups of students are asked to work collaboratively, it is realistic to expect that they will spend nearly half of their available time dealing with the emotional aspects of their social interactions

(Schmuck & Schmuck, 1979). Adding to these ideas, my study reveals that monopolization of the working tools during CCW can be a contributing factor to students' conflicts during collaborative work when they have to deal not only with their own emotions but with their peers' emotions as well. An altercation amongst students at the end of their project suggests disappointment by some group members because of the monopolization of the working tools. However, I point out the need of further studies on student's emotions in the presence of technology, because my study did not focus on this aspect of CCW.

More so, resistance amongst group participants during CCW is seen as an important fact for students' interactions (Brown & Palincsar, 1989). If the example of Maria arguing with Tara when she showed intention in using the mouse of the computer, claiming that she "was just doing something" represents resistance from Maria's side; their argumentation at that point may have happened because of the occurrence of monopolization of the working tools at a certain point of their interaction. In other words, when students are engaged in CCW, having a computer as their tool for mediation, and depending on the physical arrangement of the working group, some peers will use this tool more often than others. If this is the case, other group members may have their participation reduced throughout the activity, thus their spoken ideas become restricted. Even though resistance may occur between group members due to monopolization of working tools, team work was still a concern during this science digital video project, which can be seen when one of the peers (Casey) asks if he could help in the activity that was happening in the computer screen.

I suggest that CCW should be careful planned in a manner that students can have equal chances for participation and management of the working tools. In a computer environment, due to its physical arrangement, different peers tend to engage differently in the activity at hand. Finally, I suggest that group work does not always contribute to the improvement of lessons, as the literature generally suggests (Hilke, 1990), because it depends on how individuals within their working group interact with each other. I also point out the need to continue to pursue research that will provide insight into ways of developing collaborative working situations that can contribute effectively to the knowing and learning of students during science lessons.

Notes

*Images were extracted from pictures taking during the activity in the computer lab, and they represent the participants in this project.

**Transcriptions conventions have been used: ↓ and ↑- upward and downward in pitch; (3.0) – time in seconds; (.) – noticeable pause of less than 0.10 seconds; <<p>> - lower than normal speech volume; (( )) – double parentheses surround transcribers comments; [- square brackets in consecutive lines indicate the beginning of overlapping speech; ^ - upward in pitch of just one syllable in a word.

Chapter VI – Conclusion

The purpose of this thesis is to explore teacher-student and student-student interactions during out-of-classroom science projects. Data was collected in the context of five science fieldtrips conducted by a classroom teacher and fifteen computer sessions conducted by myself in a public school in British Columbia. Hence, my database is formed by my personal fieldnotes, videotaped science fieldtrips, and videotaped computer sessions, where groups of elementary students worked collaboratively to produce science digital videos about their out-of-classroom experiences.

As methods of data analysis I combined interaction analysis and discourse analysis because both methods assume that actions are fundamentally social in origin, organization, and use, and are situated in a particular social environment. Hence, both methods guided me throughout because the main focus of my research is in social interactions of elementary students and teacher during science projects. Additionally, I used a cultural-historical approach as my theoretical framework, which allowed me to relate human subjects in culturally and historically situated activity (my research participants) and object (the production of science digital videos) within the context in which students' and teacher's interactions occur. Specifically, cultural-historical activity theory (CHAT) allowed me to focus on the activity occurring and avoid "getting in the heads" of the participants and making assumptions about their behavior. In terms of my daily interactions with the participants I made every effort to understand their interactions and work with them in a mutually beneficial manner. Moreover, such approach has been shown to be an ideal tool for analyzing and theorizing educational settings.

In the first section of this concluding chapter, I provide a brief summary of the three studies that constitute this thesis, emphasizing the major findings derived from each. In the second section I articulate the threads that integrate the findings of the three studies into a coherent whole. Finally, I describe implications that these studies have for science education in general.

Summary of the Three Studies and Major Findings

Study I - Egomorphism in simple words: Discursive pedagogical artifact in/for science education

In this study, I expand the concepts of egomorphism to the field of science education, because this term has been only used in the anthropology arena. I also investigate how egomorphism mediates communication between teachers and students during science lessons. I provide the reader with a background of egomorphism, highlighting the fact that students bring to the school their own way of articulating scientific phenomena.

In addition, I articulate how humans understand animals through their own *ego* or *selves,* based on the assumption that people's personal experiences rather than human-ness are the primary points of reference for understanding both human and non-human things, thus characterizing egomorphism. Furthermore, I differentiate egomorphism from anthropomorphism based on the definitions of anthropomorphism, which is the attribution of characteristics that belong *only* to humans to non-human things.

I used two genuine episodes extracted from my database to illustrate the phenomenon in study. I present in the first episode, which happened during a science fieldtrip to a local site, a teacher employing egomorphism to articulate concepts of conservationism towards marine animals. I use this example, to illustrate the fact that science educators, through their discourse, can put students and animals at the same social group (humans). In so doing, they (educators) give the students the chance to understand the animals in the sense that they (animals) are like humans, not human-like. The second episode happened within the school setting, while the teacher articulated concepts of plant physiology. I use this example to illustrate that teachers use human characteristics towards non-human things (such characteristics do not belong only to humans). In this example, the teacher discusses with his students the topic of plant physiology, he gives students the chance to understand what the roots of the plants are really like, when comparing them to toes. Since having toes is not a characteristic that belongs only to humans, this episode cannot be seen as anthropomorphism, rather, egomorphism is an appropriate term to use instead.

My analyses reveal that when teachers, during science lessons, compare human to animals, it does not necessarily imply that they are always employing anthropomorphism. In comparing animals to humans, the characteristics may not be only human characteristics, hence anthropomorphism is not an appropriate term. Thus, if it is not anthropomorphism, I suggest that egomorphism can be an appropriate theoretical concept to use instead.

Through detailed analysis of the episodes and comparing my findings to my database, I point out that through their discourse, teachers create a range of possibilities for learners to see themselves in the animals (or in the environment as a whole), when teachers compare students to animals, for example. In this way, teachers open in the students the possibility for them to understand animals as they understand *themselves* on the basis of their own perception that the animals are "like them" (students themselves) rather than human-like. In so doing, teachers make familiar to the students their object of study.

My analyses also reveal that egomorphism is a discursive device available to teachers that mediates teacher-student interactions during science lessons. Additionally, I point out that egomorphism, in science education is a hybrid language (i.e., non-scientific and scientific) that teachers employ when they articulate scientific concepts with their students in a way that it is accessible to everyone in class. Such hybrid language mediates teachers' interaction with their students, whose primary language is that of the everyday world rather than the one used in scientific publications.

Study II - "Don't say yuk, say hum." An analysis of interjections as students' communicative, participative and cognitive practices during science fieldtrips

The objective of this study is to discuss the role of students' interjections in their discourse and participation in activities that unfold in the context of science fieldtrips. In this study, I consider the full meaning potential of interjections as communicative acts, instead of pre-established representations of states of mind as the general literature suggests, or that the interjections represent a particular feeling, emotion, or cognitive

status, irrespective of the (cultural, social, historical, personal) context which each the interjection is used. Thus a cultural-historical approach guided me throughout to reach such understanding. Additionally, I followed the principles of interaction analysis and discourse analysis to conduct the analysis of three episodes that illustrated the phenomenon in study. I analyzed interjections uttered by elementary students as communicative acts, in the sense of language as action. That is, speech and accompanying nonverbal aspects of language are not seen as translations of the student's thoughts, but as action, the students taking up a position in a world of significations.

The analysis of the first episode presented revealed that interjections are more than an expression of student's emotion. They are in fact embodied students' cognitive being when students are interacting with their object of study and with their peers, during science fieldtrips. That is, the interjection communicates students' engagement and understanding of the object of study to their peers, thus making their cognitive effort concretely available in the situation. Moreover, students may use interjections to name their object of study in the absence of an appropriate scientific name for it. Likewise, interjections uttered by students at particular moments in their activities play an important role in mediating communication and interaction between individuals in the group, and it also provides a means by which the student's cognitive engagement in the activity is reified both to peers and to the analyst as well.

The analysis of the second episode revealed that interjections not only establish the informal character of conversation within peers during science fieldtrips, but it also can be used as a *password* that may initiate conversation between different sociocultural

groups (e.g., learners and educators). For example, using an interjection for the first time, during a conversation that happened between one of the students and I. I (as a science educator) *signed in* my membership in students' sociocultural and age group. When using interjections, such as *yuk,* teachers are in fact using a language that is closer to the language that the students speak. In this way, teachers and students speak the same language, just like parents may change the way in which they talk to their toddlers. In conclusion, my analysis shows how interjections mediate interaction within sociocultural groups, even and especially if participants do not belong to the same social group (*e.g.,* science instructor and students). Hence, this episode illustrates how interjections can be an example of the use of language and discourse as culturally and socially specific to achieve membership in a particular social or cultural group.

