Group Structuring Effects on Gender-Specific Discourse Interactions Within Knowledge-Building Communities

by

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A thesis submitted in conformity with the requirements for the degree of Masters of Arts
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ABSTRACT

Group Structuring Effects on Gender-Specific Discourse Interactions Within Knowledge-Building Communities

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One relatively recent educational paradigm which has great promise in ameliorating the scientific literacy crisis and the lack of girls choosing careers in science is social constructivism. The centrality of the role of discourse in social constructivist settings necessitates the consideration of differences in discourse styles between males and females. This study examines how structuring students in all-girls, mixed-gender and all-boys groups effects the level and type of discourse produced during face-to-face interactions. Girls in gender-specific groups demonstrated advanced levels of both social and cognitive development compared to the other groups. Students in this study also participated in electronic database conferencing. The discourse on the database produced evidence that girls who had difficulties during face-to-face discussions, made more contributions, displayed greater confidence and showed improvements in motivation. The implications of these findings in the restructuring efforts of science education are explored.
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CHAPTER 1: INTRODUCTION & LITERATURE REVIEW

1.1 Introduction

There has been a great deal of discussion concerning the effectiveness of school science curricula in producing a scientifically literate citizenry (Black & Atkin 1996; Hodson, 1993; Matthews, 1994; Ramsey, 1993). Although the debate has ensued for nearly three decades, problems continue to exist on many levels in society including low enrolment in science classes, declining numbers of people choosing careers in science and the lack of an understanding of basic scientific knowledge amongst members of the general population. These difficulties are, to a greater extent in the 1970s, compounded by the need for a successful transition from manufacturing-based to knowledge-based economies - a transition which educational institutions will play a crucial role in achieving (Bereiter, Scardamalia, Cassells, C. & Hewitt, J, 1997).

To complicate the matter further, countless studies have indicated a great dearth of females in scientific fields of study (Clewell & Ginorio, 1996; Kahle, 1996; Lee & Burkham, 1996; Peltz, 1992; Ridley & Novak, 1996; Rose, 1994; Vetter, 1996; Volman & Van Eck, 1995). Indeed all one needs to do is walk into any contemporary mechanical engineering lecture to realize this truism. Despite intense and rigorous developments from educational researchers, these trends do not seem to be diminishing which may lead one to conclude that there is a serious mismatch between the pedagogy currently informing school science and a pedagogy necessary to effect success for all learners.

Traditional science teaching and learning methods have taken the majority of the blame for this persistent phenomenon. The arguments include, too heavy a reliance on textbook oriented activities, exclusive representation of final form theories, an emphasis
on memorization and regurgitation rather than inquiry processes, transmissive modes of delivery and the lack of any meaningful collaboration between students (Driver & Leach, 1993; Duschl, 1990; Linn, 1992; Loving, 1997; Meyer & Woodruff, 1997; Tobin, 1997).

The search for alternative methods has likewise met with mediocre success. One strategy which gained some popularity during the 1980s was discovery learning in which the culture and nature of science was misrepresented as something that one could naturally and logically assimilate through experimental manipulation. Although initially ushered in as a more progressive and more pedagogically sound method of teaching, it fell well short on the measure of true conceptual development. In essence, what discovery learning failed to promote was the understanding that learning science involves being initiated into scientific ways of knowing (for a more detailed account see Driver, Asoko, Leach, Mortimer & Scott, 1994).

Recently, a more promising view of learning has emerged that aims at identifying the sociocultural variables influencing achievement. This research paradigm, commonly referred to as social constructivism, places primary importance on collaborative inquiry and the tool of discourse as the vehicle for learning (Woodruff & Meyer, 1997). The emphasis is on creating communities of learners where knowledge is being constructed and where process rather than content becomes the central component driving curricular practices. In addition, it mirrors the present research strand in cognitive science which focuses on determining how scientific thinking manifests and evolves in the real world and how conceptual understanding and progress in science is attained at a macro level through discursive activities. The research being reported here will be conducted within this specific paradigm. The intention is to explore gender-specific teaching strategies for the purposes of creating more gender inclusive programs in order to
promote greater participation of females in science. At this juncture, an overview of the current literature in the field of social constructivism and gender issues in science education will be necessary to provide insight into the philosophical commitments informing the investigation.

1.1.1 Research Questions

The principle questions guiding the literature review and the study framework are:
1. What are the patterns that emerge in discourse interactions when placing students in gender-specific and mixed-gender groupings in small-group settings?
2. How do the discourse patterns differ across gender-specific and mixed-gender groups?
3. What changes are produced in female discourse patterns when participating in alternate instructional settings geared towards gender-inclusive programming?

