Participation, Positioning, and Power: Opportunities to Learn in a University Kinesiology Classroom

By

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A thesis submitted in conformity with the requirements for the degree of Doctor of Philosophy

Department of Curriculum, Teaching, and Learning
University of Toronto

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Abstract

Past studies in science education research have documented that people of colour and women continue to be underrepresented in science-related university programmes and careers. To better understand issues of equity and student achievement, providing equitable opportunities to learn (OTL) in diverse, content-focused classrooms has been recognized as an important aim in educational research. This critical microethnographic study examines a Canadian, undergraduate, Kinesiology classroom and how the professor’s framing of science learning made space for a range of OTL. Then I explore how students’ navigation of scientific discussions shaped their access to particular OTL.

Drawing from cultural-historical activity theory and positioning theory, this dissertation brings into focus the sociohistorical and discursive practices of students and teachers in a science classroom. The research draws data from classroom videotapes, interviews, and stimulated recalls, wherein two participants were the foci of analysis. The analyses consider students’ verbal and non-verbal acts of positioning, highlighting how these positions can facilitate and/or constrained their access to OTL. In one group, a focal student appeared to take up the position of a facilitator, and in another, there appeared to be no expert or facilitator. The second student
adopted a powerful role in one activity, then shifted from an initially more passive role to a mediator position in another group. My findings show how a common task led to differential contexts for learning. In particular, conflicts and student differential uptake of positions in small-group settings are examined for their ability to potentially foster unique OTL.

My study’s theoretical contributions include a synthesis of sociocultural theories of learning, as well as how these theories can be strengthened through sustained attention to multi-levels of inquiry. The different grains of video analysis afford a broader look at how students learn together in scientific discussions; what resources they draw upon to make meaning; how they negotiate the multiple, interactional demands of the task; and how power and social relations shape available OTL. Implications for science education research are also raised, including suggestions for a greater analytic focus on student-led spaces, and bringing together conversations of learning, identity, and power.
Personal Acknowledgements

Behind the solitary image of a budding academic writing quietly at their desk belies the unseen imprints of people who have traversed through their lives and left indelible marks on the author’s thoughts and writing. Writing this dissertation was a true collective achievement. I have been fortunate enough to explore one of my dearest passions in life and develop it as part of my career. Along this academic trajectory, I have been fortunate to meet, work with, and learn from the people I mention below. They have deeply shaped my graduate studies’ experiences and my identity as a scholar, researcher, colleague, and friend. For that good fortune and for all the opportunities I have been granted, I am grateful. The following individuals were most influential in the creation and writing of this thesis.

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March for Science 2017

On April 22nd, 2017 (Earth Day), tens of thousands of scientists, students, and citizens mobilized across North America and across the globe in hundreds of cities in an effort to draw attention to the domain of science and the role it plays in our everyday lives. Inspired in part by the Women’s March that took place on January 21, 2017, researchers and concerned citizens alike articulated their concerns for the U.S. administration’s positions on scientific research and public rejection of established scientific theories such as climate change (Reuter, 2017). The March for Science began modestly as a Reddit1 topic of conversation surrounding U.S. budget cuts to the Environmental Protection Agency and climate change references being purged from federal websites (Mortillaro, 2017). Over time, the movement has grown to include over 1.3 million participants, with marches in over 600 cities, and a coalition of 300+ partnering organizations (March for Science, 2017).

Champions of the March for Science movement advocate for robustly funded and publicly communicated scientific research, and a diverse and inclusive scientific community that seeks to constantly expand and revise our knowledge of the natural world and universe. The organizers called the movement “non-partisan but political” (Mortillaro, 2017), urging government leaders to respect the process of peer review and make decisions consistent with the knowledge and implications developed from scientific research studies. In addition, some science scholars have argued that the most effective way to protect scientific integrity and

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1 Reddit is an American social news and pop culture discussion aggregation website founded in 2005.
interest in scientific inquiry is to encourage the general public to value and invest in the domain (e.g., Bencze, Alsop, Ritchie, Bowen & Chen, 2015; Brickhouse, Einsenhart, & Tonso, 2006; Pedretti, Bencze, Hewitt, Romkey, & Jivrag, 2006). A critical part of this process involves developing public science education that encourages students to think critically, ask questions, and evaluate scientific knowledge against its interconnections to society, technology, and environment (Fensham, 2002; Hodson, 1999; Zeidler, Sadler, Simmons & Howes, 2004).

A collaboration mobilized by the March for Science was the Guerilla Archiving Event that took place between Canadian scientists at the University of Toronto, their American colleagues at the University of Pennsylvania library and the Internet Archive – a non-profit organization with a project underway to archive government websites in preparation for the transition of the Trump presidency. These partnerships are significant in that they cross international and institutional borders, and attempt to bring together various social movements, such as the environmental movement, and freedom of information acts (Dwyer, 2016). According to the March for Science organization, these collaborations represent a move toward cross-community solidarity in supporting academic research and critiquing policies that seek to restrict scientists’ ability to communicate their findings (Reuter, 2017). As these science movements emphasize the importance of public scientific literacy (a term to be later clarified), I argue we must also consider the institutional and classroom processes through which scientific literacy is cultivated in students – young people who will become future educators, policymakers, researchers, and scientists, and perhaps even more importantly for the larger portion of non-specialized citizens who will take part in modern society.

As mentioned above, the March for Science movement draws attention to the concept of scientific literacy, broadly defined as the knowledge of valued scientific content and discourse
practices that includes: the development of critical decision-making skills, the ability to analyze, synthesize, and evaluate information, an understanding of science as a “way of knowing” and the practices used to develop such knowledge, and the consideration of ethico-moral reasoning in scientific activity (Hodson, 1999; Lederman, 1999, 2006; Pedretti et al., 2006; Roth, 2007b; Zeidler et al., 2005). Such a broad notion of scientific literacy, while readily acknowledged as a desirable goal for science education reform, also indicates its ambiguity. Brickhouse (2002) suggests this ambiguity contributes to why reforming science curriculum is so difficult. In addition, what counts as canonical scientific knowledge evokes epistemological and ontological concerns that formal curricula tend to align with Eurocentric histories and practices and exacerbate asymmetrical power relations among students from non-dominant backgrounds (Aikenhead, 2006; Bang, Warren, Rosebery, & Medin, 2012; Costa, 1995).

These issues pertain to academic institutions circumscribing what is important for students to learn in order to prepare a generation of future scientists and a “public that would be knowledgeable enough to be sympathetic to the work of scientists” (DeBoer, 2000, p. 588). Traditional science education tends to focus on the achievement of scientific literacy, and often centres the teacher and school as the loci of epistemological authority (which may be true in certain contexts) and learning (which I contest). However, examining school science learning also requires a consideration of the ways in which classroom practices shape how individuals are “expected, obligated, and entitled to participate as well as the meanings that other members make of their participation” (Gresalfi, Martin, Hand, & Greeno, 2009, p. 50). Rather than an overt focus on formal curricula and teacher practices, I argue for a discursive shift in focus to the processes of student participation. Thus, my dissertation re-centres students at the centre of learning, and examines students’ opportunities to engage with the disciplinary content, valued
discourse practices, and to be recognized as knowers and doers of science. This is closely aligned with Davies and Harré’s (1990, 1999) and Harré and van Langenhove’s (1999) work on positional identities, which concerns the fluid characterizations, roles, and divisions of labour that people construct for themselves and others through verbal and non-verbal means.

This critical microethnographic study seeks to investigate the kinds of opportunities to learn (hereafter OTL) that are differentially accessed by students in everyday interactions within an undergraduate Kinesiology course entitled *Ethics and Power in Kinesiology*. It is a required course for upper-year students enrolled in the Bachelor of Kinesiology program and focuses on ethical dilemmas encountered in the fields of physical education, sports, and health sciences (syllabus, 2016). Drawing from cultural-historical activity theory [CHAT] (to be elaborated on in Chapter 2), I conceive of the classroom as a dynamic, social “activity system” that contains learners, teachers, tools, norms, work practices, curriculum materials, and the physical environment. I highlight the potential role of these dimensions in shaping the range of available OTL. Then I present case studies of two focal students and examine how they navigate through conflictual scientific discussions. Using a critical microethnographic approach, I consider several levels of analysis: first, I systematically look at how the classroom is organized, and the kinds of activities and problem-solving skills that are encouraged; then, I “zoom in” to explore how students participate and shape the participation of others, and how these acts influence their access to and uptake of particular OTL.

The broad question guiding my research is: What kinds of opportunities to learn do the students access as they manage their participation in particular scientific activities within the context of a Canadian, undergraduate, Kinesiology classroom? Two main sub-questions arise from my study:
1) What is the range of opportunities to learn represented by particular dimensions of the science classroom system?

2) Within scientific discussions, how do students’ participation and acts of positioning shape their access to and uptake of particular opportunities to learn?

The study aims to consider: (a) how the analyses of interaction patterns, times, and spaces in the science classroom make particular OTL salient and therefore available; and (b) how the negotiations of scientific activities by different student groups influence the differential student uptake of OTL. Understanding access to OTL also requires an understanding of the interrelations of power dynamics and identity (both terms to be subsequently defined) among students in diverse classrooms (Moje & Lewis, 2007; Oakes, 1990). In the forthcoming sections, I will describe the sociohistorical systems of power that are entrenched in science classrooms, but also how power is enacted, maintained, and resisted through the ways student position themselves and one another in moment-to-moment interactions.

Science Learning and Opportunities to Learn

Defining scientific literacy. The current development toward “science for all” and a concern for North America’s slipping, international standing in school science performance have influenced policy initiatives to increase focus on student achievement outcomes (American Association for the Advancement of Science [AAAS], 1990; National Research Council [NRC], 1996; Organization for Economic Cooperation and Development [OECD], 2015). Moreover, the body of North American research documenting attrition rates in science-technology-engineering-mathematics (STEM) postsecondary programmes and career fields continues to grow (e.g., Chen, 2013; Hango, 2013; Seymour, 2001; Simon, Aulls, Dedic, Hubbard, & Hall, 2010). The aforementioned studies highlight that students are choosing postsecondary STEM majors at a
lower rate than that of their social sciences and humanities counterparts, and often switch out or do not complete their degrees (attrition) at a rate of approximately 50-60 per cent. These statistics generate government and industry concern over North America’s footing in global competition, especially when describing the future of research innovation and a STEM-literate work force. Recent reform initiatives thus have argued for an increased emphasis on nature of science (NOS) and hands-on scientific inquiry.

NOS is broadly defined as the values and assumptions inherent in the development of scientific knowledge (Lederman, 1999, 2006; Tobin & McRobbie, 1997; Tsai, 2002). What tends to be advocated for in reform initiatives is to provide students with the opportunities to learn science in ways that minimize the gap between the nature of science as it is represented in formal schooling and the nature of science as practiced by professional scientists. A rich understanding of NOS often positions science as a creative, human endeavour that is subject to change, and is socioculturally and politically embedded (Abd-El-Khalick, Bell, & Lederman, 1998; Fensham, 2002; Pedretti & Hodson, 1995). The assumption is that teaching NOS well will lead to the development of students’ problem-solving and decision-making abilities, which in turn, will translate to higher science achievement. It is posited that students will then apply these skills and knowledge to become critical and scientifically literate citizens (AAAS, 1990; Council of Ministers in Education, Canada [CMEC], 2015; NRC, 1996). However, there is little consensus about how to integrate NOS into instructional planning and teaching strategies.

While some studies call for a focus on socioscientific issues (i.e., topics related to science-technology-society-environment (STSE) curricula, Hodson, 1999; Pedretti et al., 2006), other scholars call for an inquiry into how schools are governed and organized; how curriculum is taken up and opportunities are distributed; and how equitable classroom activities can be
structured (e.g., Barton, 2003; Carlone, 2004; Roth, Tobin, & Ritchie, 2008). As typically practiced, STSE education has been criticized for not being embedded in any particular theory of learning nor having a clear articulation of its political aims (Pedretti & Hodson, 1995; Zeidler et al., 2005). As well, Pedretti and her colleagues (2006) contend that teachers fear extensive coverage of STSE issues may devalue the canonical content in traditional science curricula. Other tensions emerged related to classroom control, overt politicization of the subject matter, and challenging teachers’ professional identities and ideas of expertise.

These tensions are not new, and in Douglas Roberts’ (2007) conception of scientific literacy, he proposes that there are two schools of thought: broadly speaking Vision I and Vision II. Vision I describes scientific literacy as proficiency in scientific procedures and products, such as experimenting and theories. Vision II, on the other hand, looks at the situations in which science has a role, such as decision-making about critical, socioscientific issues. As Roberts stipulates, both views of literacy reinforce that science plays an important role in a number of matters related to the public and private sphere. He further argues that the ambiguity about the different definitions of scientific literacy can be elucidated by focusing on the two visions, then by fine-tuning the answers to the questions of “what, how, for whom, and in what sort of conceptual balance” (ibid, 2007, 11). Thus, what this brief review of literature seems to suggest is the idea of “science for all” is difficult to operationalize and requires much more nuance and consideration of context in science teaching.

When considering content areas such as science and mathematic education, the domain’s norms and expectations have been historically privileged and shaped by European American practices and values (Anderson, Holland & Palincsar, 1997; Lemke, 1990, 2011; Gee, 2004). Being “good at science” therefore often requires particular kinds of performances that legitimize
White and middle-class experiences, while marginalizing “others’” experiences (Brickhouse, 2001; Barton, 1998). Further still, there is little agreement about what “science for all” looks like and how the science education community actually endeavours to understand the diverse needs of students (Bang et al., 2013; Hodson, 2006; Wildy & Wallace, 1995).

For the purposes of this study, I envision scientific literacy as the idealized version of science education – those who “have” it, exhibit a broad understanding of scientific content and practices, and there is an assumed linear translation of it from teacher to student toward the purposes of academic achievement and increasing scores on empirical assessments of science knowledge (DeBoer, 2000). However, my dissertation problematizes the assumption that literacies are something that an individual acquires or “has.” In other words, scientific literacy “is not a given, but is socially constructed by members of a classroom in their interactions over time” (Tuyay, Jennings, & Dixon, 1995, p. 76). Instead, I use the term scientific competence, which involves the ways learners and teachers contribute to the co-construction of scientific understanding within the context of a particular classroom system. Therefore, what counts as “competent” is context-dependent, communicated through talk and action, and varies from setting to setting. This definition of scientific competency has implications for how school science can shift to invoke a broader spectrum of socioscientific issues, societal experts, and media sources (Fensham, 2002).

The shift in focus to the co-construction of scientific competence is also important because it highlights the ways that students’ participation (and therefore learning) is a function between what students do and what OTL are available to them. OTL are traditionally conceived of as various resources that influence school conditions, pedagogy, and curricula (Barton, 2001; Mo, Sing, & Chang, 2013; Oakes, 1990). Anderson (1990) originally defined OTL as the overlap
between what students are taught and the content on which students are tested, thus referring to
the conditions within the school or classroom that ostensibly promote learning for all students.
The inequalities in access to resources and particular kinds of discourse practices reduce
students’ opportunities to develop scientific competency and to be recognized as knowers and
doers of science.

However, different classrooms and schools provide different OTL to students to the
extent that different kinds of student behaviours are encouraged particular classroom practices
are privileged, and certain topics are covered and not others. Thus, if researchers are interested in
equitable learning and OTL, I contend that we must ask: what mediating tools are available for
learning; what activities are enacted in the classroom; what ideas and issues are taken up; and
what skills for problem solving are encouraged (Gee, 2008; Greeno, 2006). In addition, learning
is not just about mere exposure to information and instructional practices; learning also involves
student participation and individual acts of agency – how people choose to participate and the
consequences for doing so, how they shape the participation of others, and how both are
differentially facilitated and/or constrained by the activity structures, set within particular
classroom contexts (Esmonde, 2009b; Gresalfi et al., 2009; Holland, Lachicotte Jr., Skinner, &
Caine, 1998). The processes of negotiating what it means to “do science” therefore are shaped by
various dimensions of the system, within which they participate (e.g., tools, rules, and division of
labour, to be further clarified in Chapter 2).

The concept of “doing science” is problematized in this dissertation, as I take an
interactional view of context. Erickson & Shultz (1981) claim, “Contexts are constituted by what
people are doing and where and when they are doing it,” (p. 148). From this point of view, my
research looks at the local and interactionally-produced discourses students evoke to understand
the enacted practices of school science within this particular activity system. Whether these everyday interactions and classrooms activities might qualify as “science” under normative grounds remains open to debate (see Kelly, Chen, & Crawford, 1998).

Learning school science also encompasses more than just engaging with course content and valued discourse practices. Learning also involves “a process of becoming” (Gee, 1990; Lave & Wenger, 1991; Wortham, 2004a), as participation leaves a “mark” on people. As Gee (2015) argues, “[Participation in particular discourses] are ways of recognizing and getting recognized as certain sorts of whos doing certain sorts of whats” (p. 156). From a cultural-historical approach, as a student learns science, they engage in the accepted kinds of collective activity that characterize scientific communities. Thus, being “good at science” requires particular kinds of performances on the parts of the students (Carlone, 2004; Lemke, 1990). Concurrently, these actions must be socially intelligible and recognized by others. These activities become associated with varying designations of success and thus, scientific competency. In other words, an individual who is recognized as competent requires them to be socialized into the science community (in this study, the classroom) through recognizable interactions with the teacher and other students, who make meaning of particular actions that are based on their previous experiences and histories with schooling and the content area, which in turn are shaped by the sociopolitical culture in which they are embedded (Brickhouse, 2002; Gee, 2001; Gutiérrez & Rogoff, 2003). In other words, ideas about what science is, how learning takes place, and what classrooms should look like are ideological and social constructs that live within society and are enacted by people. For the purposes of my research, OTL is thus conceived of as an interactional phenomenon, which include access to course content and discourse practices and corresponding identities, but also the active sense-making of the learner.
Opportunities to learn in science classrooms. The question of how to support more, if not all students to becoming recognized as scientifically competent involves questions of equity and fairness. I borrow from Esmonde’s (2009b) understanding of “equity” as the fair distribution of OTL, where sociocultural theories of learning are brought to bear on what constitutes a learning opportunity. The term “fair” refers to a qualitative understanding of justice rather than an allocation of quantifiable resources (e.g., instructional time, number of qualified teachers), though they are related. What one considers to be fair then is a political question as well as an empirical one, influenced by the imminent classroom interactions as well as the larger sociocultural and economic contexts that greatly influence the allocation of resources and how schools are staffed. Dominant groups and institutional structures often regulate the distribution of activities, bodies, space, and time (Moje & Lewis, 2007; Roth et al., 2008; Tuyay et al., 1995), which are carried out by people on a micro-level through access to content, practices, relationships, as well as quantifiable resources.

In arguing that science education is marked by layers of inequalities and differential power dynamics enacted by people, my dissertation conceptualizes OTL as the intersections between access to scientific content and discourse practices and access to (positional) identities as legitimate knowers and doers of science (Figure 1). One’s participation in scientific discourse practices, and the extent to which their performances are recognized as scientifically competent, develops their identity as a kind of science learner (Gee, 2000). Taken together, I am interested in students’ uptake of available OTL, which are shaped by their engagements with the academic content and discourse practices, as well as with social others.

Critical examination of the distribution of OTL in science classrooms has not been studied extensively, but recent studies have focused on contexts that support equitable
interactions in other content areas (e.g., Esmonde, 2009a, 2009b; Dookie, 2015; Gresalfi, 2009; Kotsopolous, 2014; Lee, 2008; Moje & Lewis, 2007; Nasir & Hand, 2006). These studies suggest that a student’s social identity/ies (e.g., belonging to a division of race, gender, language, sexuality and so forth) and the ways in which power unfolds in everyday interactions between members in a classroom, can facilitate and/or constrain access to particular OTL.

Figure 1. Students’ uptake of opportunities to learn.

Figure 1 is an illustration of a student’s learning as a function of the relationship between what they do, given what opportunities they have to participate. Opportunities to learn will be at times, used interchangeably with opportunities to participate in classroom activities, as access to scientific content can be evoked through nonverbal means, such as blocking access to a learning artifact (e.g., a worksheet in group work), therefore literally preventing engagement with particular scientific activities. In relation to the topic of equity, my conceptualization of OTL allows me to examine who has access to certain opportunities and who does not, by recognizing
the concurrent influence of who is recognized as a contributing member of the group, whose ideas are taken up, and what counts as acceptable kinds of participation.

**Perspectives Needed to Broaden our Understanding of Science Learning**

**Cultural-historical activity theory (CHAT): The classroom as an activity system.** Traditionally, learning is conceptualized as a cognitive activity that happens “in the head” of an individual (Engeström, 1987/2015, p. 27). In particular, science learning is often characterized as the memorization and reproduction of facts garnered from textbooks and abstract scientific authorities (internalization). “The traditional model of classroom instruction is a historically formed habit” that shapes many teachers’ and students’ experiences of schooling (Engeström, Miettenen, & Punamäki, 1999, p. 328), with the image of students oriented to a sole authority figure who imparts stable and valid knowledge. Questions are asked to which teachers already know the answers; students’ performances are evaluated based on their adherence to standardized knowledge and practices, and differential performances of student ability “masquerade as an inevitable reality” (Simon & Campano, 2013, p. 22).

However, as some learning theorists argue (e.g., Engeström, 1999; Roth et al., 2008), to understand the persistence of traditional schooling and how student acquire particular frameworks about science learning, we must work to make the familiar strange. Historical control mechanisms that Dorothy Smith calls “relations of ruling” such as curriculum models and the management of time and space in classrooms, must be analyzed (2005, as cited in Roth et al., 2008). One such example is Tyler’s (1950) highly influential rationale for the “basic principles of curriculum and instruction,” where formal curricula are developed centrally, and
schools and teachers subsequently implement the topics and objectives of the curriculum documents.

Science textbooks are often used as a concrete manifestation of the formal curriculum and perpetuate a particular attitude and discourse about the domain of science. Haraway (1988) contends that these books adopt a particular kind of disembodied scientific language and promote an ideological doctrine of objectivity. A common consequence of the uncritical use of textbooks in classrooms is the removal of school science from human life worlds and/or science will matter in the same way to a student as it does to a scientist (Fensham, 2002; Gee, 2015; Moje, McIntosh Ciechanowski, Kramer, Ellis, Carrillo, & Collazo, 2004; Ochs, Gonzalez, & Jacoby, 1996). As Lemke (2001) further asserts, traditional curriculum models often perpetuate a “falsification of the nature of science to [take] concepts outside of their social, economic, historical, and technological contexts” (p. 300), which can promote narrow and highly technical views of science.

Instead, sociocultural theories of learning, stemming from Vygotsky (1978, 1986), gives substantial weight to the role of social interaction in learning. In addition, Vygotsky challenges the idea of learning as a “closed system,” and suggests that learning happens through a system of interconnected meanings and cooperative activities or communities. These communities give us the tools for meaning-making, such as shared language, beliefs and value systems, and specialized practices (Anderson et al., 1997; Lemke, 2001; Rosebery, Warren, & Tucker-Raymond, 2016), as well as the potential for innovation and change to these practices and application of these collective practices to different contexts (externalization). Classroom communities have been a large focus of sociocultural theory research (e.g., Aikenhead & Jegede, 1999; Ballenger, 1999; Costa, 1995; Heath, 1983; Wallace & Wildy, 2004).
Engeström (1987/2015, 1999, 2001) expands on this theory by conceptualizing the classroom as a historically-inherited activity system, treating learning as a social practice that includes patterns of interactions, understandings, attitudes, and norms that serve to organize (or “idealize”) activity. Put in another way, Gee (2015) asserts that learning “big-D” Discourses, such as science and mathematics, are inherently ideological processes, in that they necessarily involve learning a set of values and viewpoints about the relationships between people, foregrounding the kinds of problems that are important to the community, and the “best practices” to go about solving those problems. Gee further argues that adoption of these Discourses means taking on an “identity kit,” complete with particular ways of acting and thinking, so that others will recognize the individual as a particular kind of person, thus encompassing the social aspect of learning. Different content areas have different practices rooted in different epistemologies (ways of knowing) and ontologies (ways of being), which provide different opportunities for participation in a particular context. Learning science is therefore a social and historical event, which considers the learner-within-context as an interdependent unit of analysis (Bronfenbrenner, 1976; Cole, 1996; Goodwin, 1994; Greeno, 2006; Gresalfi, 2009; Gutierrez & Rogoff, 2003).

Drawing specifically upon CHAT, the dimensions of the classroom activity system include the acting subject (focal participant), division of labour (roles and responsibilities of the participants), rules (classroom norms and university policies), tools (curriculum, learning artifacts), community (members of the activity system), and object (collective goal of science learning). Engeström (1999) conceives of the activity system’s object as the central organizer for the participants’ actions. The teacher’s asymmetric power in the classroom system allows them to “set the agenda, establish the nature of the discourse, and determine what is and is not
appropriate classroom and laboratory behaviour” (Hodson, 1999, p. 778). Thus, teachers are powerful influencers who shape the collective object of the activity system. In Chapter 4, I focus on how the professor of the Kinesiology class organized the learning environment and made space for particular activities, modes of assessment, and patterns of behaviours, which I argue, framed the range of OTL and possible (or likely) interactions to take place within the classroom. My first analytic chapter draws on ethnographic data to provide a contextual framework for science learning and uses the CHAT triangle to provide a systematic analysis of available OTL.

In prior conceptualizations of CHAT, the researcher analyzes the activity system, looking at it from above. Engeström (1999, 2014) points out that an activity system as a unit of analysis calls for the complement of a system’s view with the subject’s view. The researcher must also select a subject (or several) who is a member of the local activity, through whose interpretations and experiences the activity is constructed. Movement between the two views is important, because “this dialectic between the systemic and subjective-partisan views bring the researcher into a dialogical relationship with the local activity” (Engeström, 1999, p. 10). Thus, my study of the university Kinesiology classroom system draws on a critical microethnographic perspective (to be expanded on in Chapter 3, Bloome, Carter, Christian, Otto, & Shuart-Faris, 2005; Fitch & Sanders, 2004; Payne & Rocco, 2009) to better understand what is happening and what is being learned in moments of scientific discussions that are informed by different dimensions of activity that operate on multiple timescales.

The ethnographic data collected in a critical microethnography is at once, personal and opaque – collected in incidental and automated ways from activities and contexts within which students are situated. The goal is to first sketch the contours of the Kinesiology classroom and how the teacher framed science learning. CHAT offers a systematic review of relevant
dimensions operating in an activity system (Dubois & Gadde, 2002), which I use to inform my analysis of the range of OTL. Then, to merge the theoretical with the empirical, I ask: In what ways do students’ relationships relative to science, the contexts from which they learn, and the available tools and practices, shape how they engage with and make sense of course content?

**Considering multiple timescales and historicity.** My study considers science learning as the interactions between the personal, micro-, meso-, and macro-level activities in a particular science classroom. Different levels of schooling operate on different timescales, from individuals’ biographical experiences to the momentary interactions between people to larger-scale histories of schooling and scientific practices (Anderson, 2009; Brickhouse, 2002; Ogbu, 1981; Waitoller, 2014). For example, time is a salient feature in the organizational structure of formal schools, although understudied (Roth et al., 2008; Tuyay et al., 1995). On the micro-level, it determines the length of particular classroom activities and interactions. On the meso-level, it can determine details like course pacing and setting exam dates. On the macro-level, it determines larger-scale societal constructs, such as when people are expected to graduate, start their careers, etc.

To bring it back to the Kinesiology classroom, an activity system is shaped by its history of collective practices, as are the participants within the system by other spaces, at other times, and with other people (Engeström, 2001; Gutiérrez & Rogoff, 2003; Moje & Lewis, 2007). In addition, the inherent division of labour within an activity creates different roles and responsibilities for the participants, constituting a heterogeneous learning space populated by people with multiple agendas and goals. Diversity thus is a precondition for every learning context, although the issues may be distinct from more culturally homogenous contexts compared to more heterogeneous classrooms (Brickhouse et al., 2006; Heppner, 2017; Theobald,
Thus, I use CHAT because it orients the researcher to conceptualize the cognitive and relational processes of school science learning against the organization of the classroom and its participants, as well as against the formalisms of the scientific community.

**Positioning theory: The student’s identity as a positional construct.**

While CHAT recognizes a need to incorporate the subject’s level view of the activity system, these conceptualizations, which involve considerations of subjectivity, emotion, embodiment, and ethico-moral commitments, are still in its infancy (Engeström, 2014; Engeström & Sannino, 2010; Radford & Roth, 2011). I propose integrating positioning theory into my theoretical framework as one way to complement the subject view that is missing in CHAT analyses. Positioning theory concerns the fluid positions, roles, and responsibilities that people make available for themselves and others through their talk and actions (Davies & Harré, 1990; Anderson, 2009). If Engeström and Kerosuo’s (2007) words hold true, “activity theory is strongly committed to pedagogical and interventionist actions to facilitate and change learning,” then we cannot overlook what is done and learned together in joint activity in favour of a system’s view.

In my previous research, I have directed attention to how learners engage in problem-solving tasks through collaboration in laboratory contexts (Ritchie, 2016). For my dissertation, I highlight how participants – carrying their own diverse histories and social identities – co-construct knowledge in scientific discussions, and in doing so, can interact in ways that manifest activity-level contradictions through patterns of talk and action. I “marked” these moments as potential catalysts for change and development (Oliveira, Akerson, Colak, Pongsangon, & Genel, 2010; Simon, 2016; Yamagata-Lynch & Haudenschild, 2009). Previous research using CHAT has conceptualized classroom contexts as historically organized through cooperation as well as
conflict (e.g., Forbes, Madeira, Davis, & Slotta, 2009; Gutiérrez, Baquedano-López, & Tejeda 1999; Kelly, Crawford, & Green, 2001). Contradictions are not necessarily open conflicts; they are historically accumulating tensions within and between activity systems (Engeström, 2001). Contradictions may therefore encompass interpersonal conflicts (in ways that we traditionally conceive them, such as arguments), but can also include innovative attempts to change the local activities and/or apply collective practices to new contexts (e.g., problem-solving).

Using video to document the classroom interactions, my dissertations examines the ways students position themselves and each other through verbal and non-verbal means (e.g., body orientation, facial expressions, voice pitch, gesturing, physical blocks). The concept of ‘positioning’ is used to describe how people discursively locate themselves (reflexive positioning) and social others (interactive positioning) through differential access to content, discourse practices, spaces, and kinds of relationships (Davies & Harré, 1990, 1999; Holland et al., 1998). These forms of positioning play a role in social inclusion and exclusion and are intricately linked to access to OTL. When there is a misalignment between a student’s reflexive positioning and others’ interactive positioning of the student, conflicts may arise (Kotsopolous, 2014; Yamagata-Lynch & Haudenschild, 2009).

However, the question of how connections can be made between the micro-level of student positioning to the larger-scale level of classroom activity remains. I argue to better understand students’ acts of positioning, a researcher must consider the broader social influences of any context, including how the students’ individual social identities interact with the institutional power dynamics that exist between various social groups (Dei, Holmes, Mazzuca, McIsaac, & Campbell, 1995; Gee, 2015; Wortham, 2004b) as well as the meso-level influences of the classroom climate, the students’ practice-linked identities (to be further explained in
Chapter 2), and interpersonal relationships that carry over time and space (Dookie, 2015, Holland et al., 1998; Zacher, 2008). These macro- and meso-level influences interact with the micro-level acts of positioning observed in sessions of group work, which in turn, shape how students take up particular OTL.

**Considering intersectionality of social identities.** Social identities do not exist as objective definitions or discrete scientific categories, rather they are unfinished processes and products of sociohistorical and political agendas, both ideological and material (Gee, 2015; Holland et al., 1998). Different categories of social identities are said to operate “distinctly yet in relation to one another” (Gaztambide-Fernández, 2009, p. 161, as cited in Dookie, 2015). Thus, I consider the concept of *intersectionality*, in which people are shaped by a number of intertwining social identities and histories (Crenshaw, 1991; Holland & Lave, 2001), and to which Rogoff (2003) argues, there seems to be some tendency in sociocultural literature to apply only one type of sociocultural analysis for each social group, and neglecting the roles of others, constituting a “box problem.” Although I consider intersectionality as potentially informing students’ interactions and acts of positioning in my study, the methodological complexities of studying intersectionality and the potential interactions of individual epistemologies and ontologies call for different tools of investigation that are beyond the scope of my study.

In this study, I do not explicitly address issues of race, gender, sexuality, socioeconomic status (SES), dominant language, and so forth, although they are germane to discussions of equity and identity in schools and in society more broadly (Carlone & Johnson, 2007; Curnow, 2017; Dookie, 2015; Oakes, 1990). I do not dismiss that students’ positioning in racialized, gendered, and socioeconomic (and so forth) social groups may be intricately tied to positioning related to their science identities; however, they are not always spoken about explicitly
(Esmonde, 2009b; Esmonde & Langer-Osuna, 2013). In Zacher’s (2008) study of Grade 5 students in a language arts classroom, the researcher found that students rarely claimed their identities in relation to social categories explicitly; rather, they spoke openly about topics of friendships and popularity in their discussions. In my study, positioning related to scientific competency and interpersonal relationships were more readily discussed, and therefore formed the basis for my analysis of positioning.

Lemke (2001) maintains that a sociocultural perspective on science education is skeptical and critical, in that we only understand our actions within a few local reasons on a certain time scale and in a limited range of contexts. In alignment with CHAT, Anna Sfard (2008) further asserts that when a researcher attempts to map people’s actions onto the activity’s objects, one needs to remember that trying to specify all the elements of one’s realization is not a viable research task. Rather than asking whether the participants are all “the same,” Sfard suggests trying to see whether there is a reason to suspect that they might be different (ibid., p. 167). Given the high degree of social, cultural, and linguistic diversity in Canadian classrooms, and their interwoven, evolving nature, it is impossible to consider all the dimensions of social identity that may come to bear on the process of a student’s science learning at any given moment. However, at a certain moment of interaction, one particular social dimension may become more salient than others (Dookie, 2015; Lemke, 2001). Interviews and a close video analysis of intergroup interactions therefore provided a view of how members made decisions, constructed the social context, and the frame(s) of focus in the group (Phillip, Olivara-Pasillas, & Rocha, 2016).

I argue when critically theorizing about identity and students’ actions within scientific discussions, the researcher must consider the individual’s and collectives group’s histories of
engagement with specific activities (Gutiérrez & Rogoff, 2003; Nasir & Hand, 2006), as well as the students’ capacity for improvisation within interactions (Forbes et al., 1998; Roth & Lee, 2007). As my research takes a critical microethnographic approach, I take the stance that broad generalizations of how classroom systems operate rarely examine how individuals jointly construct meaning in moment-to-moment processes within particular activities. Furthermore, Holland et al. (1998) contends that individual acts of improvisations should command the researcher’s close attention because they may only be excluded at the “risk of ignoring the back-and-forth of engagement” (p. 277). Even within grossly asymmetrical power relations, rarely do the powerful participants control the less-powerful so much so that the latter’s actions are rendered irrelevant to the interaction. Thus, Chapters 5 and 6 involve a more in-depth analysis of the focal participants’ talk and actions as they negotiate understandings of the course content and define the limits and directions of the common task. The finer grain analysis shows how the construction of scientific discussions by the different student groups involved more than talking science; it involved establishing and maintaining positions and social hierarchies, constructing relationships, and defining what counts as an intellectual contribution.

The ethnographic nature of my research describes the context from which to understand the patterns of activity, expectations, and norms that the members of the classroom system developed throughout the course (over ontogenic time). Then, by looking closely at the discourse processes within key events (i.e., conflictual intergroup interactions), I examine the ways science gets talked about, invoked, and portrayed to students. My analyses show that not all common tasks are interpreted and acted upon by students in similar fashions. A common task did not necessarily lead to common access to OTL. Rather, the task, as it was framed within the context of interaction and the specific social organization of the group, allowed for an array of
opportunities that were interdependent on a particular set of micro-, meso-, and macro-level factors that then became salient in the interaction. The analyses, informed by both CHAT and positioning theory, extend my understanding of how school science learning is enacted between peers in moment-to-moment social interactions, the co-constructed and dynamic nature of students’ positional identities, and what counts as appropriate participation within the specific group context. As I seek to understand more about the factors that support and/or constrain particular OTL in science classrooms, the dissertation also raises questions about how the construction of scientific discussions by different student groups can lead to different learning contexts, and often involved more than talking and doing science.

The Researcher’s Perspective

As I use the synthesis of CHAT and positioning theory to inform my theoretical lens, I wonder about how positioning theory can be helpful in understanding how researchers and participants position each other and themselves in conversations, particularly in interviews. To briefly describe positioning theory, it is the “discursive practice whereby people are located in conversations as observably and subjectively coherent participants in jointly produced storylines” (Davis & Harré, 1999, p. 37). The structure of conversations includes positions, storylines, and speech acts. Any narrative that collaboratively unfolds with social others draws on social and material resources and the roles available to the participants within those structures. The ways in which people understand the storyline(s) can vary, because the available resources may also be differentially accessed by different people, thus allowing for multiple possible readings of a social interaction (Radford & Roth, 2011; Ritchie, 2002).

As a burgeoning researcher, my research perspective is informed not only by my theoretical orientations and interest in science education and equity issues in classroom learning,
but also by my ontogenic development and life experiences. For example, I am a multiracial Chinese-Canadian woman who grew up in an upper middle-class, oftentimes trilingual household, and I attended predominantly White, middle-class elementary and secondary schools. My postsecondary education was concentrated in the STEM fields. As a woman of colour, I am aware of and experience first-hand the issues of race and gender that play out in higher education. My name does not match with how others often perceive my racial identity. While rarely explicit, I am frequently met with looks of confusion when individuals first know my name prior to meeting me, and coy questions of whether I belong in certain spaces, where I am really from, and/or if I have changed my name or taken my partner’s name. Simultaneously, being cisgender, English-speaking, and well-educated, I am also privileged in many respects by mainstream society. These intersecting identities frame how different people perceive my status, and the amount of legitimacy afforded to me. My insider-outsider status as a doctoral candidate in a prominent Canadian university informed my research process as I studied opportunities to learn science in a university Kinesiology course. These fragmented ways in which I am perceived and choose to present myself, sometimes facilitate and sometimes constrain my access to particular stories, relationships, and opportunities. My positionality, life experiences, and theoretical orientations thus serve as the lens through which I engage in research.

My study is rooted in an interpretive paradigm of knowledge, which attempts to make sense of the world through the meanings that people bring to them (Creswell, 2013). Through this lens, qualitative research is a situated activity that views knowledge as constructed through the positioning and professional vision of the researcher (Denzin & Lincoln, 2000; Goodwin, 1994; Holland et al., 1998). In accordance with the interpretive paradigm, this study acknowledges that research is a subjective endeavor, guided by my set of epistemological and
ontological beliefs. In each interpretative moment within the research process, my subjectivities and voice interacted with the data selected for collection and analysis.

As I familiarized myself with concepts of identity and positioning theory through my literature review, I became more sensitized to methodological issues of power and representation. Scheurich (1997, as cited in Ritchie & Rigano, 2001) contends that “the researcher brings considerable conscious and unconscious baggage … and this plethora of baggage, in the guise of the interviewer, interacts with an interviewee, who, of course, brings his/her own baggage to the interaction” (p. 74). Further to this, as I grew more entrenched in the data analysis stage, I actively searched for ambiguities and “marked” moments in my data that raised questions and used them as catalysts for further inquiry.

In reading studies that foreground the politics of interviewing (e.g., Limerick, Burgess-Limerick, & Grace, 1996; Ritchie & Rigano, 2001; Ritchie, Rigano & Lowry, 2000; Wortham, Mortimer, Lee, Allard, & White, 2011), I was struck by the relational parallels within the researcher-student-teacher triad in the literature and my own study. I became more aware of the shifting positions and power relations that informed my interactions with the participants. As Ritchie (2001) contends, “if we accept that interviews are sites of interacting subjectivities (as well as beliefs, emotions, goals, etc.) where meaning is co-constructed and co-authored by the participants” (p. 752), then multiple possible readings of events are possible.

Because my dissertation is focused on understanding how students manage their participation in scientific activities and take up particular OTL, the findings are conceptualized as constructed through partial accounts from both the researcher’s and focal participants’ interpretations as opposed to searching for an objective grand narrative. Drawing from the interpretive paradigm, this study includes thick rich descriptions of the university science
classroom in action (Latour, 1987) to provide contextualization cues that constitute the local environment, as well as the participants’ experiences of the classroom activities through interviews. This study resists the impulses often observed within quantitative research to find isolative, causal relationships between variables in the phenomena being studied (i.e., between acts of positioning and access to learning opportunities); instead my analysis embeds the findings within the active educational processes as they are being constructed in the classroom system.

When examining the ways in which students position one another in scientific discussions, my interpretations may be different from the ways in which the students themselves, experience and interpret them. It is therefore important to appreciate how the participants in the study view the particular classroom activities and interactions therein, rather than imposing my interpretations and perspectives. However, I resist the “Romantic impulse to elevate the experiential to the level of the authentic” (Silverman, 1997, p. 248, as cited in Denzin & Lincoln, 2000). Rather, I rely upon the theoretically grounded concept of (positional) identity/ies juxtaposed by the participants’ narratives garnered through interviews to inform my analysis. In addition, my study acknowledges and locates my epistemological and ontological orientations in the analytic processes. Such an orientation sheds light on the importance of considering both researcher and participant positions. As such, I foreground the voices of the focal participants and take strides to distinguish their voices from that of mine.

Moreover, this critical microethnographic research analyzes moment-to-moment interactions to garner a better understanding of how scientific practices and norms embedded in the classroom are enacted (Bloom et al., 2005; Pane & Rocco, 2009), and makes no assumptions about the relationship between access to OTL and (positional) identities except that they both are constantly negotiated in interaction (Esmonde, 2009b; Mehan, 1998).
Existing microethnographic studies often are limited to classroom teaching practices, and these studies have also tended to focus on teacher education and/or professional development (e.g., Engeström, 1995, 1999; Forbes et al., 2009; Yamagata-Lynch & Haudenschild, 2009; Zuengler & Miller, 2006). However, the foci of my study shift across the analytic chapters: from the teacher to the student, and from the classroom-level to individual student actions. It is posited that such multiple levels of analysis will encourage a more holistic view of existing formal schooling conditions and structures instead of a partial and idealized version.

In my dissertation, I investigate students’ access to and uptake of OTL in scientific discussions, set within a university Kinesiology classroom. The theoretical orientation draws from CHAT and positioning theory to construct a framework for examining the sociohistorical and discursive practices of students and teachers, embedded in a particular system. The empirical analysis considers the ways in which each of the two focal student participants in intergroup interactions negotiate an understanding of a common task involving socioscientific issues. The analyses show how a common task led to different contexts for learning school science, to the construction of different products, and to differential access to particular OTL. In particular, student uptake of differential positions in group work is presented as a way of understanding how individual student contributions matter to group meaning-making processes.

My research design was cross-sectional, as opposed to longitudinal. As a result, the study can offer little theorizing on the focal student’s learning process as an ontogenic experience and makes no claims that any documented shifts in the participants’ identities or perceptions of science are permanent. My empirical research, however, contributes to the body of CHAT literature by pursuing a dialectical analysis of the various dimensions that represent the classroom activity system, students’ access to particular OTL, and the consequences for learning
in intergroup interactions. My analysis invites consideration of the concomitant influences of historical collective practices and individual improvisational acts on how students take up OTL within particular activities. With these underlying philosophical orientations and research intentions in mind, I now return to the study’s research goals and questions.

Research Goals and Questions

The present study aims to qualitatively investigate the kinds of OTL students access as they negotiate their participation in scientific discussions in a university Kinesiology classroom. With a focus on the classroom as an “activity system” and the positional identities of the focal students, I am interested in examining the enacted practices in the moment-to-moment social interactions of particular group members. Moreover, I am interested in how power and privilege are involved in students’ access to particular OTL, and how the students themselves, describe and interpret these experiences. The analysis takes into account the intersectionality of identities and the invocation of multiple forces from different timescales on local activities. To reiterate, the research question guiding my study is:

What kinds of opportunities to learn do the students access as they manage their participation in particular scientific activities within the context of a Canadian, undergraduate, Kinesiology classroom?

1) What is the range of opportunities to learn represented by particular dimensions of the classroom system?

2) Within scientific discussions, how do students’ participation and acts of positioning shape their access to and uptake of particular OTL?
In the following sections, I describe the theoretical underpinnings of this work and introduce the study’s critical microethnographic perspective. The study integrates CHAT and positioning theory to conceptualize school science learning as engaging in scientific content and discourse practices while simultaneously being recognized as a knower and doer of science. My study aims to: (a) to sketch the contours of the Kinesiology classroom in a systematic way; and (b) the ways in which discourse processes are invoked and unfold in student conversations and relationships and shape how they engage with and make sense of course content. I highlight how students negotiated conflictual scientific discussions, consider the ways in which their interactive and reflexive acts of positioning shape their differential uptake of OTL, and analyze their actions against the classroom system.
Chapter 2
Literature Review

Chapter Overview

The present study takes an individual-within-context perspective as a unit of analysis, to examine the kinds of opportunities to learn (OTL) that students take up as they navigate conflictual scientific discussions in the context of a diverse, Canadian university, Kinesiology classroom. Two sub-question arise from the study: (1) What is the range of OTL represented by particular dimensions of the science classroom activity system?; and (2) Within scientific discussions, how do students’ participation and acts of positioning shape their access to and uptake of particular OTL?

Using cultural-historical activity theory (CHAT) and positioning theory as my integrative theoretical framework, I conceive of the university Kinesiology classroom as an “activity system” – a complex, social organization in which the subjects interact with their communities (e.g., teachers, other students, administrators), artifacts (e.g., worksheets, textbooks), objects (e.g., students’ learning, teachers’ learning), division of labour (e.g., participation structures, patterns of interactions, kinds of assessments), and rules (e.g., classroom rules and norms, school policies; Engeström, 1987/2015, 1999; Waitoller, 2014). Different classrooms have different regularities of shared, norms and practices, and thus provide different OTL by shaping the ways students “are expected, entitled, and obligated to participate [and] also the meanings that [they] make of particular acts of participation” (Gresalfi et al., 2009, p. 50).

In addition, members of the activity system have different ontogenic histories, which can refract the collective object and other dimensions of the activity system in dissimilar ways, manifesting in different kinds of interpretations, values, beliefs, and sense-making practices.
Furthermore, participants’ positionalities come into contact with the power-imbued boundaries of social categories (e.g., race, gender, socioeconomic status [SES], language, and so forth) and the formalisms of the scientific community, which legitimize particular ways of knowing and being in the classroom (Deng & Luke, 2008; Rosebery et al., 2016).

Drawing on microethnographic perspectives which facilitate a multi-level analysis of the relationship between science learning and student interactions, I illustrate how a common task can lead to differential contexts for learning, and thus to different OTL. My analyses illustrate how students’ participation are a function between what they actually do and what kinds of opportunities they have to engage with the course content and discourse practices and access to science identities. Put another way, the construction of scientific discussions involved more than talking science; it also involved establishing, maintaining, and resisting positions, constructing social contexts, negotiating group membership and defining the limits and direction of a task (Brickhouse & Potter, 2001; Kelly et al., 2001; Martin, 2016).

In the sections that follow, I: (1) present the current landscape of science-technology-engineering-mathematics (STEM) undergraduate education; (2) review the theories that frame the present study; and (3) integrate the theories to show how they work together to address the research goals.

**Student Demographics in Undergraduate STEM Programmes**

In increasingly complex and globalized societies, the focus in science education research is often on student enrollment in undergraduate STEM programmes. Many countries like Canada and the United States consider STEM skills to be vital to the development of a country’s economy and technological innovation. As a result, governments, policymakers, educators, and business leaders alike are concerned with the production of a STEM-literate workforce that is
prepared to meet the country’s increasing labour and innovation demands (Council of Canadian Academies [CCA], 2015; Hango, 2013). However, North American students’ enrollment rates in these undergraduate programmes tend to account for only 15-30% of all undergraduates who have declared a major (Higher Education Research Institute [HERI], 2010).

In a longitudinal study of a 2004-2009 postsecondary cohort that tracked beginning university students, Chen (2013) reported a 48% STEM attrition rate by the end of four years. The term, attrition, refers to undergraduate students either switching to a non-STEM field or leaving the university completely before completing a degree (Wintre, Bowers, Lorder, Lange, 2006). While seemingly high, Chen suggests these attrition rates are comparable with those of non-STEM related fields, such as humanities, social sciences, and business studies. Moreover, the Association of Universities and Colleges of Canada ([AUCC], 2011) and the CCA (2015) report a relatively stable trend of women enrollment in STEM programmes from 2000-2008 and 2000-2011, respectively.

However, student persistence in STEM fields continues to be an important equity issue. Although women students make up the majority of university graduates, they continue to be underrepresented in STEM programmes (Hango, 2013; Simon, Aulls, Dedic, Hubbard & Hall, 2015). A National Science Foundation (2015) report reveals a downward trend of women graduating with physical sciences and engineering degrees. In addition, the differences in STEM bachelor’s degree completion rates for U.S. underrepresented minorities (e.g., African American – 18.4%, Latinx, 22.1%, Native American – 18.8%) students versus White (33%) and Asian (46%) students remain large (HERI, 2010). These reviews of research on the intersections of gender and race and science education highlight persistent sociocultural and demographic trends
within university classrooms. STEM fields thus may present unique barriers to students of colour and White women (Brickhouse, 2001; Seymour, 2002; Simon et al., 2015).

STEM scholars (e.g., Brickhouse et al., 2006; Barton, 1998; Lemke, 2001), who are interested in issues of equity, claim that factors used to explain academic success in STEM programmes are relatively static, and tend to foreground one aspect of social identity, while under-examining student agency. While outside the purview of my dissertation, Carlone (2004) and Carlone & Johnson (2007) call for further research involving successful women of colour in science that “takes into consideration the complex interplay between structure and agency and the ways these tensions play out over [ontogenic] time” (p. 1188). Although women have made considerable strides in their participation in STEM fields over the past few decades, many continue to avoid pursuing higher education and occupations in science domains.

More recently, there have been studies that relate student identity to science learning across diverse classrooms in various international contexts (e.g., Aikenhead & Jegede, 1999; Bang & Medin, 2010; Costa, 1995; Reveles et al., 2004). However, few studies have examined the processes of science learning set within a Canadian university context. The uniqueness of the Canadian context, especially in urban areas, is characterized by its linguistic and cultural diversity of the student body (Cummins, 2007; Takeuchi, 2012). As Cummins (2007) contends, “it is no longer sufficient to be an excellent science teacher or math teacher in a generic sense, excellence must be defined by how well a teacher can teach science or math to the students who are in his or her classroom” (p. 6). In other words, science education research also requires a shift in focus from teaching to learning; from the formal curriculum to how the classroom system and activities are structured (i.e., the enacted curriculum), and a consideration of how race, ethnicity, and/or gender (and other social categories) can interact to influence student participation
These findings inform my study by highlighting the need for analytic attention to how university students manage their participation and (positional) identities within scientific activities.

A Turn toward Scientific Competence

As described in Chapter 1, scientific literacy refers broadly to the attainment of a set of “functional” scientific content and discourse practices, codes of behaviour, values, norms, and representational systems of science (Hodson, 1999). However, perennial challenges to defining and assessing scientific literacy subsist, particularly as current scientific practices have seen a shift toward technology, cross-disciplinary inquiries, and a knowledge-intensive era (DeBoer, 2000; Hurd, 1998; Lederman, 2006). How do teachers evaluate students’ comprehensions of scientific knowledge when it is so readily at their fingertips? And without a clear idea of what scientific literacy means, how do education reforms that make scientific literacy a goal take place? Studies of school science learning show that learning processes are rarely unproblematic (Aikenhead, 2006; Aikenhead & Jegede, 1999; Costa, 1995; Sharma; 2007), and what students learn is sometimes different from what a teacher or curriculum outlines (Greeno, 2006; Mehan, 1998). Thus, I challenge the narrow notions of students’ literate abilities, which are often “institutionally constructed through deficit-based pedagogical policies and practices” (Simon & Campano, 2013, p. 28). Instead, my dissertation problematizes the idea that scientific literacy is something that one “acquires” through the unproblematic transfer of knowledge from a more knowledgeable person to a less knowledgeable one to a more collective idealization of learning – that when two individuals collaborate, regardless of developmental level, entirely new actions can unfold (Roth & Lee, 2007; see also Engeström, 1987/2015; Roth & Radford, 2010).
Rather I prefer the term, *scientific competence*, as it highlights the constructed nature of what it means to be successful in science classrooms. CHAT conceptualizes the classroom as a system of expectations and entitlements that is organized around shared content and discourse practices and focuses on the dialectical nature of learning. What counts as “competent” gets negotiated in particular classrooms – classroom practices differ in the extent to which they surface particular problems as important to the community of practice, encourage particular ways of problem solving, and position students differentially by how they are expected to initiate action, take up, or challenge others’ intellectual contributions (Greeno, 2006; Gresalfi, 2009). The term “construction” highlights the collaborative nature of learning, as meaning-making are locally negotiated through interactions between the teacher, students, and what space is made for specific ideas and practices in the activity system (see Figure 1).

The process of negotiating what it means to “do science” does not happen in one moment, or in one way. Even in a single classroom, the contexts of learning are dynamic. Different contexts and the social organization of group members in a particular activity can facilitate and/or hinder access to particular OTL (Esmonde, 2009b; Greeno, 2006; Kelly et al., 2001; Takeuchi, 2012). Unlike the more stable construct of scientific literacy (either you are or you are not literate), I view scientific competence as locally defined enactments and performances that may accumulate over ontogenic time to position a student as a particular kind of person. Thus, a critical sociocultural perspective posits a student’s scientifically competent identity as a social construction that is related to dialectical negotiations between micro-level interactions and more sedimented practices of the activity system, and is enacted on an ongoing basis (Curnow, 2017; Dookie, 2015; Moje & Lewis, 2007).
Empirical studies of science in action have examined the cultural practices among members of scientific communities, and how through its formalisms and discourse practices, knowledge is recognized, established, transformed, and/or rejected (Lemke, 1990; Ochs et al., 1996). Drawing from a sociocultural perspective, scientific knowledge and understandings are constructed through talk and interactions around problems and tasks meaningful to a particular community. Learning school science therefore entails participating and communicating in socially appropriate ways as circumscribed by the activity system, nested within larger social, political, and economic contexts. Students act and interact with the teacher and others to construct the legitimized knowledge of the classroom; “their learning of and about science is therefore inseparable from the surrounding environment in which it takes place” (Reveles, Cordova, & Kelly, 2004, p. 1112).

This sociocultural conception of scientific competence diverges from the more traditional notions of scientific literacy that often refers to an attainment of certain scientific concepts and ideas (AAAS, 1990; Duncan & Rivet, 2013; Hurd, 1998; NRC, 1996). Yore (2003) suggests that an overemphasis on content instruction in school science suggests to some people that mathematics is the language of science, unnecessarily narrowing the conception of formal science as technical and formulaic. Further to this, Price & McNeill (2013) contend that the science curriculum is imbued with veiled meanings and significance by those who create and teach it, which are often passed on uncritically to students. Without explicitly engaging in dialogue about those meanings and the “potential [abuses and] uses of the science curriculum …, students are often unaware of the potential identities they may take on as citizens and scientists, the ‘as if’ potential worlds they may enter, or the actions they may take” (ibid., p. 502). Noting that most students do not choose a STEM-related major in postsecondary education or enter into
a science-related career field (Chen, 2013; NRC, 2012), studies of knowledge construction in scientific communities and science classrooms foreground the discursive nature of scientific processes and shed light on how school science experiences carry meaning and power (e.g., Arnold, 2012; Lemke, 1990; Martin, 2016; Ochs et al., 1996). Fensham (2002) suggests it is important to identify the multiplicities of knowledges, and that this understanding is directed toward particular social purposes. He further argues that with uncritical assumptions about science learning and what science education can offer to the nonspecialized citizen, science is left to the silos of scientists and science educators.

Moving from Fensham to Roberts’ (2007) conception of scientific literacy, he proposes that there are two schools of thought: broadly speaking Vision I and Vision II. Vision I describes the science domain itself, including the scientific procedures and products, such as experimenting and theories. Vision II, on the other hand, looks at the situations in which science has a role, such as decision-making about critical, socioscientific issues. He further argues that the ambiguity about the different definitions of scientific literacy can be elucidated by focusing on the two visions, then by fine-tuning the answers to the questions of “what, how, for whom, and in what sort of conceptual balance” (ibid, 2007, 11). These tensions are not new, and as Roberts stipulates, both views reinforce that science plays an important role in a number of matters related to the public and private sphere.

Without these fundamental understandings, I argue that school science does a disservice to students by only teaching science, and not about science. Much of the scientific knowledge that students learn may be outdated within a few years of leaving school. However, if students learn to appreciate the roles and status of scientific knowledge and understand the potentially contentious nature of scientific inquiry, science scholars submit that such skills will enable
students to more easily acquire additional scientific knowledge and better examine the validity and reliability of those claims later on (Aikenhead, 2006; Hodson, 2006; Price & McNeil, 2013). Consequently, even if formal science education does not result in the major production of future scientists, these studies may aid in the closer approximation of the touted idea of “science for all” in education.

Next, science education researchers who take a sociocultural perspective contend the scientific vision must be expanded to include how science is applied and translated in economic, government, military, political and public settings (e.g., Pedretti & Hodson, 1995; Lemke, 2001; March for Science, 2017; Roth, 2009). When other domains of scientific application are considered, expanded discourses such as social and institutional practices (e.g., Wildy & Wallace, 2004; Roth et al., 2008), mathematical symbolism and specialized visual representations (e.g., Roth & McGinn, 1998; Roth, McGinn, Wosczyna, & Boutonné, 1999), conversational (e.g., Crawford, Chen, & Kelly, 1997; Moje, 1995; Ochs et al., 1996), and written modes of scientific discourse (e.g., Norris & Phillips, 2003; Sørvik, Blikstad-Balas, & Ødegaard, 2014) emerge as important vehicles for science learning, imbued with their own norms of what constitutes knowledge and how best to come to know about it. Thus, engagement with science is not possible without a reasonable degree of competency in other areas.

Because the dissertation is concerned with students’ access to OTL in science classroom contexts, two levels of analysis are employed for this study, first on the activity level in how the teacher framed science learning and classroom activities, and two, on the interactional level in how students navigate scientific discussions. By examining how and what students negotiate as valid knowledge and intellectual contributions, my study provides “a more differentiated and subtle picture of epistemic activities” than can be found in more traditional studies of content.
classrooms (Lynch, 1992, as cited in Kelly et al., 2001, p. 137). I expect that students who are differentially positioned in the classroom would have different perspectives on their learning and group work. I therefore include student interviews to document their interpretations and experiences of the science classroom.