The analysis of the third episode reveals that interjections, in the context of science fieldtrips, establish stance within collaborative working groups. In other words, the use of interjections allow students to position themselves within the group, either in accordance with or in divergence from the other group members' stances. Interjections may function to make explicit students' personal stances in relation to what may have become "the rule," that is, behaviors and opinions that are accepted within the group as the usual and perhaps most legitimate ones.

It was also observed in this study that fifth graders communicate through interjections quite often, as I can attest from the various instances in which the students in my database make use of interjections. In fact, children usually are more "economical" in their dialogues, making use of a variety of slang, expressions, and interjections to

communicate with their peers. This, however, does not mean they have nothing to say; quite the contrary, interjections, as I demonstrate here, may play various different roles in students' interactions with each other and with the objects of study, which may give important clues to teachers and adults who endeavor to talk to these children as to how they understand what the children are trying to say.

In conclusion, interjections are no longer understood uniquely as expressions of feelings or emotions that can be attributed to people in diverse situations. They are communicative actions that have their own meaning arising from the cultural and social interaction within which they were performed. In other words, interjections carry different meanings and achieve different communicative tasks depending on the cultural and situated context in which they are used. Additionally, interjections mediate interaction between peers, and, most importantly, reify the students' engagement and *cognitively being* in the activity. Such communicative acts accomplish certain functions, which the speakers (e.g. students) convey their participation in the activity and communicate their understanding to other students, teachers, and in reference to the material at hand (i.e., the object of study). In other words, interjections provide teachers and analysts with concrete evidence of students' attentiveness to the tasks at hand, thus presenting educational potential, both for instruction design and interaction between students and teachers, as well as for assessment purposes.

Study III - Monopolization during computer collaborative work: the making of science video projects

The objective of this study is to explore monopolization of mediational tools (e.g., computer and its components) during student-student interactions in the context of a computer setting, where peers work collaboratively producing digital videos about previous science fieldtrips in which they were engaged. For the purpose of this study I called monopolization in computer collaborative working (CCW) groups as a situation where, an individual in a group of students controls an activity that is intended to be conducted collaboratively. If this is the case, the individual's actions are mediated by his or her extended access to the mediational tools—i.e., one student has a longer period of time in contact with the mediational tools (e.g., computer and its components) than other group members.

In this study, I discuss my findings in the form of two assertions: (a) The path of students' common understandings within CCW groups is influenced by the physical arrangement of students around the mediational tools. In this assertion I first describe the physical arrangement of students around the computer. That is the positioning of the students in relation to the machine as well as in relation to their peers. Second, I demonstrate the path of student's common understanding of the working groups, suggesting a diagram that represents the path of such common understanding that goes from the CCW groups to the computer, to be digitized in a movie format (DVD). (b) Monopolization of mediational tools as an outcome of students' social interaction. In this assertion, I articulate that the monopolization of mediational tools that occurs within a

CCW is an outcome of students' social interaction. Along with these students' social interactions, I articulate how emblem gestures, physical contact and verbal communication mediate monopolization of mediational tools in CCW groups.

In my first assertion, my data reveal that student's physical arrangement around the computer supported a unique path of student's mutual understanding from the working groups to the computer. That is, before being processed into the computer, the group's common understanding has to go through a single student (normally, the one who seats closer to the computer). Additionally, my data suggest that the physical arrangement of the students around the computer may have facilitated the monopolization of the mediational tools (e.g., mouse, computer screen and keyboard), by one of the group members. For instance, the fact that only one student was positioned closer to the computer than the other members, gave this student opportunity to input student's common understanding of her group into the computer, a fact that may have helped her to manage the computer throughout the whole session.

The data analysis of the episodes I present in my second assertion first reveal that body movement of students within CCW groups demonstrates their awareness of the presence of their peers. In the episode I provide, the body movements of one member within the working group are evidence of such awareness; more so, it demonstrates that the student who sits closer to the computer collects information from peers to further process it into the computer. In other words, during CCW one student may turn his/her body towards different peers, talk to them, and articulate their own individual understandings to achieve a common understanding that represents the group's agreed

ideas that will be finalized in the machine. Second, my data reveal that students manage not to be interrupted while taking actions—and they can accomplish this through an emblem gesture, such as holding index finger towards mouth, meaning silence. In this way one student can manage to be in charge of group member's participation in the activity. Additionally it demonstrates that participants in a CCW group act in certain ways because other members allow him or her to act in that way. Third, my data reveal that physical contact (e.g., pushing peers away from the working tools) that may happen amongst group members mediates monopolization of the mediational tools. Fourth, my data analysis reveals that verbal communication amongst peers also mediates monopolization of the mediational tools within CCW. If this is the case, whenever a group member asks peers for permission to do the work that was supposed to be done collaboratively, this individual is in fact empowering the student who is charge of the computer to keep his or her control over the machine.

In Closing

As specified in chapter I, the three core chapters that form this thesis are three different and independent studies. Yet, they are interrelated because all three deal with discourse in science learning during out-of-classroom activities. Additionally, I use throughout the same theory, participants and methods of data collection and analysis. Moreover the general significance of my findings to science and environmental education are what bring the individual chapters into a cohesive focus. For instance, the implications of these three studies, which I discuss individually further on in this chapter, range from teacher education, to elementary education, to research methodology.

These three core chapters could be defined in one sentence: “the making of science fieldtrips,” because I put myself as a researcher behind the scenes of a student self-production of digital videos about science fieldtrips. Being behind the scenes gave the chance to closely observe how teacher and students interact and articulate their own ideas amongst themselves during out-of-classroom science projects. That is, the three studies that form this thesis are additionally tied together by their overall objective, which is to explore elementary student-student or teacher-students interactions in the context of science fieldtrips.

Through my research, I focus mostly on three different phenomena that could happen in any elementary classroom; such phenomena became evident throughout this study. By exposing these three phenomena for teachers, researchers, or administrators I both try to draw a complete picture of my experience as a graduate student and open the discussion of how these phenomena could be understood.

Implications

In this thesis I provide descriptions and analyses of common situations that may happen during any science fieldtrip or any science project that take place outside the formal classroom (e.g., computer laboratory and fieldtrips). More so, my study is not about an individual elementary teacher and individual group of students, but about three different processes that any teacher and students may find themselves in. In other words, my research is focused on how real people cope (act and react) under real instructional circumstances. For example, I am mostly interested in understanding how teacher and students interact during science fieldtrips, and how groups of students interact amongst

themselves during collaborative work. Additionally, the episodes I describe and analyzed are indicative of what elementary teachers and students do during out-of-classroom science projects, so it is important to understand what is going on and how it is going on amongst participants to improve science learning within different settings (e.g., computer environment and science fieldtrips). Thus, my research has implications for science learning and instruction in general. Likewise, I would like to clarify that the episodes I presented throughout are not a reflection of any individual's teaching or a reflection of what their students know about science, but the real processes that real people like myself in this field are trying to understand: It is my hope that my work will further illuminate this perspective.

Moreover, most of the published research studies to date on teacher-student interactions and student-student interactions have been narrowly focused and unquestionably non-dialectical, without taking into account the culture and the context in which such interactions happen. Therefore, I see this thesis as significantly advancing the cultural-historical approach, because its emphasis on dialectical analysis of different situations that students and teacher may find themselves in.

My study also contributes to furthering this work, which for the most part, has focused on teacher-students and student-student interactions. This thesis in its present form, and the publications that will be generated from it, constitutes a contribution to educational and science studies theory.

Implications of individual studies

Chapter 3 of this thesis has a substantial contribution to science education, because I am extending anthropological concepts (e.g., egomorphism) to the science classroom. More specifically this study is of interest of science teachers, because egomorphism mediates their talk during science lessons. In the science classroom, this new concept, I identify as a hybrid language (scientific and non-scientific language), which is a language that is intelligible to anyone in the class.

Chapter 4 explores the role of interjections during science fieldtrips. This particular study contributes to the understanding of students' talk during science fieldtrips. Student's utterances, such as interjections, during fieldtrips may sound meaningless at a first glance, when in fact, they carry different meanings and achieve different communicative tasks depending on the cultural and situational context in which they are used. This study brings awareness to science teachers about how his or her students interact amongst themselves during science fieldtrips when they work collaboratively. Finally this study contributes to the literature because most studies on interjections consider them to be only linguistic/verbal expressions of human emotions. My study goes beyond the mere expression of the mental states or mental acts of an individual, I present interjections in its full meaning, functioning as communicative acts that mediate interactions between peers, and most importantly, reify students' engagement and cognitively being in the activity.