The following section will begin with a short discussion highlighting much of the seminal research which has laid the foundation for the consideration of science as a discursive activity. Specifically, two concepts, the social construction of scientific knowledge and the mechanism of debate will be discussed. The implications of these perspectives on science education will be addressed next, followed by a review of current studies centring on gender issues in science. Finally, this chapter will conclude with a recapitulation of the research questions and how they were used to formulate the specific study goals in addition to a description of the theoretical framework within which the study was situated.
1.2 Science as a Discursive Activity

The goal of improved scientific literacy has forced educators to reevaluate the goals of school science in terms of its efficacy and function. A result was the move towards developing more authentic curricula which would represent as closely as possible, the way a community of scientists operate. In order understand the workings of the scientific community, two fundamental epistemological qualities about the nature of science must be considered: 1) science as a socially constructed activity (Driver et al., 1994); 2) knowledge claims as negotiated through the mechanism of debate or argumentation (Bereiter, 1994; Kuhn, 1993; Pera, 1994). These qualities are further elaborated on below.

1.2.1 The Social Construction of Scientific Knowledge

Early empiricist views of science held that proper scientific inquiry was carried out by systematic and careful observation of natural phenomenon from which data was collected and rigorously tested to derive a theory (Case, 1996). This form of inductive, mechanistic thinking was premised on the belief that all knowledge about the universe was predetermined and that science was in the business of revealing the 'truth' about how it functioned. One of the most important tenets of this paradigm, also characterized as positivism, was that observations could be made irrespective of any theoretical constructs and that there was a single scientific method to follow in order to obtain unequivocal facts. Most representatives of scientific knowledge including textbooks, resources and teachers portrayed science in this way up until at least the middle of the twentieth century (Vygotsky had apparently figured on empiricism's eminent demise much earlier, however, we in the western world were not privy to his writings until the 1970s).
A number of discoveries in the area of modern physics in the early twentieth century, contributed to a paradigmatic shift in science exploration; a shift from a mechanistic world view towards viewing the world as a system of relationships. As Heisenberg states, "the world thus appears as a complicated tissue of events, in which connections of different kinds alternate or overlap or combine and thereby determine the texture of the whole" (cited in Capra, 1982, p.81). In addition, philosophers of science such as Karl Popper vigorously challenged traditional epistemological beliefs and forced a further reconsideration of the nature of scientific study. However, in the realm of education, it was not until the publication of Kuhn's *Structure of Scientific Revolutions* (1962) that the research world began to focus on the restructuring of school science curricula (Case, 1996). Paramount to his argument illuminating science's historically documented developments of oscillations between normal and revolutionary science, is the notion that knowledge objects and theories are constructs of the scientific community and as such are not absolute or universal truths. Kuhn advocates the position that science works not so much to seek better approximations of the truth (as Popper would argue) but to create a model which best describes the evidence being considered at any point in time (Loving, 1997).

These arguments opened the door for sociologists, philosophers, psychologists and the like to construct a new conception of scientific study. To put it in simple terms, according to this perspective knowledge is socially constructed and thinking is profoundly influenced by participating in social practice. Knowledge is not 'out there' for us to discover; there are no predetermined laws of the universe to be derived through objectively measured, theory-independent data and there is no universal method for doing so. Rather, concepts, models and theories are constructed by members of the scientific community according to the conventions and procedures agreed upon under the particular operating paradigm or research focus - conventions and procedures which
can change over time (Driver et al., 1994; Driver & Leach; 1993; Duschl, 1990; Pera, 1994).

1.2.2 The Mechanism of Debate

Having the foundation laid down for the social construction of knowledge, researchers have turned to explicating the mechanism which drives scientific activity. Pera (1994), describes a model in which the process of dialectics underpins the logic of science rather than methodological (positivist) or counter-methodological (relativist) positions. He states that scientific activity progresses in the form of a debate between, at the very least, three participants; nature and two competing theories in the community. Scientists must come to a consensus through negotiations via the factors of scientific dialectics which include empirical evidence, confutation and persuasion. Appealing to the notion of consensus as the modus operandi determining the validity and the eventual acceptance or rejection of scientific theories, circumvents any philosophical weaknesses inherent in relativist claims. As Pera writes, “Agreeing upon a correct answer means neither passively listening (or reading), nor fabricating under the pressure of private or social interest: it means, rather, finding that view (cognitive claim) that best holds out against criticism” (p.134).