The formal and enacted curriculum of a particular classroom does not only describe the legitimization of particular content, but also refer to how ideas are communicated, justified, contested, and made meaningful. The classroom activities encourage students to learn the course content and perform the practices that are associated with scientific competence. Borrowing from Gee’s (1990, 2001) concept of discourse, I conceive of scientific discourse practices as socially recognized ways to convey scientific ideas and participate in the formalisms and procedures of the scientific community. Conceiving of scientific literacy and/or scientific competency without paying attention to how these discourse practices influence student uptake of OTL (or make them more likely to occur) in the classroom, risks overlooking the social dimensions that are central to science learning. The interactional aspects of learning have to do with the ways in which students recognize themselves and are recognized by social others as knowers and doers of science (or not, Gresalfi et al., 2009). The social organization of a classroom influences what kinds of interactions are afforded and encouraged in a given learning environment, and what kinds of student identities become available. As Greeno (2006) asserts, “It is virtually meaningless to ask whether someone has learned a particular topic … without taking into account the kind of activity systems in which a person’s knowledge is to be evaluated” (p. 80). This idea aligns with my definition of scientific competence.

In the following section, I briefly review sociocultural theories that inform how I conceptualize science learning and identities. Then I focus on the synergistic integration of
CHAT and positioning theory as my theoretical framework, with an eye toward the university Kinesiology classroom as an activity system oriented to the collective (formal) object of school science learning, and the other toward students’ participation and acts of positioning in intergroup interactions. Through their patterns of talk and interactions, I demonstrate how different student groups negotiated a common task across different contexts, and made visible the different and varied OTL that developed in scientific discussions.

**Review of the Sociocultural Theories of Learning and Identity**

First, this research is grounded in sociocultural conceptualizations of science learning, meaning that substantial weight is given to the role of social interaction. Rather than viewing learning and knowing as merely an accumulation of facts, skills, and theories (internalization), the present study shifts attention to the kinds of practices in which students participate, and the ways people relate to one another in a particular classroom activity. For the purpose of this research, learning is therefore defined as a change in participation in a particular set of practices, through which an individual increases their capabilities for participation in ways that are valued and socially recognized. Thus, learning is also a process of becoming through which an individual becomes recognized as a “kind” of person (Gee, 1990; Lave & Wenger, 1991).

Sociocultural theory proposes that learning is mediated by social interactions and the use of tools (e.g., shared language, belief and value systems, specialized discourses, artifacts) to solve culturally important problems, as defined by the community of practice (Cole, 1996; Lemke, 2001; Vygotsky, 1978/1986) This conceptualization presents a departure from a more Cartesian (separation of body/mind) mentalism of learning, in which learning is conceived of as cognitive and vertical development, moving the individual from incompetence to competence (Engeström, 1987/2015; 1995). In other words, learning extends “beyond the skin” to consider
how knowledge may be distributed across moment-to-moment interactions and resources that arise out of those interactions (Resnick, 1991, as cited in LeBaron, 2005). CHAT therefore suggests a renewed attention to context or the “activity system” as a critical aspect of what students come to know and value, and who they come to be. The activity system becomes the unit of analysis, and the subject (student) is a participant acting dialectically in and with “a system of social practices that includes specific patterns of interaction, understandings, assumptions, norms that serve to organize activity” (Gresalfi, 2009, p. 330), making particular interactions and OTL more likely than others.

In the next section, I explore CHAT literature with a particular focus on classroom spaces. It is important to my study, because I consider my research site – the university Kinesiology classroom – as an activity system, in which the classroom practices are constructed both locally by its participants and historically by the school institution that reflects the formalisms of the scientific community writ large. In the traditional science classroom, norms and expectations for behaviour and sense-making are shaped by masculine, Eurowestern practices and values, and often reinforce power relations present in the macro-level of society (Brickhouse, 2001; Lemke, 1990, 2001; Rosebery et al., 2016; Rosebery, Warren, Ballenger, & Ognowski, 2016; Seymour & Hewitt, 1997). In this light, the kinds of OTL in the classroom are shaped by the dominant scientific epistemologies and ontologies, which in turn, may narrow teachers and students’ interpretations of what kinds of knowledge and acts have intellectual power and value.

**CHAT and Science Education**

As previously described, I consider the university Kinesiology classroom as an activity system. Using the CHAT a triangle heuristic to represent the activity system (Figure 2), the
nodes of the triangle represent the dimensions that make up the context of the activity, e.g., subject (the acting participant), tools (learning artifacts), object (collective goal around which system is oriented), community (members of organization), rules (acceptable behaviours, norms, and institutional policies), and division of labour (roles and responsibilities allocated to different members). As Engeström, (2001) maintains, the object is only understandable against the backdrop of the activity system, that is, the science classroom. The activity system reproduces and sustains itself by generating actions (performed by the teachers and students) directed toward the system’s object (i.e., collective science learning).

The collectivity of the activity system provides opportunities for students to participate in shared tasks and doing so in ways that are beyond the scope of individual efforts (Ritchie, 2016; Roth & Radford, 2010). In other words, the teacher and students work together towards the attainment of an ideological vision of science learning, usually explicated by the formal curriculum. The participants’ actions within the classroom activities ostensibly contribute to realizing the collective object, simultaneously transforming both the system and the participant embodying the action in a dialectical fashion (Roth, 2007b; Wenger, 1998). As Radford & Roth (2011) contends, the goals and object of activity are refracted differently to each participant, as a result of their varied ontogenic histories and school science experiences, the division of labour inherent within a shared task, and their uptake of different positions in intergroup interactions, Thus, a common task can lead to differential contexts for learning and outcomes for each individual student (Kelly et al., 2001)

In CHAT, the ‘outcome’ dimension refers to the individual sense-making of the collective object by the participant (subject). As CHAT is a dialectical theory of learning, I use the convention, ‘object ↔ outcome’ in my dissertation to talk about the joint activity of
meaning-making that is done by the student acting within a particular context. The double headed arrow represents the dialectical nature of learning.

![Diagram: The triangle heuristic of an activity system.](image)

(Adapted from Engeström, 1987/2015, p. 78).

**Figure 2.** The triangle heuristic of an activity system.

As the content and discourse practices of science classrooms have historically privileged particular ways of knowing-talking-seeing-acting (e.g., applying and understanding scientific terminology and speaking more abstractedly and impersonally; Ochs et al., 1996; Rosebery et al., 2005), CHAT is an appropriate theoretical framework as it maintains a sharp focus on the activity system’s historicity, and how that aspect organizes and constrains participants’ actions (Anderson, 2009; Engeström, 1995, 2001). In Roth and his colleagues’ (1999) ethnographic study of a Grade 6/7 physics classroom, they demonstrated how different artifacts, social configurations, and physical arrangements afforded different interactional spaces, participant roles, and levels of participation. Thus, students’ differential participation within the classroom are analyzed against the organization of the classroom system as well as the more macro-level history/ies of what constitutes physics knowledge and appropriate procedures.
Activity systems therefore, are “dynamic, open, semiotic systems of meaningful actions and meaning-making processes” (e.g., classrooms, work environments; Lemke, 1990, p. 191), and not defined by any one member. Teachers may structure a perfectly equitable activity, but a single cooperative activity may be taken up in multiple ways in the classroom (Esmonde, 2009b), whether it is due to a difference in interpretation or a difference in the ways of how the students elected to accomplish the task. These differences suggest the need for a closer examination of how group members negotiate understandings of a common task.

While the literature on classroom practices have identified broad areas for further investigation (e.g., emphasizing competition over cooperation, marking intellectual contributions over behavioural ones; Esmonde, 2009a; Gresalfi, 2009; Mo et al., 2013), it does not explain why classroom practices do not impact all students in the same way or which aspects of classroom practice may better support particular kinds of engagement toward science learning among diverse students of the same classroom. Put another way, while structural and historical processes are implicated in what is perceived as appropriate behaviour in the science classroom and as a result what is recognized as scientific competence, they are neither deterministic or absolute (Bloome & Egan-Robertson, 1993; Holland et al., 1998).

While the teacher holds the most power in shaping the collective object(s) and activities of the system, students play an important role in taking up opportunities to participate in ways advocated for by the teacher and co-constructing knowledge. In this view, the formal curriculum that is used by the teacher influences but by no means determines what actually happens as students begin to engage with the scientific tasks and content (Bang et al., 2012; Gresalfi et al., 2009; Warren, Ballenger, Ogonowski, & Rosebery, 2001). The available OTL are simultaneously influenced by how students choose to participate, how they shape the
participation of others, and how both are facilitated and/or constrained by the activity structures in which they are invited to participate (Esmonde, 2009b). In addition, learning cannot be divorced from individual motivations and desires that are mediated by more nebulous concepts such as emotions, identities, values, and ethics. As Delpit (1992) and Gutiérrez & Rogoff (2003) note, part of equitable teaching involves navigating and taking seriously the sense-making repertoires valued in other cultural-historical communities, and to find ways to capitalize on a diversity of students’ approaches to learning. This view has important implications for research on the equitable distribution of OTL in classroom activities.

**Internalization and externalization of science learning.** As Engeström (2001) and Engeström & Sannino (2010) contend, learning and knowing are typically conceptualized as vertical processes, aimed at moving students toward higher levels of competence (internalization). There is a competent teacher who knows what is to be learned ahead of time, and thus the knowledge to be acquired is conceived of as something relatively stable, and usually bounded within a dominant textbook. However, as mentioned above, although the teacher and formal curriculum may shape the available OTL in the classroom, students may take up the learning opportunities in various ways. Students therefore are “all the time learning something that is not stable, not even defined or understood ahead of time. [They] must learn new forms of activity which are not yet there. They are literally learned as they are being created,” (Engeström, 2001, p. 137).

Similarly, Gutiérrez and her colleagues (2007) contend that learning also happens horizontally in a complementary process, which includes not only what students learn in formal environments but also across social boundaries and the creation of new cultural artifacts (externalization), thereby expanding their action possibilities. Less attention has been paid to
externalization, because as Engeström (1995) submits, external processes are often more difficult to explore as these studies would have “to deal with an array of heterogeneous elements which constitute [the learners’] micro-environments” (p. 400). As a result, science learning is not a simple matter of rational decision making and changing one’s mind; it is a social process with social consequences. Science education does not only affect individual learners, but is embedded in larger-scale effects, such as important sociocultural, political, and economic contexts. As Lemke (2001) argues, even “if we choose to ignore the larger-scale contexts in which we work, we cannot ignore the ways in which student learning is also embedded in those contexts” (p. 301).

An example provided by Lemke (2001) is the teaching and learning of the evolutionist-creationist controversy. For a student who believes in creationism, it is not a matter of changing one’s views about a topic in the scientific domain without the need to change anything else about their lives or their identities. It could also mean “breaking an essential bond with your community (and your god). It could lead to social ostracism … and complicate your family life” (ibid., p. 301). Individuals do not exist in a closed activity system; they take part in sociocultural practices that extend outside the classroom (Aikenhead, 2006; Costa, 1995; Hodson, 1999; Holland et al., 1998) that dialectically inform their understandings and identities related to science learning. Furthermore, Lemke (2001) argues it is a falsification of science learning to profess that students or “anyone can or should live by extreme rationalist principles” (p. 301), and to pretend there are no social consequences to changing one’s identity/ies or beliefs.

**Ethico-moral and social dimensions of science learning.** As discussed above, science learning is not merely a vertical process in which a student internalizes the academic content and discourse practices. However, a vertical view of science learning is simpler, and makes it easier
for horizontal aspects of learning to be characterized as extraneous or not as important for change in schools (Engeström, 2001; Gresalfi, 2009; Roth, 2007a). For example, the largest focus of attention of sociocultural research in science education appears to be on cultural conflicts between school science and the students’ lives outside the classroom (e.g., Aikenhead & Jegede, 1999; Bang & Medin, 2010; Barton, 1998; Costa, 1995; Sharma, 2007). However, there is some criticism that many of these studies show a tendency to apply one type of analysis for each social group (i.e., looking at race, gender, or SES only, as if they exist extraneously outside one another), and neglecting the role of others (Carlone & Johnson, 2007; Gutiérrez & Rogoff, 2003; Lemke, 2001; Seymour & Hewitt, 1997). To some extent, these studies may reflect earlier stages of sociocultural analyses and current methodological limitations. However, viewing social dimensions as simply influences on learning suggests that these aspects of engagement are extraneous to content-oriented, “authentic” learning (Gresalfi, 2009; Roth, 2007a), or perhaps more dangerously, may re-inscribe notions that variance in academic learning is an inevitable reality (Simon & Campano, 2013).

Earlier articulations of CHAT neglected the role of emotions, identities, and ethics. Following in the tradition of Vygotsky (1979, 1986), educational studies informed by critical sociocultural theory (e.g., Greeno, 2006; Moje & Lewis, 2007; Roth, 2007b) have extended to include emotions and other subjectivities as integral aspects of human cognition rather than as merely influences on learning. Moreover, Roth (2007a, 2009) argues the dialectical structure of CHAT does not distinguish between the bodily actions and cognitive activity, as they presuppose and guide each other. For example, Tobin and his colleagues (2013) illustrated how a Grade 7 classroom’s positive emotional climate was correlated with dialogic interactions, use of humour, and collective effervescence. The researchers argue that the emotional valences available in
particular actions not only fed into the kinds of learning that occurred, but also fed back into the emotional climate of the classroom activity system, and refracted among individual students’ emotions.

In Roth’s (2007a) ethnographic study of a Canadian salmon hatchery, the researcher demonstrated how the fish culturists’ emotions as well as their interactions with management mediated their decision-making actions and motivation to continue their work. Thus, I argue learners’ affective dimensions (including but not limited to bodily states, emotions, ethical-moral commitments, identity) dialectically inform their participation as they both unfold in interactions.

The emotional and ethico-moral determinants of action are new predicates to CHAT, and are methodologically inferred through linguistic cues, intonations of speech, facial expressions, and body orientations (DuBois & Karkkainen, 2012; Engeström & Sannino, 2011; Gofmann, 1961, as cited in Bloland 1979; Hoschild, 1979; Martin, 2004; Metcalfe, 2006; Sidnell, 2012; Vygotsky, 1986), and require further research.

My study includes the consideration of ethico-moral dimensions to science learning (one aspect of externalization), because the Kinesiology course itself involved not only engaging with the course content that included considerations of ethical dilemmas in socioscientific issues, but also an explicit recognition that science education is a political and powerful endeavour “inseparable from the material and ideological circumstances in which students are positioned” (Hodson, 1999, p. 777; Hodson, 2006). Borrowing from Roth (2007b), I use the term ‘ethico-moral’ broadly as an aim oriented toward fairness and justice and motivated by concerns for society and others. Through concrete actions and participative thinking, individuals are said to embody the ethical aims of science learning.
Through the trajectory of the course, for example, Kinesiology students were repeatedly presented with case studies that presented ethico-moral dilemmas involving scientific activity (e.g., animal testing in Kinesiology labs, objectification of bodies in gross anatomy courses, organ harvesting for transplant surgeries). These case studies and other classroom activities offered students opportunities to engage with the course content and develop their personal ethico-moral subjectivities. Thus, the ethico-moral dimensions of science learning (for this course) exist at both the individual (personal) and ideological (collective) level.

There is an imaginative component to the process of learning and identity development, as a student becomes exposed to and negotiates collective but idealized practices (Dookie, 2015; Nasir & Hand, 2006; Roth, 2007b) found in formal schooling. They include ideals of what a science classroom looks like, how group work is supposed to unfold, and what a high-status student does in order to be recognized as scientifically competent. Holland (2001a) refers to these ideological practices as “as-if” worlds that are sociohistorical interpretations that mediate positional identities. These imaginations are shaped by the culture within which it is embedded (Brickhouse, 2002). Depending on how students position themselves and how they are positioned by others, they perceive differential access to actions, resources, and roles in different classroom activities.

Science Identity/ies

The sociocultural perspective broadly defines identity as a dynamic, fluid construct, tied to the social world, social constructs, and social processes. Holland and her colleagues (1998) describe identity as “imaginings of self in worlds of action, as social products … [they] are lived in and through action, so must be conceptualized as they develop in social practice” (p. 5). In addition, Gee (1990) emphasizes how identities are operationalized through “big-D” Discourses
or “ways of writing-doing-being-valuing-believing … in the world” (p. 142), that links locally situated actions to ideological and recognizable ways to be.

Aligning with these theoretical perspectives, Roth and his colleagues (1999) assert that how well students enact scientific discourses is an indication of how well they can participate in scientific activities and be recognized as a kind of science student, rather than how well they understand an “objective” reality (i.e., whether they are scientifically literate or not). Moreover, the recent sociolinguistic turn in educational research has shaped the ways in which studies analyze how people use linguistic resources and different kinds of representation (e.g., gestural, graphical, mathematical) to make meaning, shifting attention to how an individual’s science identity emerges through conversations and various discursive practices in which they participate (Carlone, 2004; Lemke, 1990; Sidnell, 2013; Wortham, 2004b; Zacher, 2008)

**Positioning theory and science identities.** Holland and her colleagues (1998) state, “People tell others who they are, but even more important, they tell themselves and try to act as though they are who they say they are” (p. 1). These self-understandings have strong historical, emotional, and volitional ties. Identity is one way of naming the process in which an individual forms and re-forms themselves over their ontogenic life history and in the histories of social collectivities. However, these forms of personhood are not unidirectional; people are positioned through accidents of birth (Spivak, 1988) and interactionally by social others. In this section, I discuss positioning theory, and how the theory – synergistically integrated with CHAT – informs my theoretical framework for the study.

Positioning is largely a conversational phenomenon, and positioning theory grows out of social psychology and technological advancements including cameras and videorecorders (e.g.,
Bloome et al., 2005; Fitch & Sanders, 2004). The technological advancements illuminate previously unavailable interpretations of subtle, micro-level interactions, such as body orientations, facial expressions, artifact manipulation, and how language uses shape non-verbal means of communication, and vice versa. According to Davies & Harré (1990, 1999), our senses of selves involve learning about storylines and categories of people, which include some and exclude others, and participating in the appropriate discursive practices of a particular storyline. Through participation, a learner positions themselves within these stories, and recognizes themselves as having traits of a particular character or group member. In other words, a person constructs an identity by “reproducing the collective upon the individual, the social upon the body” (Holland et al., 1998, p. 169), and orienting themselves to the public standards of their enacted identity/ies in an ongoing interactive process that simultaneously occurs at micro- and macro-levels. Therefore, an individual can be thought of as an axiological site for acts of positioning (and not just agents or targets of positioning, Anderson, 2009; Leander, 2004).

Davies & Harré (1990) added to the notions of identity by introducing the idea of *positioning*, whereby selves are located largely in conversations “in jointly produced storylines” (p. 48) as kinds of people acting within trajectories of knowing and being. Positional identities include *interactive positioning* in which a person positions another, and *reflexive positioning* in which a person positions themselves, and refers to the dynamic movement of individuals in conversation. For example, Ritchie (2002) used positioning theory to analyze the social interactions of mixed-gender and same-gender groups during scientific identities, in which some students enacted a victimization storyline across both mixed group and same-gender activities. Such positioning can shape further interpretations of the participants’ actions; that is, in this study, identities carried over into different contexts. Acts of positioning in the classroom,
therefore, can have broader significance, in which a student becomes attributed as a certain kind of person across relationships and/or institutions (e.g., being labelled as “dumb” or “smart,” Simon & Campano, 2013).

Positional identities differ from but are informed by social identities (e.g., social categories including but not limited to race, ethnicity, gender, sexuality; Holland & Lave, 2001). For the purposes of this study, positional identities are conceptualized as micro-identities that are constructed in moment-to-moment interactions and are related to the roles and responsibilities individuals take up in collaborative activities. Though individuals do not have perfect freedom in constructing their positional identities (Brickhouse, Lowrey, & Schultz, 2000; Esmonde, 2009a; Gutiérrez & Rogoff, 2003), they can always exercise agency in the face of powerful institutional and social constraints, by engaging in a limited range but meaningful acts in their day-to-day interactions. For example, in Kotsopolous’ (2014) year-long study of a diverse mathematics classrooms, she examined how Grade 8 students positioned themselves differentially as experts and/or novices in group work, and noted instances of misalignment during a common task. Students who reflexively resisted interactive acts of positioning were at times, considered non-cooperative. Thus, an individual may reflexively contest their interactive positioning by others, but there can be social consequences that make certain actions unlikely or unfavourable.

**Student agency and improvised identities.** Students’ acts of participation in group activities, which can range from contributing, justifying, transforming to openly resisting ideas, belies the improvisational nature of positioning in the flow of interactive event. Using the available resources evoked from the social and material conditions at hand and past biographical experiences, improvisations (as an instance of individual agency) “make a difference for the next moment of production” (Holland et al., 1998, p. 45). In Zacher’s (2008) study of a diverse Grade
5 language arts classroom, she examined the relationship between literacy events and students’ identity development. In a storytelling activity, four boys read aloud their homework stories while simultaneously negotiating their positioning in the social hierarchy of the classroom by spontaneously including their peers in their retelling of stories. This research illustrated that even in brief events of assigned work, students found space and time to express agency. They positioned themselves and others by drawing upon resources that emerged in interactions (Esmonde & Langer-Osuna, 2013; Kelly et al., 2001). The Grade 5 boys made improvisational choices to accomplish both their academic and social goals in these imagined, written worlds.

What is important for the dissertation then is not that students act, but the ways in which student agency may be exercised and the consequences for doing so within group activities in the space of the university Kinesiology classroom. The structure and/or the group dynamics of a common task may make it difficult or unappealing for individuals to engage in potentially contentious positioning moves, as it can open themselves and/or their ideas up to critique or dismissal, or being characterized negatively (Dookie, 2015; Kotsopolous, 2014; Ritchie, 2002). However, to dismiss acts of positioning is to ignore the contested process of meaning making. As Holland et al. (1998) contends, even in the face of great asymmetric power relations, powerful participants such as teachers, rarely control the less-powerful students insomuch as their resistances are rendered irrelevant to the context. Thus, as I speak about learning the course content and discourse practices in a science classroom, an understanding of negotiation, conflict, and power dynamics in intergroup interactions is crucial if educators and researchers alike are to better understand the potential influence that individual student contributions play in group processes, and how conflict potentially provides new resources and unique OTL.
Practice-linked and social identities. Although my study focuses on activity systems and positional identities (i.e., micro identities taken on in moment-to-moments acts of interaction), I am also informed by meso- (i.e., categorical identities that develop over time and are tied to the specific context, relational) and macro-level (i.e., social identities) aspects of identities. As previously discussed, students in the Kinesiology course were tasked with engaging in critical thinking and applying theoretical concepts to “ethical dilemmas in sport, kinesiology, physical education, and health sciences” (syllabus, 2016, p. 5). As students engaged in these activities with their teacher and peers, they were ostensibly developing an identity-in-practice (Tan & Barton, 2008; Wortham, 2004b) of an “ethical self.”

As identities are associated with what we do, individuals may develop a “thickening” of an identity (which are enacted through multiple resources, practice, and over time; Holland & Lave, 2001). Roth (2007b) demonstrated the process of identity thickening in an ethnographic study he conducted across three years of a rural middle school in Canada. He studied two student-participants, Michelle and Graeme, who were initially positioned as disinterested science students. Through their participation in a science unit on water pollution and later volunteering, they embodied the ethical aims of engaged environmentalists. These practice-linked identities were gradually garnered over time, taking on a collective and more stable quality. As these identities thickened, Michelle and Graeme became recognized as certain types of people.

At the classroom level, the academic content and available OTL are broadly framed by the teacher’s formulations of the course. Students thus, do not just take on any identity; they take on identities that are collectively possible and recognizable in the activity (Roth, 2009). For example, in Anderson’s (2009) study of a focal student’s acts of positioning in a mathematics classroom, she described how the student, Nate’s identity was mediated by the group with whom
he worked. They did not recognize his repeated contributions. This conflict led to an ontological gap between Nate as a person and Nate as a kind of student, who participated but was often inaccurate in his reasoning. The scholar raised the question of how this interactive positioning sedimented some of the ways that Nate’s participation was characterized and carried over across different contexts in the classroom.

Similarly, I argue that for my study, the linkages between one’s ethico-moral considerations about scientific activity and one’s development of a courageous and ethical self (syllabus, 2016) are articulated through opportunities to participate with the course content and discourse practices (e.g., kinds of participation structures, case studies, assignments), as well as the social processes involved in being heard and “to author meaning in small group and whole-class discussions” (Anderson, 2009, p. 307). Therefore, a practice-linked identity can be reconceptualized as a dialectically negotiated process across multiple feedback loops of interactive and reflexive positioning that traverse over different spaces, times, and contexts.

Learning as Contested Interactions

As mentioned previously, most classroom activity occurs at the intersection of disciplinary engagement and interpersonal engagement. In most moments of interaction, students are simultaneously engaged with content and with social others (Gresalfi, 2009; Kelly et al., 2001). Recall that in Chapter 1, I define OTL in the study as the interrelations between one’s access to scientific content and discourse practices, and one’s access to (positional) identities (see Figure 1). Science learning then, refers to a student’s uptake of particular OTL within an activity, set in the context of a Kinesiology classroom. My critical microethnographic analysis examines the ways in which students navigate science learning in the classroom on two levels: 1) an activity-level view of OTL represented by the dimensions of activity system and Dr. Farrell’s
framing of science learning; and 2) a micro-level view of focal students’ participation and acts of positioning, and how they shape their access to and uptake of particular OTL in scientific discussions.

By studying these complex classroom processes that affords differential access to OTL to differently positioned students, I argue that learning is not a smooth transactional process that merely takes place between an experienced expert and an eager novice. Conflict and resistance often characterize learning interactions. Both teachers and students must exert considerable effort to overcome differences in understanding and communicate (Mehan, 1998). Radford & Roth (2011) assert it is these differential refractions in joint activity that define learning. If the object of the activity system appears the same to all participating members, then there would not be anything to learn.

**Conflict as manifestations of activity-level contradictions.** I introduce the concept of *contradictions* in activity systems as potential sources of learning and innovation in activity (Engeström, 1987/2015, 2001; Holland & Lave, 2001). Contradictions are inherent in activity systems, because of the dialectical nature of human activity. New types of learning develop from older forms of activity. With respect to science learning, an individual’s actions within a particular activity, set in a classroom context, is both independent of and subordinated to the object-mediated system. Unlike the more conventional usage of the term, contradiction does not necessarily mean an aggravated conflict or a disagreement (though, it *can* encompass these ideas); rather in CHAT, the term is used to emphasize how the dynamic tensions within joint activities (between the individual and collective or the material and ideal) can bring about imbalances and the potential for instigating change (Yamagata-Lynch & Haudenschild, 2009).
Conflicts or local struggles between participants are the discursive manifestations of an activity system’s contradictions and “are always part of the larger historical, cultural, and political-economic struggles but in particular local ways, worked out in practice (Holland & Lave, 2009, p. 3). Put another way, as contradictions are defined as historical and systemic phenomena, Engeström and Sannino (2011) assert that empirical studies do not have direct access to them. Rather, they are recognized by researchers through how participants articulate and construct them (i.e., through verbal and non-verbal forms of communication; Hatch, 1997; LeBaron, 2005; Martin, 2004; Metcalfe, 2006). These conflicts become sites for examining how new understandings and strategies potentially emerge, as different participants work together towards common understanding of the ideological, collective object in an activity system.

By analyzing the inner contradictions present within and between classroom activity systems, they can reveal tensions and misalignments in the perceived roles and responsibilities of the students. This approach demands attention to the ways that power dynamics, relationships, and differences in meaning making and participation play out in group activities (Engeström, 2001; Engeström & Sannino, 2011; Holland & Lave, 2001; Price & McNeill, 2013). Thus, Conflict is an essential feature of classroom interactions (Mehan, 1998; Zacher, 2008). By examining how common tasks led to differential context for learning, I explore the range of interactional demands and distribution of OTL associated with group membership.

**Power and positioning in the classroom.** Attention to power is a centrepiece for (positional) identities. Not all individuals have the same access to opportunities to participate in academic content and discourse practices; they may be given or denied access to particular physical and social spaces, artifacts, relationships, and/or kinds of actions (Dookie, 2015; Kelly et al., 2001; Oakes, 1990). Power dynamics are also made visible in the ways in which status or
hierarchies are constructed, maintained or challenged (Esmonde & Langer-Osuna, 2013; Lim, Tan, & Barton, 2013; Moje & Lewis, 2007; Zacher, 2008). Within the classroom, power is often visible through the construction of competence in intergroup interactions (Anderson, 2009; Esmonde, 2009b; Kotsopolous, 2014).

In the Kinesiology classroom, the professor was the science expert who had the authority to decide which answers were considered correct, and initiated or ended classroom activities and conversations, thus circumscribing acceptable student behaviours. Within group activities, students also worked out a social order. It is through these micro-practices that systems of power and difference can be produced and reproduced (Bloome & Egan-Robertson, 1993; Moje & Lewis, 2007). Some students may be positioned as experts, decide what contributions were correct, and initiate and/or dominate conversations. At the moment-by-moment level, these negotiations are mostly easily seen in talk.

As my study is focused on how students participate in classroom activities and access particular OTL, I examine these questions in interaction: Who is given opportunities to talk? Whose ideas are taken up in discussions? Whose ideas are marginalized or ignored? These questions are important, as they suggest issues of power and inequity. Group work can be a learning context prone to power imbalances, particularly when students from dominant social groups are grouped with students from non-dominant social groups (Biachini, 1997, 1999; Esmonde, 2009a; Esmonde et al., 2009; Kotsopolous, 2014; Ritchie, 2002; Ritchie & Rigano, 2001). Under these circumstances, perceived status differences between social groups may shape the ways students choose to participate and shape the participation of others. In other words, race, gender, and SES (and so forth) are involved in the construction of scientific competency in intergroup interactions (Holland et al., 1998). Further to this, studies on identity work and
learning have documented how multiple, intersecting social factors interact and play a role in producing differential outcomes in participation (Cummins, 2007; Curnow, 2017; Mo et al., 2013; Nasir & Hand, 2006; Takeuchi, 2012).

Although positioning in scientific competence is often associated with positioning in social categories and central to discussions of equity and access to OTL (Aikenhead & Jegede, 1999; Carlone & Johnson, 2007; Costa, 1995; Oakes, 1990; Seymour & Hewitt, 1997), these connections are not always made explicit (Dookie, 2015; Esmonde, 2009b; Esmonde et al., 2009). As Zacher (2008) observed in her study of the relationships between positional identities and literacy events in a Grade 5 language arts classroom, her participants did not refer explicitly to social identities. Rather, she noted that the students almost always talked about identity politics in terms of affiliations and relationships that included topics of mutual interests, popularity, and toys. Similarly, because positioning in terms of scientific competence was more readily talked about in my research’s student interviews, they formed the basis for the analysis of positioning in my study.

**Group work in scientific activities.** Group work has been offered up as one way to meet the challenges of access and equity in diverse student populations (AAAS, 1990; NRC, 1996). However, several scholars (e.g., Bianchini, 1997; Esmonde, 2009a; Kotsopolous, 2014) argue that these outcomes are by no means guaranteed; rather Anderson, Reder, & Simon (1996) suggest that some studies gloss over the difficulties in collaborative learning such as difficulties in coordinating schedules, inequitable distribution of tasks, and potential interpersonal conflicts.

For example, in Kelly and his colleagues’ (2001) study of a Grade 12 physics class, the construction of scientific tasks in different student groups revealed more than “doing science;” it
also involved establishing and maintaining positions and relationships within the groups and negotiating the limits and direction of a specific task. In another study, Martin (2016) illustrated how students’ acts of positioning in small-group activities were oriented to the maintenance of “good student” identities, invoked the teacher’s authority, put little value in group discussion and explaining their own ideas – interactions intended to support science learning. Therefore, while collaborative learning can benefit some students, it is not an academic “panacea that always provides outcomes superior or even equivalent to those of individual training” (Anderson et al., 1996, p. 10).

As the aforementioned studies suggest, variations of learning contexts and group dynamics (and in turn, what discourse practices are valued and which OTL are available) must also be navigated in intergroup interactions. In any given moment during a common task, set within a classroom context, students simultaneously engage with the content and with others, which can become sites of conflictual practice (Kelly et al., 2001; Price & McNeil, 2013). While these sites can be productive, providing opportunities for new meaning making and forging new relationships and connections (Gutiérrez et al., 1999), they can also create difficulties that impede student access to scientific content and science identities.

Call for a critical microethnographic analysis. This line of research points to the multiple ways that classroom practices and student relationships interact in moments of group activities. As learners manage their participation in scientific tasks, two aspects of engagement are considered: the ways in which they work with academic content and the ways in which they work with others. I posit that one way to extend such a multi-tiered analysis is to systematically examine the activity system using the CHAT heuristic, but to “hover low” to the empirical data (i.e., classroom interactions; Bloome et al., 2005, ix). The influence of social
categories on student interactions and acts of positioning must be described locally instead of in broad strokes (Bloome & Egan-Robertson, 1993; Crenshaw, 1993; Lemke, 2001), or risk “appealing to shallow macro-level explanations conceived mainly in terms of normative structures or obvious power dynamics” in the classroom (Anderson, 2009, p. 309). On a micro-level, face-to-face interactions make visible the nature and effects of participants’ local actions; how people construct, transform, and contest knowledge; how some social categories become more salient or valued than others in interactions, and/or the local constraints within which they work (Holland et al., 1998; Saxe & Esmonde, 2005).

Through close microethnographic accounts of the science classroom, I foreground the daily life of the teachers and students, and how they act within key events and across different settings in which they find themselves. The participants are viewed as active agents who choose to participate in various ways, and their actions cannot be umbrellaed under broad generalizations of classroom activities or collapsed under deterministic processes of cultural reproduction. Thus, a critical microethnographic analysis is appropriate for my study, as this perspective examines student participation in “forward- and backward-looking ways” (Anderson, 2009, p. 296). In other words, the focal students’ identity/ies and prior participation patterns were taken into account as potentially shaping present and future participation. In my study, the focus of analysis is first, on the range of OTL dialectically afforded by Dr. Farrell’s formulations of the classroom activity system, which influence how different ways of participating are recognized, valued, or resisted across learning contexts. Then I examine how students co-construct knowledge and make meaning through imminent acts of positioning and draw upon the social and material resources as they arose in conflictual scientific discussions.
The work that is done (i.e., science learning) is a local phenomenon, and requires a close look if the researcher is to better understand how and why particular OTL are accessed by students (Gresalfi, 2009). However, a critical microethnographic perspective goes beyond the imminentist ontology of positioning theory to include a mediational approach that accounts for the different layers of interaction, identity, ideology, and timescales that interact in a common task to produce a more holistic view of science learning. As Anderson (2009) argues, a moment’s interaction – through recursion or when vested with authority – function as local openings to become associated with a student’s institutional label like “smart” or “dumb,” but not deterministically so. Students’ uptake of OTL is therefore more than the accumulation of moments. Through the collection and sedimentation of many local and abstract factors, such as conflicts, test scores, positions, and social alliances, contribute to what a scientifically competent student looks like.

**CHAT and Situated Learning Theory**

CHAT finds many points of overlap with situated learning theory and learning as legitimate peripheral participation (Lave & Wenger, 1991), which characterizes “communities of practice” as members who share practices, language, beliefs, and values. By participating in these practices alongside more experienced individuals, novices are envisioned as being enculturated into the community, learning the rules and social conventions. However, there are limits to how situated learning theory can be applied to school science, because students go to school to learn, and often do not participate in scientific communities until they are working as graduate students or in STEM-related career fields (Arnold, 2012; Roth, 1999). Although successful students may be perceived as exhibiting a high degree of scientific competency, there is no “legitimate” participation, that is, students will not be recognized as scientists and are not
doing the work of scientists for the most part. Rather, “legitimacy is achieved by the possibility of belonging to this classroom-bounded community that includes students and teacher” (Roth, 1999, p. 296).

Gutiérrez and her colleagues (2007) further argue, “Because learning is not the primary reason for why people participate in their everyday practices, [informal] learning is continuous with experiences encountered in everyday lives” (p. 70), whereas school science (and subsequent enactments of scientific competency) often create discontinuous experiences for the participants (Aikenhead, 2006; Bang & Medin, 2010; Sharma, 2007). Thus, I argue a more useful conception of science learning in the classroom is object-oriented activity in an activity system. The classroom is conceptualized as a dynamic and open social organization in which subjects interact with others and the environment, their actions are mediated by culturally meaningful tools, and the local activity can be influenced by more remote forces.

For example, in my study, the students in the university Kinesiology classroom system engaged with the professor, their peers, as well as learning artifacts (e.g., book, journal articles, Blackboard\(^2\)) to mediate their science learning (i.e., collective object). Their participation, however, was facilitated and/or constrained by more than the immediate environment to include the organizational structure of the school, the kinds of activities for which Dr. Farrell made space (see Chapter 4), and their previous experiences with formal schooling. Thus, CHAT is an appropriate lens for my study, as school science is not a “true” enculturation process into scientific communities of practice, which tend to change more slowly over ontogenic time (Roth

\(^2\) Blackboard Learn is a virtual online learning environment and course management system that is utilized by many North American postsecondary institutions.
& Lee, 2007). Conversely, the formal schooling system, especially in postsecondary education, rarely allows for the formation of a stable community of practice, as students move from class to class several times a day. In addition, the ratio of novices to experts (i.e., with many students to teachers) is rather large in North American classrooms, as opposed to a small ratio of novices to experts in most professional communities. Thus, the traditional concept of the *zone of proximal development* (ZPD), in which a novice learns from a more expert member (Vygotsky, 1978), may not always hold true in a classroom. Furthermore, this conception of ZPD can function to re-centre the teacher and the formal curriculum as the locus of learning (Bruna, 2009). Roth & Radford (2010) proposes a different way to think about ZPD – from a symmetric perspective. That is, instead of situating ZPD in a knowledge transmission mode where the expert imparts knowledge to the novice, it is a form of “coming together” and raising collective consciousness of the action possibilities within interaction – something that is not achievable in solitary form. A more appropriate term for my study then, may be *collective learning*, in which students work together collaboratively and entirely new actions may unfold, even if they are at the same developmental level (Ritchie, 2016; Roth & Lee, 2007), which harkens back to the idea that participants’ actions in an activity system are ostensibly oriented to the collective object.

Taken together, the key entry point to examining science learning and the students’ uptake of particular OTL lies in examining the participants’ actions within the local context as the unit of analysis. For my study, I carry out a critical microethnographic investigation of the subjects’ moment-to-moment acts of positioning within scientific discussions, but also consider their actions against the collective activity system, to make visible the social construction of knowledge. I argue that different learning contexts created by the different student groups, such as conflicts and social alliances, can potentially create new meanings and OTL.
By adopting a critical sociocultural perspective, the present study also maintains that the students’ actions are also shaped by emotional and ethico-moral dimensions, in which more recent articulations of CHAT assert, are new avenues for studying the linkages between identity, actions, and learning (Engeström & Sannino, 2010; Greeno, 2006; Roth, 2009). I argue that these dimensions cannot be considered independent of the activity occurring in the Kinesiology classroom, because they are tied to the collective object of science learning, the kinds of tools used (“official” texts, the potentially controversial topics discussed), formal and enacted rules (values and norms for conducting ethical scientific processes), etc., articulated in the activity system. In addition, these horizontal dimensions of learning are not all equal. Depending on their affiliations with various social groups and practices, they are afforded differential levels of power and consideration, which can be seen in how individual contributions in group processes are heard, positioned, ignored, and/or taken up (Kelly et al., 2001).

**Integrating CHAT and Positioning Theory**

To demonstrate the potential of the present study’s theoretical framework, I reviewed examples of classroom studies grounded in sociocultural theory, and illustrated how incorporating positioning theory as an additional lens adds a critical and nuanced layer of analysis that considers the mediational role of improvisation and individual agency in science learning and accessing particular OTL. While positioning theory provides the theoretical lens for examining how students choose to participate and shape the participation of others in discursive processes, an overt focus on subjectivities and individual experience may lead us back to an individualistic view of learning (Greeno, 2006).

As Lemke (2001) argues, researchers have a further responsibility to articulate how conceptions of feelings and personhood differ across different cultural-historical communities
and learning environments, “because they are in part artifacts of communities” (p. 311). With CHAT as the unifying theoretical framework, my study’s analysis maintains a focus on the articulation of broadly relevant notions of ways to be a student and legitimized ways to learn science in a particular classroom. This has implications for making connections to how other university science classrooms are structured and what kinds of discourse practices are encouraged. Then by looking closely at how students interact with content and with social others, I examine how they are positioned against such notions, and how their local actions are made meaningful by the kind of activity system against which their participation is evaluated.

In the next chapter, my study’s methodology of critical microethnography, methods, and data analysis are described (Bloome et al., 2005; Fitch & Sanders, 2004; Mehan, 1998). I examine the ways in which classroom activities shape student participation at two levels: (a) a coarser grain of analysis that systematically describes the content, discourse practices, and kinds of activities supported by Dr. Farrell’s framing of science learning; and (b) a finer grain of analysis that investigates the moment-by-moment process through which focal students access and take up particular OTL within specific activities. Using positioning theory, these acts of positioning can be seen most readily in talk (but also include non-verbal forms of interaction; Hwang & Roth, 2008; LeBaron, 2005; Metcalfe, 2006). Thus, in my research, the unit of analysis dialectically shifts from the activity system to the interaction.

I engaged in qualitative analyses of video and interview data obtained from in situ events in the classroom. As students and the teacher spoke with one another about the content, about themselves, and about their current activity, I borrowed from critical discourse analysis, looking at the form and content of the participants’ talk as well as how they communicated through non-verbal means (Lemke, 2001; Sannino, 2008; Sidnell, 2012; Wooffitt, 2005). Studies of this sort
emphasize the subtly differentiated picture of epistemic activities as taken up by individual participants, how intellectual contributions are interactionally produced, recognized, and understood as embodied practices, and how common tasks are negotiated and accomplished. Therefore, I pay attention to contextualization cues such as voice intonation, pauses, body distance, facial expressions, as well as word choice. Such cues are used by members to signal membership, cultural meanings, identity, and intentions that other members of the group can read and interpret to guide their interactions (Engeström & Sannino, 2010; Sidnell, 2012).

As previously described, the study grounds itself in an interpretive research paradigm. It adopts the theoretical underpinning of CHAT (and more broadly, critical sociocultural theories of learning) and employs positioning theory as a supplemental perspective to help foreground student learning and identity work as intimately linked to agency and participation. Drawing specifically from positioning theory, this study considers the ways that positional identities are constructed moment-to-moment and shaped by reflexive and interactive acts of positioning.

By centring my theoretical framework on the synergistic integration of CHAT and positioning theory, I consider how the university Kinesiology classroom system is constructed, through Dr. Farrell’s framing of science learning and support of particular classroom activities. Then I shift my gaze to how participants participate and acts of positioning in particular activities, set within the classroom context, shape their access and uptake of particular OTL. The concept of dialecticism informs my study (e.g., activity ↔ action and object ↔ outcome), and frames how I view science learning. As I zoom in and out with my classroom analysis across my analytic chapters. I argue that students’ learning processes “mov[es] up and down, outward and inward,” (Engeström & Sannino, 2010, p. 1), occurring in dynamic and relational ways that extend beyond talking science.
Chapter 3
Critical Microethnography as Research Methodology

Research Questions

The central question addressed in this research study is to examine what kinds of opportunities to learn (OTL) do students access as they manage their participation in scientific activities within the context of an undergraduate Kinesiology classroom. Two sub-questions arise from the main research question:

(a) What is the range of OTL represented by particular dimensions of the science classroom activity system?

(b) Within scientific discussions, how do students’ participation and acts of positioning shape their access to and uptake of particular OTL?

As described in Chapter 1, I define OTL as the intersections between the student’s access to scientific content and discourse practices and access to (positional) identities. I examine the focal students’ access to and uptake of OTL (and hence science learning) in order to better understand the conditions that facilitate and/or constrain the equitable distribution of OTL within group work. For my analysis, I ask how students negotiated the social context and demands of a common task, as well as how group dynamics influence the kinds of OTL that emerge. This dissertation shows how the construction of scientific discussions by different students led to differential learning contexts and always involved more than doing and talking science.
I locate my study in the critical “microethnography” methodology, which is grounded in intellectual traditions of anthropology (Au, 1980, Geertz, 1973; Ogbu, 1981), discourse analysis (Fairclough, 1993; Gee, 1999; Sidnell, 2012), sociolinguistics and New Literacy Studies (Barton, Hamilton, & Ivanic, 1998; Brandt & Clinton, 2002; Simon et al., 2012, Street, 1995). Critical microethnography brings into focus the small-scale and short-duration nature of key events (criteria for determining the key events will be discussed later on). Giddings (2009) calls microethnography, the study of events – which foregrounds the temporal dimension of learning, and “the dynamics of the elements in play, entities coming together, material and aesthetic chains of cause and effect or feedback” (p. 149). Rather than make assumptions about the primacy of any particular dimension of the activity system in an event, a critical microethnographic lens looks for the generations of new relationships and distributions of affect, effect, and feedback constituted by various dimensions. The methodology is concerned with how people use shared language, practices, and other means of communication to construct meaning from moment-to-moment and diverges from “old school” microethnography methods (e.g., Ogbu, 1981; Spradley, 1980). Prior articulations of microethnography paid more attention to how events are organized, how participation is structured, and attempted to answer, “What is going on?” within social activities through the study of behavioural phenomena (Fitch et al., 2004; Ogbu, 1981).

While “new school” microethnography continues its focus on communication and embodied cultural practices, the studies extend beyond the skin (LeBaron, 2005; Simpson, 2011)

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3 The term, “locate” refers to an intellectual position, rather than a physical one. Although a classroom occupies a physical and material space, the students and teachers who inhabit the space may occupy different intellectual location(s). Therefore, a classroom has multiple intellectual locations. In alignment with Bloome et al. (2005), by naming and acknowledging intellectual location(s), my study aims to make visible spaces that might not otherwise be made visible. That is, the concept of “location” is another way to mark invisible power dynamics and privileges what is often unseen in qualitative research.
to include the surrounding context as both resources and medium through which participants interact. In other words, learning is not a private process, but rather distributed across individuals whose interactions shape the construction of knowledge and practices – practices that have evolved over time in specific sociohistorical contexts (Engeström, 2001; Fitch et al., 2004).

My study aligns with this methodology, in that I examine the micro-interactions within a science classroom, to better understand “the complete chain along which [scientific] competences and actions are distributed” (Bruno, 1992, as cited in Giddins, 2009, p. 150). By looking closely at how students interacted with content and with others, I examine how they participated and shaped the participation of others in group activity, how they constructed social contexts and negotiated what counted as an intellectual contribution, and how their local actions were made meaningful by the kind of activity system their participation is evaluated against. The assumption is that local activities are shaped by their dialectical relationships to other dimensions (e.g., tools, division of labour), and to meso- and macro-level sociocultural and political processes (Bloom et al., 2005; Pane & Rocco, 2009), which in turn, influence what is considered important content and problems to be solved, how learning happens, and how students make meaning of particular actions. I argue that it is not interesting and is even somewhat futile to delineate clear boundaries between the learning environment and the processes of science learning, as learning materializes in social interaction among humans and through non-human, material-semiotic, ecological features of the setting (Haraway, 2004, as cited in Giddings, 2009).

In the following sections of this chapter, I first describe the overarching research tenets of critical microethnography, then how this methodology informs my research design, and finally how critical microethnography frames my research questions and analysis.
Critical Microethnography – What is it Good for?

Critical microethnography draws from critical theory (Delpit, 1988; Freire, 1970), discourse analysis (Fairclough, 1993; Gee, 2005; Sidnell, 2012), and interaction analysis (Erickson & Schultz, 1981; Jordan & Henderson, 1995). The following research tenets are the main characteristics of critical microethnography (Bloome et al., 2005; Fitch et al., 2004; LeBarton, 2005; Pane & Ricco 2009) that I used to inform my analysis of the science classroom:

1) The critical aspect of critical microethnography involves examining: a) what is being learned; b) how and why something is being learned; and c) what patterns of behaviour, expectations, and norms are being socially reproduced as a result of power relations that occur during the learning processes.

2) The micro- part of critical microethnography involves analyzing moment-to-moment and turn-by-turn interactions: a) how participants communicate through verbal and non-verbal means; and b) how language is being used to facilitate and/or constrain opportunities for learning.

3) The ethnographic part of critical microethnography involves: a) longer periods of participant-observation; b) interviewing the participants about their experiences; and c) collecting relevant documents and artifacts that were produced.

As Bloome et al. (2005) argue, critical microethnographic methods are informed by five theoretical tools: contextualization cues (i.e., any feature of linguistic form that contributes to the social features of the situation), boundary making (i.e., socially constructed ‘happenings’ within the classroom such as participation structures – group work, whole-class discussions), turn-taking in conversation, negotiating thematic coherence (i.e., organization of a set of meanings in and through an event), and intertextuality (i.e., the juxtaposition of various ‘texts’ that share a
common referent). The term, ‘text’ here is broadly defined as a kind of production that can be written or spoken and gains its meaning through its relation to other texts (Fairclough, 1993). As “talk is not privileged at the expense of other symbol systems” (LeBaron, 2005, p. 496) in a microethnography, the analysis often presents various research products (e.g., video data, transcripts, graphical representations, descriptions) alongside each other to represent the different communicative resources that participants draw upon in interactions.

As previously described, I envision the university Kinesiology classroom as an activity system, which contains learners, teachers, curriculum materials, tools, and the physical environment. In other words, the classroom is a complex, social organization with many moving parts, some human and some non-human. By using the CHAT triangle, I encompass the “critical” aspect of critical microethnography. I systematically analyze the dimensions of the classroom activity system that co-constitute science learning and the range of OTL represented by them. This type of structural analysis is useful because first, it makes visible the cultural-historical influences and organizational effort in establishing such an activity system. In other words, the construction of a science classroom is not done in an ad hoc manner and relies on a particular framework of activity. Next, the analysis demonstrates how the teacher chose to develop particular nodes of the system. Third, by looking at the range of OTL in the Kinesiology classroom, I use CHAT to consider the dialectical relationships and networks constituted by these various dimensions, rather than just on the separate dimensions themselves.

A critical microethnography fits in well with my integrated theoretical framework of positioning theory and CHAT, as both are oriented toward identifying and conceptualizing relationships between particular dimensions of a system, in this case, the relationships between
access to OTL and context. A microethnography’s finer-grained approach provide vivid, temporal examples of the ways in which a common task led to differential contexts for learning.

In the sections that follow, I present the Canadian postsecondary institution and the Ethics and Power in Kinesiology course as the contexts for my study and the rationale for how they were selected. I then explain the recruitment process, and how the two focal students came to participate in my research. Next, I provide a detailed description and justification of my research methods, including the data collection, analysis, and the mobilization of the results. Finally, I weave critical microethnography as a methodological lens throughout the chapter, which serve as the rationale for informing my research design and method and framing my subsequent analysis.

Choices in the Field: Research Context

The research was conducted in a senior-level undergraduate science class, Ethics and Power in Kinesiology, at a large Canadian university with a total student enrollment of over 50,000 students. The school is considered to be an elite, research-based postsecondary institution wherein a focus on equal opportunity, equity, and justice is an explicit part of the school culture (as evidenced by the university’s mission statement and the course syllabus). Borrowing broadly from Gaztambide-Fernández’s (2009) definition of elite schools, an elite school is defined based on five dimensions: a) typologically elite (being identified as an independent school); b) scholastically elite; c) historically elite (based on the role of elite social networks in their historical development); d) geographically elite (ubiquity of space and sprawling campuses); and e) demographically elite (based on the population that attends the school).

Negotiating access to elite spaces has often been seen as one of the biggest challenges in the study of elites (Conti & O’Neil, 2007; Gaztambide-Fernández & Howard, 2009). One
approach that researchers have used to access these spaces is to develop collaborative projects with the faculty and/or institution, which are predicated on multiple relational layers and shifting politics (e.g., Simon & Kalan, 2016; Wallace & Wildy, 2004). The story of how I gained access to the university will be discussed in the following section. I foreground the dynamics of my insider-outsider status that shaped the research process, as well as my connections to the networks of elite groups in the university.

**Access to the school.** Given my dissertation’s focus on the themes of science learning and equitable distribution of OTL, I was interested in a school with linguistic and cultural diversity. Specifically, I sought after university science courses, because of the limited studies done on undergraduate science learning in classrooms, and the high level of student attrition in STEM fields across North America (approximately 48% for bachelor’s degrees and ~69% for associate’s degrees; Chen, 2013; Hango, 2013; Seymour, 2002).

Prior to conducting this research, I was offered the opportunity to meet with several faculty members in the Kinesiology department at the Canadian university that would be my research site – an opportunity facilitated by my supervisor Dr. Indigo Esmonde. The Kinesiology department created an internal “Equity, Diversity, and Social Inclusion” committee whose interests included integrating a more critical and equity-focused lens into their courses’ formal curricula and developing concrete examples of pedagogical strategies that are guided by the same interpretative lens. We met several times in early 2016 and continued an email correspondence surrounding topics of mutual interest and research collaboration. Through these meetings, I was better able to understand the school community, issues with which the faculty was concerned, and the student demographics.
In March 2016, I gave a presentation and circulated information about my proposed study to the Kinesiology faculty and received an invitation to begin my work with Dr. Farrell, whose teaching practices are informed by post-structural, post-colonial, and feminist theory. In their Ethics and Power in Kinesiology classroom where I conducted my study, lessons were based on a range of philosophers and critical scholars’ works such as Paulo Freire and Michel Foucault. The course explicitly explored an ethical framework that encouraged students to “courageously develop an ethical self … and respond intellectually, politically, and personally to a range of ethical dilemmas in the field of Kinesiology, physical education, and sport and health sciences” (syllabus, 2016, p. 1), that I understood to be the collective object of the classroom activity system. For brevity purposes, I term the object, “science learning.”

Access to the classroom. The participating class was selected based on the professor, Dr. Farrell’s availability and teaching of a science course. Dr. Farrell self-identified as a critical, feminist scholar with research interests in ethics in sport and physical activity, and spatial and ecological determinants of physical and health cultures. All biographical and professional information about Dr. Farrell was taken from the university department’s faculty profile and is publicly available. They have taught this specific course for several years during the fall and winter terms of the school year, but this was the first time it was offered as a summer-intensive course, taking place from May to June 2016.

4 All names used in this dissertation are pseudonyms.
5 The dissertation follows the APA guidelines to attempt to avoid bias in language and makes a concerted effort to use gender neutral pronouns when applicable. Personal correspondence between the researcher and Dr. Farrell indicated that they did not prefer a particular pronoun.
Ethics and Power in Kinesiology was a required course for upper-year students enrolled in the Kinesiology program at the university. Classes took place over four weeks in May 2016. A total of 51 students were enrolled in the course. Classes were held on Monday to Thursday, from 1-4 pm. Formal assessments included a variety of group presentations, an essay, two quizzes, and one cumulative exam. Quizzes took place at the end of the second and third week of the course, and the final exam and assignments were due in June 2016.

Video Research and Data Collection

In order to investigate the aforementioned research questions, I utilized critical microethnographic methods, which included face-to-face interviewing, participant observation, field notes, video recording of the lessons and group interactions, and analysis of classroom-produced artifacts (e.g., the syllabus, PowerPoint slides, student artifacts produced for class tasks; Pane & Rocco, 2009). The study was designed to obtain rich ethnographic data of daily classroom practices and evidence of student participation throughout the lessons, with a concurrent goal of observing how the focal students took up OTL in group activities. Video recordings were essential to capturing a “thick description” of the micro-interactions of talk and non-verbal communication (e.g., body orientation, eye gaze, facial expressions, gesturing, Geertz, 1973, p. 7; LeBaron, 2005; Mehan, 1998; Simpson, 2011) In addition, video allows for the recording of subtle interactions such as pauses and tone of voice, and artifact manipulations, contextualized within a particular social situation (e.g., the closing of a book to indicate that one is ready to leave), that the researcher can review and others can help verify.

Borrowing from Bronfenbrenner’s (1976) concept of ecological validity, a student’s verbal and non-verbal means of expressions can only be made meaningful if they are interpreted
against real-life educational settings. I collected multiple types of data to represent a fuller picture of classroom learning. Approximately 30 hours of classroom video were collected, along with 8 hours of interview data with two focal students, totalling in 38 hours of video. Any interpretations in my video data analysis were supplemented by my daily field notes, classroom artifacts (e.g., PowerPoint slides, syllabus), and student interviews. In the data corpus, there were videotapes of 10 classroom sessions available, filmed from the beginning to end of class.

To facilitate an analysis of the breadth of classroom activity in the lessons (Engeström, 1987/2015), I paid particular attention to collective activity shifts, or as Bloome and his colleagues (2005) might call them, boundaries of events. Within critical microethnography, establishing the boundaries of events is important, because they signal to both the participants and the researcher what is going on within analyzable chunks of data, the kinds of relationships people have with each other, and what meanings are being jointly constructed. Contextualization cues and explicit linguistic cues oriented the researcher to what constituted an event. In the Ethics and Power in Kinesiology course, these events often emerged as distinct participation structures (e.g., lectures, whole-class discussions, small group work).

As Jordan & Henderson (1995) contend, events happen before they officially happen, and continue after they end, and are marked by verbal and non-verbal preparatory activities, rearrangement of artifacts and bodies, and negotiated interactions. Prior to the start of the Kinesiology class, there was another course taking place in the same room. As such, I was not able to film the beginnings of the classes, such as how students entered the room, chose their seats, etc. However, I applied the same principle to selecting and chunking the participation structures into events for deeper analysis (Derry, Pea, Barron, Erickson, Engle, Goldman, Hall, Koschmann, Lemke, Sherin, & Sherin, 2010). I attempted to keep the camera on the focal
students for approximately 30 seconds before the activity “officially” began, and 30 seconds after it ended.

**The selection of focal students.** I attended every class of the 12-session course. Following an introductory classroom visit wherein I introduced myself and stated my general research goals, that is, to investigate the range of OTL available in the class and how students take up these opportunities within the context of a university science classroom. Students were invited to be participants in my study, which involved being filmed throughout the course, and taking part in an initial and final interview, and one Stimulated Recall Interview (SRI). The specifics about the different interviews will be detailed later on in the chapter.

In the following class, nine participants in a class of 51 enrolled students consented to participate in the study. I conducted an introductory interview that included the participants’ general perceptions about science, the course, and themselves as science students, either face-to-face or through email (see Appendix A). All interviews were prefaced with the reminder that the participants could at any time, skip a question, say something off the record, ask the researcher to omit or erase something after it was said, and/or withdraw at any time without negative consequences. As well, it was emphasized that Dr. Farrell would not have access to the interview data until after the course was over, and all marks were submitted. At that point, all identifying information would be removed and/or concealed. The participants also had the option of withholding all interview data from the professor.

A section of the interview was left open-ended and elicited demographic information including the students’ self-identified age, race, gender, SES, and so forth. The summary of the initial participants’ demographic information is displayed in Table 1. Because of the open-ended
nature of the self-identifying questions, there is some heterogeneity in the answers. Thus, I use
the language employed by the students in the farthest right column in the presentation of the
results. I opted to designate all races with upper case in accordance with APA style guidelines.