In chapter 5, I explore the issue with monopolization of mediational tools within collaborative working groups in computer settings. This study contributes to the

specialized literature in which little is yet known about monopolization of the mediational tools in CCW. Additionally, this study contributes to the understanding of the diverse problems that can occur when students are working collaboratively sharing their working tools. More so, this study contributes to the understanding of elementary teachers who find the computer environment an appealing area of activity for students to learn with and from their classmates. This study, also adds to the numerous constraints that teachers may find when they have their students working collaboratively in a computer environment.

Implications for science fieldtrips

In regards to activities that may happen during science fieldtrips, this study brings awareness to teachers about how students interact during out-of-classroom activities. For instance, due to the hands-on nature of the fieldtrip, students, being "unsupervised," have more autonomy, which is evident through their speech, when they freely communicate to each other and use more informal language, which is suited for the specific circumstance. Thus, during fieldtrips, students are not concerned about the rules of conduct (and the possible breeching of these that may be caused by their choice of language and behavior), which are typical for the classroom, such as the use of "appropriate" language. Rather, in out-of-the-classroom activities, students make use of a language that is their own, the language they commonly use amongst themselves to converse with their peers.

The particular characteristics of the fieldtrip afford students the possibility of using their own language to interact amongst themselves and make sense of the world around them, resorting to the use of words and terms (e.g., interjections) that they may be requested to avoid within the traditional classroom environment. My research already

points to some advantages of out-of-school activities over traditional classroom tasks, the most prominent of them all being the autonomy and freedom that the students enjoy, which is evident in their choice of language and attitude within their working group, and which permits us (the adults, teachers, outsiders to these students' particular culture) to grasp some of their world views and ways of being (linguistically, cognitively, and bodily).

Implications for computer collaborative work (CCW)

This thesis brings teachers understanding about what is going on amongst collaborative working groups during computer sessions. It also adds to the literature some constraints (e.g., monopolization of mediational tools) within CCW. Whereas many of the research questions and issues may be similar to those proposed for virtual work teams, my research points out that there is still a need for additional research to increase our understanding of how group work might be used more effectively in computer settings.

Personal implications

The past four years that I studied and researched in the masters program (including one year in the biology department) left me, for many reasons, with a bittersweet taste in my mouth. Throughout these years I have had the chance to meet fantastic people, as well as a few not so fantastic ones. Moreover, in the beginning, not everybody believed in my potential (and for many times I did not believe it either).

"Bruno, you are a limited person, your English is not good enough for grad school. Besides you need more lab experience. You cannot do it." These words, as I heard from a professor from the biology department have echoed in my mind (and still do) for so many nights and days. For a moment I saw all my dearest dreams slipping through my fingers. I could not do it because I was a person with considerable limitations. After coming from such a distant place (Brazil), leaving my life, family and friends behind, I learned another language in a few brief months to complete and pass a test of English as a foreign language exam (TOEFL); a requirement of any international student to be accepted in North American universities, I realized that I could not accept the fact that I was a limited person. Somehow I have managed to move on with my career.

These years at University of Victoria have had a huge implication for my personal life. I have learned a side of me that I did not know. In the beginning of my masters program in the education department, I did not know if I would be able to publish in another language, if I could be part of a serious research group, or that I could learn different theories, and so many other things. I did not know that I could get this far, and here I am, ready to tell this/my story and so many others that are still to come. Therefore, this last chapter marks the conclusion of my writing (because a masters degree requires an endpoint) but not the conclusion of my process of becoming, because I have learned that I have no limits.

But I still haven't found what I am looking for…

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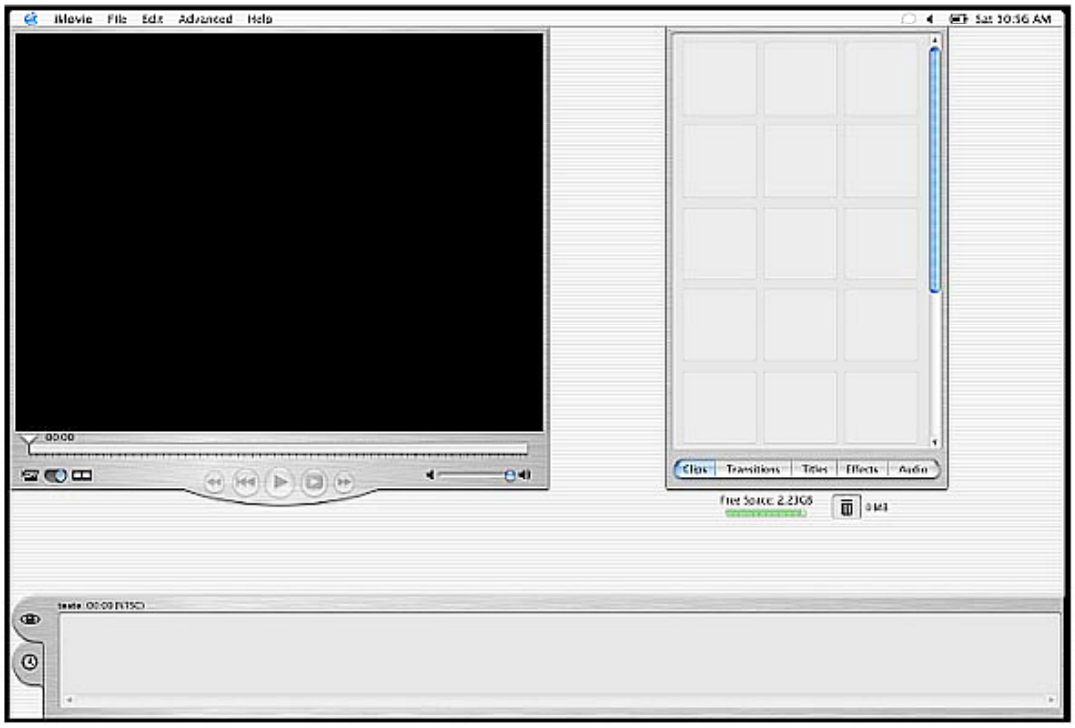
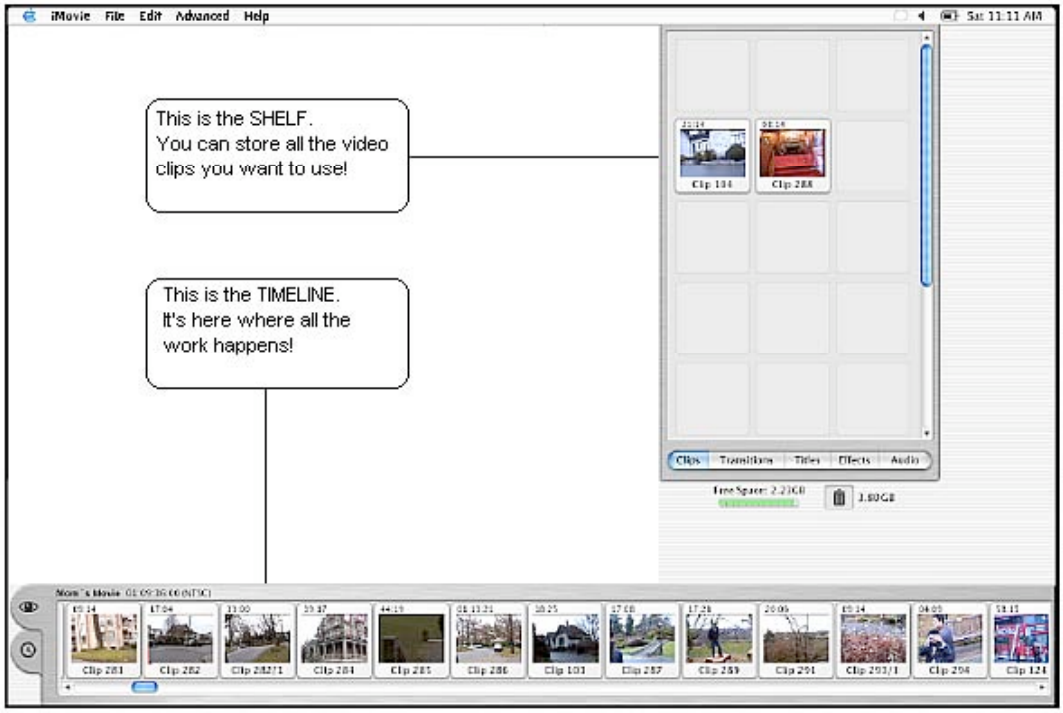
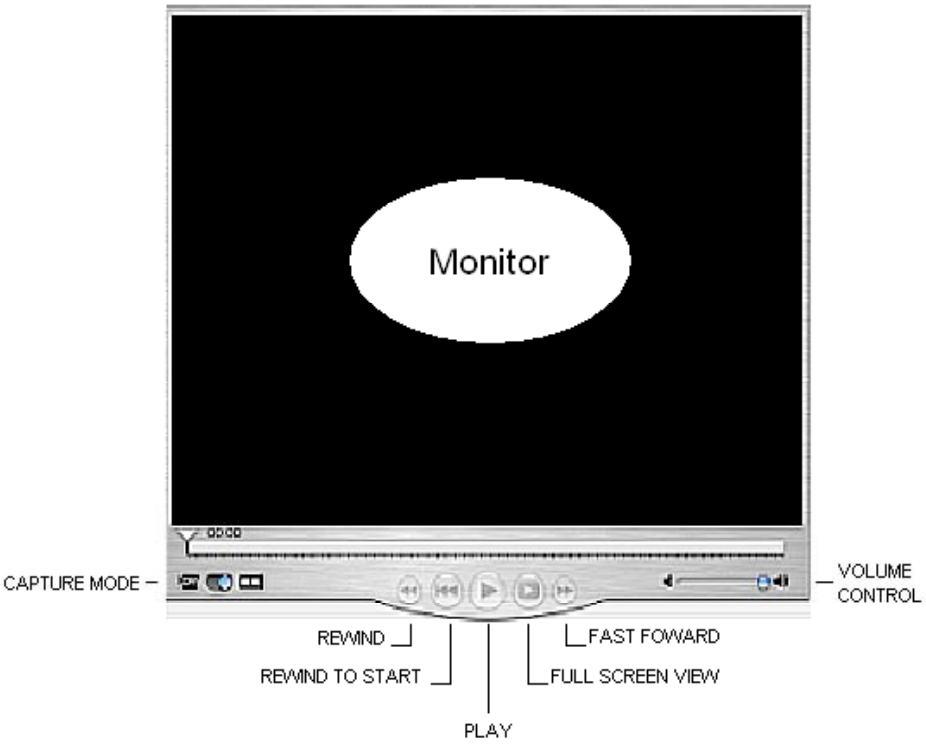
Appendix I – iMovie™ Tutorial