Similar to Pera, Bereiter (1994) states that there is no need for this contentious debate between positivism and relativism (also referred to as postmodernism). He advocates the notion that the corpus of scientific knowledge consists of human constructed ideas. By virtue of human fallibility, all theories then are fallible and can ultimately be replaced. However, he criticizes the postmodernist’s main argument against objectivity claims and states that the central issue ought to be progress. He writes:
The key assumption supporting the scientific enterprise... is not objectivity but progressiveness. It is not necessary to believe that science is approaching some objective truth, but it is necessary to believe that today’s knowledge is better than yesterday’s. Otherwise, there seems to be no point to science. (p. 4)

Bereiter further parallels Pera’s position on the mechanism driving scientific activity when he implicates the process of dialectics as the vehicle to achieve progress. Dialectics in this case explicitly represents the discourse that occurs between competing camps of thought. Hence, it is progressive discourse which constitutes a scientific method of sorts and which governs the actions of the scientific community.

Others in this field have defined science as a specialized form of argument. Kuhn (1993), suggests that all knowledge items including data and other forms of evidence, must be entered into the realm of public debate. She makes the claim that scientists are well aware of the necessity for strong justifications to support their arguments in order to convince the scientific community - a practice which is perpetuated when scientists consistently uphold these rules of scientific research. She explains that educational researchers have tended to focus on the achievements of individual scientists rather than focusing on the social contexts and dialogical exchanges influencing decision making. Argumentive thinking, she purports, leads to one acquiring the skill of distancing themselves from their own beliefs to the point where they may be able to view them as ‘objects of cognition’. This is the ability to think about one’s ideas on a metacognitive level. In this way scientists are able to critically evaluate their understanding and coordinate new evidence as it evolves as part of their existing cognitive schema.

Science as argumentation may be thought of as analogous to Pera’s dialectical model and Bereiter’s notion of progressive discourse in terms of advocating the centrality of dialogue and debate. Upon close study, their positions are similar on several other
points. For example, all have attempted to explain the dynamics of science as it occurs at
a macro level, that is, historically and theoretically the evolution of public scientific
knowledge. Science is competitive, clearly bound by regulatory mechanisms, albeit not
the hypothesis-testing strategies linked to a traditional scientific method, and have a
characteristic formality in their interactions between other groups within the community.
The interaction between groups has been described as science being conducted through
inter-group discourse (Woodruff & Meyer, 1997). However, there is another very
important kind of discourse that occurs at the micro level of theory generation between
group members on the same research team. This has been termed intra-group discourse
(Woodruff & Meyer, 1997) and it represents a much different dynamic.

Dunbar (1995) documented the operations of four extant leading microbiology
laboratories over a one-year time frame. His goal was to capture elements of cognitive
processes in authentic situations as they emerged in day-to-day practice. His findings
indicated that among the most successful laboratories i.e., the ones which made
significant advances in their research agendas, were the ones which utilized analogical
reasoning skills during episodes of disparity. Of greater interest, however, were the
insights gained into the social dynamics within these highly successful research groups.
His analysis showed that questions played an important role in reconceptualizing
theories during individual presentations. But these were questions not of the
competitive genre. Rather they were questions of clarification posed by other members
of the team which usually resulted in one or more researchers engaging in deductive
reasoning along with the presenter. This kind of collective problem solving was
practiced extensively by one laboratory which produced successful changes in all
aspects of their research program. As evidenced in this excerpt, it can be said that the
driving mechanism in this case was collaboration not competition:
We have found that subgroups focus on particular features of the problem, change these features and then pass on their part of the solution to another member of the group. The researcher presenting then picks up the proposed solutions and integrates them into his or her conceptual framework, and then the group goes through another round of problem solving. (p. 388)

To summarize the arguments thus far; it has been shown that science is considered a socially constructed enterprise operating through the mechanism of discourse. This social construction can take on two distinct functions; one of competition in the case of inter-group discourse and one of collaboration in the case of intra-group discourse. One important thing to note here is that these two types of discourse do not operate in mutual exclusion. Both dynamics are necessary for the progress or development of scientific knowledge as a whole. As Woodruff and Meyer (1997) write:

Virtually all scientists are members of both types of communities...The inter-laboratory community provides the public forum for scientists. This forum sets and applies a discipline’s standards and benchmarks and supports the arbitration that lets the discipline advance. These environments are high risk forums for scientists’ egos and careers. Intra-laboratory communities, by and large, are private and low risk environments. Scientists use this private forum to discuss ideas that are not fully worked out without high risk to their ego or career. As such, the discourse can be inquiry oriented, jointly constructed, fragmented, and extended. (p. 29)

1.3 Implications for School Science

Historically, educational research in science has closely mirrored the philosophical paradigm under which scientific research operates. The reconsideration of science in a social constructivist milieu creates new challenges for educators who are interested in offering authentic experiences for students in the classroom. Perhaps the greatest of these challenges is the fact that embracing social constructivism requires a rather large
paradigmatic shift on the part of the teacher from more traditional views. Other challenges may include, how to plan for alternate instruction and what resources would best facilitate this change. These are, in fact, dilemmas which are very familiar to us in education as they inevitably surface each time a new pedagogical focus emerges. Indeed the literature is inundated with suggestions and applications for the recent trends in cooperative learning, assessment and evaluation and classroom management. In presenting science as a discursive activity, researchers in this field have accordingly attended to these dilemmas. However, one point which sets this stream of research apart from the others is the fact that it is premised on discourse. As such, it requires additional consideration of variables which have not traditionally been a part of the mainstream research; an important one for example, is how discursive patterns differ between males and females and the impact this has on curriculum programming.

The next section will briefly explore the existing body of research available on gender research in the field of science education with a view to identifying differences in discourse styles between males and females.

1.4 Gender and Science Educational Research

The discussion will be divided into two broad categories: i). characteristics of the students and ii). characteristics of the learning environment (Lee & Burkham, 1996).

1.4.1 Characteristics of the Students

Gender studies in science have consistently demonstrated a difference between the way girls and boys interact. Lee and Burkham (1996) found that females seem to be much more conscious of their learning environment and do not respond as favourably as males
do in competitive tasks. Attitudinal differences in the importance that girls place on their relationships with other people and their responsibilities and connections to those around them play a far greater role in their lives than boys (Peltz, 1992). Moreover, differences in self confidence and motivation levels appear to produce differential outcomes in both achievement and participation levels between genders. Girls tend to underestimate their competence in science (Kahle, Parker, Rennie & Riley, 1993); they are more cautious in whole class discussions and are less likely to take risks for fear of getting the wrong answer (Peltz, 1992) and even very able girls’ expectations for success are more fragile than boys (Lee & Burkham, 1996). Gilligan (1982) suggests that women’s realities are very different than men’s and therefore they look for different aspects of a situation before engaging in any debate about it.

In addition to characteristics influencing classroom interactions and the more affective aspects of learning, further differences are seen in girl’s opportunities to participate in hands-on investigations and oral discussions. Boys are more likely to control the manipulation of materials and equipment (McLaren & Gaskell, 1995) while girls are typically relegated to the role of note-taker (Peltz, 1992). Perhaps the most pronounced form of inequity occurring in the science class however, is the way boys dominate the discourse during whole-group discussions (Kahle et al 1993, Kahle, 1996).

We can see a vast number of differences between boy’s and girl’s interaction styles and attitudinal dispositions towards the learning of science. One could easily attribute these differences to inherent, genetic gender qualities eg. males are more aggressive. However, as we shall see in the next section, much of the characteristics displayed by students may be a result of learned behaviours acquired from inequities manifested in the learning environment.
1.4.2 Characteristics of the Learning Environment

Interestingly, girls and boys begin their educational careers with a similar understanding of the importance of science in their daily lives. Their feelings of self-efficacy and motivation to learn science appear to start out on equal footing. However, there is a clear indication in the research that by the middle grades, both interest and achievement levels in girls begin to decline (Lee & Burkham, 1996). This may lead one to conclude that the variety of gender-specific characteristics of the students listed above have resulted from environmental factors. In fact, much of the work in gender equity studies has shifted now to examining how the structure, organization and curricula of school science lead girls to opt out in later grades (McLaren & Gaskell, 1995) and continue to produce a dearth of females in science-related careers.

One answer may be that at the broader levels of scientific culture, through their communication modes and values being propagated from one generation of scientists to the next, science has been characterized, historically, as a male dominated culture. A complete critique of the writings on masculine science is beyond the scope of this paper (see Rose, 1994 for a more detailed account). However, the point of interest here is how this perception has filtered down to the level of enculturation into school science. As Krugly-Smolska (1996) writes, “Many science teachers still believe that science is the body of facts and theories produced by science and that these can be transmitted to students. These are the same teachers that, unaware and unquestioningly, transmit the culture of science with all its myths” (p. 28).