Table 1
Initial Student Participants’ Demographic Information

<table>
<thead>
<tr>
<th>Student Pseudonym</th>
<th>Age or Year in program</th>
<th>Gender</th>
<th>Race</th>
<th>Sexual Orientation</th>
<th>Other identities mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anya</td>
<td>20, year 3</td>
<td>Woman</td>
<td>Indian</td>
<td>N/A</td>
<td>Canadian, religious</td>
</tr>
<tr>
<td>Anson</td>
<td>20</td>
<td>Man</td>
<td>Filipino</td>
<td>N/A</td>
<td>Canadian</td>
</tr>
<tr>
<td>Becka</td>
<td>21</td>
<td>Woman</td>
<td>Southeast Asian</td>
<td>N/A</td>
<td>Average student, “hands-on” learner</td>
</tr>
<tr>
<td>Chrissy</td>
<td>20</td>
<td>Woman</td>
<td>Filipino-Chinese</td>
<td>Straight</td>
<td>Catholic upbringing, dancer, restaurant host, grew up in small town, First world citizen, socially awkward but vocal, single parent family, athletic, average student, older sister</td>
</tr>
<tr>
<td>Jem</td>
<td>Year 4</td>
<td>Woman</td>
<td>White</td>
<td>Straight</td>
<td>Pole vaulter, student leader, athletic lifestyle, dedicated student, older sister, roommates with fellow student, personal trainer, Christian</td>
</tr>
<tr>
<td>Sam</td>
<td>21, year 4</td>
<td>Woman</td>
<td>“Gujarati or Indian”</td>
<td>N/A</td>
<td>Immigrant, Canadian, not a “gym rat”</td>
</tr>
<tr>
<td>Selena</td>
<td>20</td>
<td>Woman</td>
<td>East Asian</td>
<td>N/A</td>
<td>Dancer, musician, plant-based lifestyle and diet, body builder, not a “typical” Kinesiology student</td>
</tr>
<tr>
<td>Simone</td>
<td>20</td>
<td>Woman</td>
<td>Guyanese</td>
<td>Bisexual</td>
<td>Penta-Costal Christian</td>
</tr>
<tr>
<td>Steve</td>
<td>Year 3</td>
<td>Man</td>
<td>Italian</td>
<td>Heterosexual</td>
<td>Catholic, Canadian</td>
</tr>
</tbody>
</table>

I privately approached the initial participants to be focal students, invited them to take
part in a follow-up SRI and final interview, and two individuals, Chrissy and Jem, agreed.

Specific information about each focal student will be provided in Chapter 5 and 6, respectively.
Other students were not made aware that there were focal students. Interviews were set up discreetly and took place outside of the class time and in a different location.

Although the initial student participant pool decreased from 9 to 2, I decided to include the student demographic information in my dissertation for two reasons: 1) to highlight the diversity of the science classroom; and 2) to illustrate the trajectory of my research design and procedures. I mention this to highlight that throughout my fieldwork, I had to remain flexible with my strategies and data were not determined *a priori*. In addition, although in Chapter 1 I draw attention to my position as a researcher and doctoral student at a prestigious school as well as my relationship to Dr. Farrell, which afforded me some sort of insider status to the school community. However, in some moments, my status was questioned by myself and at times, by others. These incidents helped me to continually reflect on the positioning of the researcher, the professor, and the students, and consider the shifting power relations in the classrooms. Similar to Ritchie and his colleagues’ (2000) study of preservice science teachers in more experienced teachers’ classrooms, these shifts were not planned nor systematic. Rather, they were context-dependent and illustrate how participants can disrupt the traditional interviewer-interviewee relationships. These ideas inform my analyses, and I weave them throughout my dissertation.

**Videotaped observations.** Throughout each lesson, I oriented a digital video camcorder with a wide-angle lens and an external microphone in one direction of the classroom (Figure 3). During group activities, I repositioned the camera and zoomed in on the focal students’ groups. Depending on the task, the group members were sometimes assigned and varied in size from two to four members (more details are in Chapter 5 and 6). The goal was to get a data sample that was large enough to represent the breadth of the participation structures
represented in the classroom, but also to closely examine the focal students’ participation and acts of positioning in intergroup interactions.

As my study mainly focused on student interactions and with Dr. Farrell not consenting to being videotaped, there was not a second camera set up to document the details of the teacher’s actions. Therefore, the teacher was also not an “official” participant, although they were aware that the camera might film them if they stepped in frame, and that their voice, the lessons’ content, and any public teacher-student interactions would be recorded and potentially analyzed from the video data.

For group work, I set up the camera to focus on the focal students’ interactions. I opted for external microphones instead of attaching a lavalier mic to the student. As well, instead of staying behind the camera all the time, I checked the sound and video periodically. These measures were taken to decrease attention to the focal students, mitigate the stressfulness of being videotaped, and to minimize interference with the social interactions (Dookie, 2015).

Participants who consented to being videotaped sat in the stage left section of the classroom (see Figure 3). All the students were free to sit wherever they would like but were made aware of the possibility of being filmed if they sat in the stage left section. During whole-class discussions, I tried to shoot the section as widely as possible, using a wide-lens with a shot gun microphone. In group activities, I zoomed in on the group interactions, and focused on the focal participants.

After a group activity ended, the video camera zoomed back out to document the restructuring of the classroom activity and any post-task discussions. Through the class, I took on an observer-participant role, and limited interactions with the students. I sat in the front, and to
the side of the class (see Figure 3). This afforded me a particular vantage point to observe the students’ seating arrangements and take pictures of classroom artifacts that may not have been filmed by the video camera (e.g., blackboard writings which were located behind the camera), as well as check on the recording equipment periodically with minimal interference to the class.

![Camera orientation to the classroom.](image)

*Figure 3. Camera orientation to the classroom.*

*Note:* The black dot represents where the teacher usually stood. The orange dot is where I sat. The blue triangle is where the camera was positioned.

Video data mainly recorded the student-student and teacher-student (if they stepped into frame and/or audio) interactions. The video data were also used to conduct a microethnographic analysis of the focal students’ intergroup interactions – their moment-to-moment acts of positioning, and how they used artifacts and other non-linguistic cues for communication. Video is particularly useful for this methodology, as the researcher can revisit the data. Verbal and non-verbal aspects of communication occur co-extensively in context. Without video, these subtle interactions may escape a researcher’s notice.
In addition, Roth & Lee (2007) notes that moments of human activities and praxis only happen once. As a result, having video data allowed me to return to the instances of interest and develop and progressively refine my interpretations of the data (Engle, Conant, & Green, 2007). In using the method of “progressively refining hypotheses” (ibid., p. 240), researchers begin with a general question, collect relevant data to the question, and progressively develop the question and analyses to account for the observed phenomena. This method was suitable for my study, because I was able to closely analyze group activities and how students constructed knowledge. Through repeated viewings of the video, I was able to further refine my interpretations, and examine the multiple interactional demands required for participation as they engaged in scientific discussions.

Field notes. Field notes were written to include broad themes, classroom topics, and activities within each class, as well as what was missed in the video data, such as seating arrangements, who was speaking (if they were speaking out of frame of the video camera) and noting utterances that were difficult to hear. In each field note, I described a general overview of what occurred in the lesson that day, the types of participation structures, group formations, artifacts used, and moments of interest alongside time stamps. Writing field notes also helped me to notice what I was interested in, my assumptions, and my viewpoint – in other words, to take notice of what I noticed (Pink, 2001), and progressively refine my research questions.

Digital camera. A digital still camera was used to record student work, what was written on the blackboard, and other learning artifacts that were introduced into the lessons.

Interviews. Each initial student participant (n=9) took part in an introductory interview, either face-to-face or through email. The students who then agreed to be a focal
participant were videotaped as they engaged in sessions of group work. A preliminary analysis of video footage was conducted within the first 10 days, selecting target segments of video data involving the focal student engaged in group work. They were shown to the participant in the subsequent SRI, which took place in the second week of classes. Finally, within a week of the course ending, I conducted an exit interview with both focal participants.

**Introductory interview.** If it occurred face-to-face, the introductory interview was semi-structured and was designed to gain qualitative insight into the students’ initial perceptions of science as a domain, the Kinesiology course, their social identities, and their perceived status as a science student. The interview aimed to elicit their views on science’s connections to ethics, technology, society, and the environment. All initial interviews took place within the first week of the class.

The initial interview lasted about 1-2 hours and was conducted at a time convenient to the participants in my office. The interviews were video recorded to document non-verbal cues of communication (e.g., body language, tone of voice, facial expressions). The full protocol for the introductory interview can be found in Appendix A. The interviews were content logged minute-by-minute, and each question was time stamped according to when the participant answered them for future transcription purposes.

**Stimulated recall interview (SRI).** Following each lesson, the video was processed, and a minute-by-minute content log was created, detailing collective activity shifts in participation structures, major interactions, and topics of conversation. During this content logging process, moments of interest were flagged (Ballenger 2009; Mehan, 1998; Oliveira et al., 2010). This process will be elaborated on in the Analysis section. The selection of these moments of interest was guided by my research goals, more specifically the second research question (i.e., Within
scientific discussions, how do students’ participation and acts of positioning shape their access to and uptake of particular OTL?).

Since the SRIs took place in the second week of classes, I had a maximum of 5 separate days/class lessons of video data to choose from. With participant observation, there is risk of “hypertypification” (Erickson, 1982), a phenomenon in which the researcher tends to sample only evidence that confirms their hypothesis. Attempts were made to mediate this phenomenon by selecting video footage from different days and at various points in the sessions of group work using an online random number generator. As a result, I selected 3-5 video segments involving each focal student, with each segment ranging from 45 seconds to 5 minutes in length. In each SRI, the video footage was played for the participants, and then they were asked to respond to each of them separately (see Appendix B). The SRIs were semi-structured in nature. The criteria for the selection of the video footage were: a) the focal student participating in a group activity; and b) my field notes and class lesson content log’s moments of interest.

To begin, the student was told they would be watching segments of group work involving them and that I would be using the footage to prompt their memory, feelings, and experience of the session. Questions that were used as prompts during the interview included: (a) explaining the context of interaction; (b) the goals and/or purposes of the common task; (c) thoughts/feelings/reasonings behind the focal student’s own actions; (d) what went well; what did not go well; (e) unexpected occurrences; and (f) final comments.

6 http://random.org
The video was displayed on a computer screen, and they were invited to pause the video at any time to share their responses. In all cases, the focal students watched the segments of video to completion before responding. After all the target segments of videos were played, students were asked if they wanted to review any footage again; once again, they declined. At the end of each video segment, I asked them to tell me what was happening in the video, then share their thoughts and reactions on their overall experiences of the instance of group work. Wrap-up questions included asking them about their feelings on the course thus far, and any further reflections on their learning and class activities (See Appendix B for the SRI protocol).

The SRIs were video recorded and also content logged. In order to facilitate an integrated analysis of video and interviews, I timestamped the sections of classroom video footage that the focal student referred to in the SRI, then included them in the class lesson’s content log to aid cross-referencing. Overall, the SRIs lasted about 60-90 minutes.

**Final interview.** The exit interview was administered within one week of the course ending and lasted 1-2 hours. The interview was conducted outside of class time and at a location convenient to the focal student. One final interview was video recorded in my office, and another was audio recorded as it took place at a coffee shop. They were content logged and timestamped according to when each question was answered for future transcription purposes, and to illustrate the major themes of the focal students’ responses.

The main goal of the final interview was to determine if there were any emergent shifts in the focal students’ understandings of science and to gain further insight into their identities as science students. The first question asked the participant to reflect upon their overall experience in the course and to share any positive and negative experiences. The next three questions focused on their class participation, and the kinds of work they did in the class. The final
questions asked specifically about if there were any shifts in how the participant viewed science and to reflect on if there were specific instances in the lessons that prompted changes in their thinking and/or behaviour (See Appendix C for the Final Student Interview Protocol).

Data Analysis

In the following section, I present the analytic process for the videos, then the interviews. I end with a description of how the microethnographic analyses of video and interviews were integrated to illustrate how the students’ participation and acts of positioning shaped their access to particular OTL in scientific discussions. To reiterate, the term “opportunities to learn” (OTL) is used to describe an interactional phenomenon of the various ways student participate in a specific activity, and in my dissertation, are shaped by their access to scientific content and discourse practices and access to (positional) identities (see Figure 1). Sources of OTL that were considered included the teacher, other students, the task itself (formal or informal, assessed or not), any learning artifacts produced, and tools (e.g., textbooks, laptops, if used). Thus, in my analysis, I examined in a moment-to-moment process, how focal students chose to participate and shaped the participation of others, how the scientific discussion unfolded and differential resources arose in interactions, and how students’ access to and uptake of particular OTL were facilitated and/or constrained by the relationships between the different student groups, emerging conflicts, resources that arose in interactions, and their positional identities.

As described in Chapter 2, an activity system is delineated by its acting subject (focal student), object ↔ outcome, rules, tools, community, and division of labour. Engeström (2009) puts emphasis on objects as “generators and foci of attention, motivation, and meaning” (p. 305). The teacher as the main authority, structures classroom activities and shapes patterns of behaviour, norms, and general attitudes (Amit & Fried, 2005; Anderson, 2009). In this study, the
activity system’s collective object, science learning, were circumscribed by how Dr. Farrell
organized the lessons and conducted their pedagogical strategies, and the formal curriculum. The
teacher’s framing of science learning was systematically analyzed using the CHAT triangle
heuristic and will be discussed in greater detail in Chapter 4.

In an effort to maintain a broader level “activity” view of the focal participants’ actions, I
drew from Engeström’s activity theory (1987/2015, 2001), and kept the dimensions of an activity
system (e.g., tools, rules, division of labour and so forth) in mind when studying each video
segment. In working from a critical microethnographic perspective, this means that while I hover
low to the micro-level patterns of talk and actions (Tuyay et al., 1995), I also pay attention to the
constraints within which the participants worked and the ways in which they were expected,
obligated, and entitled to participate (e.g., participation structure, if they were being assessed,
Gresalfi et al., 2009).

Part I. Overview of the Video Analytic Process and Framework

Macro-level coding. After content logging all 10 class lessons minute-by-minute, a
whole-to-part inductive analysis was conducted, in which significant events, transitions, physical
groupings, and themes were marked (Erickson, 2006). Drawing from Jordan & Henderson
(1995), significant events were selected based on three criteria: (a) They have recognizable
beginnings and endings (usually articulated by the teacher’s explicit instructions); (b) they have
sustained conversational segments (over 30 seconds); and (c) they contain at least one source of
OTL. After reviewing the videos, the most distinct events that emerged out of the data corpus
were participation structures (e.g., lecture, group work), often indicated by gross shifts in
discourse practices, body orientations, artifact manipulation, etc.
Participation structures. Participation structures refer to broader patterns of action in which “individuals share a common task orientation and attention focus” (Jordan & Henderson, 1995, p. 67). The scholars further argue that the identification of these structures is essential to understanding interactions in formal school settings, as they require the coordination and collaboration of multiple participants in order to produce and sustain these social structures.

Based on the Patchen and Smithenry’s (2014) continuum of participation structures, I attempted to characterize these activities based on the distribution of authority, and the opportunities for various levels of student participation. The reason for this being that I am working from a critical lens, and thus, consider how power circulates amongst structures and people.

Patchen and Smithenry (2014) distinguish participation structures by which students participate as individuals (PI), as groups (PG), or as a collective (PC). On this continuum, the PI structure most closely resembles the classroom set up for lectures and film-watching (i.e., where the teacher delivers content in whole-class formats, and students are expected to participate as individuals); the PG structure corresponds with what is generally known as small group work or collaborative learning (i.e., where a student works with others to complete a task); and the PC structure turns toward student-directed forms of inquiry and practice (i.e., where students take on more responsibility for constructing knowledge as a community, and there is noticeably less teacher intervention), and resembled the more exploratory “Science Walks” organized by Dr. Farrell (to be detailed in Chapter 4).

The second round of coding involved using an online random number generator to choose 5 minutes of each participation structure that occurred in each lesson. For example, if the class participated in a whole-class discussion and a lecture that day, I would code a 5-minute segment of the class discussion and a 5-minute segment of lecture, separately, to a total of 10
minutes of analyzed video. The length of each participation-structure activity was noted and used to determine the number range for the random number generator.

For example, in a 24-minute video of a whole-class discussion, the number range entered into the random number generator would be “0-20.” If the generator produced a “7,” then I would code the video footage from 7-12 minutes, creating activity “chunks” of that specific participation structure. These video chunks were played in their entirety – multiple times with and without sound – and I noted “interesting” instances, the social context, and their lengths of occurrence. In each lesson, the analyzed video segments accounted for 14 – 21% of the total video footage. The development of this coding system was an iterative process and involving repeated viewing of the video chunks, multiple passes of coding, and progressive refinement of the generated codes (Angelillo, Rogoff, & Chavajay, 2007; Erickson, 2006).

The program Microsoft Excel was used to create the coding tables. Within each video segment, a brief description of the participation structure and the participants’ actions were included. A preliminary code, “interesting,” was used. An “interesting” instance included a timestamp and a label for the code (e.g., lack of eye contact, overlapping talk). The various components of the coding table are identified in Figure 4 below.
**Figure 4.** Example of a preliminary “interesting” coded video segment

Figure 4 depicts an example of a random segment analyzed: from left to right, the video timestamp, the pseudonyms of the participants, participation structure and main task, a screen shot, a brief description of the video segment, the identified “interesting” code(s), and any emergent patterns of interaction which I termed “themes” (but may or may not be necessarily “interesting” to me). The general purpose of this preliminary coding was informed by my theoretical framework and utilized to identify the broad strokes of verbal (V) and non-verbal (NV) means of communication, to highlight how ideas were elicited and taken up; to note what (if any) tools were utilized; and observe if there was a particular division of labour.

**Identification of Key Events.** Within these “interesting” 5-minute video chunks, I needed to find a way to systematically decide which segments to include for further analysis. As my research considers the classroom as an activity system that is organized through regularities of shared practice, I compared my “interesting” video chunks with Engeström’s (1987/2015) concept of *contradictions*. Contradictions are defined as historically accumulating tensions between the nodes of the activity triangles and/or across intersecting activity systems. On the
activity level, contradictions are potential sources of learning and innovation, which can manifest in individuals’ altered practices and behavior and/or application of practices to new contexts (Engeström, 1987/2015, 2001; Gutiérrez et al., 1999). Table 2 describes Engeström’s four levels of inner contradictions in an activity system.

Table 2
Levels of Inner Contradictions in Activity Systems

<table>
<thead>
<tr>
<th>Levels of Inner Contradictions</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>When activity participants encounter more than one value associated to an element within an activity system (e.g., the object of science learning may look and be valued differently by teacher and a student)</td>
</tr>
<tr>
<td>Secondary</td>
<td>When activity participants encounter a conflict between two or more nodes in the activity system (e.g., if students are expected to share their mistakes with the class [tools] as a means to facilitate their science learning [object], but students may resist if they feel uncomfortable)</td>
</tr>
<tr>
<td>Tertiary</td>
<td>When activity participants face conflicting situations by adopting what it is believed to be a newly advanced method for achieving an object and the dominant object (e.g., if students are expected to both memorize scientific vocabulary for assessment and engage in self-directed, critical inquiry, but high-stakes testing focus primarily on the former set of skills)</td>
</tr>
<tr>
<td>Quaternary</td>
<td>When there are conflicting interests between the central activity being studied and its neighboring activity systems (e.g., how students perform in a particular class will affect their candidacy for graduate school)</td>
</tr>
</tbody>
</table>

Adapted from Engeström (1987/2015).

In alignment with critical microethnographic perspectives, the notion of contradiction is interesting to me because from larger grains of analysis, teaching and learning are often represented as smooth, consensual processes, in which students move linearly from incompetence to competence (Gutiérrez et al., 2007; Mehan, 1998). However, in finer grains of analyses, conflicts and tensions often emerge in interactions between teachers and students. The idea of “conflict” needs to be problematized, as I do not use the term to solely refer to explicit arguments and/or disagreements (although they are included in the definition). In interaction analysis, conflicts are routinely observed as mishearing, lack of understanding, intrusions, and
are repaired just as quickly with “neither participants nor observers consciously experenc[ing] the trouble” (Jordan & Henderson, 1995, p. 71). For the purposes of my study, conflict is defined as the micro-level manifestation of an activity-level contradiction. As my research focuses on how students’ participation and acts of positioning shape their access to particular OTL, conflicts are of particular interest because they delineate individual contributions and understandings to a scientific discussion. As a result, I examine the potential influence that dissenting knowledge plays in the distribution of OTL across group members, and how conflict potentially provides unique OTL and shifts in activity (Engeström, 2001; Kelly et al., 2001; Tuyay et al., 1995).

Over multiple iterations of coding and methods of constant comparison (Glaser & Straus, 1967), video segments that were coded for ‘contradictions’ and involved the focal students, were selected for closer analysis and identified as key events (Derry et al., 2010; Jordan & Henderson, 1995). The video data that was initially collected for the SRIs formed the preliminary categories of interest. As new lessons occurred over the final weeks of the course, the video data were compared with previous data to determine any emergent relationships. In line with Glaser and Straus, initial inferences about the focal students’ participation in various activities were treated as conjectures. The criteria for the selection of ‘key events’ also included the quality of video and sustained interactions (over 30 seconds).

This constant comparative process of reconciling provisional categories with subsequent data framed my following round of analysis. Next, I examined specific instances of conflictual small group work that involved the focal participants, because this participation structure afforded me finer grained insight into their acts of positioning, not necessarily available through other structures such as lectures and whole-class discussions. This is because while group work does not guarantee the focal students’ verbal participation, it is more likely to be observed than
in other structures. In order to apply a thick description to the events, the video data were supplemented by the focal students’ interviews and provided a means of triangulating inferences made about their talk and actions in the group activity (Cobb & Whitenack, 1996; Geertz, 1973). The selected video segments were used as vignettes for Chrissy and Jem’s case studies.

Further honing of the group work segments involved repeated viewings of the video data and multiple passes of coding to illustrate the more precise linguistic cues that could be used to describe the specific manifestations of contradictions (Engeström & Sannino, 2011), and the particular OTL accessed in the interactions. The range of OTL about science were described by examining students’: a) access to scientific content and discourse practices; and/or 2) access to (positional) identities (see Figure 1).

**Micro-level coding.** For the next level of analysis of classroom interactions, I drew on critical discourse analysis, which examines the characteristics of verbal and non-verbal forms of communication as a form of social practice (Bloome et al., 2005; Fairclough, 1993; Sidnell, 2010). Informed by the formalisms of the scientific community and the teacher’s framing of science, the characteristics of the daily classroom talk mediated what counted as knowledge and who was positioned as a knower and doer of science within the interaction.

In conversation, a unit of analysis is considered a basic unit of back-and-forth exchange, which usually consists of an Initiating move, a Response turn, and in the case of a teacher-student interaction, oftentimes a Feedback move (previously Evaluation), forming an IRF triadic discourse pattern. In a traditional classroom, an initiating move often comes from the teacher, eliciting information or requesting justification (Sinclair & Coulthard, 1975). The response move comes from the student, and functions to give information. The third move is a follow-up to the
response, and functions to extend previous contributions, acknowledge, confirm, correct, or reject responses. In the Feedback move, the teacher examines the student’s response and attempts to move them along the vertical axis of development (conceptualized as from incompetence to competence) and usually aligns the collective object of the class (Engeström, 1987/2015; Lemke, 1990). Sidnell (2010) argues that opportunities to participate (and therefore learn) are facilitated through turn-taking in conversations, where participants can make intellectual contributions, self-correct, repair, make sense of others’ contributions, etc. Similarly, Radford & Roth (2011) argues joint activity is at the heart of learning, which requires both active student participation and asymmetry. The asymmetry refers to cultural-historical forms of participation in an activity of which students become gradually aware, and as they learn, they become conscious of their expansive action possibilities.

Analyzing talk as a unit of exchange is important, because limited research has been done on how students of different backgrounds respond to different kinds of questions (Parks, 2010), which has important implications for equitable teaching and learning in classrooms. I also considered elements from Pomerantz’s (1984) preference framework to analyze the ways in which the participants took part in turn-taking and sequences in discourse. Pomerantz describes the range of actions that are oriented as preferred (and dis-preferred) and how these actions are performed. It follows the idea of preference as a set of normative principles (usually implicit) that participants carry with them across contexts and play a part in their expression and interpretations of initiating and responding actions. Such categorical ways of speaking are predicated on gross sociocultural preferences (Gutiérrez & Rogoff, 2003; Pomerantz & Heritage, 2013), and was only taken as a guiding framework to highlight the range of language use in intergroup interactions.
By examining Dr. Farrell’s patterns of talk, I investigated the types of discourses in which students were invited to participate. For example, it was noted in my field notes that Dr. Farrell tended to ask open-ended questions. Closed questions often characterize a preference for a pre-set and narrow range of answers, which are interpreted as being correct or incorrect. In contrast, an open-ended question generally refers to an initiating move in which there are a wide range of acceptable answers (Parks, 2010).

The small-group scientific discussions were simultaneously social situations. As students engage with the academic content, they are also engaged in social processes embedded in cultural practices of the science classroom (Kelly et al., 2001). Pomerantz & Heritage (2013) argue that in conversations, multiple preference principles may be concurrently operating, which can create conflicts in how different participants navigate the same interaction, leading to differential learning contexts. These potential conflicts will be addressed in more detail in the case studies.

I engaged in both a deductive and inductive approach to my micro-level analysis. The verbal (V) and non-verbal (NV) cues of the participants’ actions served as the rough draft to my coding categories. The preliminary versions of the coding categories were taken from videos and transcripts of student talk and supplemented by my field notes and content logs. The refinement of the “V” code focused on participants’ talk and “NV” code focused on hand gestures, facial expressions, body positioning, pauses, tone of voice, and access to/manipulation of artifacts (e.g., books, shared worksheets, blackboard). An examination of the frequency with which the codes were applied (and in some cases, the length of time) was done to highlight patterns of social interaction (Angelillo et al., 2007; Erickson, 2006).
I identified emergent themes related to patterns of power, participation, and positional identities. The preliminary verbal codes included *explicit instruction* (e.g., “Get into groups.”); *identity talk* (e.g., “I am a sports-based youth worker.”); *science talk* (e.g., “Gross anatomy explicitly teaches an anatomical map of the body.”); and *acts of positioning* (e.g., “What did you think, Geena?”). Through an iterative process, I reviewed these video segments, and determined which codes appeared most frequently and most reflected my research interests; that is, I looked specifically at students’ access to scientific content and discourse practices, and their access to positional identities as contributing members to the common task.

Finally, I drew on positioning theory and its notions of *interactive* and *reflexive* positioning (Davies & Harré, 1990, 1999; Harré, Moghaddam, Cairnie, Rothbart, & Sabat, 2009) to examine how the focal students’ acts of positioning in scientific discussions shaped their access to and uptake of particular OTL (e.g., if a student was able to speak without being interrupted; if students shared resources) and if other members perceived them as scientifically competent through their responses (e.g., if their ideas were taken up, rejected or ignored).

*Interactive* positioning refers to the ways that people position one another through interaction. For example, a student directly asking the professor a question can serve to position them as an authority figure whose contributions are valuable. *Reflexive* positioning refers to the ways in which a person positions themselves through interaction. A student who speaks authoritatively may be positioning themselves as knowledgeable about a particular topic.

While CHAT is useful in its capacity to surface the object-oriented and tool-mediated nature of activity in the science classroom (Patchen and Smithenry, 2014; Roth & Lee, 2007), it was necessary to examine the moment-to-moment acts of positioning in order to further describe the particular social and relational conditions through which the focal students took up particular
OTL. Thus, I bring into focus the dialectical relationship between collective learning and individual learning by first looking broadly at the construction of the activity system, and the range of OTL the classroom dimensions afforded the students. Then by drawing upon a critical microethnographic perspective, I “zoomed in” to examine how particular group dynamics and the focal students’ acts of positioning shaped their access to OTL.

As Fitch and their colleagues (2004) contend, the close examination of what participants do in interactions describes how they use the social dynamics as both resources and context for communication and sense-making. The classroom and participation structures within which the students work, facilitate and/or constrain their opportunities to participate by setting both explicit and implicit norms and expectations for behaviour. Crawford and her colleagues (1997) studied the science presentations of two bilingual, grade 9 boys. The scholars found that under different audience conditions – one to a teacher, and then to a small group of younger students, the boys used different rhetorical strategies to communicate their project design, experiments, and findings. Studies of this sort provide a more nuanced and subtle picture of epistemic classroom activities. In other words, how common scientific tasks are negotiated and what counts as scientific knowledge are negotiated and influenced by the social dynamics of the group.

Part II. The Case Studies of Chrissy and Jem. For Chapters 5 and 6, I used case studies as my methodological approach to study in-depth two vignettes of group activities involving each focal participant (4 vignettes in total). Using Gerring’s (2004) definition of case studies, a case study is an intensive study of a single unit, where the researcher’s aim is to elucidate features of a larger case of similar phenomena. Case studies allow us to elaborate on theoretical propositions, but not to make codified generalizations about populations or universes (Fitch et al., 2004; Yin, 2009). For my research, the thick descriptions of single-instance cases
are directed toward exploring and generating interpretations about patterns that emerge across sites of talking science. Through a positioning theory lens, I used case studies to examine how Chrissy and Jem accessed and took up particular OTL in scientific discussions.

**Telling cases.** Each vignette was selected as a “telling case” (Mitchell, 1984, p. 237, as cited in Pahl, 2004) where respondents offered a rich point of data in interviews that emerged out of the constant comparative data collection analysis (Glaser & Straus, 1967; Olivera et al., 2010). Selection and analysis of a telling case was informed by the researcher’s assumption that the work practices, identities, and the contexts that informed the second sub-research question, “Within scientific discussions, how do students’ participation and acts of positioning shape their access and uptake of OTL?” were consistently negotiated and could shift in interaction. The characteristics for describing a telling case included: a) an instance of group work that stood out to the focal participant in interviews; and b) involved a sustained and observable instance of a contradiction. These vignettes operated at a finer level of analysis relative to the phenomena under investigation and functioned heuristically to surface theoretical generalizations about science learning in certain contexts (Gerring, 2004; Rex, 2001). Excerpts from the telling cases were transcribed and drew from the Jefferson system of transcription notation (Appendix F).

**Analysis of positioning in the vignettes.** In Table 3, I describe the general characteristics of the group activities involving Chrissy and Jem, wherein I specifically looked at their participation and acts of positioning. To analyze their access to scientific content and discourse practices, it was important to look at the group’s *work practices*: interactional patterns that groups construct as they work together on a common task (Esmonde, 2009b; Kelly et al., 2001). Although the negotiated work may at times be invisible or unremarked, work practices are always negotiated, in the sense that no one student can determine the group’s patterns of
interaction without the cooperation of social others (Holland et al., 1998; Kumpulainen & Kaartinen, 2000).

Table 3
Within-case Variables in Vignettes

<table>
<thead>
<tr>
<th>Vignette</th>
<th>Kind of group work</th>
<th>Group members</th>
<th>Conflict</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vignette 1 (Focal student: Chrissy)</td>
<td>Formal, Group Article Review assignment</td>
<td>Chrissy, Geena and three other students</td>
<td>Between Chrissy and Geena</td>
</tr>
<tr>
<td>Vignette 2 (Focal student: Chrissy)</td>
<td>Informal small-group discussion</td>
<td>Chrissy, Ning</td>
<td>Between group and teacher</td>
</tr>
<tr>
<td>Vignette 3 (Focal student: Jem)</td>
<td>Formal, Group Article Review assignment</td>
<td>Jem, Stuart, and three other students</td>
<td>Between Jem and Stuart</td>
</tr>
<tr>
<td>Vignette 4 (Focal student: Jem)</td>
<td>Informal small-group discussion</td>
<td>Jem, Lee, Chrissy, Ning</td>
<td>Between Lee and group</td>
</tr>
</tbody>
</table>

Drawing from positioning theory (Davies & Harré, 1990; 1999) and Dookie’s (2015) coding categories, attention was paid to the focal students’ bodily orientations, gestures, facial expressions, and manipulations of artifacts (and so forth) relative to one another during group work, and how they may have facilitated and/or constrained another’s access to the interactional space and artifacts. The interactive positioning code was used to examine the ways in which students positioned each other through verbal and non-verbal means (Table 4). Reflexive positioning referred to the ways the students positioned themselves through interaction and was coded as aligned or misaligned with the interactive positioning of themselves by social others (Kotsopolous, 2014).

The case studies afford the reader an intensive look at how learners, relative to their participation and positioning, experience the same context differently, and to which I argue shapes their engagement with the common task and how they take up learning opportunities.
**Table 4**

*Main Codes applied in Interactive and Reflexive Positioning Analysis*

<table>
<thead>
<tr>
<th>Type of Positioning</th>
<th>Participation Structure</th>
<th>Verbal or Non-verbal</th>
<th>Mains Codes</th>
<th>Associated Labels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interactive PI structure (e.g., lectures, films)</td>
<td>Verbal</td>
<td>‘Question’ ‘Explicit instruction’</td>
<td></td>
<td>Participants involved • Open-ended or closed question</td>
</tr>
<tr>
<td>PC structure (e.g., whole class discussions, debates, student-directed discovery tasks)</td>
<td>Verbal</td>
<td>‘Intellectual contribution’</td>
<td></td>
<td>Participants involved</td>
</tr>
<tr>
<td>PG structure (e.g., pair/group work)</td>
<td>Verbal</td>
<td>‘Initiating talk’ ‘Overlapping talk’ ‘Exclusive talk’</td>
<td></td>
<td>Participants involved • Length of time</td>
</tr>
<tr>
<td></td>
<td>Non-verbal</td>
<td>‘Exclusive use of artifact’ ‘Crossing into shared interactional space’ ‘Expression of positive/negative emotion’</td>
<td></td>
<td>Participants involved • Length of time</td>
</tr>
<tr>
<td>Reflexive PI structure (e.g., lectures, films)</td>
<td>Verbal</td>
<td>‘Affirmation’ ‘Disagreement/challenge’ ‘Silence/Ignored’</td>
<td></td>
<td>Characteristics of talk (e.g. hedging, uptalk, vocal fry)</td>
</tr>
<tr>
<td></td>
<td>Non-verbal</td>
<td>‘Body orientation’ ‘Use of tools’</td>
<td></td>
<td>Characteristics of talk (e.g. opinion, extension of argument, question) • Aligns with whom? • Challenges whom? • Resources used (e.g. artifacts, citation)</td>
</tr>
<tr>
<td>PC structure (e.g., whole class discussions, debates, student-directed discovery tasks)</td>
<td>Verbal</td>
<td>‘Intellectual contribution’ ‘Distributed argumentation’</td>
<td></td>
<td>Characteristics of talk (e.g. opinion, extension of argument, question) • Aligns with whom? • Challenges whom? • Resources used (e.g. artifacts, citation)</td>
</tr>
<tr>
<td>PG structure (e.g., group presentations, pair/group work)</td>
<td>Verbal</td>
<td>Non-verbal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>--------</td>
<td>------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>‘Intellectual contribution’</td>
<td>‘Expression of positive engagement’</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>‘Agreement’</td>
<td>‘Expression of negative engagement’</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>‘Side talk’</td>
<td>‘Expression of positive emotion’</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>‘Bid to change work practice’</td>
<td>‘Expression of negative emotion’</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Length of time</td>
<td>• Head nod, head shake</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Smiles, frowns</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Move in closer/farther away</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The coded vignettes pertaining to each case study are presented in Chapters 5 and 6. Verbal and non-verbal forms of interactive and reflexive positioning were considered, with a particular focus on the actions and talk of the focal students, Chrissy and Jem respectively. The use of vignettes allowed for a detailed representation of the common task, group members, the conversations that took place, and the major interactive and reflective positioning moves in the form of a coherent narrative (Derry et al., 2010). I now elaborate on the codes used to illustrate the various kinds of interactive and reflexive positioning in the intergroup interactions.

**Verbal codes.** Given my research focus on how students chose to participate and shaped the participation of others, the most commonly used codes in my study illustrated demonstrations of power dynamics and the student uptake process of learning opportunities. For each video chunk, the segment was played repeatedly, with and without sound. Microsoft Excel was again used to create a coding table that mark any observed emergent patterns, which were reiteratively refined as codes. Figure 5 shows how the codes were initially logged. The labels associated with each code were used to describe my rationale, which in turn guided subsequent
refinement of the codes’ definitions (See Appendix D for definitions of the most frequently appearing codes). The various components of the coding table are identified in Figure 5, below.

<table>
<thead>
<tr>
<th>Video (date, video length, video segment analyzed)</th>
<th>Participants (pseudonyms)</th>
<th>Participation Structure and Main Task</th>
<th>Screen Shot</th>
<th>Emergent Code [V or NV]</th>
<th>Label [code description]</th>
<th>Emergent Code [V or NV]</th>
<th>Label [code description]</th>
<th>Non-verbal interactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>05/17/16 Tape 2, 0-10 min</td>
<td>Jem, Ning</td>
<td>&quot;Examined Life&quot;</td>
<td><img src="image" alt="Screen Shot" /></td>
<td>Crossing into interactional space (NV)</td>
<td>When Ning was talking about a situation that affects you... is in your face versus a situation (\text{[00:37:00:59]}) (\text{[00:05:01:13]})</td>
<td>Initiating talk (V)</td>
<td>Her hand away, as if to Nodding</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>seconds)</td>
<td></td>
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</tr>
</tbody>
</table>

**Figure 5.** Example of a coded video segment.

**Interactive positioning.** Both the verbal (V) and non-verbal (NV) forms of interactive positioning were coded. Verbal forms of interactive positioning included an examination of whether and how a student was granted access to the conversational floor and/or positioned as a contributing member to the group (e.g., if their ideas were taken or ignored). The main (most frequent) codes generated from the data that were used to describe the interactive positioning in group work were *initiating talk* and *overlapping talk*. *Initiating talk* was an emergent code, defined as who spoke first and at what length. This pattern of action became of interest to me, because I found that the initiator tended to dominate the conversational floor, and the following discussion tended to centre around the initiated talk. *Overlapping talk* involved initiating talk before another participant finished speaking or interrupting and positioned others’ contributions as less important. Non-verbal forms of interactive positioning included body positioning (e.g.,
leaning in or turning away), access (to shared learning artifacts and/or interactional space), gestures (e.g., shrugging), and facial expressions (e.g., smiles, frowns; see Table 3).

**Reflexive positioning.** Borrowing from Dookie’s (2015) analytic procedures, codes were generated from the data paying attention to both verbal and non-verbal acts of communication. For non-verbal reflexive positioning, codes included expression of positive/negative engagement (e.g., crossing arms, turning away), and expression of positive/negative emotions (e.g., eye rolling, smiles). After these instances were timestamped, they were temporally analyzed alongside other acts of positioning; for example, if a participant interrupted another person speaking, and the initial speaker rolled their eyes. Based on the principles of turn-taking (Sidnell, 2010; Sinclair & Coulthard, 1975), if the onset of the students’ physical moves and/or facial expressions followed or occurred during an interactive act of positioning, these reflexive acts of positioning were considered a response (one turn) to the interactive positioning.

For verbal forms of reflexive positioning, the main codes generated from the data were *intellectual contribution* and *side talk*. An intellectual contribution was defined as any utterance related to the task, including asking questions, offering ideas, suggestions, strategies, etc. (Dookie, 2015). Side talk refers to students continuing an extended dialogue while the “official” participation structure shifts from one to another (e.g., from lecture to whole-class discussion). There are nuanced differences from another code, *exclusive talk*, that I observed in interactions, and was defined as “talk used to explicitly address certain members of the group in conversation and/or explicitly prevent others from contributing.”

**Supplementary analysis of interviews.** Together, the interviews and video data informed one another. Interviews were used to access the participants’ perspectives and voices, and to provide further context to the vignettes of group work beyond the immediate acts of positioning.
Ogbu (1981) calls for a multilevel approach to ethnography and criticizes the bias toward microethnography in education research. Ogbu further laments the neglect of broader community forces, which he argues has important implications for formal schooling. In a similar line of argument, Anderson (2009) claims that a limitation of traditional analyses of positioning is that they employ an imminentist ontology, that is, “the premise that positioning is contextually tied to the moment of interaction in which it occurs and not across interactions or scales of activity” (p. 229), and calls for the need to consider meso- and macro-level influences. Bronfenbrenner (1976) describes the mesosystem as the “interrelations among two or more settings in which the developing person actively participates” (p. 25).

Informed by these methodological critiques, this study utilized critical microethnographic methods to enable a better understanding of how a common task led to different contexts for learning, and potentially to different OTL. This approach focused on examining cultural actions, artifacts, and discourse processes through which group members constructed socially accepted knowledge (Gutiérrez & Rogoff, 2003; Kelly et al., 2001; Pomerantz & Heritage, 1984). In addition to considering the imminent aspects of the group work, I used the interview data to facilitate the investigation of meso- and macro-level influences (e.g., the focal students’ pre-existing relationships with other group members, perceptions about group work, their own and others’ social identities) that may have shaped the local interactions.

While student talk about science was the primary focus for examining the construction of local knowledge within each group, science identity, social identity, requirements for intellectual contributions, and group membership also emerged as themes from the data. Through constant comparison between the interview and video data, I noted if there were any observed correlations
between the focal students’ reflections and interactions (Glaser & Strauss, 1967), as well as the differences in my interpretations and the participants’ interpretations.

Recall from the previous chapters, I understand learning as a change in participation, such as a change in students’ use of scientific discourses as they take up the academic content. As discourse is considered a form of social practice, different types of talk may also play a role in science learning (Arnold, 2012; Wood & Kalinec, 2012). Although “identify talk” (e.g., “Ning and I are both dancers.”) may not relate to course content directly, it can facilitate and/or constrain OTL through establishing group membership, and shape how learners make meaning of others’ actions and talk, and how they are positioned in scientific discussions. As such, different kinds of talk in the focal student interviews were considered in coding for their reflexive positioning and added insight into the meso-level influences that may shape individual access to particular learning opportunities.

Quantitative Data

Quantitative data included assessing the frequency of various participation structures’ occurrences within each class and totalling the length of time of each structure (see Chapter 4), totalling the frequency of each emergent code in the selected video segments, and, if appropriate, calculating the length of time that the code took place (e.g., initiating talk, physical blocks). The majority of my analysis remains qualitative in nature. The quantitative analysis was conducted to identify the ways in which verbal and non-verbal cues were used by the participants to accomplish a range of collective and individual goals, to describe the acts of positioning in intergroup interactions, and to garner a greater ecological view of how a common task could lead to different learning contexts. By quantitatively analyzing the various interactional patterns and
the use of space and time in the student groups, I made visible the differential aspects of negotiation within a common task.

**Reliability and Validity of Data**

In considering the selection of my data, I began with general insights about the social organization of the classroom, how Dr. Farrell framed science learning, and broad descriptions of daily classroom practices, garnered through my field notes and participant observation. With my video data, I drew on the concept of “ecological validity” which is defined as the “extent to which behaviour sampled in one setting can be taken as characteristic of an individual’s cognitive processes in a range of settings” (Cole, 1996, p. 222). Ecological validity examines the relationship between the learner and the different contexts of the learning environment. As a result, in my study I identified the various participation structures utilized in the daily classroom practices, chunked the video data, then analyzed the footage accordingly to approximate an ecologically valid (appropriate depth and breadth) account of the classroom activities.

Next, I drew upon CHAT and positioning theory to examine the classroom events and looked for sites of “ambiguity, surprise, interpretation, sense making and potential for change” (Engeström, 2001, p. 134). As Oliveira et al. (2010) suggest, marked moments of participants’ behaviour carry a high information load, as they potentially contain misunderstandings, tensions, and contradictions. In line with Glaser and Strauss’ (1967) constant comparative approach, engaging with these marked moments help to strengthen the researcher’s analysis by further refining their initial conjectures, grounded in data. The goal is to explicate the influence of personal assumptions, consider divergent data, and alternative interpretations and questions.

To further strengthen the validity of my findings, I employed methods of triangulation, participated in prolonged engagement in the field, and used thick description to describe my data.
(Creswell & Miller, 2000; Denzin & Lincoln, 2000; Geertz, 1973). I included multiple sources of data to interpret the intergroup interactions among the Kinesiology students, such as field notes, student interviews, and video data, and examined the OTL phenomena from multiple perspectives. The video data allowed me to revisit my interpretations of the classroom events after initial field work and had the advantage of being able to be viewed by others other than the researcher. Drawing from Cobb & Whitenack’s strategies (1996), I showed key events to colleagues and committee members from diverse social locations and sought their feedback. Having multiple perspectives on the data from my peers and other professionals who were not familiar with the setting helped me to question the assumptions that I held about teaching and learning and brought in outside theory and questions that I might not have considered.

Also, I was engaged in the field for an extended period of time, attending every class, and meeting semi-regularly with some members of the faculty to deepen my understandings of the department and their research motives. In these meetings, Dr. Farrell, other faculty members, and I spoke transparently about my data collection, analysis, and possibilities for knowledge dissemination. This research collective was an asset in a different way, because they were familiar with the study and the context. Our conversations became catalysts for further inquiry, and considerations of a wider perspective about knowledge construction and production, such as research for whom and for what purposes.

**Methodological Limitations**

In critical microethnographic studies that use video methods such as mine, a question that arises is how much participants are influenced by the camera’s presence. I attempted to be sensitive to this unnatural situation by reminding non-focal students that they could sit outside the view of the camera; asking for consent before video recording group work and interviews
even after receiving written consent; and not consistently standing behind the camera. Jordan & Henderson (1995) observe that standing for long periods of time behind a camera can make participants feel as if they are being evaluated. As well, I attended every class session, and attempted to habituate myself to the classroom routines and familiarize myself with the students, so as to cause the least amount of social interference.

While video-based data collection provides a consistent and detailed account of classroom interactions (Derry et al., 2010), it also shifts the nature of the documented interactions and relationships. Throughout the course, I noticed in the data corpus that there were moments in which some students looked at the camera, addressed the camera directly, or spoke more quietly when they noticed my videotaping them. If recording made the participants self-conscious, then it is likely to impact the way they speak and relate to one another while on camera (Curnow, 2017). However, without participant awareness, ethical research practices cannot occur.

In some ways, any research methodology in which a new individual or tool is introduced into the class’ consciousness will at least affect the onset of their behaviours, but as Jordan & Henderson (1995) contend, the camera’s novelty effects often wear off. In order to facilitate this acclimation process (Cobb and Whitenack, 1996), I was a consistent presence in the classroom. As well, I often kept the camera stable, and distanced myself from the equipment periodically.

In addition, as with any kind of research, I was not able to include every interaction involving the focal students, and this has major repercussions for my ability to account for learning in the classroom. The camera, while providing data with a level of detail and consistency unattainable by reconstructive methods, is limited by how I positioned the equipment and the means of the technology (Jordan & Henderson, 1995). While I acquired
extensive data of student interactions within particular activities in the classroom, some spaces occurred beyond my participant observation and view of the cameras, such as their Facebook chats revolving around group assignments, study groups, and the conversations that Jem mentioned she had with her roommate about the lessons, who was incidentally another student within the course. Such sites were potentially fruitful sites for documenting the uptake of various learning opportunities. However, it was not practical to collect data as they occurred outside the classroom. There also would be ethical concerns regarding the collection of personal correspondence, and the documentation of focal participants off university grounds.

With respect to my study, I was interested in classroom-based research. Thus, recording the class lessons reflected an instrumental choice, where I was able to document how science learning was framed by the teacher and taken up by the students in the classroom space. However, because learning is often continuous with everyday experiences, this reflects a dialectical tension between the formal and informal spaces of learning (Gutiérrez et al., 2007), and the limits of my methodological strategies. As one of the focal participants, Chrissy, discussed in her interview:

The knowledge [from this course] is so rich and applicable in terms of assessing yourself. A lot of these concepts are applicable to daily life. You can walk down the street, and see different things, and apply the knowledge we’ve been taught in class as opposed to if you take a Biology class. ‘Oh, the molecules!’ It’s very much more a reflection of who we are as human beings.

As Chrissy’s words illustrate, learning for her did not just happen within the walls of a classroom; it is tied to participation in different domains (externalization). Thus, I acknowledge that my data could only document part of this learning dialectic.
On a related note, interviews were used to help mitigate the video methodology’s limitations. I relied on the focal participants’ words, reflections, and my field notes to provide context and texture to their learning experiences inside and out of school, and to strengthen the ecological validity of my research findings (Bronfenbrenner, 1979; Cole, 1996). The researcher’s professional vision (Goodwin, 1995) – or expert ways of interpreting events – develops through their research interest(s), epistemologies, ontologies, specialized training, and experiences. As Jordan & Henderson (1995) indicate, “what the analyst may see or hear via the tape may not be what the participants hear and see” (p. 54). Positioning theory is useful for showing how positioning practices are experienced differentially by individuals occupying different social and intellectual positions (Anderson, 2009). The SRIs supplemented my video-based interpretations of the group dynamics and the focal students’ visible acts of positioning and were sometimes inconsistent with the participants’ interpretations of their actions (as the reader will see in Chapters 5 and 6). Finally, my introductory and final interviews with Chrissy and Jem attempted to tie in the documented group interactions with their reflections on if and how their learning and identity shifted through their participation in this course.

**Ethical Considerations**

In the research study, the primary data used was video data, supplemented by interviews and learning artifacts. The teacher and student participants all filled out a letter of consent. There were minimal risks involved with this project. All the participants were over the age of 18, and while some students may identify as belonging to an underrepresented minority in postsecondary education, there were no deliberate strides to choose participants from a particular group. Regardless, steps were used to protect their identities.
Video and audio data are difficult to fully anonymize. For this reason, in my consent forms, I was clear with my participants that if they chose to participate, they might be recognizable through the video streams. I took measures to anonymize their identity through the use of pseudonyms and censor bars in photo stills throughout my dissertation. I also anonymized the name of the school and the professor of the course. The purpose of the study was non-evaluative, meaning there were no negative consequences if or when students decided to participate or not. I emphasized that the professor would not be given access to the data until after the course ended and all marks were submitted. Participants also had the choice of withholding all information from the teacher. No student decided to do so.

In order to minimize stress and/or any risk associated with my research project, I stressed that all participants could withdraw their participation at any time, refuse to answer any questions during interviews if they felt uncomfortable, or retract any statements afterwards. When classroom activities were being videotaped, students who did not give consent were not recorded for the current research.

Analyzing Shifts in Positional Identities and Access to OTL through a Critical Microethnographic Perspective

In the current study, I locate my methods in critical microethnography, which emphasizes how people construct meaning from moment-to-moment in particular activities and investigates the relationships between social and cognitive activities in everyday settings. In particular, I am interested in: a) how the professor framed the collective object of science learning and the range of OTL afforded by the dimensions of the classroom activity system; and b) how students’ participation and acts of positioning shaped their access to particular OTL within scientific discussions.
Referring to the first research question, I studied the classroom as an activity system that included the social organization of learners, teachers, curriculum materials, and the physical environment. I detailed how Dr. Farrell organized the classroom system based on the dimensions of the activity triangle heuristic (see Figure 2). Data were collected and reviewed to find emergent patterns of talk and action within the context of specific participation structures. Four participation structures were identified as the major event transitions from the data corpus: (a) lecture, (b) whole-class discussion, (c) group work, and (d) exploratory “Science Walks” (to be described in Chapter 4). This process represented a coarser grain of analysis that broadly describes how Dr. Farrell organized the classroom, the academic content, and its activities, and thus the range of available OTL within the activity system.

Next, to find patterns of participation and acts of positioning, I considered each focal students’ access to the tools, interactional space and conversational floor, and considered power dynamics such as who initiated the talk, who tended to ask questions, interrupt, and who tended to be on the receiving end of these acts. I also quantitatively examined the frequency of emergent ‘V’ and ‘NV’ codes in intergroup interactions (and if appropriate, the length of time the code was applied for).

The intent of the study was to examine how – within particular activities, students navigated their participation to access particular OTL. Supplementary interviews involved questions of how the focal students experienced and interpreted the different classroom activities, acts of positioning, and how social identities were enacted in interactions. This was one of the main ways in which the present study linked individual participation to the meso-level relationships and macro-level social constructs. The interviews also supplemented the video data, in which questions of shifts in student learning and identity were explicitly mined for.
Overview of the Analytic Chapters

In the chapters that follow, I problematize what it means to learn science in an undergraduate Kinesiology classroom of a large, Canadian university. I argue that science learning has traditionally favoured vertical developmental processes that emphasize scientific content as an object to be acquired and applied only within narrow social spaces (e.g., lecture halls, laboratories; Leander, 2004, 2006). Traditional conceptions of scientific competence are largely relegated to reproductive labour and cognitive activity happening “within the mind” of an individual (internalization).

Bringing together notions of enacted scientific competency, positioning, and power, I conceptualize this Kinesiology classroom as an activity system embedded in larger sociohistorical structures (Engeström, 1987/2015). Through a critical microethnographic perspective, my study foregrounds the relationships between local interactions in scientific discussions with the relatively stable history and practices of formal schooling and the scientific community. This “fixity” of classroom settings in terms of physical space as well as its recognizable-ness as a kind of space constitute a particular range of followable norms due to its reoccurrence and authorization in practice (Anderson, 2009). However, structural processes and institutional categories are not deterministic, because “even systems and their boundaries are fluid and variable,” which is why attention to micro- and meso-level factors are of analytic interest (ibid, p. 292) in my study, and considers how particular OTL and positional identities might be invoked by broader social influences (Bloome & Egan-Robertson, 1993).

Thus, I investigate how, in one science classroom, focal students’ uptake of OTL were “stitched together” (Haraway, 1988) across sites of doing and talking science, and via a number of mediating factors – how the professor framed science learning, the affordances of particular
classroom activities, the group dynamics, and how the group members made meaning of one another’s contributions. In the next chapter, I detail how the teacher organized the Kinesiology classroom system and the collective object of science learning. Chapter 5 and 6 are case studies of the two focal students, Chrissy and Jem, and I examine how they participated and positioned themselves in conflictual scientific discussions, and how, through these acts of positioning, they accessed and took up particular OTL.
Chapter 4
The Range of Opportunities to Learn in a University Kinesiology Classroom

Chapter Overview
In this chapter, I discuss the characteristics of the university Kinesiology classroom system, and the available opportunities to learn (OTL) represented by those dimensions. As described in previous chapters, OTL are conceived as the intersections between access to scientific content and discourse practices and access to (positional) identities (see Figure 1). Using a CHAT heuristic, I consider how in a science classroom, the professor made space for particular activities and ways of orienting to the collective object of science learning. In exploring the day-to-day talk and routines organized by Dr. Farrell across the course, I describe three themes that emerged from the analysis of the activity system: 1) collaboration as the “new” normal; 2) the encouraging of ethico-moral perspectives on scientific activity; and 3) making visible the invisible constraints on the classroom. CHAT and the triangle heuristic are useful, theoretical constructs for systematically understanding and explaining about what counts as learning in the activity system, relative to the teacher’s formulations of science learning, which influences how students make meaning of others’ actions, available OTL, and the resulting ideologies that form in the activity system.

This chapter involves the ethnographic study of the science classroom over its entire course trajectory to identify broad patterns of participation, and what counts as knowledge within and across these events. These ways of interacting and communicating are often invisible to members (Tuyay et al., 1995). By identifying these classroom practices and the formalisms of the scientific community, I aim to make the familiar strange – to make visible the social and academic demands for participating and becoming recognized as scientifically competent. Thus,
by considering the emergent interactional patterns, times, and spaces through which students and teachers participated in common tasks, I situate the classroom as embedded in various macro-level sociocultural, political, and economic forces (e.g., different temporal structures, university policies). I make tentative observations about how the micro-level classroom interactions may function as local openings to invoke and sometimes replicate social and power relations in society. This will also be further explored in Chapters 5 and 6. Hence, this chapter examines the first sub-research question: What is the range of OTL represented by particular dimensions of the Kinesiology classroom system?

In addition, I was interested in this course, *Ethics and Power in Kinesiology*, because it diverged from more traditional university science classes, in that canonical scientific knowledge and practices were problematized; students often worked in groups; and ethico-moral ways of being were foregrounded. As stated in the previous chapter, my study draws on critical microethnographic methods. In this view, I foreground the daily classroom interactions and scientific discourse to demonstrate how a classroom activity system was developed and how Dr. Farrell framed a particular notion of science learning. While these routines set up “followable norms” due to their reoccurrence and source of authorization, this conception of science learning was by no means deterministic, as it was also shaped by student agency and what they interactionally acknowledged as valid contributions (Anderson, 2009; Kelly et al., 2001). In other words, students do not learn in a vacuum; their actions are read, recognized, and made meaningful against a collectively defined activity. Thus, a microethnographic analysis is appropriate for my research because the methods: 1) illustrate an ethnographic picture of the Kinesiology course; 2) describe how scientific competence was co-constructed by members
through their interactions; and 3) address the problematic divide between individual and collective learning that is usually ignored or rendered invisible (Roth, 2009).

As stated above, I perceive OTL as the intersections between access to scientific content and discourse practices (e.g., explaining ideas, justifying arguments with evidence, appropriately applying formal scientific theories and terminologies, Greeno, 2006; Wildy & Wallace, 1995) and access to (positional) identities as knowers and doers (Esmonde, 2009b; Gresalfi, 2009) of science. Learning science therefore requires more than just introducing students to the valued discourses of the community; it evokes concurrent changes to whom students “become” through access to conceptual, epistemological, and identity development (Costa, 1995; Lave & Wenger, 1991). As students begin to participate in a community, they also start to take on an “identity kit” as members in the aforementioned group (Gee, 1990, 1999). However, the process of negotiating successful scientific identities and what it means to “do science” does not happen in one moment, or just in one way. This suggests a dialectical construction of scientific competence between more powerful “historically and culturally constituted forms of thinking” (Radford & Roth, 2011, p. 237), and the students’ local participation and uptake of available OTL. Thus, in this study, I examine “the development of an individual in relation to the immediate environment, and the way in which this relation is mediated by forces emanating from more remote regions in the larger physical and social milieu” (Bronfenbrenner, 1979 as cited in Esmonde, 2009b, p. 1009).

Using CHAT’s triangle heuristic, I demonstrate how the individual dimensions: subject, tools, object ↔ outcome, rules, community, and division of labour, within the activity system functioned as both content and context for learning (see Figure 2, Fitch et al., 2004). I argue the
individual dimensions are important to examine, because they ostensibly are organized
synergistically toward the collective object of the course (i.e., science learning) in different ways.

To investigate the range of available OTL in the Kinesiology classroom, I first describe
how Dr. Farrell organized their lessons, activities, and spoke about the course content. The
coherence of the available OTL in the lessons was characterized in terms of their source (e.g.,
teacher, peers, activity, tools), forcefulness, defined as “the imperative a student was likely to
feel to comply” (Gresalfi, 2009), and how well the opportunities aligned with other mediators of
learning and participation (e.g., language used, body orientation, group work practices,
assessment, university policies, Anderson, 2009). This chapter is interesting, because it affords a
broader view of a science classroom, and in particular, the teacher’s formulations of the goals
and expectations for activities. By describing how aspects of the activity system are co-
constituted, I also recognize these dimensions’ boundaries are blurry. For example, what I
describe as the ‘rules’ for the curriculum also may be interpreted as the participants’ roles and
responsibilities with respect to the ‘division of labour.’ Therefore, I acknowledge that there is
some slippage in what delineates the dimensions.