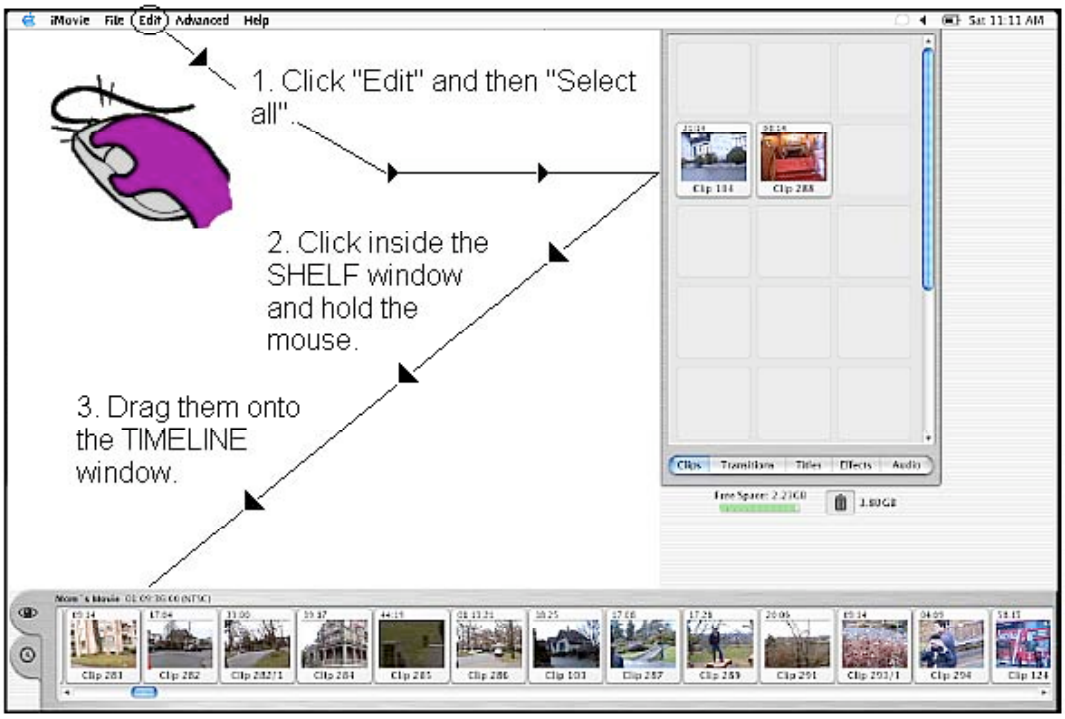
iMovie Tour - This is the first screen.