Brickhouse (1990), followed several science teachers in their daily practice and found that there was a causal link between how they viewed the nature of scientific theories and processes and how they shaped their curriculum. One teacher in particular believed
that theories were a collection of truths and the goal of instruction was for students to assimilate the theories. Consequently, he explicitly taught an ordered scientific method which he understood to be a linear, rational process leading to the scientific truth. His main method of evaluation was through tests which students were expected to memorize what they learned in class. Finally, he believed that science progresses through very exact, precise experiments, therefore, his students were expected to perform exact tests to find a predetermined correct answer.

The teacher's influence and role in the shaping of scientific attitudes can hardly be overestimated. There is a great gender effect associated with teacher's expectations in that girls are asked fewer challenging questions, receive less praise and/or criticism and generally interact with teachers a smaller percentage of the time than boys (Peltz, 1992). The instructional strategies employed by teachers also calls into question whether science classes are providing gender-inclusive environments for learning. In surveys on daily science activities, students cite lectures, reading from the textbook and answering textbook questions as the main types of activities undertaken in class (Lee & Burkham, 1996). This heavy emphasis on transmissive modes of teaching directly contradict strategies that studies have shown to be motivating for girls (Kahle, 1996).

Taken collectively, there is a substantial body of evidence that indicates girls are disadvantaged in traditional science classroom settings. Rather than the difficulties stemming from any natural gender-specific tendency to prefer one kind of subject over another, it is more likely the case that students' attitudes are a learned response to environments that do not promote inclusion. The task now is to search for a pedagogy that encourages female participation and one that will ensure an ample if not robust pool of future women scientists.
1.5 Gender-Inclusive Curriculum: Group Dynamics and Discourse Interactions

Tobin (1997) states that there is consensus among researchers regarding the qualities that a gender-inclusive curriculum should possess. These are briefly; a friendly and non-threatening atmosphere, opportunities for cooperation and shared learning, inquiry-based, problem solving activities, extra time for girls to experience practical development, role modelling and an emphasis on the relevance of science in women's daily lives. Less content and more attention to understanding as well as the teacher being perceived by students as a co-learner were also cited as important characteristics.

A few studies have also called for an examination of single-sex environments (Eccles, 1992) and/or gender-specific grouping and their effects on achievement. One study showed that in classes of mixed-gender groupings, when there was a single female in the group, her contributions were often ignored. However, extensive research is yet to be forthcoming. It may be necessary to explore this avenue to obtain a more comprehensive view of the range of possibilities for gender-inclusive strategies. Furthermore, if a social constructivist perspective is advocated where the centrality of discourse in science education is emphasized, differences in discourse styles need to be taken into consideration. We can conclude from the gender research that whole-class discussions, where students are either being selected one-by-one to answer questions by the teacher or they are individually vying for attention, is not a strategy in line with girls' preferred modes of communication. One study that supports this assertion was conducted by Rafal (1996) who examined the way girls talk in small group settings. Her findings demonstrate that for girls who previously had little access to whole-group discussions, there was a marked increase in the level of participation and the level of discourse occurring between them in small, single-sex groupings - a phenomenon which also lead to an improvement in conceptual understanding.
The importance of group discussion in facilitating learning has become widely acknowledged (Alexopoulou & Driver, 1996). Generally, small group discussions can enhance numerous learning processes eg. negotiation of meanings, speed of conceptual attainment, participation and comfort levels. Many researchers, however, have now moved beyond the question of effectiveness of small group learning (Cohen, 1994) and have begun to look at the social contexts and variables which make small group learning progressive. For example, Richmond and Striley (1996) determined that the style of group leadership played an important role in successful discourse interactions. Healy, Pozzi and Hoyles (1995) found that the most effective group structure - integrated, connected or fragmented - was dependent on the specified learning goal in mathematics. Moreover, Alexopoulou and Driver (1994) studied the effect of group size on progress in reasoning.