By describing the range of OTL to which students had access, I set the stage for
understanding the activity system’s parameters for defining scientific competency, and thus what
kinds of student actions and identities are possible, recognized, and as a result, likely to occur.
For example, a heavily teacher-directed classroom would tend not to afford opportunities for
student collaboration and practice using epistemic language. This chapter also highlights the
classroom as local openings toward the co-construction of knowledge and conflict in scientific
discussions that will further be discussed in Chapter 5 and 6.
Characteristics of the Kinesiology Classroom Activity System

In this section, I use CHAT to analyze how Dr. Farrell made space for learning science in the classroom. The classroom system’s collective object, which I termed ‘science learning’ (for brevity purposes), was shaped by the different dimensions of activity, constructing a particular relationship between the students and “Science” (the field), and between students and scientific knowledge. Then I discuss the implications for such relationships on how students made meaning of particular actions.

Using the heuristic of the activity triangle, I demonstrate the ways that the professor talked about science and structured classroom activities:

a) [Object]: a gradual “process of becoming” an ethically conscious and critical individual;

b) [Rules]: codes of interaction, academic behaviour and policies, determined by the teacher and university;

c) [Tools]: social and textual learning artifacts, mainly determined by the formal curriculum and used by the students to facilitate learning;

d) [Community]: participants in the activity system made up of a group of people with different agendas and positionalities; and

e) [Division of labour]: social interactions and structures that place members of an activity system in different roles and responsibilities, most notably seen in participation structures.

In the figure below, the subject refers to the individual(s) at the focus of the study, and community as the participating members who share the same general object. These above-mentioned dimensions are rather self-explanatory and remain relatively stable over time, that is, throughout the course’s trajectory. These dimensions are largely out of the teacher’s control. Thus, for the remainder of this chapter, I focus mainly on the dynamic dimensions of object,
rules, tool manipulation, and division of labour in the classroom that are often largely determined by the teacher.

**Figure 6.** Adaptation of the second-generation CHAT “activity triangle” heuristic for the analysis of the Kinesiology classroom system.

I artificially tease apart each of these dimensions to surface the multiple moving parts in the classroom (though they were co-constitutive, Roth, 2009; Roth & Lee, 2007), and then illustrate how they were stitched together to construct a particular notion of science learning that brings into focus considerations of ethics and power. The activity triangle situates my analysis within the CHAT framework; as well, the diagram identifies and conceptualizes the relationships between different classroom processes (human and non-human) that are emphasized in critical microethnography (Bloom et al., 2005; Giddings, 2009).
Across these three analytic chapters, I gesture toward a better understanding of how science learning and identities are mediated by classroom interactions, test scores, social alliances, and a variety of other factors that cross micro-, meso-, and the macro-scales of social life (Anderson, 2009; Bloome & Egan-Robertson, 1993). In Chapters 5 and 6, I foreground positioning theory for showing how students from different locations experience social practices differently. The dimensions of the activity system are of a different ontological grain size than the focal students’ specific acts of positioning that I will later explore. A conflation of a student’s single action and their membership as a kind of student is therefore problematic. As Bloome et al. (2005) asserts, it is not a matter of posing the “micro” against the “macro,” rather I suggest it is the work that is done in the in-between – in considering the constitutive relationships between various dimensions of the classroom systems and the meanings that participants build – that constitutes learning.

Science Learning as a “Process of Becoming” Ethical | Object of the Kinesiology Classroom

As the instructor of the Kinesiology course and a critical scholar, Dr. Farrell was automatically in a position of power. They were part of the “legitimate” scientific community, and as a teacher, was the most influential individual in generating the kinds of opportunities students had access to and constructing what “successful” science learning looks like (Amit & Fried, 2005; Moje, 1995). I look to the course content and the teacher’s discourse practices for evidence of the collective object. I draw on Dr. Farrell’s comments made during lessons and examples from the classroom artifacts, such as the course website and syllabus for their ability to speak to the teacher’s formulations of science learning. In addition, I look at the source of OTL (e.g., teachers, peers) and the forcefulness of a particular OTL (i.e., the extent to which an individual might feel compelled to take up the opportunity) for indications of how the formal
curriculum was enacted. That is, although there was a predefined set of curricular goals, which included an emphasis on “applying critical theoretical concepts to ethical dilemmas in sport, kinesiology, physical education, and health” (syllabus, 2016, p. 5), the collective objective was also mediated by several other forces: the professor’s language use, meso-level factors such as pre-existing relationships between students, students’ ontogenic experiences with schooling and perceptions of their scientific abilities, and macro-level dimensions such as the cultural organization of the university including its policies and timelines (Leander, 2004; Roth, 1999; Roth et al., 2008), and the students’ different intellectual and social locations (discussed in Chapters 5 and 6).

Formal curriculum. The course under study was entitled, *Ethics and Power in Kinesiology*, and explicitly centred around themes of social justice, power, and equity in science education. The course was unique in that it challenged the grand but implicit narrative of scientific objectivity and value-free knowledge (Deng & Luke, 2008; Lemke, 1990; Ochs et al., 1996), and integrated topics such as ethics and morals, power dynamics, racism, sexism, etc., into discussions about scientific activity. The course’s objectives were:

1) To introduce students to scholarship on a selected range of scholarship on ethical thinking in social life and physical cultural studies and apply critical theoretical concepts to ethical dilemmas in sport, kinesiology, physical education and health broadly defined;

2) To assist students in their examination of (a) the importance of reflective and nonjudgmental communication, (b) the necessity of resisting domination, and (c) the creation of new, alternative ethical relationships that may assist students in future ethical dilemmas;

3) To provoke students to engage in an ethics of questioning that pays attention to the ways in which individuals are historically, culturally and socially produced as ethical subjects; and
4) To promote a ‘new ethics of care’ and an ethics of self in social life that considers democracy as crucial to the fields of sport, kinesiology, physical education and health, as well as the cultivation of responsible, socially just and hybrid thinking (syllabus, 2016, p. 5).

The course objectives aligned with Engeström’s (1999, 2007) idea of expansive learning (externalization), that is, the creation of new artifacts and forms of activities that expand beyond the limits of traditional school learning. Throughout the lessons, Dr. Farrell attempted to draw connections between the course content and social life by “promoting a new ethics of care and an ethics of self … that considers democracy as crucial to the fields of sport, kinesiology, physical education, and health, as well as the cultivation of responsible, socially just, and hybrid thinking” (2016, p. 5). Put in another way, the teacher re-framed “the normal in [science] classrooms” (Simon & Campano, 2012, p. 23) by challenging and problematizing the very content typically presented in such classrooms.

Opportunities to engage with an “ethical” science. As I previously submitted, the collective object of the Kinesiology course was science learning but presented in such a way for students to engage in “ethical dilemmas in sport, kinesiology, physical education, health and medical sciences” (syllabus, 2016, p. 1). Part of this meant introducing students to a range of critical scholars and philosophers in the field of physical cultural studies. In a space that often reproduces the dominant Eurowestern practices and foregrounds academic achievements, Dr. Farrell was explicit about the racialized histories of science and the populations of people who have historically been “pushed out of” postsecondary institutions or had their contributions erased, amidst histories of socioeconomic inequities, racism, sexism (and so forth, Dei, 2008; Dei et al., 1995). I now introduce some excerpts, where considerations of ethico-moral dimensions within scientific topics were evident in the teacher’s discourse.
Excerpt 1 is taken from a lecture entitled *Ethical Ecologies*, in which the class discussed the historical impacts of land invasion and disease on the Indigenous peoples in North America, to which Dr. Farrell argued, disrupted their sense of belonging and place:

Much of the land that [the school] sits on … This is all Indigenous land. In terms of the kinds of reparations that are beginning to happen, it’s important to pay attention to those – how they affect … access to education, health and personal activity. I know [the school] is trying to increase its um, knowledge of [this], but also opening transition programs for Aboriginal indigenous youth who have historically not been able to make it to university in large numbers and succeed in ways that other students have. These are all policy initiatives and things that are happening right now (05/25/16).

In the above excerpt, Dr. Farrell addressed issues of government and institutional responsibility, examining what schools do (or do not do) to support the academic achievement of Indigenous students. They then connected that idea to notions of public health and higher education – topics with which the larger Kinesiology program was concerned. In addition to the lecture, the class was assigned a reading, “Nineteenth century Canada: Indigenous place of disease” (1998) by Nancy Hudson-Rodd. As part of their formal assessment, a student group also did a presentation about the governmental control of space and place of First Nations peoples and discussed the health implications of a person’s losing connection to their lands. The teacher explicitly described their rationale for including Aboriginal perspectives into the curriculum to the class:

It is important [for us] to get us thinking about Aboriginal and Indigenous issues, whether it is from an educational perspective or an ethical perspective, because I think it’s not often at the forefront of our teaching and curriculum (05/25/16).
Through required readings and assignments, Dr. Farrell integrated such sociohistorical and potentially controversial topics into the formal curriculum. The teacher attempted to connect the academic content with the students’ local experiences by referring to the university they were currently attending in its historical complicity of land invasion, as well provided opportunities for students to apply this knowledge in classroom activities, such as exams, small group work, and whole-class discussions.

Next, in Excerpt 2, Dr. Farrell discussed environmentalism and climate change – another potentially controversial topic. They connected the topic to students’ everyday experiential experiences with nature (Aikenhead, 2006; Jagger, 2014) as well as their potential future roles as social and academic leaders. The course’s objectives presupposed that the graduates of the Kinesiology program “who pursue careers in the broad fields of kinesiology, physical education and health – teaching, fitness and lifestyle counselling, coaching, medicine, rehabilitation sciences or research – will be in a position of social responsibility and leadership in society” (syllabus, 2016, p. 1):

For the same reason why I think it’s important to think ethically about our role [with animals]. I think the same for as we move forward, climate change and the environment. You’ll hear from Žižek who says that when we look outside, you see the birds and you see the trees, but you don’t see automatically think about climate change, but this is a part of our world. It’s certainly a part of yours. It’s a part of my child’s world for many years to come. So, I think it’s really important that we have these discussions and you know, prompts our thinking around what it means to think about the environment as a kinesiologist, as a health educator, teacher, um … it also means thinking about other
people’s relationships to the land, and that’s why I have that reading by Hudson-Rodd (05/25/16).

From the above excerpt, Dr. Farrell appeared to do two things – first, they appealed to the students’ “social, motivational, and affective influences” of engagement (Gresalfi, 2009). Radford and Roth (2011) calls this phenomenon “togethering,” which accounts for the ethical commitment participants make to engage in and produce joint activity, despite cognitive, emotional, and other differences. In Excerpt 2, science learning is presented as an endeavour that spans collective thought and consciousness, that is, that the aesthetic appreciation of nature and concern for our future with respect to the environment is and should be a global affair.

As Kress (1989) points out, a kind of discourse provides a set of possible statements about a given area and organizes the way a particular topic is to be talked about. Thus, I argue that talking about learning science can be a way to foster identification and solidarity with the content and discourse practices (Moje, 1995, 1997). By focusing students’ attention to daily experiences with nature, and how and why developing ethical-moral considerations with regard to scientific activity is relevant for people from different career paths, Dr. Farrell drew on multiple entry points that could engender identification with potentially controversial socioscientific topics.

Next, the teacher seemed to recognize that different jobs would operationalize the scientific field differently, thus framing science as an endeavour that can encompass a variety of perspectives, depending on the agendas and positioning(s) of an individual. “Togethering” does not just refer to any type of collective activity, Radford & Roth (2010) uses the concept to illustrate the coordination of multiple perspectives directed to a common ethical commitment. By situating science learning as a “joint” endeavour but with potential for having different meanings
to different kinds of people, Dr. Farrell made space for students to think about expanded, alternative relationships with science from different vantage points.

In Except 3, during a lesson about the production of [scientific] knowledge, Dr. Farrell again used the university as an example in how its social and economic constructs circumscribed some of the ways in which teachers taught and what students learned. They stated that students often function as “clients [for] a corporation,” which can shape how teachers and students think about and value particular kinds of engagements and knowledge. According to Dr. Farrell, with respect to the Kinesiology program in particular, learning then becomes couched in more pragmatic terms of “what do I need, and [how do I] get exactly what I need for the career that I want” (05/11/16). The teacher framed university practices as influenced by neoliberal principles, which in turn, are driven by new political economies. In other words, the micro-level student experiences of science learning are coextensive with dominant social practices, made material by a capitalist context (Deng & Luke, 2008; Simon & Campano, 2013). While Dr. Farrell was a professor, they also identified as someone who was critical of some of the institution’s practices:

We – I wouldn’t say ‘we,’ but the structure of higher education sets you up, because you are regarded not only as students, but as clients […] But what I’m going to say is … the university now as a neoliberal institution, as a corporation, etc., the university is as much to blame for this as any individual student (05/11/16).

By opening up conversations and texts surrounding scientific activity and formal schooling, Dr. Farrell encouraged the deconstruction of scientific discourse. Jagger (2014) calls deconstruction an ethical action, as it requires humility and refuses to foreground a particular epistemology as authoritative. The professor took a disapproving stance on how the university can position students as customers, “We – I wouldn’t say ‘we,’ but the structure of higher education sets you
up,” and challenged the ideologies that undergirded much of formal education. Thus, Dr. Farrell reflexively positioned themselves as somewhat of a teacher activist, who worked within and against the educational system (Simon & Campano, 2013).

In a different lecture about bioethics, the professor further discussed the potential implications of power imbalances in scientific endeavours (Excerpt 4):

Doctors’ medical atrocities did not end with the Nazi era. We have so much knowledge based on the abuses of human rights that was actually hidden from us … Not that it’s necessarily covert, but because [the scientists think] it doesn’t really make a difference. And so ‘That’s okay. It’s for the benefit of human kind’ (05/11/16).

In the above excerpt, Dr. Farrell discussed how power dynamics can exacerbate differences in epistemologies and ontologies held by scientists and citizens, resulting in abuses of human rights. They later expanded on this idea within the same lesson by providing a historical case study about a woman named Henrietta Lacks, a Black woman in the 1950s who was diagnosed with cervical cancer. She was treated at John Hopkins hospital, where her cancerous cells were extracted without her consent, and cultured for use in biomedical research. Although the lineage of the cells was known to certain researchers, this information was not disclosed to the Lacks family until 1975. In these two examples, the professor surfaced some of the abuses of scientific endeavours that are often ignored in history, in exchange for a more progressive and benevolent narrative of science.

Dr. Farrell’s explicit verbalizations of the collective object. Next, I turn to Dr. Farrell’s own words to examine their interpretations of the scientific community and how they believed local pedagogical possibilities were shaped by particular macro-level forces. In
Excerpt 5, they discussed the emphasis on “science-ness” in the Kinesiology program, and how the university appeared to conflate ideas of science with legitimacy:

There is an active process to make programs like ours more scientific and hence, more legitimate … This is the kind of era we live in now, where we have produced often a situation in which students are saying ‘This course … is not really useful for me. It’s better that I do Anatomy or Physiology.’ When we get into those types of situations, we devalue certain types of knowledge over others [because it becomes] about, ‘What do I need?’ In other words, what we discover through research and development of teaching is measured against [its] usefulness and practicality (05/11/16).

In the above excerpt, Dr. Farrell explores the institutional pressures that measures science education against an agenda of “usefulness and practicality.” As mentioned before, the course content explicitly foregrounded the university’s neoliberal ideologies as a powerful influencer in the teaching of certain scientific content over others. Similarly, Dr. Farrell emphasized that the objectives of the course was impacted by the program’s ideas of “legitimacy.”

Dr. Farrell talked about science in particular ways that promoted attention to the external sociocultural and economic contexts that influenced what the formal curriculum covered and hence, considered as valuable knowledge. They also provided students the opportunity to think about science as mediated intertextually and intercontextually by various salient texts, historical events, practices, and ideologies (Anderson, 2009), and how all these dimensions interrelate to construct the social milieu of the classroom.

While Dr. Farrell discussed the constraints of the Kinesiology program, in Excerpt 6, they also talked about ways to expand ideas of science learning:
“[It’s about] doing the kinds of work and getting the kinds of people and bodies into faculties like ours that really change it. The curriculum committee is looking at how to put equity through our curriculum in courses that are in the sciences and biomechanics, etc. […] First step, I guess, is recognition. The other thing is changing people’s minds. [You start] with courses like this. Not every Physical Cultural Studies course do we talk about this. I’m not apologizing for talking about difference and normalcy … We don’t even have anything about sexuality or gender in this course. That’s something I have to obviously change as well” (05/26/16).

Here, the professor appeared to encourage a transformative understanding of science (Ritchie, 2001), in which participants are self-aware, self-critical, and attempt change. Using themselves and the course as an example, Dr. Farrell critiqued parts of the course’s content. However, they worked within and against the institution by taking part in the Kinesiology program’s equity committee in an attempt to create a more inclusive science curriculum. These actions may be understood as “counter-practices” (Simon & Campano, 2013; Simon, Campano, Broderick, & Pantoja, 2012) that are grounded in resistant pedagogies. In this respect, the teacher, in concert with the equity committee, potentially began to create sites of activism within the school that endeavour to facilitate changes at the macro- (e.g., school), meso- (e.g., curriculum) and at the micro “changing minds”-level.

In the last lecture (Excerpt 7), Dr. Farrell’s closing statement emphatically re-stated the collective object of the course:

What kind of ethical person are you going to be? … Sometimes when you stick your neck, you’re going to get a little hurt sometimes. But what kinds of fury do you have; what kind of tools do you have now … to challenge and transgress the status quo, but you
have to remain feasible, right? I hope you bring some of these [course’s] ideas and start stepping on a few toes in the future. Good luck! (05/27/16)

With science in particular, its epistemological and ontological underpinnings are often not made explicit. Science learning in this classroom system, however, was framed as an explicit process of becoming an ethical participant in the scientific community, developing the tools for fuller participation in said community, and questioning inequitable power relations. Throughout the course, the teacher did not downplay the importance of learning the course content and discourse practices. They acknowledged the sociocultural importance of getting high marks and taking “useful” courses in Kinesiology. Concurrently, they also highlighted the interrelations of powerful social structures and formal assessments that influence why certain knowledges are valued over others, and how teachers and students come to define scientific competence. As “school science sits with school culture,” (Wildy & Wallace, 1995, p. 154) Dr. Farrell attended to the ways that institutional ideologies work to shape what the course counted as knowledge.

Summary. By talking about science – the domain’s historical uses and abuses of power within the scientific domain and highlighting the exclusion and erasure of particular voices in the dominant narrative – the professor emphasized aspects of science learning that are often neglected in more canonical literature (Lemke, 2001; Ochs et al., 1996; Oliveira, Akerson, Colak, Pongsanon, & Genel, 2010). As well, their lessons often included considerations of ethico-moral dimensions in scientific activity. As Dr. Farrell discussed in Excerpt 3, some scientists believe the ends of certain experiments justified the means: “[They think] it doesn’t really make a difference. And so ‘That’s okay. It’s for the benefit of human kind.’” Thus, I argue that the professor challenged the traditional view that “scientific discourse represents [solely]
matters of fact” (Ochs et al., 1996, p. 329), and made space for discussing different epistemologies and ontologies, and what is considered morally just in scientific practice.

Through these excerpts, I explore how Dr. Farrell represented the scientific domain in the classroom, first, as not limited to any one culture or narrative, and second, as a power-imbued and powerful practice that has historically been used to include some and exclude others. It is my contention that through a carefully curated curriculum and particular language use, the teacher aspired to encourage a broader and more ethically-minded discourse about science education. In the daily lessons, Dr. Farrell provided opportunities for students to access historicized narratives of science that are not often promoted in traditional textbooks, to question inequitable policies, and develop greater ethical-moral considerations in the production of scientific knowledge.

“Doing Science” Successfully | Tools of the Kinesiology Classroom

Science education is traditionally described as a universal practice that produces powerful and replicable knowledge about natural phenomena. In the scientific community, the default, however, often belies Eurowestern epistemologies and masculine-coded discourses of objectivity and universality (Brickhouse, 2001; Haraway, 1988; Lemke, 2001, 2011). The patterns found in formal scientific discourse often further reinforce its objective stance by minimizing scientists’ involvement in research papers and textbooks, and presenting concepts as stable, finished bundles of knowledge (Ochs et al., 1996; Oliveira et al., 2010). In this course, however, students were not only tasked to understand a range of “scholarship on ethical thinking in social life and physical cultural studies” but also to engage in identifying and applying critical theoretical concepts to ethical dilemmas in the Kinesiology field (syllabus, 2016, p. 5). The main lecture topics included:
Table 5
Summary table of lesson topics

<table>
<thead>
<tr>
<th>Day</th>
<th>Class Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2</td>
<td><em>Ethics and the Technologies of the Self, Part I and II</em></td>
</tr>
<tr>
<td>3</td>
<td><em>Constraints on Ethical Subjectivity: The Production of Truth/s and Knowledge</em></td>
</tr>
<tr>
<td>4</td>
<td><em>Constraints on Ethical Subjectivity: Meaning and Governing Life</em></td>
</tr>
<tr>
<td>5</td>
<td><em>Constraints on Ethical Subjectivity: Empathy and Non-Human Animals</em></td>
</tr>
<tr>
<td>6</td>
<td><em>Constraints on Ethical Subjectivity: Developing (Global) Citizenship</em></td>
</tr>
<tr>
<td>7</td>
<td><em>Guest speakers</em></td>
</tr>
<tr>
<td>8</td>
<td><em>Constraints on Ethical Subjectivity: Confronting Body Fascisms</em></td>
</tr>
<tr>
<td>9</td>
<td><em>Constraints on Ethical Subjectivity: Politics of Normalization and Other(ing)</em></td>
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<tr>
<td>10</td>
<td><em>Constraints on Ethical Subjectivity: Ethical Ecologies</em></td>
</tr>
<tr>
<td>11</td>
<td><em>Constraints on Ethical Subjectivity: The Production of Truth/s and Knowledge</em></td>
</tr>
<tr>
<td>12</td>
<td><em>Constraints on Ethical Subjectivity: Toward an Ethical Democracy in Kinesiology and Physical Education</em></td>
</tr>
</tbody>
</table>

This *vision* of science (Roberts, 2007) did not reject dominant epistemologies of science; rather it involved expanding the traditional conceptions of the domain to include considerations of ethics and power dynamics. The course content provided opportunities for students to engage with questions about dehumanization, normativity, and knowledge shifts in the scientific domain. Thus, I argue that the objectives of the course were not only about learning science in the traditional sense, but also learning *about* science – what is considered valuable scientific knowledge; who decides; and the boundaries of ethical scientific practices. However, whether what counts as school science in the classroom activity system would qualify as “science” proper under more normative grounds is still under debate (Kelly et al., 1998).

In the next section, I identify several tools that Dr. Farrell selected in framing the educational goals of the course, including the curriculum, the teacher’s pedagogical strategies, and assessment tools. I then considered how they were used to articulate a range of OTL.
**Formal curriculum.** The main design tool for orienting the collective object to science learning in the course was the curriculum proper itself. Even the title of the course, *Ethics and Power in Kinesiology* indicated that it would foreground a critical view of science. Students were exposed to a range of ethical issues regarding scientific knowledge and practices, such as genetic modification and the use of cadavers and animals in laboratories. The course assigned readings from a variety of sources, such as books, journal articles, and current news stories, and drew on comics, YouTube videos, documentaries, and case studies. Therefore, the question presented in the course was not only what constitutes important scientific knowledge (i.e. what will students be tested on), but also who decides and at what cost?

The main text used in the course was a book entitled, *Examined Life: Excursions with Contemporary Thinkers* by Astra Taylor (2009), which included a collection of essays by contemporary philosophers such as Cornel West and Judith Butler, and an accompanying documentary that was viewed in segments throughout different lessons. In addition, students were expected to read 1-2 supplementary journal articles that related to each class’ topic.

**Dr. Farrell’s pedagogical strategies.** In addition to the curriculum, I observed three major patterns of teacher talk. I identified them as: (a) explicit instructions; (b) critical questions about the nature of knowledge; and (c) situating scientific vocabulary. By highlighting Dr. Farrell’s language use, I examine the types of discourse practices that they made space for in the course. Borrowing from Moje’s (1995) study on teacher talk, the assumption is that language use can be controlled (at least to some extent), purposeful, and therefore may serve to engender particular relationships and identification with the course content.
Explicit instructions. As articulated by Dr. Farrell, one of the central responsibilities of a professor is to cover the curriculum and introduce the students to specific concepts, “There’s a certain kind of knowledge that’s valued and that you need to know, and you have to get certain grades for careers.” The course syllabus organized the boundaries of each lesson and how the idealized class would proceed. For example, the syllabus outlined each day’s specific topic and any formal assessments. Dr. Farrell would usually start the class by introducing the daily agenda:

(a) So, I’m going to quickly introduce the lecture, then we’re going to have Group 1 go, and I’m going to talk about the [Brian] Pronger notes, and I want to show a video segment uh, because today is the first day that we’re actually engaging with someone from this book. We’re gonna start with Cornell West (05/11/16).

(b) We went through the concepts of Romanticism fast yesterday. I think we can highlight some of the main points here from yesterday, to summarize the idea of a Romantic program is one that is totalizing and having it all. And again, you will hear this in future lectures (05/12/16).

(c) I want to finish off these slides on the [Elizabeth] Wheatley article, then I want to introduce you to [Avita] Ronell, do a little bit of group work on thinking about similarities, I mean -- differences (if there are) between Ronell, Foucault, and West. Then we’ll have our usual feedback forum, um, then we’ll have a little break, and come back afrash and start on ‘Empathy and Non-Human Animals’ (05/16/16).

Such explicit instructions are described by Sinclair and Coulthard (1975) as focusing moves, as they are meta-statements about the classroom activities. They became part of the daily routine and provided students with the opportunities to prepare for the lesson ahead. While not directly tied to content learning, these were everyday activities which formulated the classroom’s
discourse practices, such as knowing how and when to respond appropriately. As a result of their reoccurrence and authorization by the teacher, such followable norms were related to meso- and macro-level constructs as “the act of studenting rather than the act of learning” (Wallace and Wildy, 2004, p. 649). I contend that these norms provided particular opportunities for participating and constituted an important part of enacting a “good student” identity.

In the next excerpt, Dr. Farrell took up the first quiz of the course, then explicitly discussed strategies on how to “do well” in the follow-up quiz and exam:

Just be aware of some of the main thinking of the Examined Life philosophers … If you had two things you could say about [Cornel] West, what would they be? Two things about [Martha] Nussbaum, that kind of thing. That gives you a touchstone and gets you thinking, gets you connected around the topic of what these theorists are talking about. And then there’ll be some quotes [to respond to]. It could be, ‘Here’s the situation. Plug this particular ethical situation into Foucault’s ethical framework’ … Make sure you’re good on that. It’s for you to demonstrate to me what you know (05/24/16).

Here, Dr. Farrell focused attention to the ways in which students could demonstrate their knowledge of the course content on the upcoming exam. The instructions were precise and explicitly identified the academic concepts such as the names of the prominent philosophers and Foucault’s ethical framework\(^7\), on which students would be tested. Dr. Farrell also provided students with examples of possible exam questions. Thus, the teacher’s feedback suggests that successful communication in scientific discourse requires accuracy and precision, and that using

\(^7\) As defined in the Kinesiology course, Foucault’s ethical framework was based on four elements: ethical substance, mode of subjection, forms of elaboration, and telos, and was described as a process for an individual to construct their ‘ethical selves.’
language in this way would “demonstrate to [them] what you know.” Therefore, students who strove to be recognized as scientifically competent would likely adopt these strategies.

**Asking critical questions.** In a lecture about normalization and society, Dr. Farrell discussed the kinds of relationships that people have with ideas of difference and diversity:

In order to be ethical, we need to have a certain kind of relationship with difference. How we engage with difference is a very important concept in normalization. What constrains our ethical selves? Being ethical means paying attention to what the effect of norms are on people who are left out. *What kind of normative act have you engaged in already today? What positioned you (or not) as part of the norm? ... How have you benefited from the way society is organized, and how [did] that make you make a certain choice today and not others?* That’s the kind of thing to think about. Of course, we’re all positioned differently in society depending on our adherence to normalizing practices (05/24/16).

From my classroom observations, this pattern of talk was commonly seen throughout the lessons. I argue that Dr. Farrell attempted to encourage more critical thought processes in students by presenting the course content as something to be examined, as opposed to something to be transmitted and memorized. The acts of questioning provided the class with opportunities to re-examine ideas that are often taken for granted and consider alternative perspectives. In the above excerpt, Dr. Farrell’s questions brought into focus the students’ (positional) identities and asked them to consider how their positions privileged them and in what ways. This process appeared to have cognitive consequences for some students, as both of the focal participants, Chrissy and Jem, explicitly addressed and/or took up the critical questioning in their interviews with me.
In one of her interviews, Jem discussed how the course topic of genetic modification was reflected in her life as an athlete:

With [high performance sports] being so close to my heart … I think mostly because of the structures surrounding it and how often the athletes are not really looked as people. They’re more like slaves or entertainment for everyone else, or tools for money for larger corporations. I felt a lot of conflict [when I wrote] the paper on technological advancement of the human body. First, I was like, being an athlete, I would want to find a way to be a better athlete by going through this treatment or doing this to becoming less injury-prone. But at the same time, are you taking away your humanity? Are you objectifying your body more than it already is? Who are you marginalizing? Because high performance sport is a question of who has more money. It’s really not fair. These are things I need to be aware of. It’s not just me who’s in this. There’s a lot more going around me (06/13/16).

In the essay Jem wrote about genetic modification and professional athletes, she raised questions about her humanity and issues of body objectification as a Varsity athlete. Jem appeared to adopt critical questioning as a strategy to articulate her ethico-moral concerns in participating in Varsity sports, and her potential complicity in the cultural normalization of steroid use amongst professional athletes. As Roth (2007b) describes:

Participation inherently means adopting and enacting the collective motive and with it the ethical aim it encompasses, its ethos, a term that gives its name to ethics … Participation means acting like others, ‘with and for others’ in an environmental stewardship enacted by the participants in the valley (p. 91).
Thus, if we view the Kinesiology classroom as an activity system in which Dr. Farrell is a representative of the scientific community, and if we agree that individuals can manipulate their language patterns to conform to the group with which they identify, then we acknowledge the potential for teachers to influence their students’ language and thinking (Gee, 1990; Moje, 1995). However, I do not necessarily argue that Jem’s critical questioning reflected a permanent shift in her cognitive processes, or even if these questions were necessarily anything more than her queries vocalized (i.e., thinking aloud) in the interview. I do note that throughout our various interviews, Jem continued to use critical questioning to articulate her feelings on class topics.

In her final statement, Jem addressed her takeaways from the course:

I’ve had to re-think things I’m involved in – my pursuit in high performance sport in pole vaulting. *Am I doing that because it’s my intrinsic desire? Because I love pole vaulting? Or am I doing it because I want the recognition [for] my self-worth?”* (06/13/16).

Again, Jem used critical questioning to express through her emergent questions about her pursuit of high performance sport. Was she doing it because she enjoys pole vaulting? Or was she doing it for the social recognition? It is beyond the scope of my thesis to speculate on Jem’s reasons for participating in high performance sport, nor is it my research focus. My findings indicate that critical questioning was a language pattern observed in the class. I argue that Dr. Farrell used this language pattern to promote a particular way of engaging with the content, that is, to question and deconstruct dominant scientific discourses. Highlighting Jem’s questions as an example, I argue that she took up critical questioning in her assignments and interviews to articulate what it means to participate ethically as a Varsity athlete.
Situating vocabulary. Drawing from the videos and classroom observations, I noted that Dr. Farrell’s talk included a pattern of explicit vocabulary instruction, then re-situating the technical term within an ethical framework. In this way, I reason that they extended the academic conversation beyond mere content reproduction. Using the example of how Dr. Farrell talked about “biopower,” I illustrate how their defining the term and subsequent reflexive talk about language promoted language learning and increased the potential for understanding the conceptual theme of ethical engagement with scientific discourses:

Some assumptions in terms of where we need to start today is thinking about things that we take for granted if we were to talk ethically. Looking at biopower, the body is important in society in terms of how people relate to each other. First of all, you have the word ‘relations,’ which is relations between people. There’s always power in that. Power relations are how are relations between people made into hierarchies, changed because of where people are positioned in society … through no fault of their own. They haven’t had any say into [the] families, cultures they’ve been born into, how they’ve been born, whether they have a disability or not, choices they make as they grow up – [all] very social processes (05/24/16).

Broadly speaking, ‘biopower’ refers to a mode of institutional power or control over citizens’ lives and health processes. The concept often relates to the allotment of medical resources such as vaccinations and access to birth control. In the above example, Dr. Farrell first broke down the word ‘biopower,’ then situated the word within a social practice that involves groups of people and structures that differ in power and access to resources. By emphasizing how a scientific term involves “flesh-and-blood human subjects [that] cannot be reduced to abstract organizations” (Engeström, 2014, p. 78), Dr. Farrell encouraged students to think about...
power relations involved in scientific practices, such as within hospitals and government health care. The teacher’s pattern of talk did not go unnoticed by Chrissy:

[This] is how Dr. Farrell takes an approach to things. Once they put up a slide on a quote, they break down each word to help us understand what the quote means as a whole, which is good. A lot of profs don’t do that. […] I find when you’re in class, ‘This is a mitochondr[on]. This is this. This is this.’ You sit there, and you hear it, but when you go home, you have no idea what they said anymore … When I hear things or when Dr. Farrell teaches things, I feel like I’m on the right path. I’m not looking at things black and white. I’m looking at things from a more holistic perspective (05/13/16).

Dr. Farrell’s pedagogical strategy for teaching new vocabulary examined both the semantics of scientific language and the sociopolitical implications of the concept. For Chrissy, the teacher’s talk appeared to facilitate her learning. In the interview, Chrissy communicated that Dr. Farrell’s strategy was a significant resource for developing a more complex appreciation of scientific terms and their relationship to social practices.

**Summary.** From the outset of the course, the lessons placed emphasis on the role of power and ethics in scientific discourses. Dr. Farrell foregrounded the concept of power and its uneven distribution across different social structures and groups of people. The teacher also acknowledged how these power dynamics can create ethical dilemmas involving inclusion and exclusion of particular groups of people. In addition, Dr. Farrell asserted that the power differences in a scientific community create ways of being and knowing that are not equally available to all people, and may even harm certain individuals (e.g., Henrietta Lacks and her family) and non-human beings in the pursuit of knowledge. Through classroom observations and
repeated viewings of the video data, I identified three pedagogical strategies utilized in their lessons: (a) explicit instruction, (b) critical questioning, and (c) situating vocabulary. I argue that these patterns of talk about science invited students to engage with the course content in various ways, such as deconstructing dominant scientific discourses.

Official and Enacted Rules of the Kinesiology Classroom System
Referring back to CHAT, “rules” constitute a node in the triangle heuristic (Figure 2). I define the “rules” of the classroom system as “codes of interaction” that are influenced by meso- and macro-scale constructs such as the teacher formulations of the course and the structures of formal schooling, respectively. In the following section, I discuss the “official” and the “enacted” rules of the classroom. Through a microethnographic perspective, this aspect of analysis highlights the broader view of classroom constraints that shape the social consequences (e.g. access, rewards) of being recognized as scientifically competent, and hence, influence how students engage with academic content “and what they will ultimately know and be able to do” (Gresalfi, 2009, p. 329).

Official rules. Formal classrooms are special spaces in which one person (the teacher) holds most of the power to shape the learning environment and its activities (Amit & Fried, 2005; Deng & Luke, 2008; Wells, 1999). I chose two excerpts to illustrate the operationalization of the classroom activity system’s rules on two levels, macro- (school) and meso- (classroom). I argue that rules are important dimensions to examine, not only because they are constitutive of the activity system (Engeström, 1987/2015, 2001), but they help to determine the parameters of acceptable and/or scientifically competent behaviour, and thus who is recognized as a legitimate participant (Greeno, 2006; Lave & Wagner, 1991). A rule was classified as “formal” or forceful when non-compliance would most likely result in strict repercussions and/or social
consequences, such as academic dishonesty. That is not to say that these are clear-cut categories, as the institutional norms inform the classroom expectations, and vice versa.

**Course syllabus.** The official rules of the classroom system were laid out in the course syllabus, and further given legitimacy by the university policies. Thus, the official rules operated on two scales: one that detailed university policies on academic behaviour (e.g., missed assignments, plagiarism); and second, which governed the classroom rules of conduct and social expectations such as courtesy and mutual respect (syllabus, 2016). Web links to the university’s governing council, academic policies, and equity statement were outlined, and an outline of escalating steps to reporting discriminatory or harassing behaviour within the classroom was detailed in the syllabus. Students were also given explicit instructions about digital etiquette (e.g., emailing the professor, laptop and cell phone usage in class).

Next, I take a closer look at the course’s formal assessments, as they were powerful supports in facilitating particular OTL, which aligned with formal scientific discourses.

**Formal assessments.** In accordance with the syllabus, the main tools for assessment included two quizzes, a group article presentation and summary, an ‘ethical brief’ essay assignment, and a final exam. The quizzes occurred in the second and third week of classes and were composed of mainly short answer and multiple-choice questions. Each quiz was worth 7.5% of their final mark. The group presentations were worth 15%, and in every class, a different student group presented on an article that was also an assigned reading. The group members were assigned and responsible for providing a brief summary of the article, then uploading it to their Blackboard site. The main sections for the write-up included an important quotation from the article, a rationale for why it resonated with the group, two glossary words, a connection to a philosopher in *Examined Life* (2009), and a point of relevance to Kinesiology (syllabus, 2016).
For the essay, students had the option of choosing from four case studies that involved an ethical dilemma, then tasked with using the assigned readings to unpack the dilemma. The assignment was worth 25% of the final mark. The cumulative exam included two essay questions about the class content and was worth 45%. Both the essay and exam due dates were negotiated with the students. Table 6 summarizes the course’s formal assessment tools.

Table 6
Range of OTL afforded by different kinds of formal assessment

<table>
<thead>
<tr>
<th>Assessment Tools</th>
<th>Available OTL</th>
<th>Main Source(s) of OTL</th>
</tr>
</thead>
</table>
| Quiz (2 x 7.5% of final grade)          | • Demonstrating content knowledge in a set amount of time
                                                  • Internalization (e.g. memorization of knowledge pre-set in curriculum) | Teacher               |
| Group article presentation and summary  | • Written representation of scientific discourse
                                                  • Extracting pertinent information and summarizing
                                                  • Graphical representation of scientific discourse
                                                  • Collaboration
                                                  • Problem-solving
                                                  • Verbal presentation of scientific discourse | Teacher, Peers         |
| Essay (25%)                             | • Written representation of scientific discourse
                                                  • Presenting an argument
                                                  • Justifying claims with evidence
                                                  • Opportunity to integrate personal experiences | Teacher               |
| Final exam (45%)                        | • Demonstrating content knowledge in a set amount of time
                                                  • Internalization (e.g. memorization of knowledge pre-set in curriculum)
                                                  • Written representation of scientific discourse
                                                  • Presenting an argument
                                                  • Justifying claims with evidence
                                                  • Opportunity to integrate personal experiences | Teacher               |

Note: By scientific discourse, I refer to the discourse practices valued in the scientific domain such as understanding and applying scientific conventions, problem solving, and argumentation.

The kinds of formal assessments varied and included different modes of knowledge representation (e.g. graphical, verbal, written, decoding). The assessments shaped the classroom’s daily practices and students’ access to “successful” science identities. Students who
took up these opportunities (i.e., did well on formal assessments) were likely to be positioned as “high-status” students. These assessment tools overlapped with the formal rules and policies of the university, and as such, constituted powerful parts of the academic discourse. For my analysis, these OTL were characterized in terms of their source (i.e., teacher, peers) and forcefulness, defined as the imperative a student would likely feel to comply (Gresalfi, 2009). If students did not comply, it would potentially hinder their access to “successful” identities.

At this point, I take the opportunity to remind the reader of my first sub-research question: What is the range of opportunities to learn represented by the dimensions of the Kinesiology classroom activity system? In this section, I examine the range of available OTL afforded by the teacher’s formulations of various tasks, although Table 6 does not necessarily encompass an exhaustive list of potential OTL, as I did not consider the more nuanced differences between students’ engagement with content at this level of analysis, such as giving up, trying multiple strategies, and moving across discourse. Chapters 5 and 6 present a more focused examination of students’ access to and uptake of OTL.

The formal assessments were important “rules” in mediating the boundaries of acceptable student participation in activities and what counted as scientific competency. However, these formal “rules” were neither deterministic or absolute. As Jordan and Henderson (1995) state, while most events have an externally imposed structure (e.g., from a teacher), video analysis shows a more complex picture of how events are negotiated within local interactions. For example, even though when a quiz begins, and ends has clear delineations, video shows the events are constructed in joint activity in the closing of books, turning over of the quiz paper, etc. In the following section, I look to the meso-level practices of the classroom to examine how the formal curriculum was enacted.
Enacted rules. In the previous section, I examined how Dr. Farrell framed the formal rules of the classroom system, and next, how they were taken up in the classroom (Table 7). Alignment between the official and enacted rules of the classroom was coded as *strong* (i.e., consistent continuity between the teacher’s discourse and actions), *moderate* (i.e., some continuity between the teacher’s discourse and actions), or *low* (i.e., frequent discontinuity between the teacher’s discourse and actions).

Several studies have considered the links between science teachers’ epistemological views about science and their pedagogical practices in the classroom (Apostolou & Koulaidis, 2010; Brickhouse, 1990; McComas et al., 1998; Roehrig & Luft, 2004). As previously mentioned, Dr. Farrell is a critical, feminist scholar who foregrounded the role of power and ethics in scientific content and discourse practices. Their investment in these topics potentially informed what got defined as “successful” participation (or rules) in the science classroom.

However, other studies (e.g., Abd-El-Khalick et al, 1998; Lederman, 2006; Tobin & McRobbie, 1997; Tsai, 2002) paint a more complex relationship between the formal curriculum and what is enacted in the classroom. As Tobin and McRobbie’s (1997) interpretative study of a Grade 11 Chemistry classroom suggests, it is not sufficient to observe the teacher’s behaviours and infer beliefs. The “enacted” curriculum can differ from the science teacher’s espoused beliefs on teaching and learning science and on the nature of science (NOS), by what they view as viable within particular settings. Recall that I previously defined NOS broadly as the values and assumptions inherent in the development of scientific knowledge. Thus, the enacted curriculum can be influenced by a range of mediating factors, such as the intellectual forebears of the scientific community, university academic policies, and time constraints (Leander, 2004; Roth et al., 2008). Drawing from Tsai’s (2002) framework for examining science teachers’
epistemological frameworks, I explored the alignment between the teacher’s purposed beliefs on science teaching, learning and NOS, and the enacted curriculum (the actions of the teacher).
**Table 7**
Alignment between Dr. Farrell’s beliefs about science and the enacted curriculum

<table>
<thead>
<tr>
<th>Excerpt (Teacher’s Talk)</th>
<th>Science Teaching and/or Learning as …</th>
<th>Enacted Curriculum (Teacher’s Actions)</th>
<th>Alignment</th>
</tr>
</thead>
</table>
| A) “Um, I hope that the pace that we’re going is working for everybody. I don’t want to rush too many things. I also want to make sure that people understand things. And in some conversations with people during the break too, what I’m getting is … that [this summer course is] a very different engagement I’m noticing. We do it everyday than when I see it over a [3 month] term.” (05/12/16) | Teaching: pacing, content retention, responsive to student feedback. Learning: interactive, gradual, understanding key concepts.                                                                                                                                                                                                                                           | • 3-week intensive course  
• Due dates of assignments negotiated by class voting  
• Kinds of assessment non-negotiable  
• Issues-based approach to teaching  
• Class time allotted for reviewing quizzes/exams                                                                                                                                                                                                                             | Moderate  |
| B) “It was pretty intense – what you were doing last week ((referring to the content of the lectures)). Some of it goes in. Some of it doesn’t stay in. That’s okay. I’m not going to be y’know, too hard. But if I feel like if we’ve focused on something you should have taken up, then we’ll have to figure it out from there.” (05/16/16) | Teaching: empathetic  
Learning: gradual, interactive, revisionist.                                                                                                                                                                                                                                                                                                                                                                              | • Students encouraged to speak to teacher if they had questions about content or marking  
• Various participation structures  
• Multiple forms of assessment                                                                                                                                                                                                                                                                              | Strong    |
| C) Students are encouraged to develop “a ‘new ethics of care’ and an ethics of self in social life that considers democracy as crucial to the fields of sport, kinesiology, physical education and health, as well as the cultivation of responsible, socially just and hybrid thinking [and] respond intellectually, politically and personally to the proliferation of a broad range of ethical dilemmas” (syllabus, 2016). | Learning: process of becoming “ethical,” change in participation.                                                                                                                                                                                                                                                                                                                                                                 | • Course topics include controversial topics within Kinesiology  
• Teacher admits not knowing some answers and/or areas for improvement in course  
• Invited critical scholars of colour  
• Explicit discussion on power and ethics                                                                                                                                                                                                                                                                                 | Strong    |
I chose the teacher’s excerpts based on how closely they could fit within Tsai’s (2002) analytic categories. By looking closely at Dr. Farrell’s explicit talk about science teaching and learning, I make the assumption that it is possible to interpret an individual’s beliefs through their talk and actions (Erickson, 1986; Oliveira et al., 2010; Sfard, 2008; Silverstein, 1995; 2004), but situate them within the social setting of the Kinesiology course. As Tobin & McRobbie (1997) contend, “studies of action necessarily involve investigations of the goals of participants in a social setting and beliefs that observed behaviours are viable in the contexts in which actions occur” (p. 356). In examining what it means to learn science in the Kinesiology classroom, I argue it is important to examine discontinuities between the teacher’s espoused beliefs and instructional practices to: 1) show how beliefs and actions are “situative” in the sense that they are considered viable in certain contexts (Greeno, 2006); and 2) highlight any conflictual messaging that students may receive.

From a critical microethnographic perspective, I argue that different levels of interactions, authority, ideology, and time shaped the enacted rules of the classroom. Such an “interactional synchronous” analysis surfaces the interactional machinery of the activity system, and illustrates how systems, embedded in particular sociocultural contexts, contribute in defining the parameters of the activity, and what actions are possible and thus, likely (Mehan, 1998). For my study, discontinuities between Dr. Farrell’s talk and actions warrant examination, because they show the contradictions between formal and enacted rules. Thus, they represent what OTL look like “in action,” such as what kinds of discourse practices are actually privileged and the available resources for getting work done in the classroom.
Beliefs about science teaching | Science teaching as flexible and interactive. In the classroom, Dr. Farrell framed “doing science” as a process of development, evaluation, and revision. I identified a moderate alignment between the teacher’s talk about science teaching and their actions. Looking at Excerpt (B), it appeared that the teacher was concerned with lecture pacing and content retention but also expressed an overall willingness to be flexible in their delivery style, “I don’t want to rush too many things.” Throughout the lessons, Dr. Farrell emphasized that engaging in this learning process was challenging and would take some time.

Dr. Farrell also made space for student feedback and recognized the fast pace of the course, “It’s a very different engagement that I’m noticing. We do it everyday than when I see it over a [3 month] term” (Excerpt A). This summer Kinesiology course took place everyday from Monday to Thursday for three weeks, whereas a fall/winter session of the same course would take place weekly over three months. In other words, the teacher explicitly recognized how the condensed schedule may influence how students took up the course content.

However, some aspects of the enacted rules were at odds with the teacher’s teaching beliefs of flexible pacing. Although students had some autonomy in deciding their assignment deadlines through democratic voting, the structure of the university determined the broader time-space configurations for the Kinesiology course, such as when courses began and ended, when grades were due, and the course pace (Leander, 2004; Roth et al., 2008). Due to the time constraints of a summer-intensive course and the university timelines for grades submission, the allotted flexibility for deadlines was limited to a few days difference. While the teacher prefigured the modes of formal assessment for the course, I argue that this rigidity was mediated by the variety of assessment tools (e.g., essay, group work, exams), and thus, gave the students
multiple opportunities to demonstrate their learning through different modes of representation (see Table 6).

**Beliefs about science learning | Science learning as gradual and revisionist.** I argue Dr. Farrell framed learning as an interactional process of meaning-making, rather than as a process of transmission and a catalogue of facts to be memorized, “Some of it goes in. Some of it doesn’t.” (Excerpt B). The professor attempted to mediate anxiety surrounding the dense content and condensed timeframe of the course, “That’s okay. I’m not going to be, y’know, too hard.” In addition, the teacher referenced ongoing check-ins with the students, “If I feel like if we’ve focused on something you should have taken up, then we’ll have to figure it out from there.” Although not necessarily a conscious move, I noticed that the teacher often switched between singular and collective pronouns when talking about the division of labour in the course work and content learning. Grammatical constructions, such as pronoun use, have been studied as ways to engender solidarity between individuals (Fairclough, 1993; Moje, 1995). Thus, I argue that Dr. Farrell’s speech patterns suggest that learning was interactive and co-constructed between the teacher and students.

The professor also attempted to support diverse views and answers in their patterns of talk. For example, in whole-class discussions, Dr. Farrell often encouraged students to speak out in class, restating that “no answer is wrong.” Another strategy included organizing multiple participation structures throughout each lesson, which provided students with varied opportunities to explain their thinking, and practice using the epistemic language with their peers. Finally, the teacher also took an issues-based approach to science learning (Aikenhead, 2006; Hodson, 1999). That is, they attempted to portray science as historical and humanistic endeavour by introducing topical case studies that considered what counts as science, who does
science, and who benefits from it, as well as giving time for students to discuss the topics in group discussions and individually in essay assignments.

Overall, I identified a strong alignment between the teacher’s talk and actions about learning science. Students were encouraged to question and have discussions with the teacher over the content as well as their grades. They were also invited to engage in a variety of participation structures in every lesson. Students therefore had opportunities to participate in different kinds of discourse practices and with different people.

*Nature of science as a power-imbued endeavour with ethical implications.* This course explicitly invited the students to engage differently with the content than in more traditional science courses. Drawing on the syllabus (2016), the main course objective was to encourage students to develop an ethical self that can respond intellectually, politically, and personally to a broad range of ethical dilemmas related to topics in Kinesiology and health sciences. This suggests that Dr. Farrell characterized science learning as not only the cultural reproduction of facts and practices (internalization, Engeström, 1987/2015), but as a “process of becoming” (Lave & Wenger, 1991) an ethical participant in the scientific community.

I identify the alignment between the teacher’s talk about NOS and their actions as strong, because the syllabus aligned with the topics of discussion in the course. Scientific knowledge and claims were deconstructed and situated as historical, human processes and products. Classroom topics often revolved around controversial socioscientific issues, and relevant to the Kinesiology program (e.g., genetic modification, steroid use in sports, animal testing in science laboratories). Issues of power and ethics were weaved in through the readings and lectures, and thus were embedded in the course content (Abd-El-Khalick et al., 1998). Critical, feminist scholars and scholars of colour from other universities were invited in as guest speakers; and
students had the opportunity to engage in conversation with these scholars about a variety of topics including the occupation of Indigenous land and the connections to Indigenous people’s health and access to education, as well as the lack of diverse representation in the faculty of Kinesiology.

**Summary.** In this chapter, I addressed how the range of OTL was co-constituted by the various dimensions of the activity system. Through a CHAT lens, I analyzed the characteristics of the “rules” of the Kinesiology classroom. I argued the formal and enacted rules of the classroom activity system represented the official and “hidden” curriculum of the course (Apple, 1980), because they constructed the parameters of scientific competency and acceptable participation in the classroom, and distributed resources across various activities. First, I briefly described how the formal rules were communicated, (e.g., through university policies, the syllabus, and the professor’s explicit talk). Then I looked for inconsistencies between Dr. Farrell’s espoused beliefs and how the curriculum was enacted. Overall, the enacted curriculum of the Kinesiology classroom supported discussion on topical, socioscientific issues, and allowed for science teaching and learning to take place gradually and be revisited.

From my analysis, the alignment between the teacher’s beliefs and the formal rules of the classroom appeared to range from moderate to high. Aspects of the enacted curriculum were at odds with Dr. Farrell’s talk, such as the teacher’s control over what counted as valuable knowledge (e.g., teacher decides on course content, kinds of assessments). The main inconsistencies tended to stem from the institutional constructs (e.g., university timelines, standardized testing). From a critical microethnographic perspective, these asymmetrical power relations have implications on what and how students were expected to learn, within what time constraints, and what modes of representation were accepted as evidence of their learning.
Access to Diverse Content | Community of the Kinesiology Classroom

I speak briefly on the ‘community’ dimension of the classroom system, as the classroom community was mainly composed of the teacher and the students. However, I want to address the concept of diversity, as endorsed in the course syllabus and in the makeup of the class (Table 1). The assumption is that a wider breadth in the curricular topics affords greater opportunities for students to engage with diverse ideas and alternate relationships to science learning; however, I do not make any claims about students’ uptake of these ideas in this chapter.

In Dr. Farrell’s talk, they explicitly addressed the conscious inclusion of diverse social identities and epistemologies, “Not every Physical Cultural Studies course do we talk about [equity]. I’m not apologizing for talking about difference and normalcy” (05/26/16). Feminist and critical scholars (e.g., Brickhouse, 1994, 2000; Barton, 2003; Harding, 1988) have argued that women and visible minorities often feel alienated from traditional science education and careers. The domain has traditionally been masculine-coded with its claims to value-free knowledge and objective practices. These patterns persist through postsecondary schooling and jobs in the STEM sector (Abd-El-Khalick et al., 1998; Chen, 2013; Witherspoon et al., 2016).

Dr. Farrell attempted to challenge these patterns by introducing topics that interrogated the normalized production of White male expertise within science spaces. In particular, they referred to Whiteness in the Kinesiology faculty and the normalization of binary types of bodies within gross anatomy courses. Dr. Farrell also acknowledged some of the course’s shortcomings, “We don’t even have anything [explicitly] about sexuality or gender in this course. That’s something I have to obviously change as well,” (05/26/16). As well, they invited critical, feminist scholars and scholars of colour as guest speakers, who had expertise in (but not limited
to) critical sports studies and cultural relevance for Aboriginal youth in physical education. Inviting women scholars and scholars of colour into the class provided opportunities for students to engage in dialogue with experts in the Kinesiology field, and who also diverged from more traditional images of scientists. Students had opportunities to communicate and present ideas to a broader audience who were involved in the Kinesiology-related fields but not directly tied to their academic achievement. As well, the scholars’ presences may serve to engender more diverse visions of scientists and different throughways to participate as legitimate members in the scientific community.

**Summary.** Overall, the community of the classroom involved mainly the teacher and students enrolled in the course. However, multiple guest speakers were also invited in to lead lectures and whole-class discussions, such as Dr. Farrell’s graduate student, Gary, and two scholars whose research interests centred around physical cultural studies. Their academic works were integrated into the formal curriculum, and students were provided with opportunities to engage in sustained conversation with them and their writings.

I argue that the diverse curricular topics and the guest speakers in this course opened up possibilities for students to envision alternative ways of being in conversation with science education. Therefore, the professor framed science learning as not only content for students to reproduce on tests, but as a domain to be problematized and challenged. The science classroom became a potential site for change and social action that according to Dr. Farrell, first begins with “recognition [and] changing minds,” then imbued with new tools, move to enact change and “to step on a few toes,” (05/27/16).
Agency and Accountability in Science Learning | Division of Labour in the Kinesiology Classroom

Finally, I refer to the division of labour within the Kinesiology classroom as one of the dimensions that co-constituted the course’s object of science learning. ‘Division of labour’ refers to the various roles and responsibilities available to the members in the community (Engeström, 1987/2015, 2001). To facilitate analysis of the ways in which Dr. Farrell made space for learning, I argue that it is important to examine the formal curriculum, how the teacher enacted the curriculum through talk and action, and how they structured classroom activities. The major classroom activities involved various participation structures, which differed in the distribution of authority and normative expectations of behaviour and work practices (Greeno, 2006; Pathchen & Smithenry, 2014; Saxe, 2002). In the following section, I look at the characteristics of the different participation structures observed throughout the lessons, and how they provided students with expanded opportunities for participation.

As mentioned before, an individual’s agency refers to the ways in which they act (or refrain from acting), and the way in which their actions contribute to the classroom’s collective activity (Holland et al., 1998; Radford & Roth, 2011). Drawing from Gresalfi and her colleagues’ (2009) understanding of agency, it is important to note that people do not “have” or “lack” it. For my analysis, what was interesting was not that people “acted” (they always do), but the ways in which they were given opportunities to act, which can shift from context to context. In other words, the aim of this chapter is to describe the range of OTL represented by particular dimensions of the activity system and to explicate what kinds of student actions are possible and thus likely to occur.
Next, I consider the idea of accountability – what were students expected to know (content), and to whom they were expected to demonstrate their knowledge (who decides)? Accountability is intricately tied to notions of power, scientific competency, and thus student identity. Who has power to decide what content is worth knowing? And who has power to decide whether one’s argument is convincing? Put another way, the division of labour is concerned with the distribution of OTL and power. In the classroom, Dr. Farrell recognized that they held the most power in determining what constitutes scientific competency, “It’s for you to demonstrate to me what you know” (05/24/16). However, video footage illustrated that the teacher functioned as an important but distant presence in the classroom (Anderson, Holland, & Palincsar, 1997).

By considering agency and accountability within participation structures, I aim to delineate the various opportunities to take up particular roles and/or responsibilities within a particular activity (Esmonde, 2009b; Patchen & Smithenry, 2014). My contention is that Dr. Farrell structured different classroom activities that required particular kinds of social performances across different contexts, and thus, provided students with expanded OTL.