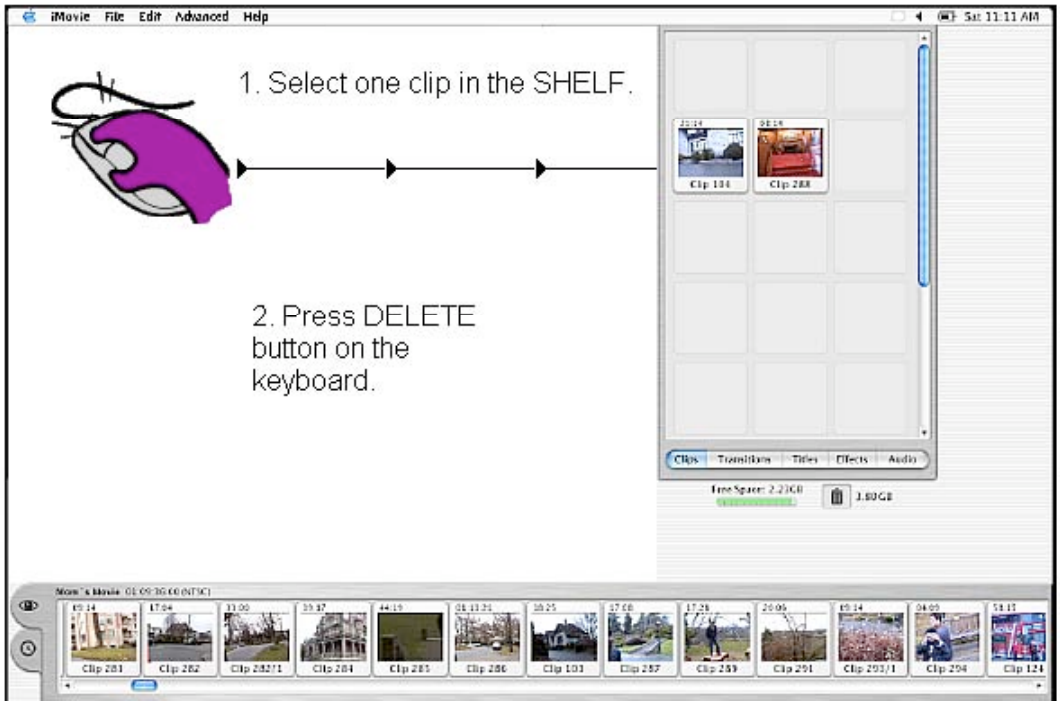




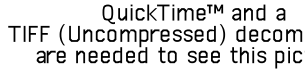
To move all clips



To delete one clip



QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.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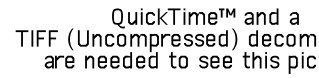
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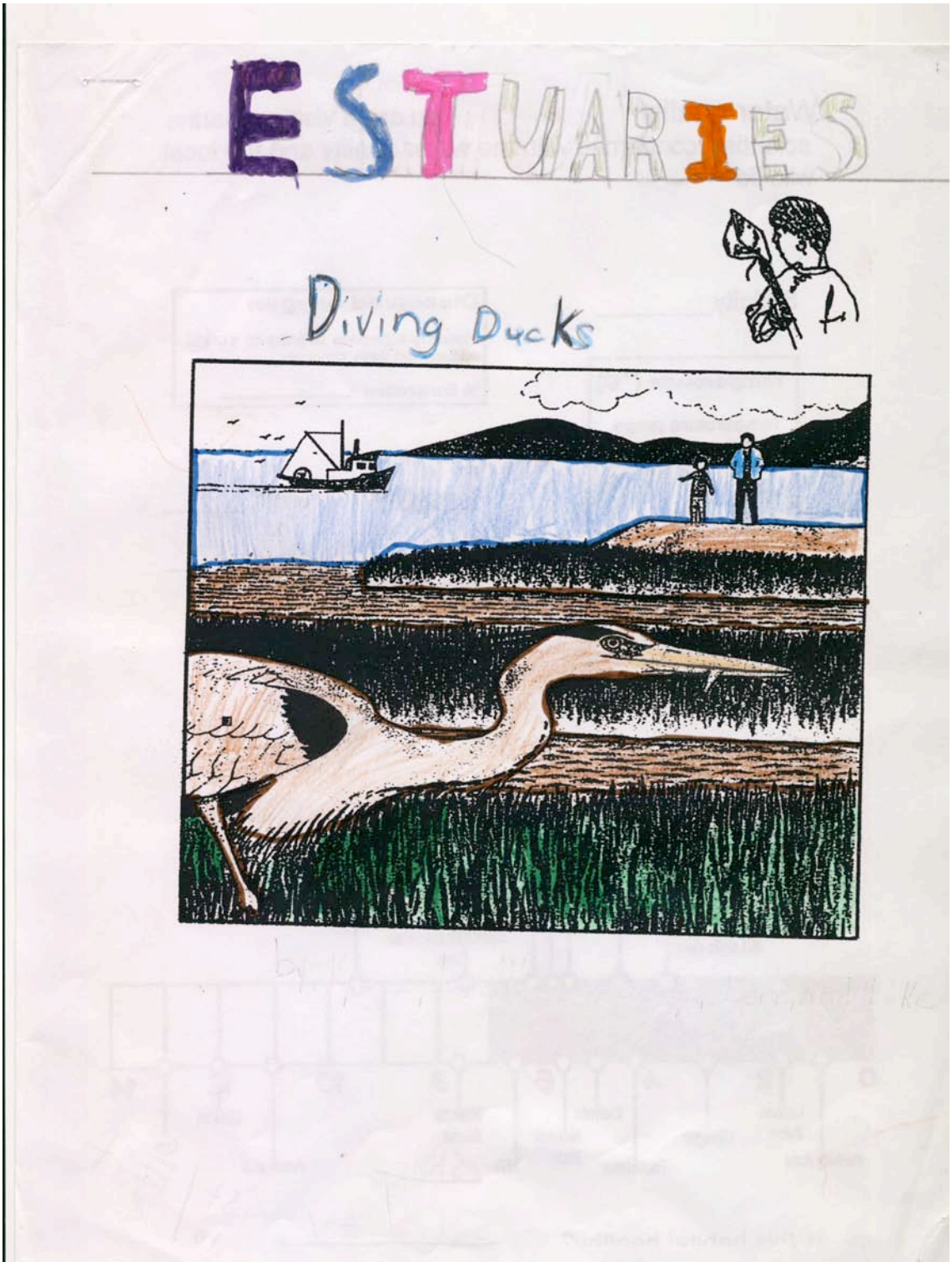
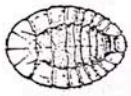
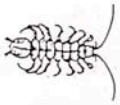
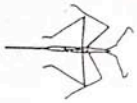
Appendix II – Example of a Booklet Used by Students During the Fieldtrips


ESTUARIES
Diving Ducks

Aquatic Organism	Aquatic Organism	Aquatic Organ
Crane fly lava  Tally Total_____	Dragonfly nymph  Tally Total_____	Midge larvae  Tal Tota
Water penny (beetle larva)  Tally Total_____	Damselfly nymph  Tally Total_____	Water boatman (adult)  Tall Total
Scud  Tally ✓ Total_____	Water scavenger beetle (adult)  Tally Total_____	Backswimmer  Tally ✓ Total
Aquatic sowbug  Tally Total_____	Whirligig beetle larva  Tally Total_____	Giant water bug (adult)  Tally Total
Mosquito larva  Tally Total_____	Whirligig beetle adult  Tally Total_____	Mayfly nymph  Tally Total
Water strider (adult)  Tally Total_____	Water scorpion (adult)  Tally Total_____	Stonefly nymph  Tally Total_
Dobsonfly larva (hellgrammite)  Tally Total_____	Black fly larva  Tally Total_____	Caddisfly larva  Tally Total_

Water quality You are a visiting marine scientist concerned with the water quality and the local wildlife.

Salinity_____

Temperature (°C)

Temperature range for Salmonids

°C

24 Die

18 Increased stress

15 Optimal

5

Dissolved oxygen

Healthy streams are 90 to 100% saturated with oxygen.