The social dynamics in group learning have a marked effect on the cognitive functioning and accessibility to conceptual growth for each individual. When the social fabric breaks down, even in inquiry-oriented classrooms, the social construction of knowledge can quickly degenerate into the ‘social destruction of knowledge’, as termed by Coleman (1992). This is when “students don’t communicate effectively, they routinely criticize or abruptly dismiss each other’s ideas, they don’t monitor the group progress, and consensus of ideas usually rests on the status of the individuals rather than its content or relevance to the task. Thus, sound ideas are routinely lost” (Coleman, 1992; p. 7). Hogan, Pressley and Nastasi (1996) also report on a study that found students in small group structures rarely engaged in spontaneous co-constructive thinking. Barriers to effective collaboration included a predominant orientation towards getting the right answer rather than concentrating on the depth of understanding and student’s assumptions about the intellectual hierarchy of their classmates.
Rafal’s study however, stands as one of the few works which has specifically targeted girls, group dynamics and discourse interactions in discursive science settings. Despite this, it is still unclear as to what exactly the differences in discourse styles are. Furthermore, additional research is needed in order to determine the gender grouping effects on individual learning in classroom environments. The present study seeks to provide further insight into how girls function in groups when taking the approach that science is a discursive activity.

The search for an epistemological and practical educational framework which would ideally support the study questions detailed above has lead to the exploration of the work set out by Scardamalia and Bereiter (1991) on knowledge-building communities and further elaborated on by Woodruff and Meyer (1997) on intra- and inter-group discourse, and on understanding discursive communities (Woodruff, Chakravorty & Smith Lea, 1997). These projects have been employed extensively to provide ideas for activity structuring and organization in the study being proposed in Chapter II. Therefore, at this point it would be beneficial to give a brief history of their development and research findings in order to provide a context for the study which follows.

1.6 Epistemological and Historical Background for an Educational Framework

Using examples of authentic research teams in science labs such as the ones illustrated in Dunbar’s study and other successful groups found in non-scientific enterprises, knowledge-building communities were conceived to capture the spirit of inquiry and problem-solving in educational settings (Scardamalia & Bereiter, 1994). Rather than the emphasis being placed on individual achievement and abilities, they looked to create strategies which would promote the success of a community of learners in a more holistic sense much like how the scientific community achieves progress in the real world. Thus,
the structure of the learning environment, with all of the social factors influencing it, became the focal point of restructuring efforts. The term knowledge-building itself refers to the classroom community working collectively to produce knowledge, the objectification of which becomes the central learning goal. To that end, the use of technology was considered an important means to facilitate the restructuring process and CSILE was ultimately created.

CSILE is an acronym that stands for Computer Supported Intentional Learning Environments (Scardamalia & Bereiter, 1991). It is essentially a communal database constructed to perform a number of functions. First, it is a place where students and teachers openly discuss their ideas about specific phenomena; ideas which may have been acquired from any number of sources eg. classroom activities, previous experiences, media influences. These ideas undergo a process of peer review, not unlike how theories are debated amongst members of the scientific community, and the ideas which hold out best against criticism are kept and added to the knowledge base that has been created by the student community. With the addition of more ideas, higher levels of increasingly more complex conceptual frameworks are generated. And these frameworks are accessible to all participants in the community, that is, knowledge becomes decentralized. More ‘knowledgeable others’ (a Vygotskian notion), such as teachers also actively participate in the process (Scardamalia & Bereiter, 1994) - an important distinguishing characteristic from discovery learning techniques.

Next, CSILE offers a number of advantages over whole classroom discussions. Listed in Scardamalia and Bereiter (1994), briefly CSILE; i). eliminates turn-taking problems - students do not have to wait to participate in the discourse; ii). promotes reflection - it affords students time to think about their responses rather than having to succumb to the pressures of oral discourse; iii). creates multiple entry points - students of varying
abilities can participate at their own pace, appropriating and contributing to the discourse according to their own learning styles; iv). encourages diverse perspective taking and sharing - since all students have access to the discourse, different ideas and different opinions can be shared and discussed, thus allowing for more broader base of information from which to debate knowledge claims; v). provides a written, cumulative record - students will be able to revisit and rethink ideas as new evidence emerges from the discourse. Collectively then, CSILE strongly supports collaboration, reflection, inquiry and a deeper level of cognitive functioning. Philosophically, it also appears to align with suggestions for gender inclusive programming noted in the previous section.

Guided by the epistemological and design principles of knowledge-building communities, Woodruff and Meyer (1997) present a model in which progress occurs via iterations of intra- and inter-group inquiry discourse. These are a recursive pattern of small and large group interactions both of which serve different but mutually supportive purposes in the construction of knowledge. They outline three mechanisms which are essential components of, what is termed, the consensus-building process and comprise inquiry discourse. These are briefly: mutual knowledge - agreement amongst group members on a set of collectively valid statements from which to build; convergence - discourse process which occurs when mutual knowledge is inadequate and members converge on relevant variables to reconstruct understanding in order to account for higher standards of evidence; coherency - focus on the larger issue of ‘fit’ once an explanation has been constructed through cycles of convergence.