**Participation structures.** I draw upon Patchen & Smithenry’s (2014) conception of participation structures to outline the main classroom activities observed throughout the lessons. The participation structures distributed “the functional aspects of activity” (Greeno, 2006, p.82), such as authority, agency, accountability, and afforded the students different ways to participate and communicate their ideas. From repeated viewings of the video data, I identified participation shifts in teacher authority, instruction strategies, student patterns of interaction, and class time spent on each structure. Four distinct participation structures and their characteristics are summarized in Table 8.
### Table 8

**Participation structures in the Kinesiology classroom**

<table>
<thead>
<tr>
<th>Participation structures</th>
<th>Definition</th>
<th>Agency and accountability</th>
<th>Range of OTL</th>
</tr>
</thead>
</table>
| Lectures                 | Teacher-directed classroom activity in which students mostly participate as individuals; transmissive method of classroom instruction | Teacher as main authority; students usually accountable to teacher to confirm veracity of answers (try to convince the teacher). | - Develop disciplinary agency (internalization)  
- Observing another’s problem-solving strategies |
| Whole-class activities   | Students work together as a class; (e.g., through question and answer, presentations, distributed argumentation, debates) | Students responsible for constructing knowledge as community; include sense-making that is socially interdependent and building upon ideas of others; teacher has epistemic and logistical authority to direct activity. | - Asking questions  
- Argumentation  
- Explaining one’s thinking  
- Critiquing  
- Clarifying ideas and being precise |
| Group work               | Students work closely with a small number of peers to complete tasks, generate questions, etc. | Parameters of task usually determined by teacher; learning as social endeavour; collaborating with and being accountable to peers. | - Maintaining joint attention  
- Collaboration  
- Asking questions  
- Explaining one’s thinking  
- Critiquing  
- Clarifying ideas and being precise |
| “Science Walks” exploratory work | Students explicitly asked to venture outside “official” classroom space to complete task; teacher mostly absent until regrouping; work alone or in groups; few behavioural parameters; independent decision-making and knowledge production. | Student-directed inquiry; students responsible for creating/introducing artifacts and completing task; students responsible for constructing knowledge as community. | - Student-directed inquiry  
- Developing conceptual agency (internalization)  
- Applying procedures  
- Knowledge production (externalization) |

Adapted from Patchen & Smithenry (2014).
Although I attempt to delineate between these four participation structures, some of the activities are not so clearly defined. For example, a classroom discussion can take on the characteristics of a lecture, especially if it is rigidly structured, with most of the questions focused on *disciplinary agency* (evaluative and content-based) and directed to the teacher; or if the teacher tends to call on certain students and ignores others (Pickering, 1995). Another example of ‘fuzzy’ borders is if group work is not “true” collaborative work, with students continually deferring to the teacher, rather than collaborating with their peers.

The focus here, is to look at how Dr. Farrell made space for participation in classroom practices. These activities shaped the ways that individuals were expected to participate and make meanings of particular actions (Gee, 1999; Holland et al., 1998) in different settings. In Table 9, I document the frequency of participation structure occurrences throughout each video recorded lesson. Often the shifts were accompanied by the teacher’s explicit instructions, (e.g. “Now I want you to get into groups,”). In the data corpus, there were a total of 12 class sessions. However, because I introduced myself in the first class and collected the consent forms in the second class, I only included the 10 videotaped sessions in my tabulations. With the video data, I was able to engage in repeated viewings, and identify more precisely the beginnings and ends of the collective activity shifts in each lesson. This is important because it contributes to the accuracy of my tabulation table, rather than just relying on my field notes.
Table 9
*Frequency of participation structures in each videotaped lesson of the Kinesiology course*

<table>
<thead>
<tr>
<th>Class (out of 12)</th>
<th>Lecture</th>
<th>Whole-class discussion</th>
<th>Group work</th>
<th>Exploratory work</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>III (3)</td>
<td></td>
<td></td>
<td>(2)</td>
</tr>
<tr>
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<td>IIII (4)</td>
<td></td>
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<td>(3)</td>
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<td>IIIII (5)</td>
<td>I (1)</td>
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</tr>
<tr>
<td>12</td>
<td>I (1)</td>
<td></td>
<td></td>
<td>(2)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>34</td>
<td>19</td>
<td>14</td>
<td>2</td>
</tr>
</tbody>
</table>

*Note:* Each tally mark corresponds to one occurrence of a participation structure.

The table was intended to create a general overview of the kinds of classroom activities organized in the course, and to determine the frequency of the participation structures throughout the lessons. It is not considered evidence for determining which structures Dr. Farrell may deem as more important or “effective” for science learning, but rather to provide a broad view of the kinds of opportunities to participate in each class.

**Summary.** Holistically, I determined that students were exposed to at least three different participation structures in every class. This suggests that Dr. Farrell framed science learning as requiring multiple ways of engaging with the course material, using different kinds of discourse practices, and with different people. As well, the students shifted between using teachers, peers, and themselves as resources for meaning-making. Patchen and Smithenry (2014) argue the most salient feature of the variations in the structures is the way in which authority is held and shared by the teacher and students. These different participation practices have
important implications for equity, as these classroom activities shape how OTL are distributed in interactions, who may hold epistemic authority, and to whom students are accountable.

Students in this class did not simply engage in teacher-directed lectures. They shared responsibilities, conducted self-directed inquiries, and participated in debates. While the structures do not determine how students interacted with the content or with each other, they provided opportunities for students to learn in different ways (Esmonde, 2009b; Gresalfi et al., 2009). By regularly shifting participation structures in each class, Dr. Farrell created space for students to not only access various discourse practices, but also access to different student identities such as experts, facilitators, discussants, critics, problem-solvers, etc. As well, since these structures were employed everyday, I argue that the professor attempted to normalize these different interactions with different individuals as par for science learning. The daily organization of different participation structures set up opportunities for students to potentially envision learning as encompassing wider action possibilities than just copying notes and memorizing facts (Hodson, 1999; Roth & Lee, 2007).

Without close analysis, however, I cannot determine the nature of the intergroup interactions across these different contexts or “whether students focused on answers, procedures, conceptual explanations; whether all students had the opportunity to explain and ask questions; or whether the interactions were dominated by one or more students” (Esmonde, 2009b, p. 254). Thus, through a critical microethnographic lens, my dissertation conducts analyses on multiple levels. In this chapter, I look at the broader activity-level of the science classroom, and the ways in which particular activities were structured to support and/or constrain different types of OTL, but I make no claims here about whether and how students learned the course content. As Moje (1997) submits, even in a tightly defined common task, the sense of purpose and continuity in the
work are largely constructed by the group members. In Chapters 5 and 6, I explore two case studies of the focal students, Chrissy and Jem; the justifications for the selection and analysis of particular cases will be detailed. I first look at how they navigated conflictual scientific discussions. Then I examine how their participation and acts of positioning shaped their access to and uptake of particular OTL.

**Weaving Together the Strands of Science Learning, CHAT, and Positioning Theory through a Critical Microethnographic Analysis**

Drawing on sociocultural theories of learning, educational research exploring the day-to-day talk by teachers and students of content classrooms made visible the ways that teachers understood NOS and the discourse practices of science, and how students were expected to demonstrate scientific competency (Lemke, 1990; Moje, 1995, 1997; Tobin & McRobbin, 1997). More recently, researchers have turned to student discourse, and emphasized the importance of looking at how students “construct knowledge, negotiate meanings, and participate in [different ways of] communication” (Moschkovich, 2002, p. 190). Learning is therefore conceptualized not only as happening cognitively, but mediated by the intellectual forebears of scientific practices, available classroom resources, language use, and other semiotic representations (Engeström, 2001; Greeno, 2006; Saxe, 1999). The goal of this chapter was to examine how learning was constructed in this science classroom and the conditions under which it occurs. Through a CHAT lens, I examined how Dr. Farrell made space for learning across their formulations of the activity system’s object, tools, rules, and division of labour. I mainly focus on these dimensions because they were the variables that were most under the control of the teacher. The characteristics of the classroom system are summarized in Table 10.
By examining how Dr. Farrell made space for science learning in the classroom, I argue that they framed science as a powerful, human endeavour, rooted in particular sociocultural and disciplinary traditions. Evidence is seen in the teacher’s verbatim formulations of the goals and procedures for classroom activities (e.g., object, rules, tools). In addition, the community and division of labour dimensions of the activity system illustrated the wide range of OTL to which students had access.

Table 10  
*Characteristics of the Kinesiology classroom system’s dimensions*

<table>
<thead>
<tr>
<th>Activity system dimensions</th>
<th>Description of the Kinesiology classroom (activity system)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Object</strong></td>
<td>Developing an ethical framework with regards to socioscientific issues</td>
</tr>
<tr>
<td></td>
<td>• Internalization: “To introduce students to a selected range of scholarship on ethical thinking in social life and physical cultural studies and apply critical theoretical concepts to ethical dilemmas in sport, kinesiology, physical education and health broadly defined”</td>
</tr>
<tr>
<td></td>
<td>• Externalization: To participate in reflexive, critical thinking, promote a new “ethics of care” in social life and fields of Kinesiology and physical education, sports, and medical sciences</td>
</tr>
<tr>
<td><strong>Tools</strong></td>
<td>Formal curriculum</td>
</tr>
<tr>
<td></td>
<td>• E.g., <em>Examined Life</em> (2009) by Astra Taylor, assigned readings, documentary, YouTube clips, comics, PowerPoints, case studies</td>
</tr>
<tr>
<td><strong>Rules</strong></td>
<td>Official</td>
</tr>
<tr>
<td></td>
<td>• Rules determined by university timeline and policies</td>
</tr>
<tr>
<td></td>
<td>Enacted</td>
</tr>
<tr>
<td></td>
<td>• Social rules as flexible, open to negotiation</td>
</tr>
<tr>
<td><strong>Community</strong></td>
<td>Teacher, students, invited critical scholars</td>
</tr>
<tr>
<td><strong>Division of labour</strong></td>
<td>Participation structures</td>
</tr>
<tr>
<td></td>
<td>• Lecture, group work, whole-class discussion, “Science Walks”</td>
</tr>
</tbody>
</table>

For the final section of this chapter, I synthesize my findings by looking at the emergent themes from the organization of the Kinesiology classroom. Then by drawing on critical
microethnographic perspectives, I discuss the implications of my analysis and how it sets up the following two analytic chapters.

**Emergent theme 1: Collaboration as the new “normal” for science learning.** Throughout their lessons, Dr. Farrell used a variety of participation structures. Collaborative work practices (e.g., whole-class discussions, group work) were a regular occurrence in the classroom, and students were afforded various opportunities to engage with the course content and discourse practices – sharing mistakes, listening to others’ ideas, and problem-solving. Students engaged in dialogue with the teacher, their peers, and other scholars. Decisions about assignments and exam deadlines were made collectively through a democratic voting process. Students were encouraged to critique and ask questions about the validity and production of scientific knowledge. Issues of power imbalances and ethical decision-making were embedded in the assigned readings and topics of discussion.

**Emergent theme 2: Encouraging ethico-moral perspectives in science learning.** Dr. Farrell’s efforts to establish a more equitable science classroom was supported by the university’s mission statement, which had a particular focus on social justice, equity, and equal opportunity. As mentioned in Chapter 3, this *Ethics and Power in Kinesiology* course was a required course for all upper-year Kinesiology students, and all students had taken a Physical Cultural Studies course as a prerequisite for this class. Thus, students had at the very least, been exposed to critical theory and socioscientific issues, such as racism and sexism in professional sport and physical education.

Dr. Farrell taught this course for several years, but it was the first time it was offered in the summer session. The teacher explicitly integrated an ethico-moral lens into the curricular
topics. By attending to the learning environment set up by Dr. Farrell, I describe the space they made for learning. A frequent strategy used for creating more equitable conditions in classrooms was to privilege multiple forms of interactional and discourse styles among students (Esmonde & Langer-Osuna, 2011). This was evidenced in the Kinesiology course by the daily use of diverse participation structures and different kinds of assessment. Various skills and ways of contributing to the classroom were recognized (e.g., verbal, written, rote, graphical). When conducting the lessons, the professor modelled different ways that students could interact with the course content, including asking critical questions and re-situating scientific terminology in an ethical framework. They also explicitly identified the ways that the students were expected to participate and make sense of the content, that is, by providing explicit instructions, reviewing exams, and negotiating with the class regarding what counts as an appropriate intellectual contribution.

**Emergent theme 3: Making visible the invisible constraints on the activity system.** In this course, Dr. Farrell explicitly foregrounded issues of power and ethics involved in the production of scientific knowledge and practices. In addition, they made visible the often-neglected but powerful influences on classroom activity, such as university timelines and policies. They made references to the neoliberal ideologies of the university, standardized testing, and the teacher’s accountability to teach to the test. Although they appeared to desire a space for students to discuss and critique socioscientific issues, the teacher also identified the need to teach students the skills by which their academic achievement (and thus scientific competency) will be measured, and the standards to which they were held accountable (Moje & Lewis, 2007). By calling attention to the educational and social structures that mediate learning and discontinuities between the “idealized” learning space and the teacher’s talk and enacted
curriculum, I ground my methodology in the critical microethnographic tradition. That is, my claims are grounded in interaction, and surface how both teachers and students navigated the organizational contexts within which they operate.

**Implications.** What does this broader view of the classroom afford the reader? What do we know now that we did not know before about this Kinesiology course? I argue that a critical microethnographic perspective is a fruitful methodological approach for my research, as it surfaces the professor’s orientation toward aspects of science learning and affords the reader insights into the provided opportunities for students to engage with particular types of problems, tools, and skills within the context of the Kinesiology classroom. As well, there is often a structural mediation to science teaching and learning that is out-of-focus when studying only the classroom level (Roth, 2009). By using the CHAT triangle to frame my classroom-level analysis, I illustrate the cultural-historical influences and deliberate effort in organizing such an activity system and surface how each of the dimensions co-constitutes science learning. Next, I focus on how the teacher chose to develop particular nodes of the system. As Tobin and McRobbie (1997) argue, classroom studies must go beyond observations of behaviour and inferences of associated beliefs by considering the macro- and meso-level organization of the activity system. In other words, how were the parameters of scientific competency in this classroom simultaneously shaped by the various participation structures and Dr. Farrell’s patterns of talk and action; as well, how is science learning influenced by the historical practices of the scientific community and the evaluations standards by which academic achievement is traditionally measured?

The conceptualization of OTL that this chapter draws on, examines how teachers and students construct patterns of everyday classroom life through their face-to-face interactions. For this chapter, I used CHAT to set the stage for understanding these interactional phenomena and
analyzed the range of OTL represented in this activity system. At this level of analysis, I focused on how Dr. Farrell’s framing of science learning and certain activities, set within a classroom context, facilitated and/or hindered particular OTL. I argue that this is important, because my analysis offers a view of the possible ways of knowing and being in the Kinesiology classroom, and thus shaping how students make meaning of particular actions and participate in activities. With a primary focus on curricular structures and materials, the aim of the coarser grain of analysis is to sketch the contours of how scientific competence is envisioned in this activity system, given these relationships to the macro- and meso-levels of the scientific domain.

The synergistic integration of CHAT and positioning theory as my theoretical framework and critical microethnography as my methodology affords a multi-level, ethnographic view of science learning. As Roth and his colleagues (2007) discuss, some critics might be tempted to say that the finding of multi-level influences on science learning is not so much a finding. However, the question remains, why do misalignments between different levels of social organizations (e.g., classroom and university) continue to exist if they are indeed recognized so easily and generally agreed upon to influence teaching and learning? And why do people then not realign these fields to support rather than interfere with student learning? By situating the science classroom as a complex activity system embedded within a particular sociocultural and economic context, my critical microethnographic work points to the distribution of power across different levels of interaction, and how they mediate local learning — limiting learning opportunities when these relationships are not recognized by educators or curriculum designers (Philip, Olivares-Pasillas, & Rocha, 2016; Rubel, Lim, Hall-Wieckert, & Lim, 2016) and enriching them when they are leveraged (Delpit, 1992; Giddings, 2009; Taylor & Hall, 2013).
A critical microethnography is typically concerned with data that is at once personal and opaque – collected in incidental and automated ways from particular activities and contexts within which learners find themselves deeply situated (Greeno, 2006; Lave & Wenger, 1991). This chapter therefore outlines the primary power relationships in the classroom and the contextual framework of activity, on which I hang my subsequent analyses. Recent research suggests these contexts are useful frameworks for noticing and understanding the social and relational aspects involved in how students engage with academic content (Jones & Kahn, 2017; Lysaker & Nie, 2017; Pane & Rocco, 2009). However, this coarser grain of analysis does not provide a complete picture of what is occurring in the science classroom. More specifically, I ask: In what ways do learners’ relationships – relative to the classroom contexts, available tools and discourse practices, and relative to the social relationships from which learning is derived – shape how they engage with and make sense of the course content? And, how might learners’ prior experiences with and relationships to science equip them for particular kinds of formal learning experiences?

In preparation for the next two analytic chapters, I do not contend every student was receptive to the professor’s framing of science, and there were times when students bristled against some of Dr. Farrell’s stances. It is important that we do not subscribe to either smooth transactions of students moving from incompetence to competence nor produce an overly deterministic view of macro-level structures that eschews student agency and strategic improvisation (Bloome & Egan-Robertson, 1993; Goulart & Roth, 2010). Even within grossly asymmetrical power relations, local interactions are important in constructing, recreating, and contesting knowledge and social relationships. One’s agency (in terms of beliefs, goals, talk, and actions) and how a learner chooses to participate are informed by what they perceive as viable or
possible in particular contexts, and what may be viable in one context might not be in another (Tobin & McRobbie, 1997).

An analysis that overlooks the strategic non-participation, displays of resistance, and/or improvisational acts of learners does so at the risk of ignoring the back-and-forth engagement, and the ways that both students and teachers are co-constructors of their social and educational contexts. I argue that in order to better understand issues of equity, there needs to be anticipation of a diverse set of repertoires, epistemologies and ontologies in the classroom, and it is important to acknowledge that students always enact agency (Holland et al., 1998; Gresalfi et al., 2009), regardless if they are recognizable (or “make sense”) to the researcher, teacher, and/or curriculum designers. Within and between activity systems, students constantly position and reposition themselves through assimilation, defiance, and a myriad of ways in between.

Viewed at a more fine-grained level, however, classroom practices illustrate little more than broad patterns of interaction and an idealized version of a particular activity system. That is not to say this chapter is not truthful or is irrelevant to my overall analysis of what it means to learn in this classroom. Greeno (2006) contends “it is virtually meaningless to ask whether someone has learned a particular topic … without taking into account the kind of activity system in which the person’s knowledge is to be evaluated” (p. 80). Rather, in the upcoming chapters, I attempt to show the reflexive interconnections between the coarser and finer grains of analysis and illustrate how events that take place in a different time-space may be generated and evoked in local interactions (Bloome & Egan-Robertson, 1993; Leander, 2004; Mehan, 1998).

For Chapter 5 and 6, I added positioning theory to my analysis, which affords a “zoomed in” view of how students accessed the course content and discourse practices. The upcoming analytic chapters aim to answer the second question of this dissertation, that is, how do learners’
differential experiences of the same context influence the distribution of OTL in intergroup interactions, and what are the consequences for their learning? I argue that access to particular activities and (positional) identities were not equally available to all students and were constantly negotiated by the members of the activity system. Positioning theory offers an additional layer to my critical microethnographic analysis by examining the micro-levels of group work and considering: what kinds of resources arise in interaction; how does a common task lead to differential contexts for learning; how were conflicts and pre-existing relationships mediated in intergroup interactions; and how does dissent potentially provide unique OTL? In the following sections, my analyses investigate how two focal students navigated scientific discussions, and how they accessed and took up particular OTL. My critical microethnography across these chapters invites readers to recast the more normative views about science learning (i.e., whether students are scientifically literate or not) by making a methodological commitment to looking at the shifting relationships across levels of organization, relationships, and people, without abandoning the micro- for the macro-level or vice versa.
Chapter 5
The Case Study of Chrissy

Chapter Overview
In the next two analytic chapters, I examine the case studies of Chrissy and Jem, two upper year students enrolled in the Ethics and Power in Kinesiology course. For each case study, I include two vignettes involving the focal student that I identified as telling cases. As mentioned in Chapter 3, a telling case is a rich data point that emerges from constant comparative data collection and analysis and allows the researcher to limit the scope of the numerous events documented in the activity system. They illuminate the potential mechanisms that influence how the focal participants participated in scientific discussions, as such they are exploratory research pathways rather than confirmatory (Gerring, 2004; Pahl, 2004; Rex, 2001). The case studies direct attention to the sub-research question: Within scientific discussions, how do students’ participation and acts of positioning shape their access to and uptake of particular OTL?

Specifically, I include positioning theory in my theoretical lens to examine how each focal student positioned themselves and each other in conflictual group work. Then I examine how these acts of positioning shaped their access to particular OTL as they participated in an emergent ‘Third Space’ – an ephemeral space of expanded activity in which the activity’s collective object is extended and the activity itself is reorganized, resulting in potentially new learning opportunities (Bhabha, 1994; see also Engeström, 1999; Gutiérrez et al., 1999). I argue that a Third Space can be a virtual space, such as a Google Doc, a material and/or social one, where alternative and/or competing interactive styles and discourses co-exist.

Confictual moments in the scientific discussions were chosen to be further analyzed because: 1) they were brought up in the focal students’ interviews as salient events in classroom
activity; and 2) drawing from CHAT, contradictions are potential sites for learning and
development (Engeström, 1987/2015; Engeström & Sannino, 2010). I describe how Chrissy and
Jem respectively participated in verbal and non-verbal forms of positioning, as they negotiated
different scientific discussions, and illustrate how a common task led to differential contexts for
learning, and how unique OTL arose for the focal participant.

As discussed in previous chapters, the collective object of the Kinesiology course is
science learning, which included learning the course content and applying critical theoretical
concepts to ethical dilemmas in Kinesiology (syllabus, 2016). The explicit integration of ethico-
moral dimensions in science learning is relatively new to the formal curricula and is somewhat
controversial (Gresalfi, 2009; Hodson, 1999; Roth, 2007b). More recent articulations of CHAT
also include these historically neglected aspects of human cognition, but acknowledge further
studies are required to theorize about how these dimensions mediate learning and development
(Engeström & Sannino, 2010; Roth, 2007a, 2009).

The next two chapters make progress in this understanding by allowing "the object [of
science learning] to gain a voice" (Engeström, 2003, p. 308), and I build a finer grained analysis
upward and outward from the participants and events in which they participate. By this, I mean I
foreground the focal students’ actions and voices in my analyses of their experiences of a
particular learning context. Drawing from the interviews and two vignettes, each case study
offers a detailed look at how each focal student managed their participation as they attempted to
accomplish both collective and personal goals in the activity – across different learning contexts
and with different group members. I ask the questions: what are students actually doing in the
classroom, and how are students positioned in daily interactions? From a CHAT perspective, the
object of science learning is an invitation for interpretation and personal sense making (i.e.,
object ↔ outcome) by the “flesh and blood dialogue partners who have their own emotions, moral concerns, wills, and agendas” (Engeström & Sannino, 2010, p. 6). Thus, as I look at the construction of scientific discussions, learning becomes at once, both personal and opaque. In Chapter 4, I was concerned with the idealized version of science learning as presented by the formal curriculum and Dr. Farrell’s formulations of the activity system. In the subsequent analytic chapters, I am concerned with the temporary rearrangements of the activity system – the time-space organization of the shared interactional space, the artifacts being manipulated, and the social organization of the group members (Greeno, 2006). In each case study, I consider the context, resources, and forms of interpersonal engagement available, as they arose out of Chrissy and Jem’s interactions with social others, respectively and how constructions of the common task may have led to different contexts for learning and potentially new OTL.

**Chrissy’s case.** In Chapter 4, I considered how Dr. Farrell made space for science learning through their structuring of various dimensions of the classroom system (e.g., tools, rules, community, division of labour), and how particular configurations of activities afforded particular kinds of engagement with the content matter and interactions with social others. In other words, different classroom practices serve to organize activity (that is, provide norms for preferred ways of thinking and representing knowledge and performing practices), and represent a range of OTL for students. However, while structures within the activity system facilitate and constrain particular discourse practices, they do not determine how individual learning and specific events unfold (Anderson, 2009; Holland et al., 1998). Within a critical microethnographic perspective, I “zoom in” on Chrissy’s case study. Bloome and his colleagues (2005) are critical of analytic approaches that take place too far “above” the events and argue that such approaches tend to bring with them some *a priori* definition of how classroom activity
unfolds. Therefore, I extend the unit of analysis from the activity system to include the subject’s specific actions, and how they are made meaningful against the larger system.

That is not to say that my analysis only focuses on the micro-level interactions. At the end of this chapter, I discuss the implications of the micro-level analyses of Chrissy’s participation within and across two different groups, illustrate the relationship to the coarser grain of analysis of the activity system in Chapter 4, and how these methodological procedures allowed me to represent a more holistic view of science learning in the classroom.

In the next section, I begin by introducing Chrissy, and briefly describe her perspectives on school science, the Kinesiology course, group work, and the identities she associated with science learning, then I follow with the microanalyses of two vignettes of group work involving her. Drawing from CHAT, selected background information was included to situate Chrissy’s actions within the local interactions, and within her own ontogenic development and experiences as a science learner. My assumption is “problems and potentials can only be understood against their own history” (Engeström, 2001, p. 136). In other words, my study draws on an individual-within-context perspective, considering the individual and the context in which the individual is acting as interdependent (Greeno, 2006; Gresalfi, 2009). Thus, I argue Chrissy’s participation in the scientific discussions must be interpreted against her own biographical history as well as the classroom’s norms and practices.

Introducing Chrissy: “This is definitely a fourth-year course.”

Chrissy was a fourth-year Kinesiology student who identified as a Chinese-Filipino-Canadian woman. She described herself as a relatively average student:
I’m very comfortable with the fact that there are people smarter than me. I’m very comfortable with that knowledge. I know I’m not the top-standing student in the class. But I can grasp concepts and I can apply them. [I have] fortes and non-fortes.

She spoke explicitly about the challenges of balancing school with work and building relationships with other students. Chrissy worked as a dancer for the Toronto Raptors as well as a restaurant host. When she first started university, she recalled that she was so busy that she did not have time to get to know her peers, “I would go to class, then literally have to run to go to a Raptors game. It would be like that on a consistent basis. On top of that, I had other dance commitments outside of that. I never really had the time to develop relationships with people.”

Chrissy’s perceptions of schooling and her science identity. Chrissy described her struggles with being an undergraduate student within a large institution, “I remember going into university, ‘I’m going to be a researcher!’ I’m very good at coming up with ideas. I like to question things. But I don’t have the GPA.” She viewed the university’s main objective as “playing games and … filter[ing] us out.” She also spoke about her difficulties with standardized testing, and described grades as a gatekeeper to the future careers she desired:

The thing is that I’m not that good with multiple choice. But I’m also not very good at writing things. So altogether, it’s just a bad combination. I just don’t test well. After every exam, I’m just like ‘Can I just have an oral exam with a professor?’ I’m sure I can explain to you everything I’ve learned this semester instead of what you’ve restricted me to on a piece of paper.

---

8 The Toronto Raptors are a Canadian professional basketball team, based in Toronto, Ontario, Canada.
Chrissy recalled an instance when a professor told her, “Average doesn’t get you into grad school,” which worried her greatly back then, “Do we just drop out of university now? Is there a point of finishing the degree? ... That’s not how you motivate students to achieve better.”

Race and culture were a salient part of Chrissy’s social identity and played a potential gatekeeping role in her choice of formal schooling. She described experiencing everyday racism, growing up in a small town in Ontario as one of the first Asian families in the neighbourhood. She recalled an incident when she was initially denied entry into a French speaking elementary school because French was not her first language, and her parents were not of French or English heritage. Ultimately, she ended up attending that school, and credited it to her mom’s determination, “Probably why I’m here today.”

Chrissy described having a Catholic upbringing and going “through the whole process ... of communion, confession, and confirmation.” She reported conflicts between her religious beliefs and the science content she learned in school, making explicit mention of her grappling with the concept of evolution. At the same time, she recognized the domain of science as:

very debatable. A lot of people affiliate science with things like, being very straight to the point, ‘fact-titious,’ where[as] I feel like the methods of science can be seen in other fields [and concerned with] very broad questions in other areas. … I don’t necessarily think it’s just physics, chemistry, biology. It’s more like what we do everyday and discovering new knowledge. That’s the new science of today.

Chrissy appreciated the well-roundedness of the Kinesiology program, “There is no one core focus. It is very multi-disciplinary. There are so many areas you can touch upon … because
there are so many aspects to science,” which aligned with her more holistic conception of science, as described above.

**Chrissy’s views on the Kinesiology course.** When asked about her thoughts on the *Ethics and Power in Kinesiology* course, Chrissy spoke more about her performance in the class than the content. She described herself as not talking a lot in class, but observed the importance of participation and networking with other students and instructors:

> What they don’t teach you is making those key connections with people. If I knew that sucking up and making myself impressionable to my teacher in my first year, from the get-go would get me places, I would have done so earlier. Now I make myself more available to teachers. I introduce myself in the beginning of the semester of the course. I make sure I ask frequent enough questions, so they know my name.

Chrissy talked about positioning herself as an engaged student by participating in ways recognized by the course and program. When she relayed an anecdote of Dr. Farrell recognizing her at the beginning of the course, Chrissy exclaimed, “Oh my goodness! I did my job! They know my face. They know my name. I’m satisfied with just that, as opposed to ‘You’re just a number.’” Throughout our interviews, Chrissy often talked about the implicit ‘rules of the game’ in university, and perceived networking in the program as vital to garnering recognition and accessing future opportunities in academic research and employment.

Chrissy appreciated that the course took place in her final year. She claimed that she now had the scientific knowledge and language to discuss the ethical dilemmas raised in class. She asserted that she would not have appreciated the course in her earlier undergraduate years:
The vocabulary and concepts are so [dense. And if] you don’t have the skills and knowledge of a university student to think about it in a different way, I would [have] literally seen it at face value, and not want to do all these readings.

For Chrissy, she needed the maturity and foundational knowledge to discuss the socioscientific issues addressed in the course, and "to understand ethics from multiple perspectives, as opposed to [it] being black and white." She claimed that in their first year, students “are still learning about who they are, and ethics is about facing who you are and where you fit in, in the face of structures and marginalization … [This is] definitely a fourth-year course.”

**Chrissy’s views on group work.** Initially, Chrissy was not a strong believer in group work, but after being exposed to the group work throughout the Kinesiology program, she noted that it “really helped my academic trajectory.” She enjoyed how people pushed each other to do better and the multiple perspectives that the structure afforded:

Now that I’m more exposed to it, you guys are sharing ideas and you’re sharing thoughts and knowledge. And that’s so key, period. You need to see other people’s opinions …

You feed on each other’s energy. So, everything’s different. You get a more well-rounded perspective, which is needed.

She went on to describe some of the possible disadvantages of group work, such as when certain individuals dominate the interactions, or “If you have that one person who’s lagging, they get the marks for all the work that you’ve done.” However, Chrissy was quick to reiterate that these negative experiences not only taught her about “different learning styles,” but also how to deal with similar situations outside of school in a “non-aggressive manner.”
Chrissy once again identified the importance of establishing relationships in school and having a diverse group of friends with “high academic status[es], those in the middle, and those [at] the bottom.” Chrissy believed being exposed to different kinds of people was beneficial for her academically, “I can see what the differences [are] in an A paper to a B to a C to a D [paper].” Chrissy added that she believed collaboration benefits all the people involved through the sharing of information and fostering new perspectives.

Next, I move onto describing the two vignettes that involved Chrissy. The following sections highlight the different organizations and expectations of the two scientific discussions, one that included a formal assessment and another that was informal group work. I examine how Chrissy navigated both activities. Then I discuss the kinds of interactions found in these two activities and focus on the potential influence individual knowledge plays in group processes and how conflict potentially provides unique OTL.

Chrissy’s Participation and Acts of Positioning in Vignette 1

Vignette 1: “Different forms of processes for different people.” To examine how knowledge was constructed in intergroup interactions, I analyzed Chrissy’s final interview, in which she was asked to describe an instance of group work that stood out to her. She talked explicitly about the Group Article Review assignment and presentation (worth 15% of their grade), and the conflict that took place. The task involved students working together to write up a summary of an assigned reading and presenting to the class. Students in Chrissy’s group were asked to read the article: “Rendering the Body: The Implicit Lessons of Gross Anatomy” by Brian Pronger (1995), a paper that explores how gross anatomy in university science courses contributes to objectifying attitudes toward the body. The assignment also
required the group to make connections to Foucault’s ethical framework and to the Kinesiology field and define two scientific terms used within the article (syllabus, 2016).

As soon as [Dr. Farrell] assigned it and we figured out who was in [the group], people were like ‘This role, this role, this role. Let me divide my role amongst all of this. Let me be in charge of this, this, this.’ Everyone is self-sufficient in that sense. It’s good in that sense. My group was on top of it in that way […] It was a group of ‘Type A’ personalities who were very on top of things, organized, trying to complete things earlier, so we would have more time for all our other assignments. Then there was that one person holding us back and creating problems.

Chrissy’s narrative centred around the informal roles that the group members took on in the task. She described most of her group members as self-sufficient and quite pragmatic. The other members of the group did not consent to being videotaped or interviewed for my study, so it is important to note that the contradiction was identified by Chrissy’s interpretations of the event only. We do not know how the other students experienced the group work.

But there was one, this one girl [Geena] who was very uneasy about the whole thing, the talking, all of it. She was like, ‘I have ESL. I don’t understand this! This is – I can’t, I’m too nervous!’ But the thing is, this assignment isn’t, it isn’t very, it’s not something worth worrying about … But she was just freaking out. She was panicking the whole time. We had to focus less on the content, and instead more on her anxiety about it.

Through my classroom observations and Chrissy’s interview, Geena was noted as an East Asian, female-presenting individual who identified as an English as a second language (ESL) student. In the interview, Chrissy did not seem particularly irritated by the incident she described. I paid
attention to contextualization cues such as pitch, verbal stresses, and facial expressions. Her facial expressions remained neutral, and she spoke openly about the event. However, I noted her use of the words “creating problems,” “holding us back” and “but.” Borrowing from Engeström and Sannino’s (2011) procedures for preliminarily identifying manifestations of activity-level contradictions, they marked linguistic cues such as “buts” and “nos” as potential instances of conflicts or innovations that may be interactionally masked for some reason. In addition, I noted the division of labour described by Chrissy in the group work, as she appeared to take on the informal role of the facilitator for Geena.

Activity theorists (e.g., Gutiérrez et al., 1999; Radford & Roth, 2011) point out that competing discourses and/or positionalities can sometimes manifest as conflicts in interactions, creating possible ruptures in mutual understanding and/or uncoordinated actions between participants. These contradictions are potential sites for transformative learning and development and aligns with Engeström’s (2014) assertion that learning is ultimately unstable. It is these contradictions and the emergent resources that arise out of engagement with these contradictions that make learning a moving and nebulous target, and potentially contributing to the development of different OTL (Kelly et al., 2001). Thus, I argue that the Chrissy’s narrative and her reported actions to resolve the identified conflict show how dissent can be heard, positioned, and potentially fruitful for some participants, therefore constituting her uptake of particular OTL.

**Chrissy’s engagement in course content and discourse practices.** As Chrissy continued to describe the task, I found further evidence in her narrative that she took up the informal position of the facilitator in the group:
So [Geena] messaged me. We discussed things, ‘What do you understand? What do you not understand? Let me try to clear up the muddy points. You can emphasize the points you do know, the strong points you’re very comfortable, confident about. If anything happens, we can back you up’ […] At this point in our university careers, everyone knows you need to be serious about these matters.

Borrowing from Esmonde (2009b), I use the term facilitator to describe students who orchestrated group activity and fostered broad participation from other members. In an interaction, a facilitator attempts to make sure most or all group members participate in some way. This could take on the form of talking to the students who needed help, assigning tasks, and/or encouraging others to contribute to joint discussion or problem-solving.

As seen in the above quote, Chrissy’s informal position as a facilitator afforded her learning opportunities, such as clarifying ideas, sharing information, and making connections to others’ ideas. She also provided extra support to Geena by working with her outside of class:

At one point, we sat together [and] tried to help her understand the content, but it became more about her anxiety about it. Okay, this is where you see, like, different forms of conversations gear off, like you see with different dynamics of people. ‘Let me know try to calm you down first.’ Different forms of processes for different people … She’s panicking. Clearly, I can’t just jump into the topic with her. I needed to coax her into calming down first, and then we can talk about things openly. If she has any questions, then I can clarify … ‘Let’s get this done. Let’s work together,’ as opposed to earlier years where we had stragglers, I would internalize it and be like, ‘It’s not fair. Oh, they got my mark for my work.’
Note 1: I took Chrissy’s words in the interview “gear off” to mean “diverge from on-task talk.”

Note 2: See Appendix F for transcription conventions.

In Chrissy’s narrative, she scaffolded Geena’s participation in the common task. As well, she paid close attention to Geena’s emotional needs and attended to her questions. Chrissy asked Geena what she understood about the content and clarified any information when necessary. Chrissy also noted Geena’s emotional response toward public speaking, and how it affected the way in which she broached the assignment with Geena, “We had to focus less on the content, and instead more on her anxiety about it.” Geena appeared to position herself as less competent within the group, and thus dialectically positioned others as more competent.⁹ In Chrissy’s narrative, Geena was the one who reached out to her for help. Chrissy ostensibly did not impose her views onto Geena. Rather, the interactional work became a site for talking science, negotiating the task, content, and positions. Through her reported interactions with Geena, Chrissy reframed the conversation from Geena’s anxiety to what Geena already understood about the article/topic. It appeared that Chrissy and Geena took up opportunities to explain their thinking, build on each other’s ideas, and make connections while maintaining a common focus on the task, which distinguishes a facilitating work practice from an expert-novice work practice. Geena’s prior understanding of the content was considered by Chrissy. In an expert-novice work practice, the group members would not engage in discussion, and instead follow the directions of the expert individual.

⁹ To this point, I would like to clarify that I am not making the equivalence that a person who identifies as being an English language learner (ELL) as inherently less competent in any content-related task than one who speaks English as their first language. In Chrissy’s narrative, Geena appears to attribute her anxiety about public speaking with her identity as an ESL student.
My analysis of Chrissy as the informal facilitator in the group was further informed by Chrissy’s reporting of the group’s actions. She used the collective pronoun “we” when talking about Geena, instead of locating herself as the sole helper. Moje (1995, 1997) describe how the first-person pronouns, “we” and “us,” can foster inclusivity between group members. Although I do not argue that Chrissy’s choice of pronouns was particularly deliberate, I notice that she did not use “we” indiscriminately. When speaking about group work practices, she tended to use personal pronouns.

To recall, my second sub-research question examines how students’ participation and acts of positioning shape their access to and uptake of particular OTL in scientific discussions, and I theorize about the consequences for student learning and the distribution of OTL within group work. Chrissy’s focus on collaboration and movement across multiple discourses (from a scientific discourse to a more relational discourse) made the position of facilitator open to her. It is possible that with Chrissy’s explicit preference for oral and non-standard modes of assessment (as indicated by her interviews), she was less interested and/or not used to performing didactic kinds of actions within group work. Instead, she appeared to find ways to participate in discourse practices that involved joint sense-making and problem-solving.

**Learning opportunities accessed by Chrissy’s position as the group facilitator.** In Dr. Farrell’s classroom, emphasis was placed on collaboration and talking science. The professor made time and space in every lesson for students to participate in small group and whole-class discussions about the day’s content (see Table 8). Thus, perhaps not surprisingly, Chrissy felt comfortable helping others in her group, as it was consistent with the teacher’s expectations and daily classroom practices. In addition to the opportunities that Dr. Farrell provided for students to
work together, I argue that Chrissy’s taking up the informal role of the facilitator in her narrative shaped her access to the following OTL:

_Providing explanations_. In her reported interactions with Geena, Chrissy had multiple opportunities to work with her on the academic content, first through the setup of the common task. Students were assigned into groups and expected to work together to produce a summary of their assigned article and present the findings to the class. Next, Geena’s targeted request for Chrissy’s help outside of class interactively positioned Chrissy as a potential expert or facilitator in the group. However, I argue that in Chrissy’s narrative, she constructed her position as a facilitator through her actions. Chrissy offered explanations that were geared toward Geena’s understandings about the content, “What do you understand? What do you not understand? Let me try to clear up the muddy points.” Chrissy’s explanations appeared to be based on listening closely to Geena, rather than a recitation of her own ideas.

_Building on group members’ ideas and establishing mutual understanding_. Chrissy’s description of her actions appeared to centre around getting Geena to articulate her own ideas and building upon them, “If she has any questions, then I can clarify,” thereby affording Chrissy opportunities to build on, correct and/or repair any misunderstandings. Chrissy also emphasized supporting Geena emotionally:

But the thing is, this assignment isn’t – it isn’t very -- it’s not something worth worrying about. If you have questions, we’re here to help [...] Let’s get this done. Let’s work together [...] If anything happens, we’ll back you up.

In Chrissy’s narrative, she seemed to take on some accountability for Geena’s understanding, possibly informed by the expectation that students would engage in daily group discussion together in the course, and/or by the structure of the formal assignment itself (e.g., the sharing of
grades), “which served to make individual comprehension a responsibility of the group” (Gresalfi, 2009, p. 348). The conversations between Chrissy and Geena appeared geared toward mutual understanding and making connections.

Problem solving and moving across different discourses. Finally, the Group Article assignment appeared to encourage students to work together, and in some cases, persevere despite difficulties. Chrissy seemed to exhibit sensitivity to Geena’s negative affective response toward the assignment’s presentation requirement. Her position as the informal facilitator allowed her to accomplish a range of collective and relational goals; she constructed a social context that established a collaborative relationship with Geena, problem solved, and completed the common task. Chrissy described the work experience as “[It’s] different forms of processes for different people … She’s panicking. Clearly, I can’t just jump into the topic with her. I needed to coax her into calming down first.” Not only did Chrissy appear to listen closely to Geena’s feelings and check in with her, she also shifted the activity from “less on the content, [to] instead more on her anxiety about it.” Facilitators orchestrate the group activity and foster broader participation from the group members (Esmonde, 2009b). Chrissy appeared to take up this position, as she described her suggestions for Geena’s participation in the presentation part of the assignment, “You can emphasize the points you do know, the strong points you’re very comfortable, confident about.” While the formal group assignment provided a common set of tasks for the group members, participants within the group also created and negotiated social contexts and OTL not specified in the rubric, such as problem solving, moving across discourses, and establishing relationships.
Connections to CHAT and the Classroom Activity System

For coding the kind of contradiction that emerges from the vignettes, I use the convention, “kind of contradiction ↔ kind of manifestation” and a double headed arrow to emphasize the dialectical nature of contradictions within the activity system (see Table 2). The term ‘contradiction’ refers to the activity-level of analysis, whereas ‘manifestation’ refers to the micro-level of interactions.

I coded Vignette 1 as an example of a primary contradiction ↔ dilemma, because there was an expression of different evaluations/interpretations of the activity (that is, the group assignment) between the group members (community). As mentioned in Chapter 2, I categorized contradictions based on four levels: primary, secondary, tertiary, or quaternary within the activity system (Engeström, 1987/2015). Next, I used Chrissy’s linguistic cues from the interviews to identify the discursive manifestation of the contradiction (e.g., dilemma, conflict, critical conflict, or double bind), which may be invisible in observations of the interaction (Engeström & Sannino, 2011). These two levels of analyses are useful in shifting the analytical gaze from the individual acts of positioning of the focal students to how these specific actions relate to the collective activity system.
### Table 11

Contradiction analysis of Vignette 1

<table>
<thead>
<tr>
<th>Activity level of contradiction</th>
<th>Features of activity contradiction</th>
<th>Discursive manifestation of contradiction</th>
<th>Linguistic cues for manifestation of contradiction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary:</strong> contradiction takes place within one node of the activity system and when differential values are attached to one element within activity</td>
<td>Contradiction takes place within the community node of the activity system, that is, within the members of Chrissy’s group</td>
<td><strong>Dilemma:</strong> expression or exchange of incompatible evaluations, either between people within the discourse of a single person</td>
<td>Geena panicked about presentation, and Chrissy saying, “it’s not something worth worrying about.” Chrissy calling this instance as a “problem” and someone “holding us back.”</td>
</tr>
</tbody>
</table>

(Adapted from Yamagata-Lynch & Haudenschild, 2009; Engeström & Sannino, 2011).

Table 11 is based on my contradiction analysis of Vignette 1 and identifies the ways in which language was used by the focal participant to accomplish a range of collective and personal goals. As well, the table provides details about the multi-level context of the intergroup interactions therein.

From a critical microethnographic perspective, my multi-level analysis affords a look what Chrissy perceived as the conflict within the group, her responses to the problem, and the local constraints within which she worked (e.g., group assignment, time limit, Geena’s anxiety). Then I consider Chrissy’s actions against the collective activity system, how the context shaped the available OTL, and how both interacted to create potentially new OTL that were not necessarily predicted by the teacher’s formulations of the task. In using this analytic method, I attempt to illustrate how the contextual factors of the classroom (and potentially even events outside the system) and the local group activity informed how Chrissy took up particular OTL.

**Summary of vignette 1.** Returning back to the Kinesiology classroom activity system, the collective object of science learning was refracted among the participants as they
engaged in scientific discussions related to the *Group Article* assignment. In other words, Chrissy and Geena showed a difference in the conceptualization of the common task. This difference suggested a need for a closer examination of how members negotiated their participation with each other if the task was to be accomplished.

Using Chrissy’s interview data, I examined how she made meaning of the collective object (object ↔ outcome) through her account of the group work and descriptions of her acts of positioning. As she negotiated her participation in these interactions, Chrissy adopted the position of an informal facilitator, which shaped particular opportunities for her to engage with the course content. As described above, I explained how her position afforded her opportunities to provide explanations to Geena, build on her ideas, problem solve, and move across different discourses.

Dr. Farrell often encouraged discussions between peers and fostered a daily practice of students working together in different participation structures. Chrissy’s account of her interactions with Geena was reminiscent of the instructor’s teaching style. Chrissy supported Geena’s science learning by using check-ins and guiding questions and focused on Geena’s prior understandings of the topic. I reiterate that I do not know Geena’s interpretation of the events or the other group members’, as they were not mentioned in Chrissy’s narrative nor did they consent to being interviewed or videotaped. In my analysis with the available data, Chrissy’s characterization of the group work practices supported a social context that was consistent with Dr. Farrell’s formulations of the daily classroom practices and the formal assessment of the assignment (e.g., writing, summarizing, presenting, see Table 6). In addition, Chrissy took up and reshaped the OTL afforded by the teacher and, through her actions, also co-constructed the
directions of the task and what counted as a common focus in the group (i.e., mediating Geena’s anxiety first).

I am careful not to re-inscribe deficit discourses regarding ELL students. Research (e.g., Delpit, 1988; Gee, 2001; Gutiérrez, 2008) has highlighted how teacher and student negative positioning of non-dominant language learners in content area courses are often normalized and such identities can carry over to other aspects of classroom life and subject matters. I find some evidence of this in Chrissy’s anecdote when she attributed Geena’s anxiety about the assignment being seemingly rooted in Geena’s self-identification as an ESL student. Although it appeared that Geena was the one who made a connection between her anxiety about public speaking to her identity as an ESL student, and thus shaping her positional identity within the group, I do not have the data from Geena to fully support this claim.

In general, there was no class time allotted to the Group Article assignment. As a result, there was no video data available to supplement Vignette 1. However, I analyzed Chrissy’s interviews to show how the group was formed, what OTL became available and were taken up, how conflict was interpreted and positioned in the group, and how Chrissy responded to the conflict. The dissent led to potential re-openings of OTL (Kelly et al., 2001). In Chrissy’s narrative, I observed the differential take up of roles and responsibilities in the group work (division of labour), and the kinds of OTL she took up.

Next, I also identify the point of conflict between Chrissy and Geena, and the construction and consequences for this new phase of activity. I argue that this becomes a Third Space, in which the focus of the common task is reorganized, new action possibilities are negotiated and expanded, and potentially unique OTL are made available to the group members. Specifically, Geena’s anxiety created a rupture in the joint activity, and provided Chrissy with an
opportunity to mediate her emotions and to provide an explanation, “But the thing is, this assignment isn’t – it isn’t very -- it’s not something worth worrying about. If you have questions, we’re here to help.” Chrissy responded to Geena by presenting her own interpretation of the assignment and offering support. Through these actions, she refocused Geena to the common task (joint activity) by creating a social context in which Geena’s prior understandings of the text counted as an intellectual contribution, and Geena was encouraged to share what she knew.

While Chrissy did not “put down” Geena’s feelings, she acknowledged that it created problems in the group. The lack of video data limited the extent of conjectures I can make, but what was visible was that Chrissy appeared to maintain politeness conventions with Geena, showed an awareness of relational discourses, and attempted to foster broad participation from different group members.


Now I move onto Vignette 2, in which I examine with the assistance of video data and focal student interviews, the group work practices of an informal scientific discussion and Chrissy’s acts of positioning therein. In this close microethnographic account, I draw from discourse analysis and consider the contextualization cues (verbal and non-verbal) and turn-taking patterns (Pomerantz & Heritage, 1984; Sidnell, 2006, 2012) to guide my analysis of how participants interacted with one another, chose to participate, and shaped the participation of others. These contextualization cues must be visible within the context of the people involved. In particular, I focus on how Chrissy participated and positioned herself in the scientific discussion, and how her acts of positioning shaped her access to particular OTL.
As Bloome and his colleagues (2005) contend, what people do in interaction is complex, ambiguous, and often indeterminate, and it can involve issues of power, social identity, and broader sociocultural processes that are outside the visible realm. As a result, I supplement my video interactional analysis with Chrissy’s stimulated recall interview (SRI) to interweave my analysis with the focal participant’s experiences and interpretations of the activity. I frame my observations of the group work practices as discursively mediated by meso- and macro-level scales of social life. This mediated critical microethnographic perspective looks beyond the immediate context of each act of positioning for the constructions of kinds of positions, settings, and access to particular OTL that different identities and activities may afford (Anderson, 2009).

Vignette 2: When counterscript isn’t off script. In the following vignette, I illustrate how Chrissy participated and positioned herself within an informal scientific discussion. I identified an emergent Third Space, as she participated in side talk with her group mate, Ning. In doing so, she reorganized the structure of the group activity and extended the collective object of science learning beyond the teacher’s formulations of the task, and potentially opened up new OTL, such as the reorganization of relationships and a shift in who continued to be a contributing member in the interaction. I argue that Chrissy’s actions evoked a secondary contradiction between her tools for learning (side talk) and the “formal” rules of the activity system (to be quiet and listen when the teacher speaks).

Side talk, along with spontaneous movements and interactions, are described by Gutiérrez et al. (1999) as unauthorized ways of participation that can function as mediational tools for productive learning. Such counterscripts are often constructed by students, and in competition with the official discourses of the classroom system. From this description, I focus on: a) how Chrissy navigated her participation in this student-led Third Space; and b) how these
“unsanctioned” interactions gave rise to resources that she drew on to engage in valued scientific discourse practices. Engeström (2014) contends that in a moment of expansive learning, what is learned cannot be known ahead of time, as “learners construct a new object and concept for their collective activity and implement this new object and concept in practice” (p. 74). Thus, I argue that the side talk interactions served as a pedagogical tool that the group members used to shape their activity and take up particular OTL.

**Microanalysis of Vignette 2**

The following analysis of group work is based on 3 min and 45 seconds of video involving the focal student, Chrissy and her group mate, Ning on May 12, 2016. This video segment was selected for closer analysis because 1) it was brought up in the SRI and other interviews by the focal student as an interaction that stood out to her; and 2) it included a sustained, observable contradiction, wherein Chrissy and Ning participated in side talk. The video segment captures the dyad’s movements from a sanctioned small group discussion to friendly side talk. As later analysis shows, this level of affiliation was important at times when Chrissy discussed Ning’s and her relationship in the classroom.

I must foreground that the side talk took place at a volume that my video camera’s external microphone could not record\(^{10}\). However, Chrissy explicitly referred to the content of the talk in her SRI (detailed in the contradiction analysis section) and maintained that the discussion was a continuation of the task at hand, that is, discussion of the ethical implications of using cadavers in science displays and laboratories. Thus, I use her response as evidence of the group’s engagement in the on-task discussion.

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\(^{10}\) Reasons for not attaching a lavalier microphone to the focal students are detailed in Chapter 3.
Context and group members. At this point in the video data, Dr. Farrell just finished a lecture entitled, *Constraints on Ethical Subjectivity: Meaning and Governing Life* and asked the class to get into groups with the people around them. Hence, groups were formed out of proximity, and did not require the students to move from their seats. Chrissy worked with Ning who sat beside her throughout this class (Figure 8). Ning was a vocal participant in the course, and often spoke up in whole-class discussions. Although Chrissy described her relationship to Ning as "not close," they often sat near each other and had similar interests, “We connect because we’re both dancers, so we have that [in] common. We have something to relate about, which makes it more comfortable to talk to her about things.”

The main task. Dr. Farrell gave the following instructions for the activity:

In what ways does the Kinesiology field reproduce the discourse of ‘body as machine?’ Give a couple of examples. We talked about gross anatomy, so try to think of something else. And to what end? Why do we do it? And the second question I want you to discuss with your partner, in what ways does our field reproduce the discourse of the ‘species body?’ So, discuss and then we’ll take some responses. After that we’ll have a break. Okay, talk amongst yourselves (05/12/16).

From Dr. Farrell’s lecture, Foucault (1990) refers to ‘biopower’ as the strategies and mechanisms through which human life processes are managed under regimes of authority and institutions. The scholar asserts that the concept has evolved into two forms: the body as a machine and a ‘species body.’ The idea of the body as machine focuses on personal discipline and optimized performance, and a ‘species body’ is one that is related to the health and reproduction of a population. Topics of discussion surrounding ‘a species body’ usually involve
biological processes such as reproductive rights, life expectancy, and morbidity. Dr. Farrell left the PowerPoint lecture notes up on the class projector (Figure 7), so students had access to the discussion questions. Both students brought their own laptops to class and could access online resources, if necessary. They also had access to their own written notes.

Figure 7. Dr. Farrell's PowerPoint slides on the topic of biopower.

Note: I include the PowerPoint slide as a learning artifact, to which the focal students in Vignette 2 had access, in order to present a more holistic view of the group work context. However, I do not analyze this artifact and the opportunities for learning that it may have afforded in particular, as I did not have visible evidence from the video that the group referred to the slides.
A Researcher’s Narrative of “When Counterscript isn’t Off Script”

Chrissy and Ning sat beside one another throughout the class. Chrissy appeared nervous at the onset of the task. As Dr. Farrell was giving the task instructions, Chrissy turned to Ning, shrugged, and smiled. She fidgeted with her hair and hat, then raised her eyebrows, swung around in her chair, nodded, then laughed as she turned toward Ning (Figure 8-A). I perceive her restlessness as nervousness, and it may have been due to the “newness” of the course and her unfamiliarity with Ning. This is supported in Chrissy’s interviews, when she indicated that they were not friends. As well, this video segment is the first lesson to be recorded, so it is possible that this group work was one of Chrissy and Ning’s first sustained interactions. After a few moments of Chrissy fidgeting, Ning appeared to mirror Chrissy’s behaviour by moving her body around and playing with her cardigan. I also posit that their nervousness may be because of my presence and/or the camera in the classroom, and that they were initially uncomfortable with my videotaping.

Chrissy began by looking at her laptop and repeating the discussion questions. The laptop participated in the construction of the event in two ways: first, the laptop functioned as a transitioning tool from the lecture to the small-group discussion, and her interactions with this pedagogical tool served to move the group activity forward and to prompt the discussion. Chrissy took up the conversational space for 16 seconds, then Ning carried on. Ning spoke on the dangers of carrying out the discourse of ‘body as a machine,’ and offered an example of a desperate and ill patient who may try experimental surgeries: “Isn’t that like when you do experimental surgery? Basically, the doctors who have no idea what they’re doing! I mean in theory, this works?” Chrissy retorted back, “Except you do it [anyway],” as it ostensibly would be the patient’s best chance at surviving. Ning replied, “Exactly!” A series of back and forth
utterances ensued. Throughout the discussion, Chrissy was in constant motion – she swung her chair around, and gesticulated with her hands as she talked, whereas Ning stayed more stationary. Ning often nodded her head and articulated agreement in her verbal turns.

Then the conversation moved onto cadavers and their ethical use in science exhibits and the Kinesiology laboratories. Chrissy discussed the Plastination process, in which bodies are injected with acetone and a polymer solution to preserve the organs and tissues for display (Figure 8-B). She contended, “No one wants that done. No one knows what may or may not happen to [the bodies],” referring to the Body Worlds\textsuperscript{11} (2007) film they watched earlier that day. The documentary described the Plastination process in detail, and illustrated the different ways that cadavers were used in the exhibits.

After 3 minutes and 3 seconds of discussion, Dr. Farrell called for the end of the activity, and Chrissy and Ning gradually oriented their bodies away from each other toward the front of the classroom (where the professor was located) but continued to participate in sustained side talk for 25 seconds. Their voices lowered, and they giggled, but their facial expressions and body movements appeared exaggerated. They made wincing expressions and attempted to make themselves look smaller by hunching their shoulders and closing up their cardigans (Figure 8-D). As they spoke, they stole quick glances at the professor and laughed quietly.

\textsuperscript{11} Body Worlds: The Anatomical Exhibition of Real Human Bodies (2007) is a documentary directed by Dr. Gunther von Hagens about the traveling exhibition of the same name. It aims to provide comprehensive insight into the human anatomy, physiology, and health by viewing real human bodies preserved through Plastination, a process invented by the aforementioned scientist in 1977.
Interactive Positioning

Shared learning artifacts. Chrissy began the discussion by re-reading the discussion questions from her laptop. Although Chrissy did not physically orient the computer screen to Ning, I noted that Ning had differential access to the discussion questions, as they were displayed on the class projector screen in the front of the class (see Figure 7). Ning also had her own laptop opened. I describe the shared interactional space as the common perceptual field between Chrissy and Ning, where they could access learning artifacts or each other’s attention without gross body movements. Throughout their interactions, they did not make use of other learning artifacts. Neither of them looked through their notes or used their computers after the initial reading of the questions.

Non-verbal interactive positioning. Chrissy and Ning sat side by side. When the activity began, they turned to face each other. It was observed that Chrissy took up more physical space than Ning (Figure 8-B, C). Chrissy appeared to gesticulate more and in grander gestures. While Ning also gesticulated, she did not cross into the interactional space, suggesting a more reserved pattern of interaction. Ning more frequently used her talk turns for verbal affirmations, head nods, and questions. When Dr. Farrell called for the activity to end, they gradually oriented their bodies to the front of the classroom. As they participated in side talk, both students giggled more and took up less physical space in their seats. Chrissy slouched forward, and Ning shrugged her shoulders and closed her cardigan (Figure 8-D).
Verbal interactive positioning. Chrissy initiated talk at the beginning of the activity, by first repeating the discussion questions and dominating the conversational floor for the next 16 seconds. This appeared to position Ning with less control over the ideas that got taken up in the discussion. Ning’s intellectual contributions were coded more frequently as
affirmations and questions in her verbal turns, as illustrated in the following excerpt (turn 02, 04, 06). The dyad discussed the ethico-moral implications of displaying cadavers in exhibits:

**Excerpt 7**
[05/16/16, Tape 5, 00:19 – 01:05]

| Turn | Chrissy: Um, even like the “physiological” aspect, and [the scientists] inject, and go right into the muscle like – (**see Figure 8-B**) | [Chrissy uses air quotes when she says ‘physiological’]  
[Chrissy mimics the action of injecting during the Plastination process] |
<table>
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<tbody>
<tr>
<td>02</td>
<td>Ning: Yeah, yeah, yeah.</td>
<td>[Ning nods her head quickly]</td>
</tr>
<tr>
<td>03</td>
<td>Chrissy: You don’t want something like that happening to you, right?</td>
<td>[Chrissy gestures toward Ning with palm facing up and open]</td>
</tr>
<tr>
<td>04</td>
<td>Ning: Right. But is that wrong?</td>
<td>[Ning bobs her head side to side]</td>
</tr>
<tr>
<td>05</td>
<td>Chrissy: I mean, yeah. Is that wrong? It’s insensitive, right?</td>
<td>[Chrissy expresses a slight grimace on her face]</td>
</tr>
<tr>
<td>06</td>
<td>Ning: Yeah.</td>
<td>[Ning nods]</td>
</tr>
<tr>
<td>07</td>
<td>Chrissy: No one wants that done. No one knows what may or may not happen to [the bodies].</td>
<td>[Chrissy gesticulates a lot and her arms crosses into shared interactional space]</td>
</tr>
</tbody>
</table>
| 08   | Ning: And I think the value, once you’re dead – it really depends on how you value you. Like you’re just literally dead. You’re just a piece of furniture, a piece of meat. Like rationally, why does it matter? What does it matter? Is that wrong? – | [Ning looks above Chrissy, then using her hands to frame her head as she says “rationally”]                                             
[Chrissy rests her hand on her cheek and squints, then points toward Ning] |
| 09   | Dr. Farrell: Okay! –                                                                                                             | [Chrissy and Ning stop talking for a few seconds, turn their bodies toward the front of the class, then continue speaking quietly to each other] |

**Note:** See Appendix F for transcription conventions.

In the short excerpt, Chrissy explained the Plastination procedure for cadavers through verbal and gestural actions. In turn 03, she posed a direct question to Ning. Ning responded with another question before offering an explanation. In turn 08, Ning made a potentially controversial statement about human bodies, then qualified her statement, “Is that wrong?”
Overall, it appeared that Chrissy made more frequent declarative statements, whereas Ning responded with more affirmations.