% Saturation _____

Turbidity

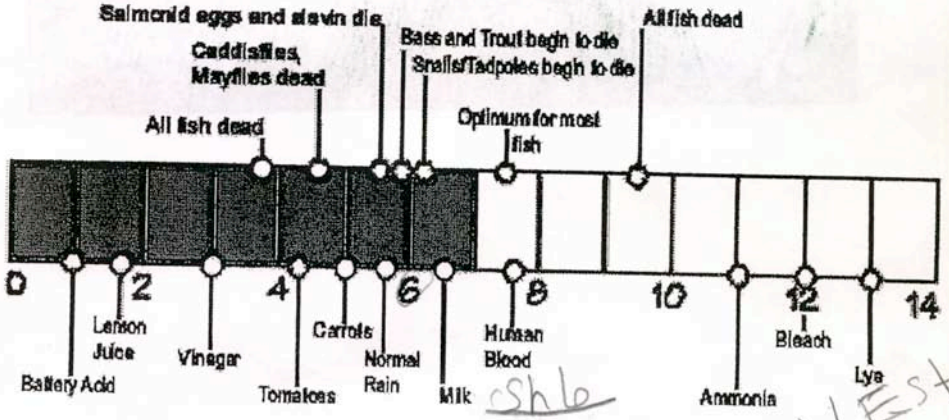
clear ✓

or

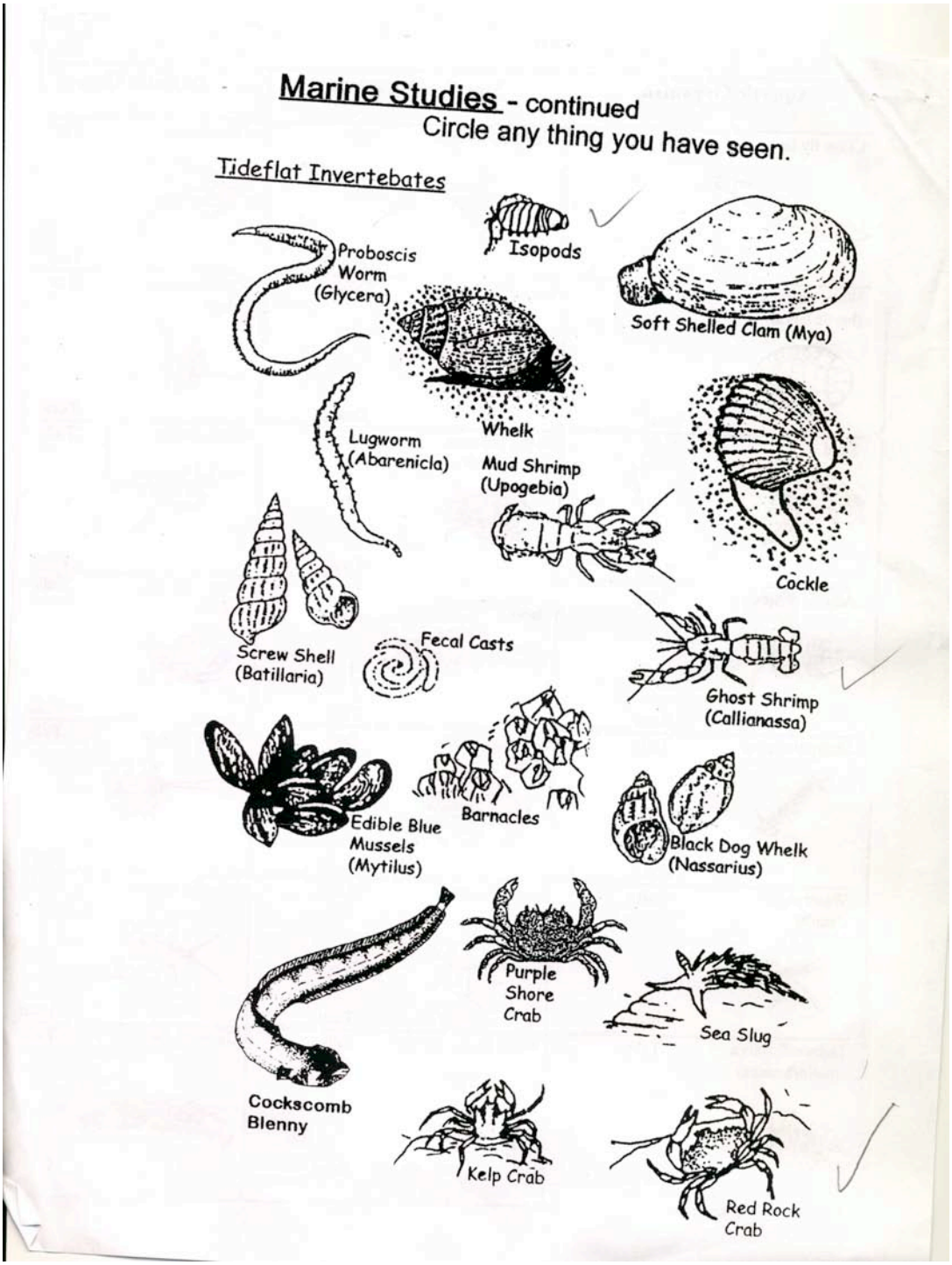
cm_____ cloudy ✓

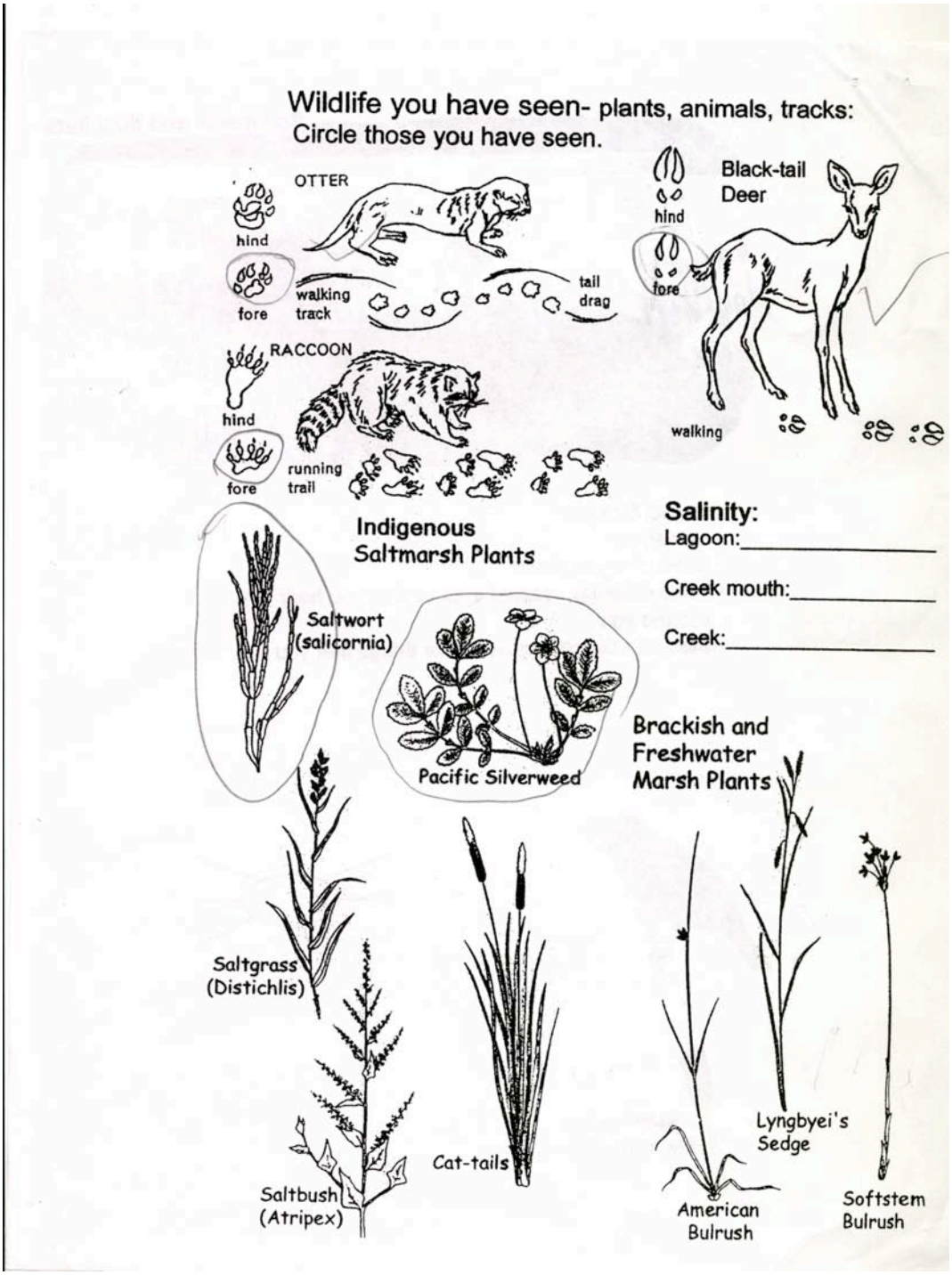
Mark pH on the scale

pH Scale



Is this habitat healthy?


Marine Studies - continued
Circle any thing you have seen.
Tideflat Invertebates
Proboscis Worm (Glycera)
Isopods
Soft Shelled Clam (Mya)
Whelk
Lugworm (Abarenicla)
Mud Shrimp (Upogebia)
Cockle
Screw Shell (Batillaria)
Fecal Casts
Ghost Shrimp (Callianassa)
Edible Blue Mussels (Mytilus)
Barnacles
Black Dog Whelk (Nassarius)
Purple Shore Crab
Sea Slug
Cockscomb Blenny
Kelp Crab
Red Rock Crab


Wildlife you have seen- plants, animals, tracks:
Circle those you have seen.
OTTER
hind
fore
walking track
tail drag
RACCOON
hind
fore
running trail
Black-tail Deer
hind
fore
walking
Salinity:
Lagoon:
Creek mouth:
Creek:
Indigenous Saltmarsh Plants
Saltwort (salicornia)
Pacific Silverweed
Saltgrass (Distichlis)
Saltbush (Atripex)
Cat-tails
Brackish and Freshwater Marsh Plants
Lyngbyei's Sedge
American Bulrush
Softstem Bulrush

Birds: Circle those you may have seen.