In a series of studies geared towards exploring high-level science concepts, they found that in intra- or small group settings, students’ behaviour was conducive to the mechanisms of mutual knowledge and convergence. During the initial phase of discussions, students generated ideas for a set of effects related to the over-all concept
eg. how light behaves, which showed a relatively elementary understanding. Their conversations focused on confirming observations, drawing on individual experiences and ferreting out a common understanding. The explanations at this time indicated little or no recognition of the relationship between specific phenomenon or underlying causes. However, as more effects were introduced and students were expected to account for higher standards of evidence, the discourse mechanism moved into the second, convergence phase. Here students used materials and identified specific variables to be manipulated in order to generate alternate hypotheses. Students’ understanding of causal mechanisms became more apparent as they began considering the relationship between elements. The mechanism shifted, once again during the next, inter- or large group phase, as groups presented their explanations to the entire class. This discourse interaction resembled a debate format where students were evaluating each others’ explanations and challenging the validity of claims, thus encouraging movement towards increased explanatory coherence and theory formation. It is important to note that each of these phases were revisited throughout the process to reestablish mutuality of thought and to further converge on relevant variables as their level of conceptual understanding continued to develop.

In addition to knowledge-building and mechanisms of intra-group and inter-group discourse, exactly what constitutes a community of learners is of primary importance particularly when considering how a successful scientific community functions. Woodruff and Chakravorty (1997) outline four elements that hold a community together - the glue factors - derived from an indepth look at the available community research. They are defined as: i). function - the specific purpose or reason why the community has been created, ii). identity - structured from a series of interrelations which dictate patterns of participation (also referred to as membership), iii). discourse - achieving a kind of language which is comprehensible and perhaps unique to the function of the
community and iv). shared values - collectively honouring beliefs about community interaction which include; tolerance, responsibility, selfless altruism, pride, valuing inquiry and valuing consensus. It is argued that these glue factors are not a prescription for creating communities, rather they are forces that are present in healthy, productive and therefore, successful ones. This information will prove to be extremely useful in the analysis of group functioning in the results section.

In this chapter, I have reviewed the research on science as a discursive activity, summarized the existing literature on gender differences in interaction styles with particular attention to discourse preferences and identified three contexts, knowledge-building, intra-/inter-group progressive discourse and successful community functioning within which to frame my investigation. The research reported here seeks to build on existing knowledge about learning in collaborative science settings with specific emphasis on gender discourse differences - the overarching aim being to support the development of more inclusive school science programs for girls. It will be useful once again to review the research questions guiding the study:

1. What are the patterns that emerge in discourse interactions when placing students in gender-specific and mixed-gender groupings in small-group settings?
2. How do the discourse patterns differ across gender-specific and mixed-gender groups?
3. What changes are produced in female discourse patterns when participating in alternate instructional settings i.e. small group vs. webCSILE environments?
CHAPTER 2: METHODOLOGY

2.1 Multiple Case Study Approach

There appears to be few definitive answers or over-all theoretical frameworks which can describe if discourse differences exist due to gender and, if so, how gender discourse differences impact on learning within a social constructivist paradigm. Therefore, the nature of the research questions lends itself to a multiple case study methodology where a more in-depth analysis of specific groups can provide a better understanding of what is going on within discursive settings. The aim of the research, thus, is more exploratory rather than trying to work under strict parameters in order to find a definite answer. Some quantitative analyses will be presented. However, this is used only in a descriptive sense in order to further substantiate the qualitative observations and assertions being made.

2.2 Setting and Participants

The study reported here is part of a larger research project focusing on the joint construction of knowledge-building communities between schools using the internet and webCSILE as a medium for instruction. The two classrooms that participated in the study, a grade 4/5 class from Vancouver and a grade 7 class from Toronto, investigated independently the concept of swinging in the realm of physical science. Both classes, after working through a series of structured events which will be further elaborated on in this section, proposed theories on how and why swings work. The Vancouver group had an extensive amount of time to work on their theories prior to the Toronto students entering into the discussion on webCSILE. There was a great deal of information
obtained from the interchange that occurred between the classes. However, as the focus of the study was to explore, in detail, the discourse differences between gender, the analysis centred primarily on the inter-group functioning of the Toronto class only. This group was also selected for two additional reasons; grade 7 students fit the middle grade range (previously note) when both interest and achievement levels in girls begin to decline (Lee & Burkham, 1996) and the researcher of the study was also the classroom teacher at the time of the study.