After Dr. Farrell called for the end of the group activity at [Tape 5, 00:59], they asked for thoughts from the discussions. This represented a recognized shift in the collective classroom activity from small group work to whole-class discussion. The teacher’s instructions initially overlapped with the student talk and was coded as a 'bid for a change in practice’ (Dookie, 2015) and marked an official shift in participation structures (from group work to whole-class discussion). I interpreted Dr. Farrell’s move as an explicit enactment of authority as the bid was taken up almost immediately by most of the students, ending the student-led conversations and changing their body orientations to the front of the classroom.

As the dyad navigated through these shifting activities, Chrissy and Ning’s voices decreased in volume, but they continued to speak to each other for 25 seconds. This instance was coded as 'sustained side talk.' The decrease in volume and the rapidness of their talk suggested that they understood their side talk was unsanctioned – a form of counterscript that was not part of the normative practices of a whole-class discussion (Gutiérrez et al., 1999). Once again, due to the lowered volume of the side talk, the audio content could not be recorded. However, in the SRI, Chrissy referred directly to the activity, and indicated that they were continuing their discussion on the topic of ethical treatment of cadavers.

**Chrissy’s Reflexive Positioning**

**Non-verbal reflexive positioning.** As the initiator in the group discussion, Chrissy appeared to take up the position of the leader in the group. She took up more physical space in the conversation and made more frequent declarative statements in her intellectual contributions. Ning was more reserved in her gesturing and articulated more frequent verbal affirmations and
questions during her turns. When Dr. Farrell started speaking, the joint attention of the dyad shifted to the professor, then back to each other. Chrissy turned her body from Ning to face the front of the classroom, where Dr. Farrell stood. As Chrissy and Ning continued to speak to each other in hushed tones, Chrissy giggled and slouched over her desk (see Figure 8-D).

**Verbal reflexive positioning.** Chrissy and Ning engaged in side talk after the group activity ended. Without context, Chrissy appeared to be engaging in off-task behaviour and may be viewed as positioning herself as somewhat defiant. She and Ning were speaking in hushed tones, and they both were giggling. The content of what was said could not be recorded. During the SRI, Chrissy supplemented the major themes of their side talk, and indicated that they were finishing up their conversation. Although side talk in and of itself may be unremarkable and tends to be a regular affordance in classroom practice, I consider this finding interesting, if not significant. I argue that Chrissy’s side talk was an improvised pedagogical tool for her learning. She reframed the task at hand, thereby creating a Third Space that afforded her an extended opportunity to explain her thoughts and make connections.

In the following section, I juxtapose the video data of the side talk and an excerpt from Chrissy’s SRI to situate the context of the contradiction that manifested as a Third Space within and between the classroom activity shifts. The ensuing analysis will make visible the dynamics of Chrissy’s participation within the group work, how it reorganized the group activity, how her actions shaped her access to particular OTL, and subsequently extended the collective object of science learning beyond the teacher’s formulations of the task.
Chrissy’s Perspective: Juxtaposing Analyses of the Interview and Video Data

In Vignette 2, I identify the sustained side talk between the group members as a local manifestation of an activity-level contradiction that arose between the nodes of the activity system (Figure 9): subject (Chrissy), tools (side talk), and rules (norms for participating in activity). As the activity shifted from small group work to whole-class discussion, I identified a pattern of interaction. The students oriented to the purposes of the task, first to each other, then to Dr. Farrell, and finally back to each other in the side talk. These visible dynamics of the group work suggest that the members were working within a set of social norms; as a result, I positioned them as relatively amenable students. In the next sequence of activity, Chrissy and Ning participated in side talk, and shifted their attention back and forth from each other to the teacher. This chain of action led to a reorganization of expert-novice relationships and a shift in who was participating in the collective activity. Throughout this period of dissension, their verbal and non-verbal communication cues indicated they were aware that they were violating the social norms of the classroom activity.
Figure 9. CHAT triangle depiction of Chrissy’s side talk as a secondary contradiction within the classroom activity system.

Note: The red lines delimit the nodes of contradiction within the activity system. The blue lightning shapes represent where the tensions may arise.

As previously mentioned, contradictions are defined as historically-evolving tensions between individual actions and the collective activity system, which are manifested in patterns of talk and behaviour (Engeström, 1987/2015). Vignette 2 was analyzed based on two levels: first by the kind of contradiction within the activity system (e.g., primary, secondary, tertiary, or quaternary), and then by how the contradiction manifested itself through linguistic cues within intergroup interactions.
Table 12
Contradiction analysis of Vignette 2

<table>
<thead>
<tr>
<th>Activity level of contradiction</th>
<th>Features of activity contradiction</th>
<th>Discursive manifestation of contradiction</th>
<th>Linguistic cues for manifestation of contradiction</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Secondary:</em> contradiction takes place between two or more nodes of activity system; occurs when participants encounter a new aspect of an activity, and process of assimilating brings about conflict</td>
<td>The contradiction takes place between the subjects, tools (side talk) and rules (norms for whole-class discussion) of the activity system as the collective activity shifts from one form to another (group work → whole-class discussion)</td>
<td><em>Dilemma:</em> Expression or exchange of incompatible evaluations either between people or within the discourse of a single person; characterize daily thinking and conduct</td>
<td>Chrissy and Ning continued to talk for an extended period of time, even after the activity shifted from group work to whole-class discussion.</td>
</tr>
</tbody>
</table>

(Adapted from Yamagata-Lynch & Haudenschild, 2009; Engeström & Sannino, 2011).

As Table 12 illustrates, I coded the contradiction in Vignette 2 as a *secondary contradiction* ↔ *dilemma*. On the activity level, it was coded as a secondary contradiction, because the analyzed segment demonstrated a shift in participation structures, which in turn shifted the ‘formal’ rules and reshaped how the focal student’s actions could be read. In other words, Chrissy’s side talk with Ning, which was initially acceptable within the group work, became “unsanctioned” as the participation structure shifted to a whole-class discussion.

The local manifestation of the contradiction was coded as a ‘dilemma,’ because the side talk was then interpreted as a “deviation from the normal scripted course of events” (Engeström & Sannino, 2011, p. 372-373) by the researcher and the focal participant herself. Chrissy and Ning spoke at a lowered volume and their nervous bodily cues suggested they understood their behaviour to be unsanctioned against the official discourse of the classroom. In addition, Engeström & Sannino (2011) call for using participants’ linguistic cues as evidence for the manifestations of contradictions. At multiple points in the SRI, Chrissy pointed out the side talk
she observed in the video segment and explained, “And we’re still talking underneath. ‘Let’s just finish what we were saying. Let’s just finish this point. We’re at a good point here.’” Thus, I find sufficient support in both the video and interview data to identify Vignette 2 as a contradiction.

It is interesting to note that although I coded the side talk as a contradiction, this was taken up in class. Dr. Farrell did not reprimand Chrissy and Ning. As previously stated, side talk tends to be a regular affordance in classroom practices, and some informal talk between students is to be expected within classroom activities. I do not know how the teacher interpreted the events, as I did not interview them. There are other possible reasons as to why Dr. Farrell might not have reprimanded them (e.g., large class size, the students’ older ages, not noticing the side talk at all, not interpreting the students’ behaviour as off-task, etc.). However, looking at the verbal and non-verbal behaviour of Chrissy and Ning, they appeared to understand that their side talk was breaking some unwritten rule in the classroom discourse.

Recall that in previous chapters, the way I use “contradiction” should not be equated to the same meaning as conflict. Rather, the former term refers to a historical unity of opposing (dialectical) tensions within a moving and evolving activity system (Engeström & Sannino, 2011). Thus, contradictions continuously manifest through participants’ discursive patterns of speech and actions, but do not necessarily result in substantive disagreements or overt changes in procedures. Contradictions thereby encompass conflicts but are also continuously emergent, interactional phenomena that are not reducible to merely arguments and/or relational problems between individuals. Contradictions are inherent within activity systems as a result of the division of labour of its participants, creating different positions and motives (Engeström, 1987/2015, 2001).
From a critical microethnographic perspective, Mehan (1998) uses the term “conflict” to characterize the relationships between members of the classroom community and contends that conflicts are part of the learning phenomenon, in that learning involves deliberate participation and is a constantly contested process. The scholar further argues that linking conflict to trouble or as external to learning is problematic, because it unrealistically situates the teaching-learning process as a smooth phenomenon, “Trouble is an essential feature of the teaching-learning interaction; it is always there, a feature that defies our attempts to correct it, or repair it, or make it disappear” (Mehan, 1998, p. 264). Thus, I argue that Mehan’s definition of conflict is compatible with Engeström’s conception of activity-level contradictions and elected to include side talk as an example of such a contradiction. Chrissy’s side talk contrasts with Vignette 1, in which the dissenting voice was invoked by Geena, rather than shifts in the collective activity. The two examples illustrate the different ways in which contradictions can manifest and extend my understandings of the role and nature of conflictual group interactions. In contrasting these vignettes, I explore the range of potentially unique OTL and relationships associated with different groups and the consequences for learning science.

Now I turn to the Chrissy’s interview data to further investigate how she experienced and interpreted the activity, and how her acts of positioning shaped her uptake of particular OTL.

**Interpreting and explaining acts of positioning.** Vignette 2 provides an example of how Chrissy navigated an informal scientific discussion. I argue that her acts of positioning and the context of the intergroup interactions gave rise to resources that Chrissy drew on to shape her opportunities to engage in particular kinds of discourse practices. Her side talk with Ning opened up a new “thirdness” (Engeström & Sannino, 2011, p. 371; Gutiérrez et al.,
1999; Leander, 2004), creating a hybrid learning context across time and space that expanded the participation structure between small group work and whole-class discussion.

As mentioned earlier, Chrissy did not consider herself to be friends with Ning, “The thing is I’m not close with Ning. I don’t know her on like, a personal level.” However, she recalled that they had common interests and were both dancers. In addition, she used their similar histories to explain their frequent gesturing in the video segment:

We have something that we can relate about, which makes it more comfortable to talk to her about things … Being dancers, we’re – we need to use our bodies and stuff to express ourselves. It’s kinda interesting to see it [on video].

Like the researcher’s microanalysis, Chrissy highlighted her physical movements during the group activity:

It’s interesting to see our interactions and stuff. I was looking at the people in the back too [students who were behind them in the scene], and it’s like we’re so – we’re moving around. Everyone else is just seated. They’re not doing as much. Shows how animated and enthusiastic we are … Me and Ning are very much, like open.

However, unlike my interpretation, which highlighted Chrissy’s control of the conversational and physical floor, Chrissy viewed her behaviour as a means to express herself, and cited Ning’s and her mutual histories as dancers to account for the observed physicality of their interactions:

It’s interesting to watch to look at [how] the person who’s listening to the [other] person is actually confirming the other person’s knowledge. That’s what’s great about this group thing, because you’re basically trying to see if you’re grasping the knowledge, the theories, the science behind what we’re learning. You can see us even with our body language [that] we’re trying to edge on [each other] – ‘I think this is
what it is. Are you getting what I’m saying? I’m talking like this big. Do you get what I [mean]?

According to Chrissy, she and Ning “both listen[ed] to each other’s answers [and tried] to help each other understand [the big picture].” In this vignette, Chrissy identified similar physical acts of positioning that were highlighted in the researcher’s microanalysis, such as her gesticulation in discussion, and their lowered voices when they participated in side talk. However, unlike the researcher, she did not view herself as dominating the conversation. Instead, Chrissy focused on her body language as a means of joint meaning-making. Her emphasis on collaboration, “Please connect with me!” suggests that learning does not just happen “in the head” of an individual but is mediated by the available social and material resources within the specific interaction (Esmonde, 2009b; Holland et al., 1998).

Chrissy did not mention her initiating the discussion or reading the questions from her laptop without orienting the screen to Ning. This may be because she was not concerned with sharing the artifact, as Dr. Farrell had just read the questions aloud, and the questions were left up on the projector screen. In alignment with Chrissy’s interpretation, Gresalfi (2009) considers “reviewing instructions” as an indication of collaborative work, in which a participant rereads the instructions or questions given by the teacher. Similar to Vignette 1, Chrissy contended that she engaged with the course content by building on others’ ideas and working toward mutual understanding. When asked about her experience working with Ning, Chrissy emphasized the importance of finding “a ground of understanding” with her and being open to different ideas in group work:

With respect to me and Ning, it’s nice because we both listen to each other’s answers first. It’s the beginning step where we’re trying to put our ideas together, to create
that big picture, and we’re trying to help each other understand. We’re very good at bridging each other’s ideas, ‘Oh, this is what you might be trying to say?’

In addition to building mutual understanding and listening closely to peers, Chrissy said she felt like Ning and her were “on the same level, intellectually.” Thus, despite my initial noticing of Chrissy dominating the conversational and physical space, Chrissy did not seem to share my point of view. She appeared to position her and Ning as equally competent and valuable contributors. This contrasts with Vignette 1, in which Chrissy was positioned as the more competent individual by Geena. As Esmonde (2009b) contends, students who may have been positioned as an expert in one interaction, may not be coded as such in another, illustrating the fluidity of positional identities and how people’s responses are evoked by the available social and material conditions of the event. Chrissy’s reflexive positioning of herself as an intellectual equal to Ning and contributing member of the group appeared to align with the interactive positioning of her by Ning, who listened to her ideas and offered feedback in discussion.

**Positioning across different anecdotes.** In her interviews, Chrissy offered two contrasting anecdotes about her past experiences with group work and discussed how being rejected can cause “even a very opinionated person like [her] to fall silent and put [herself] in a more conservative position where I’m not going to want to express as much.” Her quote suggests that group dynamics can influence how students participate and shut down discussion. As Chrissy continued with her story, she gave an example in which she once felt “intimidated by somebody’s intellect and it prevent[ed] me from speaking my mind.” In another incident, she talked about how an unnamed student’s lack of participation in the Kinesiology course stunted the group discussion:
**Excerpt 8**

[Chrissy’s SRI, May 18, 2016]

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>You have these questions to try to get people interested in [the task], to spit their ideas out. Sometimes it’ll work. You have to be like, ‘What do you think?’</td>
</tr>
<tr>
<td>02</td>
<td>‘I don’t know.’*</td>
</tr>
<tr>
<td>03</td>
<td>Okay, um, any ideas on this? Anything you can relate to in your own life?</td>
</tr>
<tr>
<td>04</td>
<td>‘Um, not really.’*</td>
</tr>
<tr>
<td>05</td>
<td>It’s like, ‘okay, it’s hard especially when you’re very social and you’re trying to engage people. I’m really trying to connect with you but you’re not giving me anything to work with! I’m trying so hard!</td>
</tr>
</tbody>
</table>

*[Chrissy does impression of unnamed student in class, speaks softly, performs uptalk, and flutters her eyelashes]:

Note 1: Although Chrissy is the only person speaking in this excerpt, I framed it as a turn-taking conversation between two people, because she was doing an impression of another student. The words inside the single quotation marks represent the verbalizations of her person she was mimicking.

Note 2: See Appendix F for transcription conventions.

The above excerpt was told to the researcher to serve as a contrast to the group dynamics of Vignette 2, in which both Chrissy and Ning appeared to be intellectual equals. Vignette 2’s group work practice was characterized as collaborative, where both members worked together and discussed their ideas. Rather than uncritically accept or dismiss one another’s contributions, the members collectively reviewed ideas put out on the conversational floor. Comparatively, Excerpt 8 demonstrated the relation between Chrissy’s bids for more information from another group member and the group member’s resistance to taking up her request. In this narrative, the conflict was evoked by the group member’s non-responsiveness and closed down the discussion.

Taken together, my observations of Chrissy’s participation and acts of positioning in the video segment and her accompanying commentary in the SRIs, I coded Vignette 2 as a
collaborative work practice in which there was no facilitator or expert. The dyad maintained joint attention toward the purposes of their task, even as the participation structure shifted. They also listened closely to one another, and each had opportunities to explain their thinking and engage with the academic content.

**Chrissy’s engagement in course content and discourse practices.**

Given Chrissy’s self-reported predilection toward verbal learning processes, it is not surprising that she had a positive assessment of the group work with Ning. Juxtaposing the video data with Chrissy’s interviews, I identified her position as a contributing member of the group (but as neither the expert nor facilitator). While I initially coded Chrissy as dominating the conversational floor, both members made substantive intellectual contributions in the discussion (see Excerpt 7), and their ideas built on one another’s. Returning to my research question of examining how the focal student participated and positioned themselves as they navigated through scientific discussions, Chrissy’s focus on collaboration and joint meaning making appeared to be consistent with how she positioned herself in Vignette 1 with Geena and how Ning worked with her in Vignette 2.

**Learning opportunities accessed by Chrissy’s position as contributing member of the group.** In Vignette 2, Chrissy was observed to be a contributing member of the group and worked collaboratively with Ning to engage with the course content. I argue that her position within the group shaped her access to particular OTL.

**Building on group members’ ideas and establishing mutual understanding.** In Chrissy’s SRI, she was explicit about the group’s work practice, “We’re trying to put our ideas together, to create that big picture, and we’re trying to help each other understand. We’re very good at
bridging each other’s ideas.” In both vignettes, Chrissy appeared to emphasize listening to others, and building on each other’s prior understandings of the content.

Chrissy also addressed the importance of communication, and the need for repairs if there are misunderstandings in verbal communication, sometimes through such non-verbal means as gesturing or facial expressions. In Excerpt 8, she relayed an anecdote in which there was little communication. According to Chrissy, she made repeated bids for more information and invoked other kinds of strategies for discussion such as asking direct questions, using non-verbal cues, and being supportive. In Vignette 2, Chrissy describes the intergroup interactions patterns:

When [Ning and I] understand each other, we don’t use our bodies as much, when we’re on that equal ground. When we’re really trying to emphasize our point, ‘I’m trying to express to you how I’m feeling. PLEASE CONNECT WITH ME! ONE OR TWO WORDS!’ I’m literally trying to shake them! [flails her arms around] Listen! Look at what I’m trying to say!”

Chrissy emphasized the importance of mutual understanding and knowing how to reopen conversations with others at appropriate times so that the group members would reconsider their intellectual contributions.

*Using and applying scientific terminology and theories.* In the initial interview, Chrissy appeared to sense the importance of learning to talk science:

Once they put up a slide on a quote, they break down each word to help us understand what the quote means as a whole, which is good. A lot of profs don’t do that. […] I find when you’re in class, ‘This is a mitochondri[on]. This is this. This is this.’ You sit there, and you hear it, but when you go home, you have no idea what they said anymore …
When I hear things or when [Dr. Farrell] teaches things … I’m not looking at things black and white. I’m looking at things from a more holistic perspective (05/13/16).

Chrissy appreciated how the professor explained scientific terms, moving classroom dialogue from what was written in textbooks to considering how science can be used to understand the world. Within Vignette 2, Chrissy highlighted the importance of practicing the scientific language and applying theoretical concepts, “Ning and I try to use a lot of different of theories, and terminologies, and links, which is nice.” Thus, I argue that Chrissy took up opportunities to engage in scientific talk with Ning, and in their side talk, participated in an extended opportunity to talk about the content.

Maintaining joint attention and brokering peers as resources. In the group work, Chrissy and Ning maintained joint attention and oriented to each other’s talk, “We listen to other people too, like, although it’s not a direct interaction, you’re still listening [to] a different perspective.” The group members served as resources for learning. They also finished each other’s sentences and asked each other questions. Each student in the dyad was involved in making their thinking visible, and each student was afforded opportunities to engage with the course content. Thus, there was a relatively equal distribution of OTL in this group’s work practices.

A (Not-So-)Special Opportunity to Learn: Side Talk and Participation in a Third Space

In the SRI, Chrissy made a point to explain her side talk with Ning:

I enjoy interacting with Ning … It’s funny ‘cause sometimes when Dr. Farrell will be kinda like and say ‘Okay, we’re done!’ And we’re still talking underneath. ‘Let’s just finish what we were saying. Let’s just finish this point. We’re at a good point here’ …
Sometimes we’ll gear off a bit, but we’ll come back to [the discussion] because literally, we’re consistently intertwining and connecting things.

Note: Recall that I consider Chrissy’s words in the interview “gear off” to mean “diverge from on-task talk.”

Through a critical microethnographic approach grounded in CHAT and positioning theory, I identified the side talk as a contradiction and the emergence of a student-led Third Space – a kind of ZPD where the boundaries of an activity structure are expanded, and the collective object and the activity itself were reorganized, resulting in potentially new OTL (Engeström, 1999; Gutiérrez et al., 1999; Kelly et al., 2001).

The juxtaposition of Chrissy’s side talk and the institutionally powerful discourse of the teacher invited noticing of the unofficial spaces that students create within and between formal spaces. Oliveira and his colleagues (2010) call these behaviours “marked moments of communication,” which carry a high information load and thus are more likely to have communicative significance (p. 676). As I mentioned before, the contents of the talk could not be recorded due to the lowered voices of the participants. However, Chrissy’s comments about the side talk suggests her participation in the side talk was not completely off-task, “Let’s just finish what we were saying. Let’s just finish this point. We’re at a good point here.” I argue that the side talk afforded Chrissy more opportunities for extended science talk, to engage with the course content, and to broker her peers as resources (Lemke, 1990, 2001).

As Chrissy stated in her interview, “Sometimes [Ning and I will] gear off a bit, but we’ll come back to it because literally, we’re consistently intertwining and connecting things.” She alluded to two important ideas in her statement: a) that her side talk with Ning was mostly on-task, and thus oriented to the collective object of science learning; and b) her side talk emerged in a kind of hybrid learning context that expanded the object and reorganized the “official”
activity (Gutiérrez et al., 1999). Although it is possible that Chrissy responded to me in a manner that justified her counterscript behaviour so that I may perceive her actions in a more positive light, the findings gesture toward some evidence of how extended and/or potentially unique OTL can be potentially accessed in Third Spaces. The focus on side talk in my analysis surfaces how contradictions in the activity system (in the Engeström sense) can be positioned, ignored, and potentially fruitful for some of the participants in the group. I do not argue that the Third Space carved out by Chrissy was particularly intentional or an exceptional moment of learning, but I do contend that its creation enabled her to access additional resources such as extra time and feedback from her team mate.

Next, I summarize Vignette 2 and discuss Chrissy’s side talk as participating in a Third Space of hybrid practices, in which she accessed additional resources and potentially renegotiated her relationship to science learning.

**Summary of Vignette 2 and participation in a Third Space.** In Vignette 2, Chrissy engaged in a group discussion concerning the ethical treatment of cadavers for science learning. This instance of group work afforded Chrissy the opportunities to build upon others’ ideas and establish mutual understanding, use science talk, and listen closely to others’ explanations. Using Chrissy’s SRI supplemented by the video data, I argue that she was not positioned as an expert or a novice, but rather as a contributing member of the dyad. She appeared to be focused on collaboration and joint sense-making about the course content with Ning. The interaction was coded as collaborative, because each student had a chance to voice their thoughts and they built on each other’s ideas.
As the class activity shifted to a whole-class discussion and the dyad continued talking, the interaction surfaced a secondary contradiction ↔ dilemma (see Table 11). The conflict was evoked by the shift in activity, as the norms for the students’ behavioural expectations shifted as well. Patchen & Smithenry (2014) observe it is these “shifts in subjects, community, mediating artifacts, and division of labour [that] contribute to variations in rules and objects” (p. 629). That is not to say the learning opportunities afforded by the official activity and the side talk are divergent. In this example, it appears that the side talk gave rise to extended resources (e.g., more time, using peers as resources) that Chrissy took up to engage further with the scientific content. Chrissy’s side talk is therefore intertwined with the “sanctioned” object of science learning, because the content of the talk is on-task, and the “unsanctioned” behaviour of the students.

It is not known how Dr. Farrell interpreted the side talk, although they did not admonish Chrissy. Throughout the lessons, the instructor rarely reprimanded students for speaking out and encouraged student discussions in a variety of participation structures. As such, students may have interpreted the learning environment as more open to behaviours that might be considered inappropriate in stricter contexts. Such daily classroom practices in the Kinesiology course may have re-shaped particular kinds of counterscripts as affordances within the classroom.

Contradictions across Vignettes 1 and 2

In each of Chrissy’s vignettes, contradictions in scientific discussions potentially provided unique OTL. The contrast of these cases showed how conflicts can be interpreted, positioned, ignored, and/or potentially fruitful for some team members, but not necessarily for all. In Vignette 1, Geena’s anxiety about public speaking appeared to “creat[e] problems for everyone.” In this case, Chrissy attempted to mediate Geena’s feelings, while working toward the completion of the common task. They continued a group practice that I coded as
collaborative, and Chrissy adopted a facilitator position. My analysis of Chrissy’s narrative demonstrated that Geena interactively positioned Chrissy as an expert/facilitator/helper by approaching her outside of class and sought extra support. I contend that Chrissy reflexively took up the informal role of the facilitator through her descriptions of her participation and encouraged Geena to share her prior understandings of the course content and listened closely to Geena’s concerns. Chrissy acknowledged the differences in interpretations of the common task and considered the merits of what Geena already knew and was comfortable with, “You can emphasize the points you do know, the strong points you’re very comfortable, confident about. If anything happens, we can back you up,” therefore facilitating Geena’s participation in the presentation.

As this example shows, talking science was not necessarily at the forefront of the intergroup interactions, which Chrissy herself recognized, “We had to focus less on the content, and instead more on her anxiety about it.” Similarly, Esmonde (2009b) recognizes a collaborative work practice does not mean that the group is engaged in particularly meaningful or intense on-task discussion. In this intergroup interaction, Chrissy was more involved in moving across different discourses and offering socio-emotional support to Geena.

In Vignette 2, the shift in classroom activity from small group work to whole-class discussion evoked the contradiction, as Chrissy and Ning continued to talk to each other. In other words, as the activity shifted, so did the expectations for student behaviour. What was acceptable behaviour in group work was not in whole-class discussion. Analysis showed that the participants were not engaged in off-task behaviour. Rather, they created a Third Space that enabled them to participate in an extended opportunity to engage with the course content, talk science, and broker their peers as resources. Although their behaviour diverged from the “official
discourse” of the classroom, I argue that the contradictory side talk served as an opportunity for learning for the group members involved.

**Implications for CHAT.** My analyses of how students navigated conflictual scientific discussions, and ultimately how their acts of positioning shaped their uptake of particular OTL, provided a way to understand the operating of small group work among members. These two vignettes with Chrissy as the focal student demonstrated multiple interactional demands required for participating in each of the student groups. In the first case, Chrissy had to navigate relational discourses as well as the task requirements for the Group Article assignment, so that competing demands could be considered. In the second case, Chrissy and Ning participated in side talk to continue with their on-task discussion about the ethical treatment of cadavers. Although their side talk was not explicitly brought to the class’ consciousness (via the teacher remarking on their behaviour), Chrissy showed knowledge of the academic content and knowledge of politeness conventions. My analysis of Chrissy’s verbal and nonverbal actions illustrated that she responded “appropriately” to the demands of the social situation in a way that recognized the official discourse of the classroom (by speaking quietly to Ning). This suggests that students’ different processing times and uptake of ideas might be considered in the organization of classroom activities.

In this chapter, I showed how a critical microethnographic approach grounded in CHAT and positioning theory made visible the factors involved in the social construction of scientific knowledge, and more specifically in the negotiated nature of group interactions and interpretations of what counts as an intellectual contribution. I focused on conflictual scientific discussions in an effort to make visible students’ understanding of the academic content through analysis of their discourse. My analyses of the vignettes in this chapter discussed some of the
ways that language and shifts in activity were made salient in intergroup interactions. The first examined how knowledge of the dominant language might be conflated with expertise in a group, reproducing asymmetric relations of power that disproportionately value Eurocentric repertoires of practice. This vignette shows us how repertoires of practice can be racialized, and how non-dominant repertoires of practice may be read as less valuable and cause students anxiety when asked to show their scientific knowledge publicly. This suggests that learning science theorists should attend to the ways particular classroom practices and valued scientific discourses may be entrenched in particular social locations which unevenly advantage people within dominant social relations.

The second vignette looked at the ways that participation structure shifts within the classroom influenced how Chrissy talked, what she talked about, and how this talk illustrated her understanding of academic content. The empirical evidence through the video data and transcripts of interviews illustrated the kinds of OTL that Chrissy took up in the side talk were extended learning opportunities about the course content. On the surface level, side talk may be interpreted as inappropriate behaviour. However, a closer examination revealed that the dyad was on-task and finishing up their discussion.

To effectively analyze this vignette, I argue that we first need to recognize the dominant epistemologies at work in this activity system, and why I coded side talk as a manifestation of an activity-level contradiction. My coding surfaces the inherent tensions between student-led ↔ teacher-led spaces that occur while participants occupy the same physical location. These tensions are often misread or dismissed in analysis, because they are ephemeral rearrangements of the activity system carved out by students (Bloome et al., 2005; Gutiérrez et al., 1999). If we
ignore spaces, we risk missing potentially fruitful sites for analyzing learning and development, and the unique OTL available in these Third Spaces.

In addition, my marking of the side talk as a conflict made me notice what I noticed. This vignette highlights the dominant epistemologies in the classroom rubbing against the student-led spaces, and how that shapes what is known, how it is known, and who is recognized as a knower. In other words, this vignette showed how a non-dominant epistemology (i.e., side talk) is often dismissed or reprimanded, while a teacher-centred, dominant epistemology is foregrounded. This has implications for who can become a recognized knowledge producer and what ways of knowing become the locus of attention in analyses. This suggests that theorists should attend to the diverse epistemologies and hybrid spaces that may be present in a classroom and understand how different ways of knowing can shape the participation and cognition of members from varying social locations.

**Implications for teaching.** My analysis of Chrissy’s side talk brings attention to the importance of listening carefully to student-led spaces, and to better understand students’ different ways of knowing. The findings from my micro-level analysis have implications for teachers and point to the need for identifying (dis)/jointed activities within the activity system. In order to expand notions of what learning processes can look like, “marked moments” such as side talk and other kinds of behaviour that rub up against official discourses can be fruitful sites for analysis and advance more coherent visions of learning that occur in classroom systems.

The concept of improvisational Third Spaces offers a window into examining what activities are actually asking of their students, what learning opportunities are privileged and/or hindered, and where the boundaries of the structures are. Vignette 2 can inform educators’
practices by asking them to look at what kinds of knowledge and practices they value. If we
legitimately believe that students can be resources to their peers, and capable of critical and
creative thinking, then we cannot disregard the productive learning potential of Third Spaces,
and where they come from.
Chapter 6
The Case Study of Jem

Chapter Overview

This chapter covers the second case study of my dissertation. The focal student is named Jem, a White woman in the fourth year of her undergraduate program of Kinesiology. In this section, I discuss how she navigated two scientific discussions and how her participation and acts of positioning shaped her access to and uptake of particular OTL. First, I investigate how Jem drew on resources as they arose in the unfolding interactions, such as group conflict, Jem’s pre-existing relationships with other students, and her high-status science identity, then examine how these resources allowed her to engage in particular discourse practices and positions, in sometimes unpredictable ways. Finally, I examine the potential influence Jem’s contributions and acts of positioning play in the co-construction of scientific discussions and how conflict potentially provides unique OTL.

The first vignette was taken from Jem’s interview data and revolved around the interactions with her and another student, Stuart, working together on the Group Article Review assignment (syllabus, 2016). The second vignette revolved around an informal scientific discussion with three other students, and my analysis drew on the juxtaposition of video and interview data from Jem. As in Chrissy’s case study, the two specific vignettes were selected for the following reasons: 1) the focal student recalled the activity as an interaction that stood out to them in response to interview questions related to classroom work (see Appendix C); and 2) the specific group activity illustrated an instance of a sustained, observable contradiction.

Recall that I draw from Engeström’s definition (1985/2015) of contradiction for my analysis – that is, an inherent, dialectical tension between the subject’s actions and the activity
Contradictions manifest themselves through participants’ particularities of speech and actions in ways that are informed by the social and material context of the interactions. Although contradictions can encompass conflicts as we traditionally envision them (e.g., in the forms of explicit arguments or dissent), they also include the everyday push-and-pull negotiation of participation and meaning-making that often evades participants’ consciousness. Thus, contradictions and conflicts are an essential feature of learning (Mehan, 1998; see also Price & McNeill, 2013; Radford & Roth, 2011).

My analyses show how the construction of scientific discussions by the different student groups involved more than talking science; it also involved establishing positions, maintaining relationships, and negotiating what counts as appropriate participation in that unfolding moment. The conditions under which learning occurred and the particular OTL taken up by Jem will be explored in further detail according to the specifics of the vignette.

I begin this chapter by introducing Jem, briefly describing her perspectives on the science domain, the Kinesiology course, group work, and the identities she associated with science learning. Then I follow with microanalyses of two instances of conflictual group work involving her. Relevant background information from Jem is included to locate the focal participant within context and analyze her actions against her ontogenic history and experiences as a science learner, the social organization of the group, and the ways in which the classroom system was organized around getting work done. As Radford and Roth (2011) assert, the ways in which the collective object tends to be represented to different members in the activity system are influenced by the participants’ own diverse histories, goals, and interests. The differences can be further exacerbated by the division of labour that organizes the activity and differentially positions teachers and students in terms of power, roles, responsibilities, and levels of scientific
competence. My study takes a critical microethnographic perspective to analyzing Jem’s uptake of particular OTL in two scientific discussions, in which the focal student’s participation in the vignettes are linked to a broader set of discursive conventions, group work practices, classroom norms, and social identity constructs (Anderson, 2009; Engeström, 1999; Gresalfi et al., 2009; Roth & Lee, 2007). Thus, I argue that the kinds of OTL that Jem accessed were a function of the relationship between her specific actions in the group given what opportunities she had to act, set in the context of the Kinesiology classroom.

Introducing Jem: “This is different from any other course we’ve taken.”

Jem was a “super busy,” White, female Kinesiology student, and a Varsity athlete. She played on the Track and Field team and discussed her desire to participate in the upcoming Olympics as a pole vaulter. She also worked as a personal trainer at the university’s gym. Her physical health and athletic performances appeared to play important roles in her life, and she “strive[d] to balance the athletic and academic demands.” Due to her busy life, Jem admitted to sometimes “being in [her] own bubble. [So sometimes] it’s good to hear other people’s perspectives, because being a Kin[esiology] student and Varsity athlete, you often are not aware of things going around you.” She self-identified as a Christian and volunteered as a student leader in “a Christian club on campus.”

Jem’s initial perceptions of schooling and science identity. Jem described herself as “a dedicated [and] engaged student, especially when it’s something [she’s] interested in.” She said she loved the Kinesiology program, and that the content was applicable to her “athletic lifestyle.” According to Jem, she was “a pretty good [learner]. I’m attentive and make the most of the time in class. I try to participate whenever I can.” Jem valued science highly, “I
treat the science-based courses way more seriously than any Arts course,” and appeared to subscribe to a hierarchical positioning of the subjects, “I would view the people who took [sciences and mathematics] as better, like smarter and more ‘Type A.’”

Unlike Chrissy, she did not mention race or ethnicity as playing a role in her schooling. However, Jem did talk about difference in terms of academic performance:

People who were in Fine Arts type stuff, like drama and even history courses, I would be like ‘Okay, you’re different from me.’ And not only that you’re different from me, I guess it’s also like you’re ‘lower.’ Going into university, I maintained that view.

Much of Jem’s science identity seemed to be associated with the Kinesiology program. She said she “enjoyed the science-y courses better,” but also engaged in some reflexive questions about the correlation between her academic performance and her fondness for the subject matter:

Is it, like, the case of the chicken or the egg? … I don’t know if my brain is wired like that, or if I’ve gone that way throughout my life and the courses I’ve been exposed to … That might be [because] one leads to another. I do better [in science], so I like it better?

Put another way, Jem seemed aware of her possibly self-confirming bias, insomuch as she fared better academically in science, which affirmed her belief in science being more important than other subjects, and her identity as a high-status science student.

Jem seemed self-aware that she bought into the narrative of science as an elite, objective practice (Haraway, 1988; Lemke, 1990). She jokingly described herself as “a robot […] who liked to categorize things … I’m completely complicit in it. It’s very weird. I have this internal battle.” In her first year of the Kinesiology program, she mentioned rarely attending her *Physical Cultural Studies* classes in her first year, “I went to maybe four lectures. It was a joke. It’s
pointless. It’s boring, so that’s just the [Kinesiology] culture.” Alternatively, she recognized that “those cultural courses … [require] deeper understanding and being able to draw connections,” but she personally preferred rote memorization and more procedural ways of learning.

**Jem’s view of the Kinesiology course.** Initially Jem did not “feel comfortable with the material [in the class],” because she “didn’t really know what the course would be about.” Jem claimed that this course “is different from any other course that we’ve taken, so I probably wasn’t participating as much.” As well, she was intimidated by the class content, and found that she “had a very vague understanding of the concept of ethics. I wasn’t aware of how philosophy was tied into all these other [science] topics.”

In every lesson, she sat near her friend and roommate, Lee. After school, Jem said that they would continue to discuss the more difficult and/or engaging topics back home [and] would “bounce ideas off each other … I feel like when there’s something I’m like, re-thinking, most times, we’ll talk about it. I told her about my whole conflict with personal training and um, like high performance sport.”

Throughout our interviews together, Jem noted a shift in her perspective on the course:

[At first] I was, like, I might as well just get [the course] done over the summer, so then I don’t have to worry about it. But then throughout the course, ‘This is just so good! It’s just so interesting!’ Most people I talked to who took it loved it.

She exclaimed that she thought everyone needed to take this course, “I should have taken this course in high school or in an earlier year [in university]! This should be mandatory. Younger kids need this.” She recounted an anecdote about spending time with Lee’s adolescent sibling, “Just hearing her sister and that group [say things], I actually said ‘You guys need to take
Ethics!” While Jem contended that she still believes science occupies the “highest spot on the hierarchy,” the topics and discussions in class “opened [her] eyes to way more ways of learning, and understanding, and knowing things than just through science and technology.”

Jem’s views on group work. For Jem, a challenge with large group discussions was being fearful of other people’s reactions. In different interviews, she mentioned feeling intimidated by other students in the class, “There were a lot of pretty deep thinkers, which was good because it gets you thinking. But I think also it can sometimes get intimidating like ‘Whoa! I do not think that deeply about things’ [laughs].” In Jem’s view, the classroom could be a competitive and unsafe space. She compared herself to others and expressed concern over whether her opinion was a “stupid thing to say” or if she would offend someone. The content-heavy readings and the potentially controversial socioscientific topics covered in the course, such as genetic modification, animal rights, and the dominance of Whiteness in the faculty, may have initially affected the frequency of Jem’s participation, “I didn’t know what to expect. But once I started doing the readings and attending lectures, I started to understand more, and it became easier to participate and contribute.”

Jem revealed that she enjoyed activities more when students were permitted to work in smaller groups and could choose their team members, “[When] I’m with my friends, you feel more free to say the things that I was thinking about or had questions about. In that time, I felt like in small groups, everyone is like, pretty open and understanding of different points of view of everything.” Jem added that she often would not participate in and/or “omit things in big group discussions.”
In the following sections, I describe two vignettes involving Jem – one that involved a formal assignment, and the second being an informal scientific discussion. I also describe the group dynamics, and the kind of contradiction that manifested in the interactions. Then I examine how Jem participated and positioned herself as she navigated through these scientific activities, and finally discuss how her access to and uptake of particular of OTL was mediated through “multiple layers of social life” – that is, through how students negotiate meaning in local contexts, through resources that arise out of the intergroup interactions, and through how the classroom shapes what students recognize as acceptable participation, and are able and willing to do together (Gresalfi et al., 2009; Haraway, 1988; Martin, 2016).

Jem’s Participation and Acts of Positioning in Vignette 3

Vignette 3: “It did not feel like a group thing at all!”: In her final interview, Jem was asked to provide an example of group work that stood out to her. She described her work on the Group Article Review assignment. The team members were assigned by Dr. Farrell (hence, Jem could not work with her friends). Jem’s group read Nancy Schepen-Hughes’ (2001) article, “Commodity Fetishism in Organs Trafficking,” in which the author considers the ethical dilemmas in organ harvesting and transplant surgery under the guise of serving larger ‘altruistic’ ends. The assignment was worth 15% of their final mark, and it involved a written summary and an informal presentation that provided:

- a brief summary of the main argument/point of article; a quote that resonated with your group (and why), a glossary of 2 new words, connection to a philosopher in Examined Life, a point about the relevance of the article to KPE/ethics (syllabus, 2016, p. 4).
In Jem’s narrative, there were communication obstacles within the group because the members were not familiar with each other beforehand. The different student groups were listed on Blackboard, so the members were not identified in-person:

I knew two of the girls in our group. One of them is on the Track team, so we know each other pretty well. The other, I’ve done group work with her before. The other two or three, I had no idea who they were […] So the four of us had originally created a Facebook message of like, ‘Okay we should get working on this.’ So, we made a Google Doc\(^\text{12}\), and then divided up the parts. Pretty much once after we divided up the parts, it was like individual [work] … all like, on Facebook and Google Doc. We each put in our individual parts.

In the interview from which the excerpt was drawn, Jem appeared annoyed at the lack of group cohesion. She exclaimed, “Honestly, it didn’t feel like a group thing at all! We didn’t even get together!” This group dynamic may have been attributed to a number of factors, such as the larger class size (n=51), the lack of familiarity between the students, and little class time afforded to working on these tasks together. None of these factors were explicitly identified by Jem but appeared in my field notes and reflections in my content logs. She went on to describe some of the tensions that arose in the group:

The night before [laughs], we realized that there was still one person in our group who was not on the Google Doc. So [laughs], we had to – I found [Stuart] on Facebook and messaged him […] So then we had to like, [laughs] figure that out. So that was like, I

\(^{12}\) Google Doc is a web-based word processor that allows users to create and edit files online while collaborating with others in real-time.
don’t know. On the day of [the presentation], it was just like, ‘Oh, you’re the other person!’

As in Chrissy’s chapter, I focus on the discursive manifestation of the activity-level contradiction, made available to the researcher through analysis of the participants’ patterns of talk and actions (Engeström & Sannino, 2011, LeBaron, 2005). I noted that Jem was laughing as she was relaying her story. Several interactional analysis studies (e.g., Hatch, 1997; Martin, 2004; Metcalfe, 2006) suggest that discourse involving humour and laughter acts to first hide, then reveal contradictions (i.e., underlying tensions) in the learner’s experiences of their social reality. Borrowing from Martin (2004), ‘humour’ was coded as any remark accompanied by laughter in my analysis. Laughing was assumed to be a discursive expression of humour, and an extension of cognitive dissonance that occurs “beyond the skin” (Resnick et al., 1991, as cited in Cole & Wertsch, 1996). In Vygotskian terms, what we construe as the mind works through artifacts and social others, thus learning is not bounded within the head or body of the individual. Rather, laughter can be read as a social expression of contradictory thoughts. I argue that alongside Jem’s laughter and the transcript of her ironic remarks and verbal stresses, it suggests that she was expressing a contradiction-centred discourse (Hatch, 1997).

She later mentioned in the interview that Stuart messaged her on the first day that the groups were assigned and asked her if she was in his group. Jem told me she responded to him non-decisively, “I was like ‘I don’t know, maybe.’” When I prompted her for more information, her response was, “Things just got mixed up and people weren’t connecting with people.”

The lack of group cohesion may have had consequences for the forms of engagement available within the group. Unlike Chrissy’s description of the first vignette, Jem’s group did not work together in a face-to-face setting outside of class time. I therefore interpret Google Doc as a
Third Space, where the activity was expanded across space and time, and potentially new OTL were produced. While group presentations can encourage collaboration and invite multiple perspectives, it can also lead to individuals opting out of group discussion, listening to peers, or participating in writing solutions (Esmonde, 2009b). Jem lamented about Stuart’s lack of participation:

After the presentation, when we had to do the write-up, we realized that there was another section, ‘the connection to Foucault’s ethical framework,’ that we didn’t have to talk about in the presentation, but we had to include in the [paper]. I noticed that in the rubric. So, I messaged the group, ‘Is anyone able to do this?’ because I was, like, super busy. Um, so it ended up being a couple of us that just like, worked on it over the Google Doc. One girl [Julie] put her ideas down of what she thought [the answers were], and I kinda fixed some things and changed it, and we just did it that way […] But I was like, ‘Hey [to Stuart], you’re supposed to be doing this part. Do you even have the Google Doc?’ … It was frustrating because it was due tomorrow.

Jem’s narrative centred around fairness and distribution of tasks. Students were somewhat interdependent on each other to produce a writing artifact – a summary report, and to speak together in a presentation about their assigned article. She described not being familiar with some of her group members, and seemingly having to “chase down” people to complete the tasks. In Jem’s account of the group work, she initially appeared to take up the informal role of the gatekeeper of academic and social boundaries within the group (i.e., who was included, who was excluded). She distributed tasks, in the Third Space and “fixed” other students’ work. As well, Stuart reached out to Jem for confirmation of group membership. Although Jem responded non-decisively to him at that time, she reported that she tried to connect with him later on to
complete the writing assignment. It appeared that Jem took up opportunities to build on others’ ideas, accurately use scientific terminology, and organize focus to the common task.

However, without close analysis, the specifics of the group’s interactions were unknown. It is important to note that Vignette 3 was marked by Jem’s interpretation of the event only. I do not know the other students’ interpretations of the event. Thus, it is difficult to speculate on the nature of the Stuart’s non-participation, as most of the work done was prepared outside of class. As well, the other group members did not consent to being videotaped, so I do not have any video recordings of the presentation. From informal class observations, I noted that Stuart was an East Asian, male-presenting student who rarely participated verbally in class discussions. He was not a participant in my research study, as such I do not have any interview data with him. Hence, I am careful not to make any assumptions about his interpretation of the group’s interactions.

For example, it is not known if Stuart reached out to other members in the group, but his Facebook message described by Jem asking her if he was in the group ostensibly positioned her in a more powerful position and may have hindered his initial participation with the group when she responded non-decisively. I do not code Jem as the informal expert, because I do not know how other members interpreted her corrections of their work on the Google Doc. However, I find sufficient evidence that she was positioned as a powerful participant at times in her narrative.

**Jem’s engagement in course content and discourse practices.** In addition to working alongside her group members, Jem noted that she made several intellectual contributions to the common task. She identified herself as an informal facilitator, “I think I was one of the main facilitators … in getting things done, but [Susan] was the one who started the Google Doc.” Taking Jem’s perspective into consideration, I revised my initial positioning of her
as the informal gatekeeper to a powerful facilitator in the group. Once again, I borrow the term “facilitator” from Esmonde (2009b) to describe a participant who orchestrated the group activity and fostered broad participation from the other members. Jem attempted to involve people in the common task, “I noticed that [we missed a section] in the rubric, so I messaged [them], ‘Is anyone able to do this?’ […] I was like, ‘Hey [to Stuart], you’re supposed to be doing this part.’”

However, Jem went on to say that she and another team member ended up doing the last part of the assignment. When asked to describe her work in the group activity, Jem explained that she “fixed some things and changed [the Google Doc],” which allowed her to engage with the course content, build on others’ ideas, as well as correcting others’ work. For the writing portion of the assignment, I therefore situate Jem in the informal position of critic, who drew on opportunities to critique and/or extend on other members’ intellectual contributions. Drawing from Hutchby’s (1996) study on a radio call-in show, the host of the show is placed in a more powerful position because callers must first state their positions when they call in. As the second speaker, the host holds the space to comment on the first speaker’s position and gives rise to a “powerful argumentative resource” (ibid., p. 486) without being subject to the same type of critique as the caller (Hutchby & Wooffitt, 2008, as cited in Esmonde, 2009b). Analogously, while Julie may have made important intellectual contributions to the Google Doc, Jem, in the second position, could build on and/or challenge others’ ideas.

**Learning opportunities accessed by Jem’s position as a powerful facilitator.** In Dr. Farrell’s classroom, there were multiple opportunities for students to work together on the course content. From an earlier interview, Jem asserted that she enjoyed working in smaller groups and with her friends. In Vignette 3, Jem worked with several people she did not know well and mentioned that she did not feel like the activity was a collaborative experience, “It did not feel
like group work at all!” Thus, while Dr. Farrell provided the space for students to work collaboratively, the social dynamics of the group contributed to the ongoing negotiation of whether certain OTL were accessible and whether they got taken up. I argue that Jem’s positioning of herself as the powerful facilitator in her narrative afforded her particular OTL.

*Organizing work.* Jem appeared to take up opportunities to allocate responsibilities to various members for the *Group Article* assignment, “I noticed that [we forgot a section] in the rubric, so I messaged the group, ‘Is anyone able to do this?’ because I was like, super busy.” She attempted to coordinate the efforts of her group members by communicating broadly with them, then speaking individually with members, such as Stuart. Jem described herself as “the main facilitator … in getting things done.”

*Making connections between ideas.* Alongside other participants, Jem helped to summarize ideas from the article and explained her understanding of the scientific concepts in the presentation. According to Jem, she and another student also ultimately took on the bulk of the remaining task, including a written section that made connections between the assigned reading and Foucault’s ethical framework. In Jem’s narrative, both she and Julie took up the opportunity to make intellectual contributions on the Google Doc, and engage with the ethico-moral dilemmas raised in the article.

*Building on and challenging group members’ scientific ideas.* The use of the Google Doc as a learning artifact afforded Jem the opportunity to monitor and build on Julie’s ideas. Jem described herself as the second contributor to the document, so she was able to both articulate her own understandings of the content as well as challenge others’ intellectual contributions when she “fixed” Julie’s writing. As the second contributor, I argue that she sustained her
position as a powerful facilitator who engaged in critiquing and/or extending other team members’ ideas.

Connections to CHAT and the Classroom Activity System

Recall that I code the kind of contradiction that emerges from the vignettes on two levels. I use the convention and the symbol of the double headed arrow, “kind of contradiction ↔ kind of manifestation” to represent the dialectical relationship between the collective activity and individual actions. The contradiction refers to the activity-level of analysis, and the manifestation refers to the emergent conflict in interactions.

I identified the intergroup interactions in Vignette 3 as a primary contradiction ↔ conflict, because there appeared to be different evaluations/interpretations of the activity (that is, about the group assignment) between the team members (community), and the conflict manifested in the apparent exclusion of a group member. Engeström & Sannino (2011) assert, as contradictions are historical and systemic phenomena, empirical studies do not have direct access to them. Rather, the scholars contend that they are recognized by researchers through participants’ constructions of talk and action. In the interviews, Jem interpreted Stuart’s acts of participation as somewhat lacking within the group activity and expressed frustration at several points in the interview. I coded the moment as a ‘conflict,’ which is described by Engeström & Sannino (2011) as “resistance, disagreement, argument, criticism … and occurs when an individual or a group feels negatively affected by another individual or group” (p. 373).

This vignette was chosen for analysis because: 1) it was brought up by Jem in the interview as an instance of group activity that stood out to her; and 2) it involved a sustained, observable contradiction, which Engeström (1987/2015) indicates as a potential site for change and expansive learning. Table 13 provides the details about my contradiction analysis for
Vignette 3. Using linguistic cues from Jem’s interviews such as her laughter and phrases/words like “frustrating” and “It did not feel like a group thing at all!”, I identified the manifestation of a contradiction within the group activity as a conflict.

Table 13
Contradiction analysis of Vignette 3

<table>
<thead>
<tr>
<th>Activity level of contradiction</th>
<th>Features of activity contradiction</th>
<th>Discursive manifestation of contradiction</th>
<th>Linguistic cues for manifestation of contradiction</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Primary</em>: contradiction that takes place within one node of the activity system and as a result of more than one value associated with an element in the activity</td>
<td>Contradiction takes place within the community node of the activity system, that is, within the members of the group</td>
<td><em>Conflict</em>: when actions of one person are interfering, obstructing, or in some other way making another’s behaviour less effective (Tjosvold, 1997 as cited in Engeström, 2011)</td>
<td>Jem’s laughter as she described the group activity, and her explicit expression of frustration, “Do you even have the Google Doc? It was frustrating because it was due tomorrow.”</td>
</tr>
</tbody>
</table>

(Adapted from Engeström & Sannino, 2011; Yamagata-Lynch & Haudenschild, 2009).

My multi-level analysis of contradictions illustrate what Jem identified as the conflict within the group, how she responded to it, and the local constraints within which she worked (e.g., kind of activity, time limit, sharing of grades). Then I “zoom out” to look at how a common task led to differential contexts for talking science, and thus to potentially different OTL. In using this analytic method, I attempt to show how the contextual factors of the classroom (or potentially even events outside the activity system) and the social dynamics of the group informed how Chrissy took up particular OTL.

Through this critical microethnographic lens, I explore how the focal participant constructed her position within the group and how the group constructed knowledge together by drawing on the resources that arose through the interactions and the tools utilized in the *Group Article Review* assignment. My contention is that Stuart’s interactive positioning of her as a
powerful figure (by asking her if he was in her group) and her second position in editing the
Google Doc aligned with Jem’s reflexive positioning of herself as the powerful, “main facilitator … in getting things done.”

Summary of Vignette 3. As illustrated in Chapter 4, Dr. Farrell’s framing of science learning encouraged particular ways of interacting with the course content, including providing scientific explanations, justifying and clarifying ideas, and considering the ethico-moral dimensions of scientific activity that is often divorced from its teaching. The students were therefore expected in participate in multiple, oral discussions about the course content, sometimes in small groups, and sometimes in whole-class discussions. When they collaborated, the activity’s structure as well as the social organization of the team members (which will be compared to Vignette 4) shaped the group work practices and types of positioning available. I argue that Vignette 3 allowed Jem to take up a powerful, facilitative role at times, and gave rise to opportunities for her to organize the work of her group members, make connections between ideas, and challenge others’ intellectual contributions.

Jem’s taking up of the informal role of the powerful facilitator in the group appeared to have implications for the power dynamics within the group. In her telling of the story, Jem attempted to distribute the tasks amongst the team members but was annoyed when Stuart seemed to not participate appropriately, “I was like, ‘Hey, you’re supposed to be doing this part […] It was frustrating because it was due tomorrow.” Borrowing from Kotsopolous’ (2014) study, low achievement students, whether perceived or actual, were characterized by their peers in the interview data as lazy or not helping. Again, I emphasize that I was not able to gather data about Stuart’s interpretation of the events or about his academic standing, but I use Kotsopolous’ findings to frame how Jem may have interpreted Stuart’s participation. Although Jem did not
explicitly label Stuart in any way, she indicated that she did not know who he was until the day of the presentation, and was frustrated because he was supposed to have worked on the Google Doc.

It is interesting to note that when I asked Jem to expand on Stuart messaging her at the beginning, she spoke shortly about it. She attributed her non-decisive response to the course getting hectic and that “people weren’t connecting with people.” Similar to Kotsopolous’s (2014) findings of how powerful students characterized the contributions of students who were marginalized in group work, Jem appeared to criticize Stuart for his non-participation. However, an interview with Stuart may have provided a better understanding of the group dynamics and his intellectual contributions to the common task.

While teachers often think of and position boys and White students as the “smart” ones in classrooms (Brickhouse, 2002; Brickhouse et al., 2000), the power relations of Vignette 3 did not appear to operate according to such patterns. However, the conflict may have included a social positioning aspect, as Jem did not offer a scientific justification about Stuart’s participation. The group dynamics may have been complicated by Jem’s intersectional identities as a White woman and self-described, high-status science student as well as the students’ unfamiliarity with each other. In addition, as mentioned earlier, Dr. Farrell encouraged discussion and debate in the class, but Stuart was noted as quiet in my field notes. Anderson (2009) discusses how a student’s position could be linked to the resources by which the positioning occurs. Thus, a student who is marked as “quiet,” as Stuart was in my notes, could be associated as “smart” in one classroom, but hinder other modes of participation in another, or be an irrelevant construct altogether. Although from Jem’s narrative, Stuart did not participate adequately, it is beyond the scope of
my data set to speculate with certainty why or which factors contributed to Jem’s positioning of Stuart.

Returning back to the classroom, Jem’s actions surfaced some tensions between Dr. Farrell’s formulations of the course objectives and expectations for participation in group work. Idealized collaborative work may be viewed as equitable ways to redistribute authority in the classroom and decentre the teacher as the locus of learning (Esmonde, 2009a; Kotsopolous, 2014; Ritchie, 2002). However, Vignette 3 shows how the social organization of team members can exacerbate inequitable power dynamics and constrain access to OTL. If a particular student does not take up the OTL to be recognized as scientifically competent, such positioning could shape further interpretations of their actions. Engeström (1995) also suggests that a complementary learning process to formal (or vertical) learning is developed simultaneously – horizontal learning or lateralization – which “deals with an array of heterogeneous elements which constitute [the students’] micro-environment; these elements reciprocally shape the transformation and are molded themselves in the process” (p. 400). These additional elements may include the histories of individual participants’ experiences with formal schooling and science, social constructs, and other sociocultural processes. By opening up the view of science learning to include horizontal, social, and affective influences on the student’s participation in group activity (Gresalfi, 2009; Roth, 2007a), my analysis of Vignette 3 makes visible the tensions between how the classroom is ideologically organized and how students participate and take up space in ways that may escape a teacher’s attention.

Chapter 4 provided a broader view of the Kinesiology classroom and its activities. By analyzing the various interactional patterns, times, and spaces represented by various dimensions of the activity system, I made visible the range of available OTL. Collaborative learning was a
routine occurrence in the classroom (see Table 9). However, the student-led group work revealed how Jem was positioned with more power (possibly because of her high-status science identity intersecting with her racialized social identity as a White woman). She also took up opportunities to engage with others about the assignment but did not recognize Stuart’s participation.