Bald Eagle

Osprey

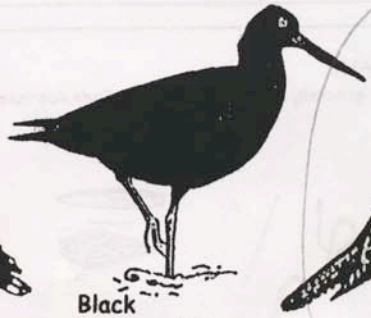
Great Blue Heron

Mallard

Double-crested Cormorant

Canada Goose

Gull



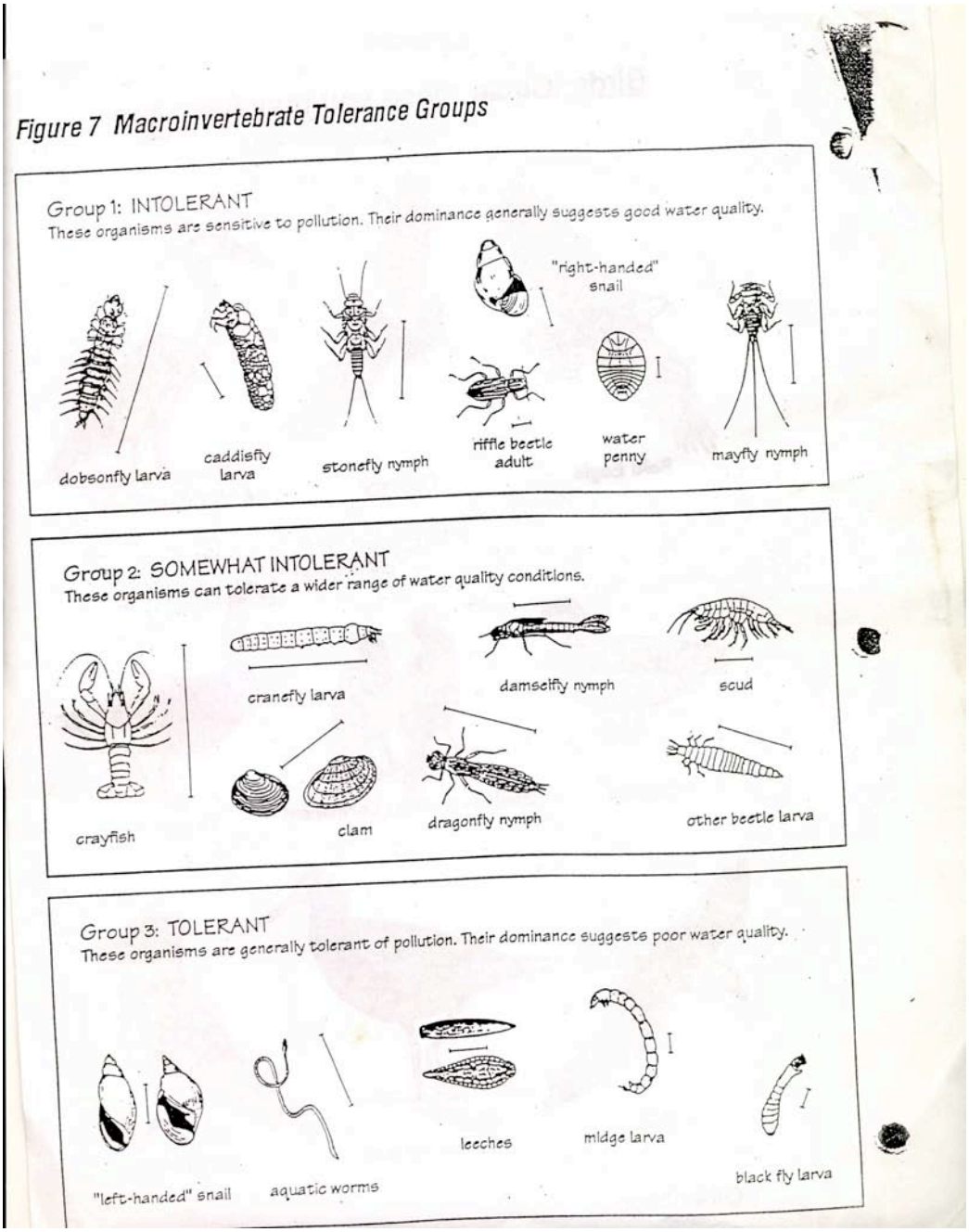
Black Oystercatcher

Belted Kingfisher

EValcher

Other birds . . .

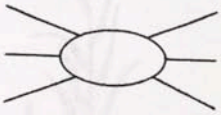
Figure 7 Macroinvertebrate Tolerance Groups



Sound Scape:

- spread out
- kneel or squat down
- listen carefully - record sounds that you hear around you
- then add describing words for things that you see

Red-Winged Blackbird



Appendix III – Human Research Ethical Approval

University of Victoria

Human Research Ethics Board
Office of Research Services
University of Victoria
Room A240 University Centre
Tel (250) 472-4545 Fax (250) 721-8960
Email ovprhe@uvic.ca Web www.research.uvic.ca

Human Research Ethics Board
Certificate of Approval

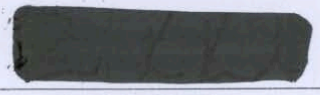
Principal Investigator	Department/School	Supervisor
Wolff-Michael Roth **Faculty**	**EDCD**	**N/A**
Co-Investigator(s): **Attached List**		

Project Title: **Pacific Centre for Scientific & Technological Literacy: Real science opportunities for students**

Protocol No.	Approval Date	Start Date	End Date
05-127	**01-Jun-05**	**01-Jun-05**	**31-May-06**

Certification

This certifies that the UVic Human Research Ethics Board has examined this research protocol and concludes that, in all respects, the proposed research meets appropriate standards of ethics as outlined by the University of Victoria Research Regulations Involving Human Subjects.



Dr. Richard Keeler
Associate Vice-President, Research

This Certificate of Approval is valid for the above term provided there is no change in the procedures. Extensions or minor amendments may be granted upon receipt of a "Research Status" form.

05-127 Roth, Wolff-Michael

University of Victoria

RECEIVED MAY 17 2005

OFFICE OF RESEARCH SERVICES

Application for Ethics Approval for Human Participant Research

A. Principal Investigator

If your project has more than one Principal Investigator, provide their name(s) and contact information under B. 4 – Other Investigator(s) & Research Team.

Last Name: **ROTH** First Name: **Wolff-Michael** Department/Faculty: **EDCI**

Mailing Address (if different from Dept/Faculty):

Phone: **-7885** Fax: **-7767** Email: **mroth@uvic.ca**

Title/Position:

☒ Faculty ☐ Staff ☐ Post-Doctoral

☐ Ph.D. Student ☐ Master's Student ☐ Undergraduate

Students: Provide your Supervisor's

Name: Email:

Department: Phone:

Graduate Students: Provide your Graduate Secretary's email address:

FOR OFFICE OF RESEARCH SERVICES' USE ONLY		Protocol No. 05-127
Committee Chair Approval Signature: [redacted]		Date: JUNE 1/05
Start Date: JUNE 1/05	Annual Review Date: MAY 31/06	File Closed:

B. Project Information

1. **Project Title: Pacific Center for Scientific & Technological Literacy: Real science opportunities for students**

   Geographic location(s) of study: **Victoria**

2. **Keywords:** 1. **authentic science** 2. **ethnography** 3. **videotaping** 4. **science**

3. **Project Funding**

   Have you applied for funding for this project? ☒ Yes ☐ No

   If yes, please complete the following:

Source(s) of Project Funding	Project Title used in Funding Application(s)
NSERC-CRYSTAL Program	Pacific Center for Scientific & Tehcnological Literacy
SSHRC-INE Program	Navigating knowledge boundaries between formal education and workplace

4. **Co-Investigator(s) and Research Team:**
   (*Include students, employees, volunteers, community organizations. The form will expand.)*

Contact Name	Role in Research Project	Institutional Affiliation	Email or Phone
Giuliano Reis	GRA	EDCI	-7834
Diego Ardhengi	GRA	EDCI	-7834
Lilian Pozzer-Ardenghi	GRA	EDCI	-7885
Leanna Boyer	GRA	INTD	-7834
Bruno Jayme	GRA	INTD	-7834

Peil-Ling Hsu	GRA	EDCI	-7834
TBA	Postdoc	EDCI	-7885
Anne Marshal	Researcher	EPLS	-7798
Andrew Weaver	Researcher	EOSC	-4006
Asit Mazumder	Researcher	BIOL	-4789
Steve Earle	Researcher	GEO (Malaspina)	250-753-3245 #2756
Kelly Bannister	Researcher	ENVI	-5016
Eileen van der Flier-Keller	Researcher	EOSC	-4019

5. **Anticipated Start Date:** **May 20, 2005**
(Allow four to six weeks for the HREB review. Researchers must not begin recruitment of participants or data collection prior to receiving HREB approval as this violates UVic policy.)

6. **Anticipated End Date:** **May 19, 2010 (Center funding is for 5 years)**
(HREB approval is granted for a maximum of three years and a Research Status Form must be submitted annually to the Office of Research Services until the recruitment and data collection phases are completed. See 1.5.2 of the Guidelines for further information on reporting requirements and researchers' responsibilities.)

7. **Scholarly Review:**

What type of scholarly review has this research project undergone?

☐ None ☒ External Peer Review (e.g. granting agency) ☐ Supervisory Committee
☐ Supervisor—required for all student research projects ☐ Other, explain below:

C. Description of Research Project

8. **Purpose and Rationale of Research**

Briefly describe below: *(The form will expand to the length of your answers.)*

a) The research objective(s) and question(s)

The *Pacific Center for Scientific and Technological Literacy* (PCSTL) has been designed to provide *authentic science experiences* for students at the elementary, middle, and high school levels—where *authentic* is taken in the sense of "family resemblance" with what people do in everyday settings. These settings include research apprenticeships in scientific laboratories (e.g., Weaver, Mazumder, Earle [Malaspina]) and work in the *EcoRowing* and *SeaQuarium* projects run by local NGOs (SeaChange [Nikki Wright]; WestWind Labs [Cathy Carolsfeld]). The purpose of this PCSTL research component is to *document learning*, as this is made visible and audible in the changing participation of students in science and technology related activities. The research will follow student participants through their school science to the out-of-school science experiences.

b) The importance and contributions of the research

Research such as this is important for understanding what and how students learn in formal and informal (out-of-school) learning environments—where learning is indicated by changing ways of engaging with the world generally and with the setting-specific tasks particularly. Any differences between the two settings will allow educators to rethink school science so that it will become more relevant to students' everyday out-of-school experiences.

9. **Methodology and Procedures**

(For community-based research, autobiographical or observational research, please see Item 9 of the Guidelines.)

a) Which of the following methods will be used? *(Check all that apply.)*

☒ Recording of participants
Using: ☐ audio ☒ video ☒ photos or slides

☐ Interviewing participants in person ☐ Interviewing participants by telephone

☐ Conducting group interviews or discussions

☒ Observing participants

In 9b) provide a description of who will be observed and where and see Item 20 of the Guidelines for more information on observations, waivers and informed consent

☐ Administering a standardized questionnaire or survey

☐ In person ☐ telephone ☐ mail back ☐ email ☐ web-based

☐ Other, describe:

☐ Conducting or administering a non-standardized questionnaire or survey

☐ In person ☐ telephone ☐ mail back ☐ email ☐ web-based

☐ Other, describe:

☐ Administering a standardized cognitive instrument or test

☐ Analyzing secondary data

☐ Anonymized data (Eligible for Waiver or Skip to Item 30, then Section L)

☐ Non-anonymized data (Skip to Item 13g, 14, 15, 19-20, 25, 27-31 & Section L,)

In 9b) describe the source of the data, (e.g., institutional, organizational, educational files, personal writings) and explain whether and how consent was obtained from the individuals for use of their data.