In a heterogeneous science classroom, it is not surprising to say that we cannot say a priori which kinds of discourse practices are going to work with all students (Esmonde, 2009a; Esmonde & Langer-Osuna, 2011; Kotsopolous, 2014). Collaborative learning may be successful for some, and unsuccessful for others. Jem’s acts of positioning allowed her access to opportunities to engage with the academic content in multiple ways, but possibly at the expense of others’ participation. In Vignette 3, Jem appeared to enact a powerful academic position. The analysis of her narrative illustrated she actively negotiated her status and participation with social others. What may be garnered from Vignette 3’s findings are that students’ positions are constantly negotiated in interaction. Linking conflict with students from non-dominant groups can be dangerous (Mehan, 1998; see also Aikenhead & Jegede, 1999; Gutiérrez & Rogoff, 2003, Lemke, 2001), as such attributions can stigmatize certain individuals and how they “fit” within formal schooling. I do not make such claims. Rather than view conflict as something to be avoided, I argue that learning is an inherently contested process for all students. Jem did not initially recognize Stuart as part of the group, and the chain of events led to a conflict. The lack of non-focal student data limited the extent of conjectures I can make, but what emerged from this example was that the social dynamics of the group constructed different OTL for different members.

In this section, I provide a microethnographic analysis of the social organization of the student group and the moment-to-moment acts of turn-taking and positioning for Vignette 4. I describe in detail Jem’s navigation of the scientific discussion, and how she accessed particular OTL. Using video data juxtaposed with Jem’s SRI, I study the focal participant’s verbal and nonverbal forms of communication, and their relationship to the social and material resources as they arose within the activity. I regard the “microbehaviours” such as facial expression, body orientation, and gestures as interdependent with talk in the unfolding interactions, and constitutive of the surrounding context (Bloome et al., 2005; LeBaron, 2005).

I integrate CHAT and positioning theory to analyze Vignette 4 in both forward- and backward-looking ways. I consider how systemic structures enter into localized activities, and how students’ prior experiences with school science, pre-existing relationships, and identities may carry over into present performances and acts of positioning. By considering the social settings of knowledge construction, and how practices and identities are enacted, maintained, and shaped, my analysis of a university science classroom extends conversations into an academic area that has not been sufficiently researched – the multiple interactional demands required of students as they engage in the interpretative processes of a common task (Anderson, 2009; Arnold, 2012; Kelly et al., 2001; Martin, 2016).

Vignette 4: The Finger Incident. In the following vignette, I illustrate how Jem navigated a conflictual scientific discussion with group members, Lee, Ning, and Chrissy. I argue that Jem participated in an improvisational Third Space (Gutiérrez et al., 1999) in response to a secondary contradiction that emerged in this instance of group work (Figure 10), and in doing
so, renegotiated her relationship with others and to the task. The positioning analysis will be expanded on in this vignette, as both video and interview data were available for analysis. The video data illustrated the moment-to-moment acts of participation in this sustained group interaction, thus I include the physical (non-verbal) forms of communication alongside the participants’ talk.

A secondary contradiction is defined as when the participants encounter a new aspect (which I term “the Finger Incident”) of an activity, and the process for assimilating this new aspect brings about conflict (Engeström, 1987/2015; Yamagata-Lynch & Haudenschild, 2009). The contradiction analysis is summarized in Table 11. I argue that in an attempt to resolve the tensions within the group, Jem’s actions appeared to reorganize the activity of the group, and incidentally redistributed the members’ roles (although I do not necessarily claim it was her explicit intent). I examined how Jem’s actions expanded the collective object of science learning to include peacemaking, and potentially provided new OTL.
Figure 10. CHAT triangle depiction of the Finger Incident as a secondary contradiction within the classroom activity system.

Note: The different coloured circles represent the expansion of objects that emerged in the activity system. The red lines delineate the nodes of the contradiction, and the blue lightning symbols represent where the secondary contradiction could have occurred. Due to the limitations of an image file, I am unable to represent the dynamics of an evolving object. Thus, I use the two overlapping cycles to demonstrate how the collective object was expanded by Jem’s actions.

As mentioned in Chapter 5, I am not necessarily arguing for the presence of multiple, collective objects within the activity system. That would require greater theoretical considerations that recent studies are attempting to address (Bakhurst, 2009; Engeström & Kerosuo, 2007; Foot, 2002; Kapelinin, 2005; Sfard, 2008), and are outside the purview of this thesis. I do argue that the collective object of science learning is refracted among its participants by virtue of the division of labour inherent in any activity and the diverse biographical histories that the participants bring to bear on their actions (Engeström, 2001; Leont’ev, 1978, as cited in Engeström, 1987/2015; Radford & Roth, 2011; Roth & Lee, 2007). At various points within the
group activity, the motives of the participants may not coincide with the system’s collective object of science learning for any number of reasons. This may be analyzed through the ways in which language was used by participants to accomplish a range of collective and personal goals (Kelly et al., 2001). As I seek to make sense of Jem’s specific actions within Vignette 4, I analyze them against the imminent context and the activity system. By zooming in to the closest timescale possible, I contextualize these micro-interactions and make visible how a common task can lead to different contexts for learning for different members and foreground the focal student’s agency and uptake of particular OTL.

Microanalysis of Vignette 4

The following analysis is based on 3 minute and 36 seconds of group work that involved the focal student, Jem and three other students, Chrissy, Ning, and Lee, on May 25, 2016. Recall that one of the aims of my study is to examine how the focal student navigated conflictual scientific discussions. I analyze how Jem’s participation and acts of positioning influenced her access to and uptake of particular OTL. The video segment for Vignette 4 was selected because: 1) the focal student noted the event as an interaction that stood out to them; and 2) it contained an observable, sustained contradiction within the activity involving the focal student. Using Engeström’s (1987/2015, 1999) conception of contradictions as a potential source of change and development, interactional conflicts were marked as points of analytical interest for me, because they surface the consistent, negotiated work done by members to construct what is appropriate participation, establish local knowledge, and the requirements for group membership.
Context and group members. On May 25, 2016, Dr. Farrell invited the students to get into informal groups to discuss a video segment of *Manufactured Landscapes*\(^{13}\) (2006), an environmental documentary that the class watched together. The group members were not assigned and appeared to form out of proximity. Jem was in a group of four, which included her roommate Lee, the other focal participant, Chrissy, and Ning (from the previous chapter). They all seemed relaxed and friendly with each other, as there were many observed instances of laughing and smiling at each other. It might be interesting to note that this is one of their final classes in the course and the students appeared more comfortable with my recording them.

The main task. The students moved into groups by orienting their chairs and bodies toward each other. Dr. Farrell posted the following discussion questions on a PowerPoint slide, and asked the students to choose a couple of them to discuss how they linked together:

1) What are some of the ideas about consumption that the filmmaker reveals?
2) How is space/place implicated in people’s consumption and displacement?
3) What power relations (local and global) are apparent?
4) What do ‘manufactured landscapes’ mean for health?
5) What course concepts help you understand the geographies of consumption and exclusion that are manifested in the film?

A Researcher’s Narrative of “The Finger Incident”

The students were seated in a square formation with Jem and Lee sitting beside each other on the second-tier row, and Chrissy and Ning on the lower tier row (Figure 11-A). Chrissy and Ning turned their chairs around to face Jem and Lee. They appeared friendly with each other,

\(^{13}\) *Manufactured Landscapes* (2006) is a feature-length documentary about the work of photographer and visual artist, Ed Burtynsky on landscapes that have been altered by large-scale human activity.
and many instances of smiling and laughing were observed at the beginning of the episode. I identified the *shared interactional space* as the common perceptual field between the group members, where they could access learning artifacts or each other’s attention without gross body movements.

Lee initiated talk and controlled the conversational floor for the first 43 seconds of the group work, with the other students physically oriented to her and expressing affirmation through head nods and/or adding single words to the conversation. In one instance, Lee had trouble finding a word to express her thoughts:

You know how the thing at the end, they were so desperate for resources that they were like, smashing the computers to get the glass? But then that caused like a, uh … [*hands gesture away from body*] It’s like … [*eyes look up and heads tilt toward ceiling*] The destructiveness of consumption is like … I feel like … You know how, like, capitalism is like … a ripple effect? [*hands in front of body and making circle movements*]

The group stayed silent but remained oriented in her direction. When Lee finally said, “It’s like the principles of energy. I feel like it feeds into each other,” all the girls nodded.

At [05/25/16, Tape 4, 00:44], Chrissy swung her chair around, and accidentally slammed it against Ning’s fingers, which were resting off the top of her own chair. Ning let out a small yelp of pain, and everyone in the group oriented to her. In this moment, Lee was speaking, “I kinda feel like it’s like energy, [capitalism] is just changing forms,” and paused in surprise when Ning got hurt (Figure 11-B). Chrissy then reached over and hugged Ning to apologize.
(A) From top left clockwise: Lee, Jem, Ning, and Chrissy [00:03].

(B) Chrissy swinging her chair around, and accidentally slamming it against Ning’s fingers [00:44].

(C) Jem and Chrissy’s bodies and gazes orienting toward Ning, [00:52].

(D) Jem turning to Lee and apologizing, [01:11].

*Figure 11.* Chronological screenshots of Vignette 4.

*Note:* The group members were in the foreground with black bars across their faces to protect their anonymity. The students with the green bars across their faces were not part of the group.

A few moments later, Lee attempted to restart the conversation twice by repeating herself, (1) “I kinda feel like …” [05/25/16, Tape 4, 00:48]; and (2) “I feel like questions of consumption are like …” [05/25/16, Tape 4, 01:02], but then trailed off when she noticed that the girls were giggling and not paying attention to her. After Jem’s bids to change the topic of
conversation were ignored, she briefly got up out of her chair and shifted her body away from the shared interactional space. The girls’ bodies and gazes were no longer oriented toward Lee but rather to Ning (Figure 11-C). The Finger Incident is in alignment with Goffman’s (1961, as cited in Bloland, 1979; see also Phillip et al., 2016) moments of “flooding out” – unintended, momentary exceptions to emotional regulation that can be contagious (e.g., laughter), and can shift the frame of focus. Lee remained silent for 30 seconds. She repeatedly scratched the back of her neck, stopped smiling, and turned her head away from the group while the girls continued on with their banter.

Jem appeared to notice Lee’s silence, turned her head to Lee, and in a lower voice, apologized, “Sorry, you were saying?” Lee shook her head slightly and retorted quickly, “That was all I was gonna say.” After this, Ning turned her chair around, leaned forward into the shared interactional space, and also apologized to Lee. In turn, Lee nodded toward Ning, shrugged, then smiled widely at her. Following that, Jem made a sustained intellectual contribution about the documentary with the group members physically oriented toward her. Lee asked a clarifying question at the end (Excerpt 9):
**Excerpt 9**
[May 25, 2016]

| 01 | Jem: I don’t know. I kinda wonder what really goes through people’s minds. Like you saw the kids and them, these little kids, like that’s obviously where they grow up. You saw them playing [in the trash piles]. They don’t have the options like us, to compare it to [other things], and so you kinda have to wonder like - | [Jem’s head turns slightly toward Lee, then orient head to shared interactional space. Hands stay placed on table.] [Ning nods.] |
| 02 | Lee: You said that’s where they –? | [turns head to Jem, furrows her brows.] [Ning drinks from water bottle.] |
| 03 | Jem: In the film, the children are playing in the field. | [Jem looks up to the projector screen at the front of the class, and points to screen.] |
| 04 | Lee: Oh yeah. | [Nods.] |

**Interactive Positioning**

**Shared learning artifacts.** In Vignette 4, there were no shared learning artifacts.

Although they had access to their individual writing tools and notes, they did not make use of them. Chrissy and Ning turned their chairs around to speak to Jem and Lee. The discussion questions were displayed on the class PowerPoint slide; everyone therefore had access to them. When Lee asked a clarifying question about the documentary directed to Jem (Excerpt 9), Jem turned her head from Lee toward the front of class (where the projector screen was located) and pointed to the screen.

**Non-verbal interactive positioning.** As mentioned earlier, the group was arranged in a square formation with Lee and Jem sitting side-by-side on the second tier of tables. Chrissy and Ning were seated across from them on the first tier. All the group members had access to the interactional space, and no explicit physical blocks were coded. When a speaker spoke, the other members of the group tended to orient toward her and communicated their
engagement with non-verbal head nods and small smiles. When Chrissy accidentally pushed her chair against Ning’s fingers, all the members oriented their bodies toward Ning. Then Lee made two attempts at reinitiating on-task talk. After her bids were unsuccessful, she averted her gaze from the shared interactional space, and remained silent for the next 30 seconds. This was coded as a non-verbal ‘expression of negative emotion.’ At [01:11], Jem turned her head away from Ning, and oriented toward Lee to apologize.

**Verbal interactive positioning.** From the video data, it appeared that Lee was initially the informal group leader. Borrowing from Kotsopolous (2014), the leader is an individual who is the powerful figure and primary initiator of work in the group activity. This aligned with my field notes that marked Lee as a frequent and outspoken contributor; she often participated in class discussions and debated with others. During the first 43 seconds of interaction, Lee dominated the conversational floor and controlled which ideas were taken up. Lee’s reflexive position appeared to align with the interactive positioning of her by her peers. When Lee spoke, these students mostly contributed in the form of one-word responses and non-verbal affirmations such as head nods. At [00:44], Chrissy swung her chair around and accidentally hurt Ning, interrupting Lee’s talking. Two attempts of a ‘bid to change work practice’ were coded, with Lee attempting to carry on the on-task discussion, but they were ignored. Lee was then silent for 30 seconds.

Following that, two instances of ‘exclusive talk’ were coded. The first was identified as between Jem and Lee. Jem seemed to notice Lee was quiet, then turned to her and apologized in a lower volume. The second was between Ning and Lee. Ning leaned forward into the shared interactional space and apologized after Jem. I noted that Jem appeared to be the first member who noticed that Lee fell silent. Jem’s actions further positioned Lee as the “dissenter,” who at
that point, had withdrawn from the conversation. Jem responded to Lee, rather than continue her banter with Chrissy and Ning. A point to wonder is if their closer relationship as roommates and academic confidantes played a role in Jem’s sensitivity to Lee’s expression of negative emotions. Jem’s apology may have prompted a chain of events, leading to Ning’s apology and Jem’s subsequent intellectual contribution.

It must be noted that the preceding discussion about positioning regarding Ning and Lee remain speculative, as I was not able to interview the other participants about their interpretations of the events. I did not interview Chrissy (who was also a participant in this activity) about this incident, because first, the SRIs took place in the second week of classes and this incident took place in the last week; second, Vignette 4 took place after Chrissy’s final interview. In the following sections, I use video data alongside Jem’s interview responses about the group work experience to substantiate my interpretations about how Jem’s acts of positioning influenced her uptake of OTL such as explaining her thinking, making connections, and justifying her arguments.

Jem’s Reflexive Positioning

Non-verbal reflexive positioning. During Vignette 4, Lee and Jem sat beside one another, but did not turn their chairs toward each other; instead their bodies were oriented to the shared interactional space (see Figure 11-A). When Lee spoke, Jem expressed her positive engagement by tilting her head in Lee’s direction and nodding intermittently. Jem’s actions suggested that she positioned herself as an engaged member of the group.

When the Finger Incident occurred, Jem turned away from Lee, and started laughing along with Chrissy and Ning. Although Lee initially laughed as well, she stopped smiling and
turned her head away from the shared interactional space at [05/26/16, Tape 4, 01:01]. Jem’s smile sustained until she turned to Lee to apologize at [05/26/16, Tape 4, 01:11].

**Verbal reflexive positioning.** In the exclusive talk with Lee, Jem apologized to her. However, there was minimal recognition from Lee, who shook her head and replied, “That was all I was gonna say.” This was coded as ‘exclusive talk,’ because it included eye gaze and bodily orientation toward Lee. Jem’s voice was at a lower volume, and she addressed Lee directly. Jem’s apology may have also prompted Ning to apologize. Therefore, I argue that Jem positioned herself as the group mediator/peacemaker. However, Lee appeared to express greater acknowledgement of Ning’s apology by nodding, then laughing with Ning. After this chain of events, Jem made a sustained intellectual contribution for 26 seconds with no interruptions.

**Jem’s Perspective: Juxtaposing the Analyses of Interview and Video Data**

To recall, my research question investigates the ways in which the focal students navigated conflictual scientific discussions and considers how their acts of positioning shaped their access to and uptake of particular OTL. Consequently, in my microanalysis of Vignette 4, I focused on how Jem managed her participation in the group activity as she attempted to accomplish a range of collective and personal goals. Then I situate Jem’s apology to Lee as an opening to a Third Space, which I argue to potentially produce different OTL.

From the beginning of this interaction, Lee appeared to control the conversational floor for 43 seconds, positioning herself as the *de facto* leader of the group. The other group members demonstrated their positive engagement by orienting their bodies toward Lee and expressing both verbal and non-verbal affirmations, thus aligning with her reflexive positioning as the informal group leader. A chance occurrence (the Finger Incident) caused a flooding out of
laughter and shifted the frame of attention from Lee to Ning. The microanalysis of the event revealed an instance of what I interpreted as a secondary contradiction ↔ critical conflict, wherein Lee was interrupted while speaking and subsequently silenced (Table 14).

Table 14  
Contradiction analysis of Vignette 4

<table>
<thead>
<tr>
<th>Activity level of contradiction</th>
<th>Features of activity contradiction</th>
<th>Discursive manifestation of contradiction</th>
<th>Linguistic cues for manifestation of contradiction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Secondary:</strong> contradiction that manifested between two or more nodes of the activity system.</td>
<td>Contradiction takes place between <strong>subject</strong> (Jem), <strong>community</strong> (group’s actions), and <strong>object</strong> (science learning) nodes of the activity system.</td>
<td><strong>Critical conflict:</strong> in social interactions, facing contradictory motives; involves feelings of being violated and silenced (Sannino, 2008); often unsolvable by individual alone.</td>
<td>After the Finger Incident occurred, Lee appeared to be silenced and expressed negative emotions when her attempts at reinitiating talk were unsuccessful.</td>
</tr>
</tbody>
</table>

(Adapted from Engeström & Sannino, 2011; Yamagata-Lynch & Haudenschild, 2009).

As shown in the table above, I coded the Finger Incident as an activity-level secondary contradiction because the conflict arose out of the group’s actions (community), Jem’s (subject) interpretation of the event, and the collective object of science learning. On a micro-interactional level, I coded the manifestation of the contradiction as a ‘critical conflict,’ because it explicitly resulted in a participant being silenced. Lee attempted to redirect the discussion back to the film twice, but her bids were ignored. In addition, the conflict appeared to require more than one person’s actions (that is, both Jem’s and Ning’s apologies) to resolve the initial tension.

The conflict disrupted the initial social dynamics of Lee as the informal group leader, which aligned with Lee’s reflexive positioning of herself. However, the chain of actions after the Finger Incident illustrated the shifting nature of positional identities. When Lee’s bids to reinitiate discussion were ignored, she seemed to resist further engagement in the group by
falling silent and physically turning away from the shared interactional space. After the Finger Incident, Lee was repositioned to the margins of interaction. Lee expressed negative emotions and stayed silent for 30 seconds. Similarly, studies (e.g., Brickhouse et al., 2000; Carlone, 2004; Hodges, 1998; Tan & Barton, 2008) have illustrated examples of students who resist marginalization by strategically withdrawing their participation to preserve their identities.

The conflict appeared to be evoked by the contradictory motives between Lee and the other members of the group. Vignette 3 and Vignette 4 are similar in that they both involved interpersonal conflicts between the participants. I coded Vignette 4 as a ‘critical conflict’ because the available video data visibly indicated Lee’s contributions were ignored, whereas I relied solely on Jem’s interviews for the interpretation of the conflict in Vignette 3. The two examples illustrate the ways in which work practices and positional identities are enacted, maintained, and transformed. In contrasting these vignettes, I explore the range of OTL and relationships associated with different student group dynamics and the consequences for learning science.

Now I turn to Jem’s interview data to examine how she interpreted Vignette 4, and how these acts of positioning afforded her opportunities to participate in the group.

**Interpreting and explaining acts of positioning.** In Jem’s interview, she described the nature of Lee’s and her relationship, “So Lee and I, we’re actually roommates,” a topic that did not come up in the introductory interview. In addition, she spoke about how they would often discuss the course outside of class:

If there were some topics we were confused about in class or if there was something that blew our minds, we would often talk about it at home. Or if we’re studying or writing our paper, we would bounce ideas off one another.
Thus, it seemed that Jem considered Lee not only as a roommate, but as a trusted academic peer and friend. She explained that although she was close with Lee, she did not know the other girls well. Jem went on to qualify her statement:

Communicating [with Lee] was um… like better because sometimes I think of something in my head, and ugh, I’m like I don’t fully understand this. But then once I started talking about it and trying to explain it to [Lee], then I was like it’s starting to make sense now.

In a similar vein to Vignette 3, Jem stated she preferred working with whom she was familiar. In Vignette 3, Jem articulated that the group work did not feel like a collaborative experience. In Vignette 4, Jem working with Lee, her roommate and friend, may have engendered heightened sensitivity to Lee’s visible shifts in participation and displays of negative emotions. Jem appeared to notice Lee’s silence and inquired about her feelings and apologized. Therefore, it appeared that friendship was a salient part of Jem’s narrative about learning science in the course. In the interview, she regularly referred to Lee and her working together inside and outside of class, “When there’s something I’m rethinking, most times I’ll tell [Lee] about it […] I told her about my conflict with personal training and also with high performance sports. Like [a lot] of those issues, we talk through.” Jem’s actions, although consistent with her positioning as a friend to Lee, did not appear to resolve the tensions in the group. In contrast, Lee responded more overtly to Ning by smiling broadly at her after her apology. Upon “solving” the issue, Jem took up the opportunity to re-centre the conversation to the film.

Similar to the researcher’s analysis, Jem also identified her informal role as the mediator in the group, although she expressed hesitation in her self-evaluation. When asked about this particular vignette, she said, “It was just like trying to connect with them. But I mean, it was just trying to get things done! … Okay people, we have to do this. [laughs] … I don’t know.” Jem
did not explicitly mention Lee being ignored, which aligns with studies that assert open conflicts are rarely acknowledged or taken up (Martin, 2004; Engeström & Sannino, 2011). Similar to Vignette 3, Jem used humour in talking about this instance of group work. Recall that I code ‘humour’ as expressions of laughter. Hatch (1997) suggests that humour helps participants discuss contradictions in a less confrontational and more playful fashion.

Lee was not a focal participant, so her interpretation of Vignette 4 was unknown. In my analysis of the video data, however, Lee was initially identified as the informal leader within the group through her dominance of the conversational floor and her frequent participation in the classroom.

In another social positioning interpretation, Jem was a self-described high-status science student who valued the domain above others, so it is possible that Jem herself wanted to stay on-topic as a contributing member of the group and noticed the Finger Incident derailed the on-task talk. It was also possible that Jem wanted to align herself with an individual she recognized as an expert. One way of garnering recognition in a group is through building alliances and shared identity (Tan & Barton, 2008; Zacher, 2008). Thus, within this brief interaction, Jem may have occupied multiple positions – as a group mediator, supportive friend, and contributing group member who re-oriented the discussion back to the documentary.

Taken together, when the Finger Incident occurred, the initial group dynamics were disrupted. The unexpected disruption caused laughter and off-task banter to “flood out,” shifting the attention from Lee to Ning (Goffman, 1961, as cited in Bloland, 1979). Lee’s bids to change the work practice were ignored, and her following attempts at participation was marginalized. From this chain of events, a redistribution of OTL occurred within the group, as different students then had access to the conversational floor. What emerged from this vignette suggests
the instability of work practices and the multiplicity of Jem’s identities that are intersected by her pre-existing relationships, status, and power within groups (and so forth, Bloland, 1979; Davies & Harré, 1990; Dookie, 2015; Ritchie, 2002). Holland and her colleagues (1998) remind us of the complexities of identities, especially in spaces “where the usual authorities are unsettled” (p. 183) such as in student-led interactions, and how they can affect a learner’s access to resources and uptake of OTL in unpredictable ways.

**Jem’s engagement in course content and discourse practices.** With respect to the range of available OTL in Vignette 4, they included (but were not limited to) using and applying scientific terminology, explaining one’s thinking processes, connecting ideas, listening to other points of view, and justifying one’s ideas. Prior to the conflict, Jem did not seem to have much opportunity to participate besides listening. She indicated her positive engagement to Lee through non-verbal cues such as nodding. The Finger Incident leading to Lee’s silence opened up the conversational space, and the opportunities to participate were redistributed. Jem was then coded as making a sustained intellectual contribution, bringing the discussion back to the documentary. Jem therefore took up the opportunity to participate in on-task talk.

**Learning opportunities accessed by Jem’s multiple positions in the group activity.** In the microanalysis of Vignette 4, Jem was interpreted as occupying multiple positions within the group, as an informal mediator, friend, and a contributing member of the group. Returning back to my second sub-research question about how students positioned themselves, and how these specific actions enabled access to particular OTL, I argue that Jem’s multiple identities within the group allowed her to accomplish a range of collective and personal goals, and take up opportunities to problem solve, explain her thinking, and clarify ideas for others.
Problem solving and moving across different discourses. During the conflict, Jem mediated the conflictual group interaction and initiated apologizing to Lee. Although not directly related to science learning, Jem’s actions correspond to the lateralization processes (or horizontal forms) of learning that are related to social, affective, and motivational factors (Engeström, 1995; Gresalfi, 2009). Jem’s actions suggest her shift in attention to Lee’s expressions of negative emotion and silence, instead of staying on-task. Scholars interested in emotional effects on cognition (e.g., DuBois & Karkkainen, 2012; Phillip et al., 2016; Roth, 2007a, 2007b) assert that these horizontal factors are not simply influences on learning, but are instead inseparable from the learning process, as aspects of interpersonal engagement, such as desire and motivation, are central to what students are willing to do and thus learn.

Providing explanations. Initially, the opportunities to participate in valued discourse practices were not evenly distributed across the group. Lee dominated the conversational floor for 43 seconds until the Finger Incident occurred. Throughout my analysis, I illustrate how Jem appeared to take up multiple positional identities in Vignette 4, and they shifted in salience as the events unfolded in the scientific discussion and provided potentially new positions and OTL for the group members. Thus, when the flooding out occurred, Lee was subsequently silenced, enabling Jem to take up the opportunity to explain her thinking about the Manufactured Landscapes (2006) documentary.

Clarifying ideas. Lee did not contest Jem’s sustained intellectual contribution and subsequent control of the conversational floor. Instead, Lee’s question in Excerpt 9 (turn 4) presented Jem with another opportunity to make another intellectual contribution. Jem clarified her thinking to Lee and shared more information with the group, further positioning Jem as a contributing member of the group. I am not arguing that Lee’s question to Jem was necessarily
intentional in providing an OTL for Jem, but rather Lee’s actions gave rise to social and cognitive resources that Jem took up in their back-and-forth engagement.

Neither Jem nor Lee (or the group members) were in a constant position of power in Vignette 4. As I seek to understand how the focal student’s participation and acts of positioning shaped their access to particular OTL, I interpret Jem’s actions against the local activity and in relation to the collective activity system, which framed the expectations and norms for group work. Thus, a synthesis of CHAT and positioning theory for my theoretical framework is an appropriate lens for my multi-level analysis. In the following section, I identify Jem’s conflict mediation as participating in a Third Space of hybrid discourse practices, in which the group members renegotiated their relationships to each other and to learning.

An Opportunity to Learn Ethics: “Togethering” and Participation in a Third Space

I argue that Jem’s apology to Lee created a Third Space, within which the participants interactionally negotiated a ZPD to accomplish a collective and personal goal (Gutiérrez, 2008; Gutiérrez et al., 1999; Roth & Radford, 2010). Third Spaces attend to vertical and horizontal processes of learning, therefore incorporating both academic content and social discourse practices and practices that attend to interpersonal factors, such as consensus, democracy, and shared knowledge (Campano, Honeyford, Sánchez, & Vander Zanden, 2010; Gresalfi, 2009). Dr. Farrell encouraged students to be courageous and ethical in their scientific activities, and “to step on a few toes in the future” (05/27/16). As a consequence, I assert that the ways in which Jem engaged with Lee and with the disciplinary content – problem solving, moving across discourses, and encouraging the re-initiation of Lee into the group – illustrated an ethical moment.
In the previous chapter, I introduced Radford & Roth’s (2011) concept of “togethering,” which entails an ethical commitment that participants engage in to produce joint activity. In Vignette 4, I suggest that Jem’s actions illustrated that ethical commitment by endeavouring to corral Lee back into the group. In a Third Space, Engeström (2001) contends that the boundaries of an activity structure are reorganized, resulting in potentially expansive forms of learning (or an expanded object). I therefore argue that Lee’s silence provided Jem with opportunities to move across discourses – from academic to social – and to attempt peacemaking. Campano and his colleagues (2010) suggest that partnerships that value consensus will assume a variety of contours as they are worked out in local contexts of activity. Thus, as people engage in new kinds of intellectual and creative labour, they will look in different kinds of ways. For Jem, I do not mean to say that her actions were particularly noble or intentional; rather, I propose that Jem noted shifts in group membership and participation through contextual cues, and through embodying a collective approach to group work, attempted to make space for Lee to re-enter the conversation.

It follows that if Jem occupies multiple positions in the group work, the object ↔ outcome must be reconceptualized to embrace a wider horizon of action possibilities beyond formal science learning. By juxtaposing Jem’s interview data with the classroom video, she appeared to position herself and was positioned by others as the informal mediator, friend, and contributing member of the group at different points in the activity. Holland et al. (1998) suggest that positional identities are improvised in the flow of activity within specific interactions that arise from the cultural resources at hand. Similarly, Engeström (1995) contends:

The [acting] subject constructs the object and singles out those properties that prove to be essential for developing social practice … Without examining the cultural-historical
construction and content of objects, our understanding of activity and cognition remains informal and superficial (p. 397).

In alignment with these scholars, I argue that in order to make sense of Jem’s actions, notions of the individual’s biographical experiences and pre-existing relationships must also be considered. In the interviews, Jem repeatedly referred to her relationship with Lee as both an academic peer and friend, while also talking about how she “just wanted to get things done” in the group. These experiences may have informed how she interpreted the conflict and took up action. In other words, the emergent conflict in Vignette 4 was “the necessary but insufficient engine of expansive learning in an activity system” (Engeström, 2014, p. 78). Jem showed awareness of ethico-moral considerations of other group members, as well as scientific discourse practices. The former aspect cannot be regarded as independent of the scientific discussion, because the chain of actions that led to the apology was drawn from the same context. Therefore, I contend that Jem’s actions should not be read as a failure to stay on-task. Jem was learning. I submit her actions took place across both vertical and horizontal dimensions of the activity, creating a Third Space that encompassed an axiological kind of learning (Figure 12).

![Figure 12. Three-dimensional representation of Jem’s science learning.](image-url)
I suggest ideas of learning need to attend to movement outward and upward along the vertical dimensions of learning, but also sideways movements to consider ethical agency, emotions, social discourse conventions, and academic knowledge’s applications to broader contexts (Engeström, 2014; Kelly et a., 2001). These dimensions are complementary rather than incompatible. Without the formalisms and standards of practice, a contribution cannot be adequately interpreted or compared to the intellectual forebears within the scientific community (Roth, 2002). Without horizontal movement, learning is merely two-dimensional and lacks application and depth. Through this perspective, I propose that scientific competency be considered more expansively and in less narrow and deterministic ways. The above heuristic illustrates a more holistic way of considering the various processes at play in scientific activity and in the construction of knowledge.

My microanalysis of Vignette 4 highlights how a scientific discussion involved more than talking science; it involved establishing and maintaining positions and relationships and creating new social contexts. These kinds of relationships and interactions cannot be mapped out ahead of time. The processes of learning, whether it is between a teacher and student or between peers, are inherently complex, and there is no guarantee that they will move ahead straightforwardly (Campano et al., 2010; Mehan, 1998; Roth & Radford, 2010). These contentious practices can be sites for new meaning-making and as Jem demonstrated, to support the broader participation of other team members and to carve new OTL for herself.

In the next section, I summarize Vignette 4 and discuss Jem’s creation of a Third space, and the implications for educational research and science educators.

**Summary of vignette 4 and participation in a Third Space.** The segment of group work entitled “The Finger Incident” centred on a secondary contradiction ↔ critical
conflict that marginalized Jem’s classmate and friend, Lee (see Table 13). The Finger Incident created an unpredictable flash point, and illustrated “the contingent nature of activity systems, including languages used, notions of selfhood, and communities” (Roth & Lee, 2007, p. 204), which gave rise to particular social and material resources within the activity (e.g., group dynamics, conversational space). Jem drew upon these resources to position themselves and others in the scientific discussion. I argue that Jem used the dissent to create an ephemeral Third Space and reopen discussion. This chain of actions led to a reorganization of relationships and a shift in who could participate in the group.

As several scholars have remarked (Esmonde & Langer-Osuna, 2013; Gutiérrez et al., 1999; Lemke, 2001; Ritchie, 2002), heterogeneous learning spaces (e.g., group work) can be fraught with conflict. While at times, conflicts can be uncomfortable, they are not necessarily to be avoided. Although the group members did not “put down” each other’s ideas, they ignored Lee’s contributions. From a critical microethnographic perspective, conflicts are an essential feature of interactions that defy our attempts to correct or make them disappear (Mehan, 1998). The conflictual context of Vignette 4 and Jem’s subsequent apology appeared to have consequences for the distribution of OTL within the group and opened up space on the conversational floor. Lee’s silence provided Jem with the opportunity to participate in sustained, on-task talk, when before she seemed to be mainly listening to others talk. I further argue that Jem took up opportunities to problem solve, explain her thinking, and clarify her ideas.

In my analysis of Vignette 4, the interconnection of the academic and interpersonal demands was found in ways that Jem navigated the scientific discussion. I illustrated that Jem not only engaged in an “ethics of care” for Lee, she also took up an opportunity to talk science. By attending to the available social and material resources that emerged out of the group conflict
(e.g., Lee’s silence and expressions of negative emotion), I assert that Jem’s apology expanded the group activity to include horizontal considerations of social relationships and ethical commitments (Radford & Roth, 2011; Roth, 2007b).

As a result, I take a critical microethnographic perspective that examines Jem’s participation in the scientific discussion in forward- and backward-looking ways. By this I mean, the object ↔ outcome exists in a dialectical relationship. While the activity system’s collective object is considered intentional and gives overall coherence to the participants’ actions in group work (e.g., using scientific terms, staying on topic in scientific discussions), the outcome is informed by the interrelations between what the individual learner’s personal goals are, what sense they make of the local interactions, and the collective object (Foot, 2002; Heyd-Metuyanim et al., 2016; Kaptelinin, 2005; Roth & Radford, 2010; Sfard, 2000).

When Jem was asked about her takeaways from this course, she appropriated the “ethics of care” discourse introduced in the course (syllabus, 2016):

Typically, I value justice pretty highly, so when I look at different situations, I [say] ‘This is right, and this is wrong.’ I still view things like that, but I’ve become more aware and instead of being close-minded in this, maybe I should look at … if there are people being silenced by me making [a] decision.”

Jem appeared to bring the ethical framework highlighted in the classroom’s formal curriculum (vertical learning) into her navigation of the social dynamics of the group activity (horizontal learning). In order to make sense of how Jem took up particular OTL within the group activity, I analyzed her actions against the local group work, as well as the meso- and macro-level constructs of social life, such as friendships and her high-status science identity.
Vignette 4 demonstrates the complexity in analyzing student behaviours and learning. Within any activity system, it encompasses different members who may share the same general object, but also carry their own histories, interests, and repertoires of practice (Engeström, 2001; Gutiérrez & Rogoff, 2003). At the moment-by-moment level of analysis, participants may “switch strategies depending on the type of [interactions] they are facing” (Engeström, 1995, p. 398) amidst the constantly negotiated parameters of the work. At coarser grain levels of analysis, what counts as valuable participation and practice in the activity system also must be considered. I do not claim that Jem’s actions and ethical commitments in Vignette 4 will necessarily carry over to other contexts, or that she will continually consider and apply ethico-moral dimensions to scientific content. Indeed, Jem herself, talked about the tentativeness of her shifts in understandings about science, “I don’t know what to think about [these ‘new’ issues]. It obviously came from this [course]. I’ve definitely started to re-think different things that I would do normally and open my eyes to what else is going on.” What I do argue is that these hints of uncertainty within Jem’s statements may be taken as productive opportunities toward a shifting vision of axiological learning. Jem’s actions showed an awareness of multiple discourse strategies, one in which dealt with the course content and common task, and the second that considered the social dynamics of the group and reopened the conversational space for Lee.

Contradictions across Vignettes 3 and 4

In each of Jem’s vignettes, contradictions in scientific discussions potentially provided new OTL. The contrast of these cases showed how conflicts can be navigated and fruitful for some of the participants in the group, but not necessarily for all. In Vignette 3, Jem contended that Stuart’s non-participation contributed to the lack of group cohesion. In this case, she attempted to corral Stuart to finish part of the group assignment but was reportedly unsuccessful.
I coded the intergroup interaction as a ‘conflict,’ because first, Jem was non-committal to responding to Stuart’s bid for membership, and second, Stuart appeared to not participate in the writing portion of the assignment, thus resulting in a disagreement between the team members. My analysis of Jem’s narrative demonstrated that she reflexively positioned herself as a powerful facilitator by attempting to distribute tasks and “get … things done.” In addition, I argue that the Third Space of the Google Doc provided opportunities for Jem to maintain her position as a powerful participant in the group and critiquing other member’s intellectual contributions.

In Vignette 4, the Finger Incident prompted the members to shift their focus from Lee to Ning. Lee’s bids to change the topic evoked a critical conflict, as the other members ignored her. My analysis showed that Jem’s apology initiated an interactional space that served to reopen the issue. In other words, she created a Third Space that enabled others to engage with the course content, talk science, and/or provide support for Lee. Although the group’s pattern of interactions diverged from the “official discourse” of the classroom, I argue that the conflict and the participation in the subsequent Third space led to the development of different OTL for the group members involved. Lee re-entered the scientific discussion, and Jem was able to make a sustained intellectual contribution.

Analyses of Vignettes 3 and 4 pushed me to think about the emergent conflicts in intergroup interactions and attend to the classroom as a multi-layered activity system. What intrigued me the most about these activities was the lack of science talk I recorded and the consistent, negotiated sense-making of the participants. By following the threads of interaction and positioning across the different student groups, I attended to how Jem enacted, maintained, and shaped her positions in scientific discussions, and noted how her positional identities were unstable. I also marked points of disruption and how they were heard, interpreted, or ignored by
some participants (Gutiérrez, 2008; Kelly et al., 2001; Oliveira et al., 2010), and sometimes mediated by new and unpredictable actions, such as Jem’s apology. Such improvised but recognizable acts illustrate how students draw on language and other semiotic resources to position themselves and others in activity (Holland et al., 1998; Roth & Radford, 2010).

In addition, not all classroom practices are successful for all students. My findings suggest that first, researchers and practitioners alike should shift their expectations that group work represents an equitable academic panacea for learning. Second, I propose that Vignettes 3 and 4 affords the reader a view that a common task often, if not always, will have an interpersonal component as well as an academic one. The documented conflicts across Vignettes 3 and 4 made visible the negotiated learning interactions and identities of the participants, whereas in “unmarked” moments, they appear more seamless where knowledge seems to flow effortlessly from person to person (Mehan, 1998; Oliveira et al., 2010).

**Implications for CHAT.** My analyses of how the focal student navigated conflictual scientific discussions, and ultimately, how her acts of positioning shaped her access to and uptake of particular OTL, provided a way of understanding how a common task led to differential contexts for learning and talking science. These two vignettes with Jem as the focal student, demonstrated the multiple interactional demands required for participating in each of the student groups. In the first case, Jem attempted to enact and maintain her position as a powerful member of the group, while navigating the task requirements for the Group Article assignment. In the second case, Jem’s apology opened up a space for Lee to re-enter the conversation and the other students to continue on with their on-task talk. Through the reorganization of the conversational space and relations, Jem then took up the opportunity to make a sustained intellectual contribution. In doing so, she showed knowledge of the course content and social
conventions. My analysis of Jem’s actions suggest that she responded “appropriately” as a friend to Lee, as well as a contributing member of the group by reorienting the discussion back to the documentary. This suggests that beyond the considerations of disciplinary knowledge, the interpersonal relationships between group members also differentially shape participants’ access to particular OTL. Overall, my analysis showed that a common task did not necessarily lead to common OTL for all team members.

In this chapter, I illustrated how in different vignettes, students also shape the participation of and thus, access to OTL for other group members. In both cases, Jem’s narratives made visible the social factors involved in the construction of a scientific discussion, and more specifically, the contested nature of group membership and interpretations of what counts as an intellectual contribution. In an effort to surface how students negotiate identities and social relationships, I examined their talk and actions within intergroup interactions. Vignette 3 indicated how social boundaries and identities were enacted and maintained. I argue that first, Jem was interactively positioned as a powerful member of the group through Stuart’s bid for membership. The Third Space then created an extended opportunity for Jem to maintain her identity as a powerful member of the group by reflexively positioning herself in the role of the critic. Vignette 3 shows us how students within the same group did not have the same opportunities for participation. For learning science theorists, this raises questions such as, how can equity of OTL in student-led group work be supported; what are the potential interactional demands required for group membership and participation; and what are the ways in which small group activity can support and/or hinder access to knowledge?

The fourth vignette looked at how fluid power and identities were in intergroup interactions, and the social demands for participation. The empirical evidence through the video
data and transcripts of interviews illustrated that beyond talking science, group work involved negotiating and constructing social contexts, and defining the limits and direction of the task. By contrasting the actions of different group members, I examined the potential influence that individual knowledge and pre-existing relationships play in group processes, and how conflict potentially provides unique OTL.

Engeström (1995, 2014) defines horizontal learning as the subject’s creative movement across boundaries to explore potential connections to the collective object using whatever information and tools that may be available. In my analysis of Vignette 4, I argued that Jem engaged in an ethical commitment to Lee by creating a local opening to a Third Space and making space for Lee and others to discuss any issues at hand. By attending to Lee’s negative emotional response, I assert that Jem’s apology expanded the group activity to include horizontal considerations of mutual support and an “ethics of care” introduced in the course (Campano et al., 2010; Radford & Roth, 2010; Roth, 2007b). Therefore, there appeared to be an alignment between Jem’s actions and the ethical framework highlighted in the classroom’s formal curriculum.

In order to examine how Jem made sense of the group work experience, I looked at her interview responses about the group work. Jem repeatedly referred to her relationship with Lee in both academic and friendship circles, while also talking about how she “just wanted to get things done” in Vignette 4. Although she did not explicitly refer to Lee being ignored, I suggest that these responses hint at the meso-level factors (e.g., pre-existing relationships) that can come to bear on how the focal participant organizes her actions within the activity. In Jem’s final interview, she offers a reflection on the course’s lessons and how they influenced her daily life:
Typically, I value justice pretty highly, so when I look at different situations, I [say] ‘This is right, and this is wrong.’ I still view things like that, but I’ve become more aware and instead of being close-minded in this, maybe I should look at … if there are people being silenced by me making [a] decision.”

In Vignette 4, I argue for a need to examine what group members are actually doing in group work, as opposed to believing that the structure of group work is an academic panacea for equitable interactions (Anderson et al., 1996). My analysis made visible how within the same group, learning was successful for some, and not for others. Although this may be attributed to “natural” differences in achievement (Oakes, 1990; Simon & Campano, 2013), I argue there is nothing natural about it. A key suggestion for learning theorists to keep in mind is to consider explicit and appropriate scripting for engaging with differences in interpretation and cultivating a different kind of relationship to collaborative learning. Instead of viewing group work as a means to an end, future studies might consider how group activities can foster a zone of proximal development that embraces a wider horizon of action possibilities beyond formal learning.

Vignette 4 demonstrates the complexity in analyzing student behaviours and learning. Within any activity system, it encompasses different group members who may share the same general object, but also carry their own histories, relationships, and repertoires of practice (Engeström, 2001; Gutiérrez & Rogoff, 2003). At the moment-by-moment level of analysis, participants may “switch strategies depending on the type of [interactions] they are facing” (Engeström, 1995, p. 398) that do not relate to the common task. At coarser grain levels of analysis, what counts as valuable participation and practice must be considered, but also at a micro-level, how do these ideals of practice interact with how group members interpret and make meaning of particular actions?
Implications for teaching. My analysis of the Finger Incident brings attention to how interpersonal communicative skills of the participants of the different groups shape the nature and direction of the scientific discussion. The findings from my micro-level analysis have implications for teachers and point to the need to first notice, then deconstruct moments of conflict in the classroom. Struggles happen in everyday interactions with and without open conflict. These instances can often be invisible to teachers (Kotsopolous, 2014; see also Anderson et al., 1997; Esmonde & Langer-Osuna, 2013). It is significant that across both of Jem’s vignettes, they do not include the teacher as a participant, indicating that even when the common task was formally defined and assessed (as in Vignette 3), the work practice and kinds of interactions therein was largely constructed by the student participants.

However, if we take seriously the concerns of equitable distribution of OTL, I urge teachers not to shy away from conflict and discussions of power relations, even in content-focused classrooms. Instead, I modestly suggest that teachers listen carefully to student groups, and explicitly teach students how to productively navigate conflict. As Kotsopolous (2014) warns, failed collaborative experiences can have exacting results on how students see themselves as being competent enough to participate in scientific discourses (or not).

Some suggestions for pedagogical strategies include being explicit about the possibility for conflicts in small group work, what they might look like, how to engage with differences in interpretation, and the potential productive consequences for learning. In other words, if students do not take up the opportunity to consider the value and/or challenge others’ ideas, they may miss opportunities “to weigh the merits of different interpretations of data, a normative aspect of scientific argumentation” (Kelly et al., 2001, p. 170). In scientific discussions, the differences,
resultant exchange of ideas, and resolution of conflicts are valued practices in scientific communities, as well they may provide students with new meanings and outcomes to arise.

Given this potential for expansive learning and new OTL, I argue that the Third Space can be a fruitful site for theorization in future science education research (Engeström, 2009, 2011). However, as Bruna (2009) warns, the Third Space has been dangerously commodified in teacher education, as a power-neutral, multicultural discourse. Hybridity is something to be “achieved” by educators, rather than something that already is (Lemke, 2001; Simon, 2013). Bruna (2009) further argues this commodified view re-centres teachers and the formal curriculum at the locus of learning. In order to disrupt this tendency, I suggest we begin interrogating these student-led Third Spaces, with an eye toward the collective activity and the other on student sense-making and personal goals (Esmonde & Langer-Osuna, 2013; Gutiérrez, 2008). If studies continue to ground the concept of science learning solely toward vertical development and under the sanction of the teacher, conceptions of scientific competency and learning remain constrained, and we risk conflating visions of learning with reproducing dominance and teacher obedience.
Summary of the Findings

Examining the underrepresentation of people of colour and White women in STEM education and career fields has led to investigations of how students in heterogeneous spaces experience formal schooling and content area learning (Ballenger, 1997; Barton, 1998; Carlone & Johnson, 2007; Crawford et al., 1997; Reveles et al., 2004; Seymour, 2002). Current research in STEM education suggests that students should engage in particular kinds of student-centred, talk-intensive activities to support the acquisition of valued content and discourse practices. However, some studies also warn against using group work as an academic panacea for creating equitable conditions for learning (e.g., Crawford et al., 1997; Esmonde, 2009a; Kotsopolous, 2014; Ritchie & Tobin, 2001; Roth & Lee, 2007).

In this critical microethnographic study, I examined the kinds of OTL students accessed as they navigated scientific discussions, set within a university Kinesiology classroom system through the theoretical lens of CHAT and positioning theory. This dissertation investigated the processes of learning by first considering the role of the teacher and how they made space for science learning and made visible the range of OTL in the classroom system. Additionally, my research examined how students managed their participation in scientific discussions and, through their acts of positioning, took up particular OTL. I highlight the consequences of the focal students taking up different positions, and how different student groups negotiated understanding of a common task. The construction of a scientific discussion involved more than talking science; participants assumed several roles and responsibilities – some resisted participation, some focused on establishing and maintaining relationships, while others still
developed alternate practices. Several levels of analyses were conducted to add texture and nuance to my dissertation’s understandings of power dynamics, (positional) identities, and science learning in intergroup interactions.

In the sections that follow, I tie together the chapters of my dissertation. First, I briefly review the arguments and findings of each chapter. Then I explicitly draw out the themes that bind the chapters together, focusing on the ideological view of the classroom system, the ethico-moral considerations of scientific activity, relationality, the instability of student identities, and the relationships between conflict and access to OTL. After tracing these emergent themes across the chapters, I describe the contributions that this study makes to positioning theory, CHAT, and identify the limitations of this project. I close by revisiting the March for Science I introduced in Chapter 1 one year later, highlighting the tensions in scientific research and politics, and embed the implications for science teaching and learning and future research throughout the discussion.

Partially because OTL have been traditionally conceived of as access to quantifiable measures (e.g., equipment, textbooks, qualified teachers), the assumption is students who are given access to equal resources will perform comparably. However, this leads to an overemphasis on opportunity-to-learn standards with a focus on teachers and technical aspects of schooling as the locus of learning, and a neglect of student discourse as well as how race, gender, SES, and other social categories play out in interactions (Bruna, 2009; Esmonde, 2009a; Gee, 2008). If science educators and researchers alike are to better understand issues of equity and differential uptake processes that emerge in classrooms, I argue that attention must be paid to the immediate environment in which learning takes place, and the importance of everyday interactions through which students construct, reshape, and contest knowledge, and may be denied access to particular opportunities.
Chapters in Review

Chapter 1 introduced the current and perennial tensions of science’s role in sociocultural domains, and how conceptions of science and scientific literacy in the public forum inform formal education, pedagogical research, and government policies. I argued that the current political climate constitutes an important context for my study. The March for Science organization has similar concerns. In addition to being critical of the surge of anti-science agendas seemingly gaining momentum in the U.S. administration (Reardon, Phillips, Abbot, Casassus, Calloway, Witze, Lok, & Rodriguez Mega, 2017), the movement advocates for the inclusion of diverse voices in the scientific community and evidence-based policy decision-making at various levels of government.

By juxtaposing my dissertation with the emergence of the March for Science movement, the chapter briefly reviewed how formal schooling and the science domain has historically been steeped in Eurowestern values and practices, which shape the dominant content and discourse practices valued in the classrooms. These interrogations of access and power dynamics in science education informed my research focus, as I examined how teachers and students constructed the patterns of everyday life in a science classroom through their face-to-face interactions, and how these constructions influence what students have opportunities to access, accomplish, and therefore learn.

To lay the foundational work for subsequent chapters, this section also provided an overview of sociocultural theories of learning (Cole, 1996; Gutiérrez, 2003; Lave & Wenger, 1991; Vygotsky, 1978, 1986;) and emergent works in the field involving identity work, activity theory, and OTL (Anderson, 2009; Engeström, 1987/2015, 2001; Esmonde, 2009a, 2009b; Gresalfi, 2009; Holland et al., 1998; Ritchie & Tobin, 2001, 2002; Roth & Lee, 2007). As well, I
briefly introduced the *Ethics and Power in Kinesiology* course, an upper-year, undergraduate, prerequisite course for Kinesiology students. Next, I located myself and my theoretical orientations within the research. Finally, the chapter introduced my research questions and how they framed my study. Overall, Chapter 1 situated my dissertation within the current sociopolitical climate and outlined the educational landscape of critical sociocultural theories of learning by which my study is informed.

Chapter 2 outlined the preceding literature that informed my work. It provided an overview of the critical (Delpit, 1992; Haraway, 1988; Holland et al., 1998; Kumashiro, 2000), equity-oriented (Barton, 2003; Ladson-Billings, 1995; Nasir & Hand, 2006), and video-based microethnographic methodologies (Bloome et al., 2005; Erickson, 2006; Fitch et al., 2004; Jordan & Henderson, 1995; Mehan, 1998) that circumscribed my study’s epistemological approach to knowledge and research. The chapter explained the historical and intellectual forebears of culture, learning, and postsecondary science education that underpinned my research questions, situating my dissertation in the learning sciences and outlining the theoretical gaps I hoped to address.

This chapter also included a substantive discussion on previous classroom-focused studies using CHAT and/or positioning theory. Finally, I provided a rationale for integrating CHAT and positioning theory as my theoretical framework. By looking at the various patterns of interactions, spaces, and times constructed by the professor, Dr. Farrell, I submit that my analysis provides an ideological view of the classroom environment. Examining micro-level interactions within the context of my study afford a finer grain of analysis, and demonstrate how students, through their talk and actions, took up particular OTL in scientific discussions, and who is granted and/or denied access to particular content and discourses practices and student identities.
In Chapter 3, I re-introduced my research questions, and described in-depth critical microethnography – the methodology that I selected to examine those questions. My study focused on the Kinesiology classroom, and two focal students, Chrissy and Ning. The chapter described the video methods and interviews conducted with the participants. The video recordings documented the lessons and the group work. The students participated in three interviews: introductory, stimulated recall, and exit. By paying attention to multi-level contexts of interaction, I grounded my research in the dialectical approach, that is, how patterns of participation and what counts as knowledge in the classroom are mediated by the social and academic demands of the scientific community, formal processes of schooling, and student interactions. These expectations, roles, and responsibilities are reflected in the talk and actions of the teacher and students. The microanalyses of the different student groups showed how the focal participants managed their participation in scientific discussions and negotiated meanings within a common task.

In Chapters 4 to 6, I presented the main findings from my study. Chapter 4 described how Dr. Farrell organized the activity system and framed the collective object of science learning. I highlighted how the teacher structured classroom activities and encouraged critical, ethico-moral considerations of scientific activity. Chapters 5 and 6 were the case studies of Chrissy and Jem, respectively. I examined how the focal students navigated scientific discussions, and how their acts of positioning shaped their access to and uptake of particular OTL. In these analytic chapters, I illustrated how these intergroup interactions gave rise to resources that the focal participants drew upon to manage their participation and make meaning within a common task. Thus, each chapter, while focusing on a different level of analysis, provided a means of representing the complexities of a science classroom and the students’ multiple, positional
identities and varied learning processes. I assert that in order to better understand the scientific activity that took place within this classroom, learning must be accounted for across different timescales and spaces and pay heed to how scientific competence is constructed by the community’s intellectual forebears as well as the local participants (e.g., teachers and students) under study.

The case studies aimed to accomplish two things: 1) to highlight how Chrissy and Jem, as active participants, navigated conflictual scientific discussions and took up particular OTL; and 2) to show how the co-construction of scientific discussions involved more than talking science and completing the classroom task. Taken together, these two chapters examined the focal students’ uptake processes of course content and discourse practices as they positioned themselves and others in intergroup interactions.

This critical microethnographic analysis, based on the synergistic integration of CHAT and positioning theory, contributed to the field of educational studies in two ways. First, this approach promoted the notion of a classroom as dynamic and multi-layered even within the same setting. That is, a common task can lead to differential contexts for learning, and some of which were not always positive for all participants. There has been limited research examining OTL across multiple contexts in a single classroom (e.g., Crawford et al., 1997; Esmonde, 2009b; Ritchie, 2002; Takeuchi, 2012). My study looked at several levels of analysis, and across different contexts and with different student groups. Second, this study used CHAT (e.g., Cole, 1996; Engeström, 1987/2015; Saxe, 2002) to disrupt notions of scientific competency as a static attribute belonging to an individual. The analyses also showed how students’ differential uptake of positions is a way of representing individual contributions to shaping group contexts, practices, and access to OTL. I illustrate how students drew on resources that arose out of those
intergroup interactions to position themselves and others within classroom hierarchies, negotiate what counted as participation, and define the limits of the task.

Central Themes

Ideological view of the Kinesiology classroom system. Using CHAT, the purpose of Chapter 4 was to explicate the dimensions of the classroom activity system, and how they represented the range of OTL. I described how the teacher organized lessons and made space for particular classroom activities. I contended that Dr. Farrell framed science learning as the process of developing an “ethical self” (syllabus, 2016), thus encouraging particular ways of approaching socioscientific problems, while problematizing certain scientific content and discourse practices. For example, the formal curriculum presented ethical dilemmas in the fields of Kinesiology and medical sciences, such as objectifying attitudes toward the body in gross anatomy courses and animal and cadaver use in Kinesiology labs.

If the reader interprets Dr. Farrell’s pedagogical strategies as somewhat political, that is, because they are. However, I argue that it is no different than what has historically been done in formal and informal learning spaces. That is, all curriculum constitutes a “selective tradition” (Apple, 1980; Deng & Luke, 2008) of particular content and discourse practices. What appears to differ is the extent of explicit surfacing of epistemological and ontological orientations inherent within the development of scientific (or any kind of valued) knowledge. Thus, my dissertation investigated how scientific knowledge is interactionally achieved or co-constructed in a university Kinesiology classroom and examined what is typically taken-for-granted in everyday interactions between students, teachers, texts, technologies and other tools.

One way to view the first level of analysis is that Dr. Farrell provided an orienting framework for conceptualizing the nature of science (NOS), science learning, and the nature of
classroom (social) life, all of which were tightly integrated with the concept of scientific competency. As previously mentioned, I conceive of OTL as an interactional phenomenon. Thus, OTL in the classroom activity system did not just involve engaging with course content and discourse practices, but also included interpersonal demands for constructing and maintaining social relationships, defining the directions and limits of the common task, and what counted as acceptable participation for group membership. In Table 15, I summarized the broad range of available OTL.
Table 15
*Summary of the range of OTL in the Kinesiology classroom activity system*

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Scientific work</th>
<th>Collaborative work</th>
<th>Scientific work with others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object</td>
<td>Meet curriculum expectations (internalization)</td>
<td></td>
<td>Teacher’s verbalization of the collective object (externalization)</td>
</tr>
<tr>
<td></td>
<td>“To introduce students to a range of scholarship on ethical thinking in social life and physical cultural studies and apply critical theoretical concepts to ethical dilemmas in sport, kinesiology, physical education and health” (syllabus, 2016, p. 5).</td>
<td></td>
<td>“Sometimes when you stick your neck, you’re going to get a little hurt sometimes. But with what theory and what tools you have now, you can challenge and transgress the status quo … I hope you bring some of these ideas and start stepping on some toes” (05/27/16).</td>
</tr>
<tr>
<td>Rules</td>
<td>Working accurately (e.g., exams, quizzes)</td>
<td>Democratic voting</td>
<td>Extra help available during breaks and appointments with teacher</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Explaining ideas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Listening to others’ ideas</td>
</tr>
<tr>
<td>Tools</td>
<td>Formal curriculum</td>
<td></td>
<td>Debating and argumentation</td>
</tr>
<tr>
<td>Division of labour</td>
<td>Engage with content (e.g., lectures, documentaries)</td>
<td>Maintaining high-status position</td>
<td>Mutual understanding</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Making connections</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Organizing work (e.g. group work)</td>
</tr>
<tr>
<td>Community</td>
<td>Maintaining friendships</td>
<td></td>
<td>Engage in dialogue with expert others (e.g., teacher, guest speakers)</td>
</tr>
<tr>
<td></td>
<td>Establishing relationships</td>
<td></td>
<td>Problem solving</td>
</tr>
</tbody>
</table>
To be clear, Table 15 should not be taken as an exhaustive list of the learning opportunities available in the classroom. As will be reiterated later on, students are agentic individuals who, through conflict and other improvisational actions, are capable of carving out their own spaces for developing and accessing unique OTL. The above table focuses on the range of OTL that are supported by the formal curriculum and in alignment with how Dr. Farrell structured the classroom and its activities, illustrating what scientific and collaborative engagement looked like at the classroom-level. These aforementioned OTL should therefore be considered provisional and did not solely determine whether and how students took up these opportunities.

Classroom practices can differ in the extent to which they encourage problematizing of certain ideas and issues, and in the ways that differences are resolved (Greeno, 2006). Therefore, in Chapter 4, I described the idealized vision of the course and the ways in which students were expected to act. This broader, systematic view foregrounded the daily classroom routines and social organization of the activity system and framed the kinds of learning that were likely to occur in the classroom (to the extent that what is conceived as possible is often constrained by technical and structural aspects of schooling). These processes are often invisible and/or implicitly communicated to the participants (Roth, 2009; Tuyay et al., 1995). Underlying this ideological view of the Kinesiology classroom is a view of learning as a collective phenomenon. From this perspective, what a student says or does is shaped by the normative expectations for their academic and social behaviour. For example, if a classroom practice particularly values “getting the right answer,” then students are less likely to take risks in sharing information and contribute publicly.
In the following section, I describe one example of Dr. Farrell’s pedagogical practices that they made space for in the course. I highlight it as a central theme, because it was a through line that ran throughout the lessons and provided a broader contextual framework for surfacing the common discourse patterns found in this classroom.

**Ethico-moral considerations of scientific activity.** Embedded within the Kinesiology course was the explicit assumption that students enrolled in the Kinesiology program at the university would take up future positions of social responsibility and leadership in society. The course aimed to develop students’ identities as “historically, culturally and socially produced … ethical subjects” (syllabus, 2016, p. 5). Ethical, socioscientific dilemmas were integrated into the lessons, such as the use of animal and cadavers in their labs. Students were also provided opportunities to engage in conversation with their peers and other Kinesiology scholars beyond Dr. Farrell. Questions posed within this course did not just include what kind of scientific knowledge is valuable (and assessed), but also, *who* is responsible for the production of *what* knowledge; who is included and excluded in these conversations; and who is harmed?

This course was also particularly interesting to me, as Dr. Farrell identified as a critical feminist scholar who explicitly discussed inequitable power relations in the scientific community, problematized the “objective” narrative of science, and emphasized the tentativeness and value-laden aspects of scientific activity. In these ways, the course diverged from more traditional science classes; as well, the teacher’s pedagogical strategies encouraged discussions and group work across the lessons. Therefore, I argue that most classroom activity was organized around the intersection of engaging with the course content and with social others. Students were afforded with a wider range of collaborative tenets of OTL that may be less encouraged in more content-focused and/or individualistic classrooms.
The findings of Chapter 4 are both specific to science learning and more general. Using the CHAT triangle heuristic, this dissertation systematically investigated how Dr. Farrell framed science learning, and the kinds of OTL the professor made space for in the activity system. In other words, examining the trajectory of the Kinesiology course afforded the researcher and reader a view of the deliberate, organizational work involved in constructing a particular kind of learning environments. My analysis explored the multiple dimensions of formal learning represented by the nodes of the CHAT triangle (see Figure 2), the dialectical relationships between the dimensions (that is, how they informed one another), and the OTL that were facilitated and/or constrained by the teacher’s lessons and activities.

Furthermore, the analytic chapter offered a dynamic view of science teaching and learning, in that I acknowledge that the classroom system is a holistic configuration of separate but related elements, and that there are historical continuities that connect the scientific community and institutional schooling, respectively (Gutiérrez & Rogoff, 2003; Nasir, Rosebery, Warren, & Lee, 2006). Simultaneously, Dr. Farrell’s framing of the course demonstrated how these continuities can be questioned and challenged. Therefore, the important take away from Chapter 4 is not that canonical knowledge is irrelevant or evil, but to pay close attention to the organization of the learning environment in which students are participating, make explicit the epistemological assumptions of the domain (e.g., NOS), and to support learners in deliberate ways to be recognized as scientifically competent.

However, what was unknown from considering these patterns of daily classroom life was how and why these classroom practices shape student engagement. It was less clear why certain practices were made meaningful for specific students, how students accessed (or did not access) learning and identity construction resources, and how they took up and/or redirected classroom
interactions (Anderson, 2009; Gresalfi, 2009). In order to better understand how OTL were distributed across groups and in different interactions, the next level of my analysis involved in-depth sociolinguistic analyses of how focal students negotiated conflictual scientific discussions and took up particular OTL. I considered the material and social conditions in which learning took place, and the consequences for focal students’ learning processes.

When I examined the talk and actions of the participants, I integrated positioning theory into my theoretical lens to consider the moment-to-moment processes of meaning-making in everyday classroom interactions. My study therefore added to the CHAT literature by shifting to a finer-grained analysis of individual perspectives and contributions to intergroup interactions, set within the Kinesiology classroom activity system in the subsequent analytic chapters, and how participants learned and completed tasks together.

**Relationality and instability of student identities.** In the context of the Kinesiology classroom, I posed the following sub-question for the case studies: Within scientific discussions, how do students’ participations and acts of positioning shape their access to and uptake of particular OTL? Thus, I considered the positional identities of the focal students, Chrissy and Jem, and how certain aspects of identity became more salient in particular interactions. Each of the case studies included two vignettes of group work, one in which the group members were assigned, and the assignment was formally assessed (Vignettes 1 and 3), and one in which the members were self-selected and involved an informal scientific discussion (Vignettes 2 and 4). They were chosen as key events because they were brought up by the focal participants in their interviews, and included an observable, sustained contradiction. The presence of a contradiction was interpreted as a visible throughway of understanding the
differential influences of individual contributions to the group activity (Mehan, 1998; Kelly et al., 2001), as opposed to the more traditional definition of contradiction (e.g., open conflict).

Using positioning theory to analyze the focal students’ participation within scientific discussions added further nuance and texture to my research. Although studies have shown that group work can be beneficial to many students in STEM, this has not been the case for all students (e.g., Esmonde, 2009a; Gresalfi, 2009; Kotsopolous, 2014; Moje & Lewis, 2007; Ritchie, 2002). To more closely examine the distribution of OTL, I argue that one should consider the students’ uptake processes – how students chose to participate in activities, and how they shaped the participation of others. While the common task across all four vignettes was defined by the teacher, the sense of cohesion and directions of the task were largely co-constructed by the students and their interactions. By adding positioning theory to my interpretative lens, I explained how science learning and identities were negotiated in moment-to-moment processes and evoked various student discourses. I describe three emergent themes from my critical microethnographic analysis: 1) the role of relationality in science learning; 2) the instability of positional identities; and 3) the relationship(s) between conflict and access to OTL.

**The role of relationality in science learning.** The view of a collective learning process that informed my research lens also fostered dialectical understandings of the relationships between students in the groups. Across the case studies, I showed how the small-group tasks were negotiated through their talk and actions, resulting in the development of differential access to OTL. In Vignettes 1 and 3, both groups were working on the *Group Review Article* assignment. While Chrissy co-constructed knowledge with Geena and appeared to facilitate Geena’s participation in the presentation, Jem was reportedly less responsive to Stuart.
Jem also took up the informal role of a critic when she corrected her team members’ work on the Google Doc. In Vignettes 2 and 4, the students participated in informal small-group discussions about the respective class topic. Chrissy and Ning engaged in side talk to continue talking about the lesson, even as the participation structure shifted, whereas Jem’s group spent most of their time dealing with the Finger Incident instead of on-task talk. Through these analyses, I contend that these four vignettes made visible the differential negotiations of a common task and what factors became salient in interpersonal interactions. These excerpts illustrated that beyond content learning, context is important. According to Tuyay and her colleagues (1995):

context … is produced by the interactions of members of the group as well as by where and how the interactions take place, as well as by the physical setting. From this perspective, an event has multiple context and events are intertextually tied within and across cycles of activity, (p. 81).

In other words, the context of each group task created different interactional spaces and discourse patterns through which the members developed and accessed unique OTL, and they drew upon different resources that arose in those conflictual interactions to make meaning.

Furthermore, the analyses showed that the construction of the scientific discussions involved more than talking science, that is, the student discourse practices did not give us a direct window into students’ understandings of the course content. Rather, group work was mediated by social and academic, collective as well as personal goals; it involved establishing and maintaining relationships within the group and differentially defining the direction of the academic task. Each of the vignettes used multiple and varied strategies for completing the common task, e.g., posing questions, explaining ideas, questioning others’ contributions, suggesting alternative courses of action, and dissenting from the group’s activity. My video
recordings and interviews made visible what each focal student decided to contribute, how they decided to contribute, and what the other group members accepted as an intellectual contribution. Therefore, through a focus on student discourse, I identified the ways in which work was being done and the interactional demands on the students for participation were surfaced.

Examples of the interrelationship between the academic and social demands were found in the ways that students treated contradictions in small-group settings. In Vignette 1, my microanalysis showed that in addition to the opportunities to talk science, these students had the opportunity to create and take up unique OTL within the group. The members had different evaluations of the group assignment. While Chrissy was quite calm about talking in front of the class, Geena was reportedly very anxious about it. Chrissy attempted to mediate her fears by listening closely to her ideas and supporting her. In Vignette 2, Chrissy’s talk with Ning was mediated by the shift in participation structures. This suggests that time and space were socially constructed (Tuyay et al., 1995). By participating in side talk, the students found a way to draw upon a desired resource – more time – and invoke a wider set of discourses and thinking processes. At other times, OTL were left untaken or were avoided, such as the case in Vignette 3. By responding minimally to Stuart, Jem may have missed an opportunity to involve Stuart. His later reported non-participation in the written task suggests a missed opportunity for the group as a whole to consider the potential merits of Stuart’s contributions to the assignment.

In Vignette 4, the Finger Incident appeared to shut down Lee’s contributions to the group discussion for a period of time, suggesting repeated missed OTL for the group. This is not to say that the other team members did not learn from these interactions or take up alternative opportunities, instead I argue the “flooding out” (Goffman, 1967, as cited in Bloland, 1979) shifted the frame of focus from the on-task discussion. As Esmonde (2009b) contends, for a
group’s interactions to be equitable, they should attend to each of the members’ meaning-making processes, not just a few. Thus, Vignette 4 illustrated there were unpredictable power dynamics at play that may have facilitated one student’s participation while constraining another’s.

The instability of students’ identities. The second discussion point involves the multiple roles and relationships students took on while engaging in the co-construction of knowledge. It may be assumed that the students in the Kinesiology class were relatively skilled learners. They were in the final years of their program at a high-ranking Canadian institution, which suggests that they had, at the very least, been successful in most (if not all) of their science courses up until this point. However, the focal students’ narratives presented a range of abilities, with Jem describing herself as a strong student, and Chrissy saying she was an average student who struggled with standardized testing.

The focal students’ interviews involved narratives surrounding scientific competency and the division of roles and responsibilities, which in turn, were associated with participation patterns and power relations in group work. In some form or another during the interviews, the focal students identified the presence of various student roles, such as leaders (those who tended to control the social interactions and dominate conversations); facilitators (helpers who assisted others and distributed work); and novices (individuals who required some assistance). Neither Chrissy nor Jem explicitly named particular students as novices, rather they expressed some exasperation and/or described certain events as “problems” when referring to learners that they indicated as not exhibiting common knowledge or participating in socially accepted ways.

These identities, however, were not stable. The specific patterns of interaction and talk within the group provided particular OTL for the students but was not solely determined by the
academic task itself (Anderson et al., 1996). Thus, while structures construct and constrain the parameters of scientific activity, they do not determine it (Anderson, 2009; Goodwin, 1994). Within unpredictable moments of interaction, such as the Finger Incident of Vignette 4, the focal student and other team members shifted positional identities. Lee went from being a central participant to being silenced. Jem moved from being a listener to an informal mediator to an active participant in the group. In considering the intergroup interactions, the power relations between students also became visible. Some students held more conversational space and time; their ideas were taken up more readily; and they were also better positioned to critique the ideas of others. However, such powerful identities were also unstable.

From a cultural-historical perspective, participants’ identities are tied to their activity, because “what someone does, including what someone does in relation with others and therefore how [they] relate, is attributed (as a characteristic) to the acting subject” (Roth, 2007b, p. 89). In other words, these enactments and recognitions carry implications for what the teacher and students do and say and shaped the available OTL in an activity (Moje & Lewis, 2007). For Chrissy, she appeared to take on a more egalitarian role across the two vignettes, which seemed to align with her expressed preference for discussion and group work in school learning. In Vignette 3, I argued that Jem took up a more powerful role in the group by maintaining social boundaries and critiquing others’ contributions. In Vignette 4, Jem moved from a more passive role to a mediating one. Depending on the context of the group work (that include considerations of the task requirements, course content and discourse practices, and navigation of interpersonal relationships and social hierarchies), the focal students were positioned differently (Table 16):
Table 16
Focal students’ positional identities across the vignettes

<table>
<thead>
<tr>
<th>Chrissy</th>
<th>Vignette 1</th>
<th>Vignette 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Facilitator</td>
<td>Neither expert, nor facilitator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contributing member</td>
</tr>
<tr>
<td>Example from transcript</td>
<td>“If anything happens, we can back you up.”</td>
<td>“Ning and I are on the same level, intellectually.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Jem</th>
<th>Vignette 3</th>
<th>Vignette 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Powerful facilitator</td>
<td>Listener, mediator, contributing member</td>
</tr>
<tr>
<td>Example from transcript</td>
<td>“I was the main [person] in trying to get things done.”</td>
<td>“Sorry, you were saying?” [to Ning]</td>
</tr>
</tbody>
</table>

My microethnographic analyses traced the manner in which the Chrissy and Jem took up particular positional identities through verbal and non-verbal means across two different student groups, respectively. In addition to moments of positioning, the focal students’ actions seemed to be influenced by their more stable, practice-linked identities. For example, in Vignette 2, Chrissy commented on Ning’s and her use of gesturing as a form of scientific communication and mutual understanding. Chrissy’s interpretation of these behaviours was informed by her knowledge of their backgrounds as dancers and was a reported reason as to why Chrissy believed they worked well together. In Vignette 4, Jem’s narrative centred around her relationship with Lee, her roommate and friend, so this aspect of her identity appeared to be an integral part of the intergroup interactions. In this analysis of Jem’s group work, I connected her positional identity as the informal group mediator to her friendship with Lee. I contend that my ethnographic observations of the classroom, interview data with the focal participants, coupled with a discursive analysis of the scientific discussions and the activity system within which the students were situated, lend strength to my analysis and findings. Without such access, it would be impossible to determine with any degree of certainty the students’ goals and/or motivations.
In addition, I noticed that Chrissy and Jem took up more powerful positions when students from non-dominant groups (e.g., English language learners, quieter students) made bids to engage in the activity. In the first vignette, Geena’s reflexive positioning as “having ESL” appeared to influence the perception of herself as a scientifically competent learner. The group presentation evoked feelings of anxiety for Geena. Chrissy reported that Geena reached out to her outside of class. Chrissy attempted to alleviate her concerns by working with her separately and offering her emotional support, and so was interactively and reflexively positioned as a valuable member of the group. In Vignette 3, Jem was positioned as a powerful facilitator, and described herself as the “main person in getting things done.” Stuart, an East Asian, male-presenting team member, messaged her on Facebook, and asked Jem if he was in her group. Jem responded to him non-committedly, but later in our interview, reported frustration at his lack of participation in the written portion of the assignment.

Although males have historically been positioned as outperforming females in the sciences (Brickhouse, 2001; Carlone & Johnson, 2007; Chen, 2013), Jem was a self-identified high-status, White student. Therefore, the complex interplay of intersectional, social categories may have a confounding role in how the students’ positional identities were differentially afforded. It is also not known if Stuart identified as a high-performing student or if there were other factors that influenced Jem’s interpretation of Stuart’s non-participation within the group. While I do not deny that positioning in relation to racialized and gendered (and so forth) categories are often associated with positioning in relation to academic competence (Dookie, 2015; Esmonde, 2009b; Oakes, 1990), I make my observations very tentatively, as I do not have data pertaining to the other students’ interpretations of the events or their academic records. As well, in the interviews, the focal students did not explicitly mention race or gender within
scientific interactions (although Chrissy did mention the language abilities of her group member in her narrative). As conceptions of scientific competencies were more readily discussed, they formed the crux of my analysis.

To build stronger connections between students’ social identities and acts of positioning, other analytic methods would be required. For example, I would need to draw on interview topics to explicitly discuss with the focal participants how they view classroom interactions through racialized and gendered lenses (e.g., Brickhouse et al., 2000; Esmonde, Brodie, Dookie, & Takeuchi, 2009; Langer-Osuna, 2011). This also calls for further research on students’ intersectional identities and their relationship to scientific competency (Carlone & Johnson, 2007; Seymour & Hewitt, 1997).

**Relationships between Conflict and Access to OTL.** The next emergent theme concerns the development of unique OTL by the emergent conflicts in the scientific discussions. My analyses of the small-group activities showed that the groups constructed different OTL across the four vignettes, and different students had differential access to OTL. This raises questions about whether students left the scientific discussions with common knowledge, which is presumably one of the goals of the activity (Kelly et al., 2001; Martin, 2016).

Within the observed small-group work, there were power dynamics and relationships that could not be determined *a priori*, and subsequent chains of events that led to a reorganization of relationships and shifts in activity. The social dynamics of the different groups differentially shaped the nature of the scientific discussions. For example, in Vignette 1, Geena’s interactive positioning of Chrissy as a knowledgeable member of the group, and Chrissy’s taking up of a
social discourse with Geena may have facilitated collaborative learning opportunities. Aligning with other learning theorists (e.g., Anderson et al., 1997; Gresalfi, 2009; Moje & Lewis, 2007; Roth, 2007b), social and affective aspects of engagement are not separate from the content-oriented learning that is traditionally the sole focus of education studies. They are central to the learning process, as they influence students’ motivations, how they interact with problems, with others, and how they view themselves. I therefore argue that Chrissy’s uptake of the role as group facilitator enabled her to engage with the course content in different ways that could not have been predicted or might have been potentially unavailable had she not taken up the role.

In the case of Jem, her power as a high-status student may have shaped her access to opportunities to orchestrate the group activity. In her narrative of Vignette 3, she attempted to distribute the academic tasks, and at least temporarily, limited another student’s participation and access to the Third Space (the Google Doc). She also occupied the “more powerful” position of critic in writing the article summary, where she edited the contributions of other team members. In contrast, her apparent sensitivity to Lee’s negative emotions may have afforded her a wider breadth of OTL in the fourth vignette. With Lee initially controlling the conversational floor, much of Jem’s participation was initially rendered to listening to others’ explanations of their ideas. However, when the Finger Incident occurred, the chain of events led to a reorganization of the group dynamics, and the conversational space opened up. After apologizing to Lee, Jem appeared to facilitate broader participation opportunities for others and for her to take up an opportunity to speak. As a result, the OTL across the group were redistributed, and Jem made a sustained intellectual contribution.

The question of what kinds of OTL did students have access to, raises concern for those students who did not access support beyond the group activity. Talking and writing were two
mediums through which the students co-constructed knowledge across the vignettes, and each student interpreted and acted upon the tasks differently. However, the analyses showed that a common task was negotiated and re-negotiated by the participants in a moment-to-moment process, fostering different OTL. The tasks, framed within the context of collaboration and/or conflict, afforded particular OTL to the group members, and in turn, may or may not have been taken up by the focal students. This suggests a need to examine situations in which students have opportunities to engage with differences in interpretations, conflict, and assume different roles and responsibilities.

My microethnographic analyses extended my understanding of student discourses and identities in science classrooms and illustrated their dynamic nature. As I seek to understand more about the factors that support and/or constrain access to OTL and particular identities, my findings raise further questions about science learning and aspects that educational researchers might study in order to further understand the co-construction of academic knowledge: How can teachers and researchers delineate the differences between doing school well and doing science well; how do these sometimes-overlapping requirements facilitate and/or constrain student participation?

**Connections to Positioning Theory**

First, this dissertation breaks away from the “imminentist” ontology that positioning theory has traditionally embodied (Anderson, 2009) by explicitly bringing into focus the meso- and macro-level forces of influence on science learning. It extends the range of analyses that learning sciences studies usually work in and considers how different ways of learning and their associated modes of access to the phenomenon were co-constituted through various ways that a specific group setting was organized. This work focuses on the social relations between students,
how they managed their participation in conflictual scientific discussions, and took up particular OTL through their acts of positioning. Vignette 1 highlights how knowledge of the dominant language may be conflated with scientific competence and expertise, and how this expression of power and privilege can skew who is considered an expert or novice in the group work. Chrissy’s ability to speak English fluently positioned her as a more powerful member of the group, and Geena approached Chrissy as someone who was knowledgeable and could potentially assist her with the academic task.

The analysis of Vignette 4 drew out the relational dynamics between the team members and called for careful consideration of the attendant storylines of the participants. The concept of “positioning” illustrated how positioning practices are experienced differently by individuals occupying different social and intellectual locations and the potential portability of the students’ identities across contexts and timescales (Gee, 1999; Wortham, 2004b). For example, Jem’s identity as Lee’s friend and roommate may have carried over to the Finger Incident and influenced how she oriented to Lee being silenced in the group.

As Anderson (2009) further contends, “positions and storylines co-emerge in particular face-to-face interactions along with attendant presumptions that limit [and/or facilitate] possible future action and interpretation” (p. 293), implying that a person not only acts through interactive and reflexive positioning, but is also an embodied site for mediating acts of positioning. Put in another way, my work suggests linking analyses of active learning processes with analyses of historical and contemporary power relations that are of a different ontological grain size. In interviews, Chrissy maintained that Ning and she were not friends; however, she mentioned that they had similar interests and were both dancers. Chrissy attributed their common history as a reason for their smooth collaboration, and why they used a lot of gesturing in their scientific
communication. Bloome & Egan-Robertson (1993) contends that people in interactions explicitly and implicitly link the local event in which they are involved, with broader, sociocultural and political contexts. The scholars claim that whether these links are well-formed or contested, is besides the point. The point is, people do make these intertextual constructions in social interactions. The present study therefore posits a connection between the micro-level interactions and the participants’ ontogenic histories and considers how learning is (at least partially) mediated by students’ drawing upon the social and textual resources that arise out of the local interactions to evoke meso- and macro-level influences (Anderson, 2009; Holland et al., 1998) that inform their meaning-making.

Differences between the Researcher’s Microanalysis and the Focal Students’ Interpretation of the Events

Across the four vignettes, the identification and explanation of the focal students’ acts of positioning were compared to the researcher’s analyses, and when possible, in conjunction with the microanalyses of the video segments. There were inconsistences between what I, the researcher focused on in my analyses, and what the focal students saw and felt within the interactions. As previously described, I came to the research with a host of experiences, perspectives, and positions that inform my ways of viewing and interpreting these cases. I am a Chinese-Canadian woman with a background in science education who sought to examine the processes of student learning and opportunities to participate, and how they relate to issues of power and equity within science classrooms. Thus, I reject the idea that a researcher can ever be a disinterested observer without their own orienting epistemologies, or that it is a stance that should be preferred.
The focal students themselves had a range of histories and experiences within formal schooling and in science specifically, as well as an assortment of intersecting identities (e.g. social, practice-linked, and so forth) that shaped their own ways of explaining and interpreting events. Further to this, I was an outside observer to the classroom events, whereas the focal students experienced the group work. These differences in position came to bear on our respective ways of seeing and interpreting the group work. By not privileging my perspective and keeping in mind our different locations, it comes as no surprise that there were differences between the researcher’s analysis and the focal students’ interpretations of the events.

One of the inconsistencies I initially noted was Chrissy’s position as the authority figure in the scientific discussions with Ning in Vignette 2. I observed that she started speaking first and controlled the conversational space. She spoke for longer instances of time and took up more physical space, whereas Ning tended to use her turns to affirm Chrissy’s intellectual contributions and took up less space. However, Chrissy did not mention these acts of positioning in the interviews. Chrissy stated that she felt like she and Ning were on “the same level intellectually,” and made observations about their joint meaning-making practices, such as their hand gestures and body movements. She mentioned that both of them were dancers – information that I was not privy to prior to the interviews – thus, her position as a Kinesiology student afforded her knowledge of other students that influenced how she viewed and intertextually explained her team member’s behaviours in the vignette.

With respect to Jem, she spoke briefly about Stuart’s lack of participation in Vignette 3. When asked further about this incident, she stated that there was a miscommunication between the group members. While I interpreted the event as a conflict in which Jem positioned Stuart as an outsider and limited his initial participation in the activity, Jem reflexively positioned herself
as “the main [person] in getting things done.” In her narrative, she helped to complete the written portion of the assignment, positioning herself as a problem solver in the group. I reiterate that I do not know if Stuart reached out to other members afterwards or how he interpreted the event.

Despite these differences in the perspectives and positions that undergird my and the focal participants’ interpretations of the small-group interactions, there were a number of notable consistencies between what the research highlighted and what the focal students remarked on in the SRIs. The subtle acts of positioning that were discussed in the researcher’s perspective were also identified by the focal students. For example, Chrissy noticed Geena’s reflexive positioning as someone who was less scientifically competent and explicitly noted the importance of doing relational work (e.g., attending to socio-emotional aspects of learning, building relationships) with Geena. In Vignette 4, Jem appeared to notice the silencing of Lee first and her subsequent expression of negative emotions, as I did upon viewing the video data. Although I may refer to these actions as ‘subtle’ acts of positioning, they perhaps were not so subtle to the focal students who experienced them in the moment.

**Methodological Contributions**

The design of this research contributes to the learning sciences and science education studies in several ways: through the multi-level inquiry of the Kinesiology classroom, the investigation of focal participants’ participation in scientific discussions, the use of video data to document the classroom interactions, and the consideration of the participants’ perspectives in this dissertation’s analysis.

First, this research contributes to the science education studies by integrating video data with my ethnographic observations. My research design is unique in that I documented the
trajectory of a university Kinesiology classroom across its entire course. This record allowed me to conduct a detailed analysis of the teacher’s pedagogical strategies, classroom activities, and issues that are problematized and surfaced. As Greeno (2006) contends, the researcher has to analyze the whole activity system without having a complete understanding of the individual components, particularly the human participants. In my research, I was fortunate enough to have two focal students who agreed to be interviewed and videotaped. While my dissertation only skims the surface in terms of the types of analyses that are made possible through this kind of data collection and analysis, I have a rich set of data that examines how students navigated different classroom activities. I highlighted the multiple interactional demands required for students to participate in group work, and how they learned the course content in ways that are partial, relational, and contested.

Rather than presenting a two-dimensional view of learning, this critical microethnography zooms in and out on the multiple levels of classroom analyses. Using the CHAT triangle, I approached the data systematically, instead of in an ad hoc manner. The methodology models a different approach to examining student learning in a way that allows for a more detailed analysis at a finer grain size, while taking a broader, systematic view of how the teacher framed science learning and made particular OTL available. Through a CHAT lens, I understood the cultural-historical practices of the scientific community as remotely shaping what counted as canonical knowledge and discourse practices in the classroom activity system.

Second, this research process contributes methodologically through the use of stimulated recall interviews (SRIs) and explicitly considers the power dynamics between researchers and their participants (Ritchie & Rigano, 2001), who occupy multiple and varied theoretical positions. As the focal participants reviewed the video data, they developed an observational
critique of the intergroup interactions and student discourses. These SRIs then became data for analysis, and in this way, I collected a rich record of the focal students’ reflections on their learning and participation. My research was part of an iterative process of analyzing the everyday classroom activities of the Kinesiology classroom, which in turn shaped the small-group interactions, and informed my analysis. I also made a concerted effort to include and distinguish the focal students’ voices from mine in my discussions. This was important to me because one, it reflected part of an ethical commitment toward a critical methodology and an acknowledgement of the researcher’s partial perspective; and two, it was a means to produce more valid analyses of the students’ acts of positioning and participation dynamics that included student considerations of how meanings were constituted within the learning environment, and within the SRIs.

**Theoretical Significance**

**Contributions to the learning sciences.** First, this dissertation brings the concept of scientific competence into focus as a construct of a particular activity system, in this case, the university Kinesiology classroom. The work also extends the context of analysis in which CHAT is often applied (e.g., within work settings and laboratories), and brings sustained attention to how postsecondary science classrooms are conceptualized and operationalized. Next, I consider how macro-level (ideologues of time, social identities, and power dynamics) and meso-level (practice-linked identities, pre-existing relationships) forces can materialize through micro-level interactions as social and material resources and inform how participants make meaning of others’ actions and talk.

The case studies of Chapters 5 and 6 examined how focal students navigated conflictual scientific discussions, and how their acts of positioning shaped their access to and uptake of
particular OTL. These analytic chapters contributed to the explication of the third generation of CHAT, which include key concepts such as emotion, identity, and ethico-moral aspects of engagement that are central to academic learning, but have been under-theorized (Engeström, 2007, 2014; Moje & Lewis, 2007; Roth, 2007b, 2009).

Epistemologies within traditional science education studies tend toward a positivist and linear trajectory of science learning and increasing academic achievement (Lemke, 2001; Oakes, 1990; Roth & Lee, 2007). This study, however, included examinations of horizontal dimensions of learning (externalization), which considered the dialectical process in which students made meaning of the collective object ↔ outcome. As Anderson (2009) asserts, learning is a local phenomenon, but students who do the work may draw upon resources from different timescales, which are not all local. Thus, for my microethnographic analyses, I foregrounded the improvisational nature of student interactions, but made space for constructs such as social identities and cultural resources to inform local action. Through focal student interviews, the dissertation considers the mediation of larger structural factors, relationships, and available resources invoked in interactions and learning (Bloom & Egan-Robertson, 1993; Tuyay et al., 1995).

Contributions to science education studies. The domain of formal science tends to be rooted in and reproductive of dominant, Eurowestern theories of knowledge and ways of knowing. However, the professor and the Ethics and Power in Kinesiology course brought in and acknowledged other epistemologies and encouraged rethinking and expanding on traditional ideas of knowledge, objectivity, and science education by surfacing issues of power and ethics inherent in scientific activity. From Roberts’ (2007) visions of scientific literacy, a more critically-oriented form of scientific competency emerges in this classroom system that is more
in line with Vision II. One may even argue that as the lessons came to a close, Dr. Farrell’s encouraging of the students to “bring some of these [course’s] ideas and start stepping on a few toes in the future” illustrates ideological, local openings of what Sjöström, Frerich, Zin, & Eilks (2017) may view as ‘Vision III’ – a broadened and politicized science education that is aimed at transformation and sociopolitical action.

Similarly, within science education research, the focus is often on top-down and vertical processes of learning, with studies emphasizing how teachers’ beliefs influence their pedagogical practices, and the importance of choosing the “right” curriculum for students (Abd-El-Khalick et al., 1998, 2000; Hodson, 1999; Pedretti & Hodson, 1995; Tsai, 2002). While these works undeniably have their place and teachers are in a unique position of power to shape OTL within the classroom, they do not determine what actually happens as students engage in academic tasks (Anderson et al., 1997; Bruna, 2009; Esmonde, 2009; Kelly et al., 2001). As asserted by Wittgenstein (1958, as cited in Goodwin, 1994), a category or rule cannot determine its own application. In other words, seeing what can count as knowledge “in a relevant domain is both a contingent accomplishment and a locus for contestation” (ibid, p. 627). Thus, this dissertation is part of an emerging body of work in the science education literature that argues for the dialectical shift to student learning. The locus of analytical attention then becomes on how students make meaning, adding depth and texture to science education studies by illuminating the multiple and varied ways students engage with course content, through patterns of discourse, and navigating through context-specific conflicts and Third Spaces.

CHAT offers a richness in theorizing about science teaching and learning that centres on dialecticism, with each subject acting as a fibre in a thread of the classroom activity system, embedded within larger sociocultural strands (Roth, 2009; Roth & Lee, 2007). Extending the
metaphor of fibres and knots, students in the Kinesiology classroom learn through “knotworking” (Engeström, 2007) – a negotiated process through which students construct, maintain, and contest extant knowledge and social relationships. That is, students, rather than teachers, become the site of learning, and they learn something that is not stable or completely finished. These knots are created, resolved, and reproduced by the joint activity of the participants, loosening one knot and tightening another. By closely monitoring the unpredictable, micro-level interactions in the group, this study explores how students collectively constructed scientific knowledge and navigated the multiple, interactional demands for participation within the common task.

Implications for Science Researchers

This study suggests the importance of looking dialectically at how a particular activity system was constructed and how acting subjects participated in the space. Similarly, Esmonde & Langer-Osuna (2013) argue for attention to both the teacher-led and student-led spaces of the classroom. In the focal groups, contradictions surfaced in the student-led space, but often without direct conflict. If my analysis ended at the description of the level of classroom practices, it might have constructed a very different image about how I described the formal space of science learning. In examining the micro-level interactions and the local contexts, I concluded that a common task did not necessarily lead to equitable OTL; students did not necessarily interpret and act upon a task similarly, and all members’ contributions were not taken up equally.

In addition, I argue that analytic attention must be paid to both scientific discourse and social discourse, and not have social talk be immediately dismissed as “off-task” work. Social discourse often hints at the emotional climate within the group and indicates the building and/or maintenance of social relationships and hierarchies. Furthermore, examinations of student
discourses can shed light on how student agency and identities are enacted in unique and unexpected ways and the different ways that learners engaged with learning and conflict.

**Implications for Science Educators**

For teachers, this study illustrates the promises and challenges of diverse classrooms. Dr. Farrell framed a space where students were exposed to a variety of participation structures and tools for learning, and regularly engaged in dialogue with different members of the scientific community. However, a teacher-centred focus on equitable instruction and strategies appeared to be insufficient, as the sense of cohesion and directions of a common task were largely constructed by the students. Bloome and Egan-Robertson (1993) and Anderson et al. (1997) describe the limits of studies that view science learning as a process of enculturation into normative classroom practices, as they tend to be overly deterministic, and eschew the learners’ agency and the importance of local events in constructing and/or contesting knowledge. The findings from the dissertation invites science educators to rethink whole-class and small-group discussions as potential sites for power struggles, rather than an academic panacea for equitable interactions. These power struggles may affect students’ access to OTL but can also be potentially fruitful by repositioning how conflict is heard and interpreted in the classroom. These emergent moments have the potential to be productive openings for questions, alternative meaning makings, and varied ways to participate competently (Gutiérrez et al., 1999; Kelly et al., 2001; Lemke, 2001). This raises further questions for analysis: How can teachers become more aware of what is happening in student-led spaces and these potential emergent conflicts; when and how should they intervene; how can students engage productively with conflict; and how can teachers engage students in opportunities for dealing with different interpretations of knowledge?
Finally, my analyses of the group work have implications for how teachers structure classroom activities. The findings describe how a common task led to differential contexts for learning, and how differently positioned students took up particular OTL, which suggests a complex set of interactional demands required of students not only to understand different points of view, and also to complete a common task. This highlights the importance and challenge of paying close attention to student interactions and thinking carefully about the tensions between “doing school” well and “doing science” (Esmonde et al., 2009; Martin, 2016). In other words, the multiple interactional demands of a collaborative task often extend beyond scientific argumentation to include students’ desires to be right, maintain relationships, construct social hierarchies, and align with the norms of the classroom and/or group dynamics. Thus, I invite teachers to think carefully about what they are actually asking of their students in certain tasks, how their expectations can shape student group activity and in turn, how those expectations influence individual science learning. When classroom compliance and maintenance of “good student” identities are foregrounded, I argue that OTL science can take a back seat. Consistent with recent research in collaborative learning (e.g., Curnow, 2017; Dookie, 2015; Esmonde & Langer-Osuna, 2013), the different contexts of group activity that emerged from my analyses may not align with “on-task” descriptors of science learning, but instead reflected differentials modes of access available to the students within specific interactions. That is, the focal students learned what was appropriate for group membership in that moment, rather than solely focusing on learning course content.

Limitations of the Study
Learning is a lifelong process of becoming, and what I document here is a very small moment across the space-time of science learning for two focal students, Chrissy and Ning. This
study follows their learning processes through a summer-intensive course, and the final interviews of the focal students took place within one week of the end of the course. The time elapsed in the study is extremely short and is not a complete or linear story of becoming. While according to the interviews, the focal students’ orientations toward science shifted, the nuances argued within my dissertation are that learning processes and identities are constantly shifting to accommodate their participation and membership in new practices and contexts. Longer-term engagement with these students and/or with a larger group of participants would be helpful to better understand the trajectories of science learning beyond positional identity shifts – when and how it happens. Tracing students’ continued ontogenic development would give the study richer data on how their identities and learning processes travel and unfold over time, and how they shape and are shaped by other courses and experiences in the Kinesiology program.

As well, since my study was limited to two focal students, I was limited in my ability to make claims about how and why some participants took up certain positional identities and OTL in scientific discussions, and how well the group worked together. Throughout my analytic chapters, I did not gather data on the other team members’ interpretations of the group activity besides the broadly descriptive field notes collected in my classroom observations. This was because the other students did not consent to being interviewed or videotaped. In other studies, it may be fruitful to investigate, through SRI techniques, how all the participants within a particular group interpreted their experiences and their team members’ actions, to compare points of overlap and divergences in the activity, and ostensibly how well group members communicated with one another and constructed common knowledge.

In relation to ideas of equity in my current research, power dynamics among the focal students’ social identities (e.g., ethnicity, gender, race, social class) were not highlighted,
although I made some cursory observations about them. Instead, my study focused on their positional identities and how they related to the kinds of OTL they accessed within scientific discussions. Further examination of the intersectionality of students’ multiple, social identities will add further nuance to the students’ experiences of science learning, and if certain aspects (or combinations) of their identities become particularly salient within different interactions.

Finally, I would not necessarily expect that an orientation to social justice and ethics will remain a consistent focus for all participants. Although both students expressed a shift in how they viewed science education and learning, they are still learning and becoming, and their participation in scientific communities is still emerging. For that reason, my analyses of student uptake of OTL is limited to the context and the timeline; it has not been borne out of data beyond the Kinesiology classroom. In addition, part of taking up ethico-moral considerations of scientific activity was an explicit part of the course’s academic expectations. Therefore, it is hard to delineate between the influences between students’ desires to maintain “good student” identities and doing science well (Martin, 2016). This is outside the scope of my work here and requires further research to understand how and when participants’ identities and practices become more salient in active educational processes, and/or how and when they become crystallized and recognized as a stable aspect of their identity. It is also important to recognize the strong but temporal influences of interacting objects in group work – such as the pressures of doing well in school, time limits of activities, as well the students knowing that they were being videotaped – all of which may have contributed to how students participated and interacted with one another.
Directions for Further Research

The present study examines how students navigated conflictual scientific discussions and took up particular OTL in the context of a university Kinesiology classroom, and how their acts of positioning influenced the distribution of OTL within the group. The implications drawn from this study are limited because of the self-selection of the participants, the small sample size, and temporal scope of my observations. Nonetheless, it raises a number of questions for future research. For example, the study did not look in-depth at how the focal students might access different OTL across different learning settings, such as laboratories and practicums. What would their patterns of participation have looked like? What are the organizational dimensions of those activity systems? How do those systems facilitate and/or constrain particular OTL?

During the interviews, the students did not explicitly focus on socially constructed identities such as race and gender, power relations, or conflict. As such, much of my analyses remain at the interpretative level. Further research might foreground the social categories in student interviews to garner their perspectives on how their social identities influence the nature of intergroup interactions in science classrooms. They may help to develop more nuanced views on successful and unsuccessful group practices and the ways in which students’ socially constructed identities were potentially enacted and drawn upon in interactions and during the interviews to make meaning.

As Esmonde (2009b) contends, certain aspects of work practices and positional identities may be more generally a result of the school context and not specific to the domain (e.g., science). School contexts typically support a concern for earning good grades, following instructions, and working independently. Thus, the study extended the CHAT literature by qualitatively discussing the lived experiences of students, as they navigated through the formal
schooling system, set within the context of a science classroom, and as such, students may experience tension between doing school well and doing science well. By unpacking the notion of learning as also access to particular identities, I problematized who is perceived as “good at science” and why. This suggests that understanding scientific competency requires looking beyond a student’s actions, in reference to the epistemologies of formal science, to how their actions are interpreted in the context of the classroom system.

By viewing learning and positioning in small-group interactions as mediated by other structures that are not necessarily solely beholden to the formalisms of the scientific community, it brought into focus what students are actually being asked to do in activities. Furthermore, such an orientation surfaces how teacher formulations of the course objectives, mediate the kinds of available OTL in the classroom. My analysis also documented how different group dynamics led to differential contexts for learning and supported particular learning opportunities, but not others. In this way, my study paid attention to the construction of scientific discussions, as I consider how particular activities and interactions made certain acts of participation more likely.

Finally, my work adds complexity to CHAT by addressing the need to centre science learning as “discourse- and activity-centred processes of experiencing” (Sannino, 2008, p. 253). This study analyzed two case studies of Chrissy and Jem in order to examine how the focal students positioned themselves and accessed OTL in scientific discussions across different contexts. As I have tried to show here, classroom interactions are complex and improvisational. A teacher can set up a collaborative activity, but what happens within that activity depends on the improvisational choices of the participants and the resources that arise out of the unfolding interactions (Esmonde, 2009b; Goodwin, 1994; Holland et al., 1998). The analyses revealed that
individual participation, social relationships, the task requirements, and teacher constructs of the learning environment all conjointly shape students’ access to and uptake of OTL.

My study goes beyond prior work in this area because of the dialectical analytic methods used to outline the relationships between collective and personal goals. As such, the relationships between opportunities to participate and student agency become central tenets to science learning and access to science identities. Future studies might consider an institutional ethnography methodology, looking at student records, and involve research questions such as: How does an individual’s pattern of participation within scientific activities characterize their identity in a group or community; and how do existing academic identities mediate student participation in scientific activities, and therefore the reproduce and/or maintain that identity in ongoing activity?

Another direction for future research might focus more explicitly on the intersections of race, gender, (dis)ability, sexuality, and socioeconomic status, and how they influence acts of positioning and constructions of scientific competency, especially in diverse classrooms. More complex analytic tools would be needed for this kind of analysis, and across ontogenic time (Wortham, 2004). Analyzing science classroom systems with an eye toward micro-interactions attempts to reconcile how local acts of positioning rub up against cultural-historical repertoires of meaning and practices, practice-linked identities, and social categories (Gutiérrez & Rogoff, 2003). This study attempts to show, in a partial way, how science learning is discursively mediated by student participation in scientific discussions as well as the cultural-historical practices and resources afforded by the structures of the university science classroom.

An alternate analysis might include empirically analyzing the manifestations of contradictions that surface in science learning environments through a close analysis of the linguistic cues in interactions. In addition, future studies might explicitly explore how teachers
and students interpret emergent conflicts in classroom activities, and how students describe these events through an analysis of the video of SRIs, and further foreground participants’ voices using collaborative analysis processes. These studies, in concert with student reflections, might support more productive students’ strategies for navigation of conflicts? These questions consider relationality and identity as central to academic learning and illuminate ways that educators can design spaces to accommodate for a wider range of OTL and/or offer opportunities for dealing with differences in interpretations.

March for Science – One Year Later

In Chapter 1, I introduced the March for Science that took place in 2017, which was partially prompted by the U.S. President Trump’s call to roll back environmental regulations and slash funding for health and environmental agencies (Ross, 2017). As it stands, the U.S. administration has withdrawn from the Paris climate agreement, dismissed Environmental Protection Agency scientists, and threatened science partnerships with their infamous “Muslim ban” (AAAS, 2017; Louheed, 2017). The March represented a flash point in science advocacy, but since then has faced criticisms from within and without the scientific community as being too political, too diluted, and/or failing to adequately address issues of diversity and representation. The question becomes then: How might we utilize the momentum from the March for Science to continue encouraging thoughtful mediations on the practices of the scientific community and ensure that support for science is maintained? Thus, to close, I want to revisit the idea of developing scientific competency within schools and increasing public engagement and valuing of the domain and its impacts on society.
I explicitly argue for the contributions this research makes to better understanding science learning and access to OTL. If this work is successful, it will not only be in that the ideas are coherently argued and well-supported by theory, but it will also be useful to cultivating more productive science learning environments and addressing equity-oriented issues that continue to plague academic learning. The concepts of relationality and identity are important in shaping how students participate and access OTL in the context of a university science classroom, and how they potentially inform our negotiation of what counts as knowledge and who counts as a knower and doer of science in intergroup interactions.

Conclusions

The present study had two aims: (a) to explore how the professor framed science learning in the university Kinesiology classroom and the range of OTL they made space for; and (b) to investigate how students navigated conflictual scientific discussions and took up particular OTL. My critical microethnographic analysis employed methodological triangulation of different ontological grain sizes of data, involving the analysis of field notes, learning artifacts, video data, and student interviews. This process facilitated a multi-level inquiry into students’ access to and uptake of particular OTL (i.e., the intersections between access to scientific content and discourse practices and access to positional identities) within particular group activities.

The integrated theoretical framework of CHAT and positioning theory shed light on how students managed their participation and acts of positioning through conflictual scientific discussions. The researcher’s microanalysis of the classroom video looked systematically at dimensions of the activity system, such as tools, rules, division of labour, and community, and illustrated how the activity system was constructed through regularities of shared, normative practices, and encouraged specific forms of engagement. However, this view would be limited if
I solely focused on the teacher’s constructions of science learning, as it loses sight of the individual students’ actions by studying the classroom as a social organization.

The microanalyses of video interactions and focal student interviews described how acts of positioning were conveyed through both verbal and non-verbal means of communication. The researcher’s analysis of group work revealed four major themes: ethico-moral considerations of scientific activity; relationality; instability of student identities; and the relationships between conflict and access to OTL. The focal students’ interviews illustrated that they too, experienced and identified acts of positioning. These findings highlighted the importance of considering the voices of participants and revealed the potential for misinterpretation and misrepresentation when we rely solely on the professional vision of researchers (Goodwin, 1994).

Building on CHAT, the study also provokes discussions on overcoming dichotomic views of micro- and macro-interactions within the classroom system, and theorizes learners as positioning themselves and others, but also functioning as embodied, axiological sites for positioning. Within interactions, people draw upon resources as they arise and construct intertextual links between local events within which they participate and broader sociocultural frameworks (Bloome & Egan-Robertson, 1993) to inform their positioning.

The research played a vital role in shaping conversations around learning science, learning to “student” (Wallace & Wildy, 2004), identity, and access to OTL. The findings from Chapter 4 illustrated how Dr. Farrell framed science learning and the normative practices of the classroom system. This process shaped the context for classroom learning, and also how students were expected to engage in the naming of and problematizing particular issues in scientific activity. For future science education studies, I offer modest suggestions in how to structure
science classrooms that represent a wider range of OTL by paying attention to the various dimensions in the activity system.

In the following analytic chapters, I illustrate how a common group task led to different contexts for learning, set within the context of a science classroom. Through the case studies of Chrissy and Jem, I offer insight into how interpersonal relations, maintenance of positions and power, and perceived scientific competence informed how the group functioned. The implications of these findings are complex – that these inherent differences can be sites for conflict, and the construction of group tasks involved more than just constructing knowledge and talking science. The dissertation directs attention to questions of individual student contributions to meaning making in group practices, and how conflict can be reconceptualized to provide new and unique OTL in interactions.

Although the teacher in this classroom explicitly tried to move students away from these conceptions (and was successful to some degree), the findings from this study illustrated how some of the more traditional beliefs about science appeared to underlie some of the social interactions, and when particular individuals and/or group practices deviated from these norms, they were interpreted by the focal students as “problems.” Instead of reproducing the same dynamics of top-down science teaching and learning, the work affirms, in many respects, that learning is directed by the students, and is sometimes different from what a teacher or designer intended (Greeno, 2006). This can trouble ideas of teacher-centredness and control. My research points to the potential for both vertical and horizontal learning. In my study, I illustrate how students navigated scientific discussions, and negotiated beyond what counts as knowledge to include who gets to participate, whose contributions were heard, taken up, and/or ignored, and which practices, identities, and ways of knowing and being were privileged as legitimate.
For broader science education, this research project foregrounds the interactional and institutional processes that facilitate and/or constrain student movement and participation in and out of these spaces, but also signals several areas for further work. This research points to strategies for reconceptualizing conflict and engaging students in opportunities to navigate more productive throughways. It also shows that there will be conflict and contestation in any kind of learning, but that conflict can also be productive in generating new opportunities to learn, meanings, and identities (Curnow, 2017; Kelly et al., 2001; Mehan, 1998).

Further, this project submits that for the science advocacy movement to gain further traction, it will require critical and ethico-moral considerations of scientific activity – to critically question whose voices are being heard, whose voices are being silenced, and knowledge for what purpose? Protests can be cathartic, powerful, and shine light on problems at hand, but they do not specify on how change and development will proceed. Much like how classrooms are structured, teachers and curricula may direct attention to particular problems and skills that are valued in the wider community, but they do not determine how moments unfold and how opportunities are talked into being, which is why attention to micro-level practices and interactions are of analytic interest and educational importance.

Promoting public valuing and engagement with science and scientific communication in concert with popular culture and social media conversations is no doubt a noble strategy to establish the domain of science as integral to public policy. But it will require learning and mobilization of the part of young people and students, and there are opportunities and spaces in formal schooling, which set the stage for collaboration and substantive foundational and potentially innovative work, should people choose to engage in it. This research project offers some specific insights in terms of participation in scientific activities that will require a shift in
conceptualizing ways of knowing and being, conflict, what group activities can achieve, and what student identities mean in interaction. While my work shows that science learning is possible but enacted in various ways, it also demonstrates the challenges that are present in group work, and further still, within scientific communities. This will require learning, collectively, through the lenses of participation, identity development, and relational epistemologies to reconsider power dynamics and opportunities to learn within science education reforms and the science advocacy movement.
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Appendices

Appendix A. Initial Interview Protocol

Before beginning, I would like to remind the focal participant that they can skip any questions they do not want to answer, say something off the record, ask the interviewer to omit or erase something after it has been said, and withdraw at any time without negative consequence. The instructor will not have access to the interview data until the course is over and marks are submitted. You also have the option from withholding all interview data from the instructor.

Initial Questions

1. Please tell me a little bit about yourself and the identities you affiliate with. (Prompts: name, age, race, ethnicity, dominant language, socioeconomic status)

2. What are your general views about science and/or kinesiology? How would you define ‘science?’

3. How would you describe yourself as a science/kinesiology student?

4. Speaking to your academic experiences, what are some common ways of teaching and learning (working) in your classes?

5. In your own words, please tell me about the course you are taking now.

6. Please tell me about the kinds of work you do, individually and collectively in this class.

7. Can you give me an example from this course of when you felt you were learning about science and/or kinesiology, and it went well? Why? (Prompt: When you had an ‘aha!’/breakthrough moment)
8. Describe your feelings about small group work in science class.

9. What ways of learning science do you prefer? Do different ways of class work impact your participation (e.g. individual, small group, whole class, experiments/labs)? How?

10. What is your understanding of the nature of science?

11. In your opinion, what is the role of ethics in your understanding of science?

12. In your opinion, what is the role of society and technology in your understanding of science?

13. In your opinion, what is the role of the environment in your understanding of science?

14. What other factors influence your understanding of science and/or kinesiology?

15. Is there anything else that you’d like to say about your feelings about your experiences in science and/or kinesiology?

Interviewer’s Comments:
(regarding your experiences in science and/or kinesiology, interview process, interview questions, etc.)
Appendix B. Stimulated Recall Interview Protocol

**Italicized text reflects the researcher’s script.**

1. Explain when and where the video footage is from:
   - *e.g. This is video footage from (today’s/yesterday’s) group work activity.*

2. Have participant state the goals/purposes of the group work activity:
   - *Please identify the members of the group and how/if you know them. Describe the context of the task, the topic of conversation, and the major goals of the activity.*

3. Explain the stimulated recall process:
   - *I’m interested in hearing about your experiences of this group work. I’ve chosen a few parts of the group work activity that I’d like you to comment on. Please share as much of your thoughts, feelings, reactions and interpretations as possible. First, we’re going to watch some parts of the group work footage together. As we watch, you can tell me to pause the video at any point that you would like to comment on what is happening. For example, if you want to tell me about the reasons behind some of your actions, give me context about the interactions, how you felt at a particular moment, why you think your group members were saying or behaving in a certain way, unexpected occurrences, things that went well, things that didn’t go so well the group work, conflicts, etc. I’ll also stop the video about every minute so that we can discuss what just happened. Once we’re done, if there are any other parts that you’d like to re-watch and/or comment on, please let me know.*

4. Questions to pose after watching the video:
   - *What are your general feelings about this group work experience? (Prompt: Do you think it went well? Do you think it went badly?) • What could have made this group work activity have gone better? Were there any challenges/disagreements in this group work? Can be about content or interactions*
   - *Any other comments on the footage that we’ve just watched? • Are there any other parts of the video that you would like to re-watch and/or add comment to?*
Appendix C. Final Student Interview Protocol

Interview Notes

Before beginning, I would like to remind you, ________________________________ (full name) that the interview is being collected as data and/or recorded for my doctoral thesis research project. You have the right to not complete the interview at any time, skip any questions you do not want to answer, say something off the record, ask the interviewer to omit or erase something after it has been said, and withdraw at any time without negative consequence. Also, please contact me if you need any clarification about my project or the questions: [email] or at [phone number].

Final Questions

1. Reflecting on the Kinesiology course, tell me about your experience of this course. (Prompt: How is it similar/different from your previous experiences/science courses?)

2. Reflecting on the Kinesiology course, how would you describe the classroom environment? (Prompt: overall emphasis, classroom attitudes, norms)

3. What kind of coursework and/or activities did you participate in (e.g. individually and collectively)?

4. Please give me an example of group work that stood out to you. Why? (Prompt: Was there anything unexpected, surprising, or that you didn’t like about it?)

5. What stood out to you the most/was most memorable in this class (Prompts: assignments, general content, readings, teacher, specific interactions/conflicts, students)?
6. What were some of your main takeaways from this course?

7. Can you give me an example of a time you felt you were learning about (what you identify in 6)?

8. Has your stance on the relationships between science and society changed? How? Were there specific experiences from this course that prompted this?

9. Has your stance on the relationships between science and technology changed? How? Were there specific experiences from this course that prompted this?

10. Has your stance on the relationships between science and the environment changed? How? Were there specific experiences from this course that prompted this?

11. How have your understandings of science and ethics changed since our first interview? What are some thoughts and/or beliefs involving science that stayed the same?

12. Is there anything else that you would like to add about your feelings and/or reflections on this course/science/kinesiology in general and/or your position as a science student/___?
Appendix D. Coding Table for Verbal and Non-Verbal Actions

*Definitions of Most Frequent Positioning Moves*

<table>
<thead>
<tr>
<th>General positioning moves</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affirmation</td>
<td>Ways of recognizing an individual’s contribution; interactional indicators of validation, (e.g., head nods, verbal agreement).</td>
</tr>
<tr>
<td>Exclusive talk</td>
<td>Exchange between two or more people that does not include the majority of participants in interaction, despite being part of larger conversation. Often expressed through gaze, body orientation, explicitly addressing certain members.</td>
</tr>
<tr>
<td>Bid to change practice</td>
<td>Any verbal requests made by focal student to change norms of group; may be intentional or unintentional.</td>
</tr>
<tr>
<td>Overlapping talk</td>
<td>When a second speaker begins talking before the first speaker is finished.</td>
</tr>
<tr>
<td>Expression of positive engagement</td>
<td>Non-verbal behaviour to demonstrate attention, (e.g., head nods, eye gaze toward speaker); may be intentional or unintentional.</td>
</tr>
<tr>
<td>Expression of negative engagement</td>
<td>Non-verbal behaviour to demonstrate inattention, (e.g., looking around, use of tools); may be intentional or unintentional.</td>
</tr>
<tr>
<td>Expression of positive emotion</td>
<td>e.g., smiling, laughing</td>
</tr>
<tr>
<td>Expression of negative emotion</td>
<td>e.g., frustrated sighs, rolling eyes</td>
</tr>
</tbody>
</table>

Adapted from Dookie (2015) and Curnow (2017).
Appendix E.  
Linguistic Cues for Coding Manifestations of Activity-Level Contradictions

**Discursive manifestations of inner contradictions.**

<table>
<thead>
<tr>
<th>Manifestations of Discursive Contradictions</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dilemma</td>
<td>Expression or exchange of incompatible evaluations; not universal; occurs in everyday life; often reproduced versus resolved, e.g. “I’m hungry but sleepy.”</td>
</tr>
<tr>
<td>Conflict</td>
<td>Perceived divergence of interests, or because of another’s incompatible behaviour; when the actions of an individual are interfering/obstructing in some way making another’s less effective; typically resolved by compromise, submission to authority or majority, e.g. “I disagree with your perspective on animal rights.”</td>
</tr>
<tr>
<td>Critical conflict</td>
<td>Individual faces inner doubts that they cannot solve alone; can involve feelings of being violated or silenced; resolution can involve new meaning-making and personal emancipation, e.g. romantic relationship ending, using metaphors, narratives, “I now realize that …”</td>
</tr>
<tr>
<td>Double bind</td>
<td>Individual faces unacceptable alternatives in their activity system; can have unpredictable consequences and collective, transformative potential or expressions of helplessness, e.g. rhetorical questions, “What can I do?”</td>
</tr>
</tbody>
</table>

Adapted from Engeström and Sannino (2011).
Appendix F.
Jefferson System of Transcription Notation

Jefferson Transcription Conventions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Name</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>underline</td>
<td>Underlined text</td>
<td>Indicates emphasized or stressed speech</td>
</tr>
<tr>
<td>ALL CAPS</td>
<td>Capitalized text</td>
<td>Indicates shouting or increased volume speech</td>
</tr>
<tr>
<td>°</td>
<td>Degree symbol</td>
<td>Indicates whisper or lowered volume speech</td>
</tr>
<tr>
<td>(text)</td>
<td>Text in parentheses</td>
<td>Unclear speech, with researcher’s inference about text</td>
</tr>
<tr>
<td>((text))</td>
<td>Text in double parentheses</td>
<td>Indicates researcher’s comments</td>
</tr>
<tr>
<td>[min:sec]</td>
<td>Numbers in square brackets</td>
<td>Indicates time in minutes and seconds of specific incident</td>
</tr>
<tr>
<td>[text]</td>
<td>Italicized text in square comments</td>
<td>Indicates non-verbal activity of participant</td>
</tr>
</tbody>
</table>