☐ Using computer-administered tasks

☐ Testing of computer program or products

☐ Using human tissue (e.g., blood, hair, DNA, gametes)

Ensure BioSafety Human Tissue Form is completed, signed and attached. If using human tissue only, skip to 13g-15, 19-end

☐ Other, specify:

b) Provide a sequential description of the procedures/methods to be used in your research study. List all of your research instruments and assessment tools, and in an appendix provide copies of all instruments. If not yet available, provide drafts or sample items/questions. For multi-method or other complex research, use this section and the following sections in ways best suited to explain your project.

Students will be observed [recorded in handwritten fieldnotes] and videotaped in their normal science classrooms and in the out-of-school *authentic science* settings offered by research laboratories (Weaver, Mazumder, Earle) and the EcoRowing and SeaQuarium programs. The researchers (Weaver, Mazumder, Earle) and the two NGOs are part of PCSTL and are partners in the research. The participants MAY BE asked questions about what they think is going, what they are currently learning.

c) Where will participation take place? (e.g., UVic classroom, coffee shop, elementary school)

Elementary, middle school, high school classrooms, UVic laboratories (Weaver, Mazumder) and research sites (Mazumer); possibly Nanaimo, in an out-of-school forestry field research program

d) How much time will be required of participants?

No time apart from their regular participation in the school or after-school programs

10. Selection and Recruitment of Participants

a) What is the target population for participant selection?

Elementary, middle, and secondary; adults involved in "teaching" or doing authentic activities

b) Provide the number of participants and describe salient characteristics:

i) Anticipated number of participants: **50**

ii) Characteristics of participants (e.g. age, gender, race, ethnicity, class, position, etc.):

no distinction made

c) Provide a description of your exact recruitment process. Explain:

i) Who will recruit/contact participants (e.g. researcher, assistant, third party) and describe any relationship between the investigator(s) and participant(s) (e.g. instructor-student, manager-employee)

ii) How will the recruitment be done (e.g. in person, by telephone, letter, email, advertisement) and from what source(s) will the participants be recruited

iii) The steps in the recruitment process

iv) Whether the permission of other bodies is required (e.g. school boards).

The school boards and schools already have been recruited and indicated willingness in the PCSTL; Weaver's weather stations are already placed in the schools (no research is being conducted); EcoRowing (Nikki Wright) and SeaQuarium (Cathy Carolsfeld) already run their program with schools interested in becoming part of PCSTL. The students are aware of the curriculum interventions. The research will be described to them by a researcher in person; they contact the researcher if they want to participate in the research component. All students interested may participate in the research.

Attach all relevant recruitment materials in an appendix or apendices. See Item 10(c) in the Guidelines for information on ethical recruitment.

D. Possible Inconveniences, Benefits, Risks and Harms to Participants

11. Benefits

Identify any potential or known benefits associated with participation and explain below.
When identifying and explaining the benefits, keep in mind that the anticipated benefits should outweigh any potential risks.

☒ To the participant ☒ To society ☒ To state of knowledge

a. All participants and non-participants benefit through the curriculum intervention assisted through PCSTL activities, but not necessarily through the collection of data for research purposes.

b. The state of knowledge about how *authentic learning environments* mediate knowing and learning will be advanced. Ultimately, society will benefit, as the research results will be used in and modify subsequent curriculum interventions

12. Inconveniences

Identify and describe any known or potential inconveniences to participants:
Please consider all inconveniences, including time devoted to the research.

No known inconveniences anticipated. Those who sign up for the research will know that a camera is going to be used, and they therefore will do so despite inconveniences THEY anticipate. Over the past 20 years, I have videotaped over 400 students and about 100 scientists, technicians, and workers. To date, only 1 student has not signed up. No student or adult EVER expressed being inconvenienced.

13. Estimate of Risks

Could this study involve the following? Please answer each question by putting an **X** in the appropriate boxes:

a) Could a participant feel demeaned or embarrassed during their participation in the research?

☒ Very unlikely ☐ Possibly ☐ Likely

b) Could a participant feel fatigued or stressed due to the research?
☒Very unlikely ☐Possibly ☐Likely

c) Could a participant experience any other emotional or psychological discomfort as a consequence of participation?
☒Very unlikely ☐Possibly ☐Likely

d) Is there any social risk, possible stigmatization, loss of status, privacy and/or reputation?
☒Very unlikely ☐Possibly ☐Likely

e) Are there any physical risks?
☒Very unlikely ☐Possibly ☐Likely

f) Could a participant experience any economic risk? (e.g. job security, job loss)
☒Very unlikely ☐Possibly ☐Likely

g) Do you see any chance that participants may be harmed in any other way? (e.g. risk to community)
☒Very unlikely ☐Possibly ☐Likely

14. Possible Risks

If you indicated in Item 13 (a) to (f) that any risks are *possible* or *likely*, please explain below:

a) What are the risks?
b) What will you do to try to minimize or prevent the risks?
c) How will you respond if the risk of harm occurs? (e.g. what is your plan?)

n/a

15. Level of Risk

a) Using the TCPS definition of "minimal risk" cited below, do you believe your research qualifies as "minimal risk" research? ☒ Yes ☐ No

The research can be regarded as within the range of minimal risk if potential participants can reasonably be expected to regard the probability and magnitude of possible harms implied by participation in the research to be no greater than those encountered by the participant in those aspects of his or her everyday life that relate to the research. The designation of minimal or non-minimal risk affects the way the application is reviewed not the substance of the ethical review."

b) Explain your answer to 15(a) by referring to the level of risk stated in the TCPS definition:

The participants are not being asked to do anything other than what they are doing; they are only observed and videotaped, and occasionally may be asked questions about what is currently going on.

16. Deception

Will participants be fully informed of everything that will be required of them prior to the start of the research session? ☒Yes ☐ No *(If no, complete the attached Request to Use Deception form.)*

E. Compensation

17. Is there any compensation for participating in the research? (e.g., gifts, money, social advantage, bonus points) ☐ Yes ☒ No

If yes, explain the nature of the compensation and why you consider it necessary:

(It is important to consider if the amount of the compensation is such that the participant could consider it a form of inducement.)

F. Power-over Relationship

18. Are you or any of your co-researchers in any way in a position of authority or power over participants? Examples of a "power-over" situation include teachers-students, therapists-clients, supervisors-employees and possibly researcher-relative or researcher-close friend.

☐ Yes ☒ No ☐ Varies

If *yes* or *varies*, describe below:

i) why it is necessary to conduct research with participants over whom you, the researcher, has power
ii) the nature of the relationship
iii) what safeguards (steps) will be taken to minimize inducement, coercion or potential harm
iv) how the dual-role relationship and the safeguards will be explained to potential participants.

n/a

G. Free and Informed Consent

The following questions address the competence of participants to give consent, the process used in your research to obtain consent, ongoing consent, and the participants' right to withdraw. Consult Item 19 of the Guidelines for further information.

19. Participant's Capacity (Competence) to Provide Free and Informed Consent
Describe your prospective participants: ***(Check all that apply.)***

☒ Competent adults

☐ Non-competent adults:

- ☐ Consent of family/authorized representative will be obtained
- ☐ Assent of the participant will be obtained

☒ Competent Children

Minimal Risk Research

- ☒ Children under 13: consent of parent/guardian will be obtained, and child consent will be obtained
- ☒ Youth 13 to 18: consent of youth will be obtained, and parental consent is required due to institutional requirements (e.g. school districts)
- ☒ Youth 13 to 16: consent of youth will be obtained, parents will be informed
- ☐ Youth 13 to 16: consent of youth will be obtained, parents will *NOT* be informed
- ☒ Youth 17 to 18: consent of youth will be obtained, parents will not be informed
- ☐ Other, explain:

Above Minimal Risk Research

- ☐ Parent or guardian consent will be obtained and child/youth assent/consent will be obtained
- ☐ Other, explain:

☐ Non-competent Children:

- ☐ Consent of parent/guardian
- ☐ Assent of the child/youth will be obtained

☐ A protected or vulnerable population (e.g., inmates, patients).

20. Means of Obtaining Consent: *Check all that apply. See Item 20 of the Guidelines.*

☒ Initial verbal explanation and a signed Consent Form. (*Attach copies.*)

☐ A Letter of Information and a signed Consent Form. (*Attach copies.*)

☐ A Letter of Information and verbal consent. (*Attach a copy of the Letter of Information and describe below how you will document verbal consent. Explain below in Item 22 why written consent is not appropriate.*)

☐ Implied consent (e.g. through mail back or web-based questionnaires or surveys).

☐ Other means. (*Describe and provide justification below in question 22.*)