As the teacher of this classroom, I had been involved in on-going action research focusing on improving instruction within a social constructivist paradigm over a four year time-frame. During this period of action-research, several research strategies were developed; taking anecdotal reflective teacher notes, audio-taping and analysing group conversations, periodically assessing students' conceptual development through surveys and questionnaires and holding formal and informal class discussions. Although the students changed every year, patterns of classroom dynamics began to emerge which ultimately led to my interest in gender and science research. Due to the extended amount of time teaching the students, I was able to understand intricacies of class dynamics and details about individual students which would otherwise not be known to an outside researcher. This allowed me the opportunity to make more accurate observations and draw more accurate conclusions from the results due to my knowledge about patterns in classroom behaviours, past academic experiences, strengths and weaknesses of the students etc. In addition, I was familiar the premises underlying webCSILE and had an initial understanding of the potential of this tool to promote and support discourse interactions.

The grade 7 classroom was located in an inner-city urban Toronto school. The school was situated in a low socioeconomic area and had a rich blend of culturally and
ethnically diverse students. There were 24 participants, 14 girls and 10 boys with a great range of cognitive skills and abilities. These students received instruction in the subjects of English, Math, Social Studies and Science from the same teacher and rotated together to their exploratory classes. Prior to entering grade 7, they had very little practice in cooperative or collaborative group learning and after undergoing fairly extensive training during the grade 7 year (only in their core classes) they began to work productively in groups at the time of the commencement of the study.

There were two parts to the study which took place over three weeks. The first part entailed instruction and activities designed for whole class participation. Thus, in the first week, all 24 students worked together in small group and large group settings. The students were divided into six groups of four; one group of all girls, one group of all boys, two groups with one boy and three girls and two groups with an equal number of boys and girls. Each group’s discussions were audiotaped for analysis.

2.3 Small Group Construction

Of the six groups that participated in the study, the two groups that had a gender make-up of one boy and three girls did not have their full compliment of members at the time of data collection. Therefore, in order to keep the group numbers consistent at four members each, the discourse data of these two groups will not be presented. The gender construction and a brief description of the members in each of the groups being used for the analysis follows. The students’ original names have been changed.

Group 1
This was an all-female group consisting of Jenny, Kim, Mandy and Nelisha. Nelisha and Kim were relatively high achievers in all subjects compared to Jenny and Mandy
although generally, they were perceived by the class as average students. Jenny and Mandy both had a history of difficulties on most academic tasks. None of the girls in the group were particularly close to each other socially.

**Group 2**
This was an equal ratio mixed-gender group consisting of Candice, Yolanda, Max and Sean. Candice experienced difficulties in all subjects including science due to a lack of motivation and self-esteem. Yolanda, another female, was a fairly consistent worker with less than average results in most subjects. Both of the boys underutilized their academic potentials however, were able to produce average work. The boys were close friends with each other in the group.

**Group 3**
This was also an equal ratio mixed-gender group consisting of Kay, Tammy, Al and Harry. Kay was one of the top academic students in the class. Tammy struggled with math and science concepts however had above average verbal and written skills. Al was an average student in all subjects and Harry was an E.S.L. student who worked very hard to improve his abilities. Kay, Tammy and Al were good friends.

**Group 4**
This group was an all-boys group consisting of Henry, Mitch, Mark and Aaron. All four of the boys, particularly Aaron and Mark, were high achievers. Although Mitch had a history of behavioural difficulties, he had excellent problem solving skills. Henry and Mark were good friends among the group. While Aaron and Mark had a friendly relationship, they were competitors in the class.
2.4 Lunch Hour Group

A select group of volunteers continued in the second half of the study for two additional weeks. They collaborated together, read and posted notes on the webCSILE database during extra-curricular times. The number of students in the volunteer group varied from day to day however, there was a core group of three to five girls who attended regular sessions and who provide the data for analysis. They are referred to as the “lunch hour group”. The contributing members were: Jenny, Kim, Mandy, Mitch, Yolanda, Candice and Tammy. More specific information on the cognitive and social abilities of each member of this group will be further elaborated on in the sections presenting the webCSILE data.

In the first week, activities were scheduled during four half-day intervals which lasted for approximately 2.5 hours each. Several groups came into the classroom both before and after sessions to further explore their ideas and to aid in the set up of the activities. The volunteer group spent time on the database for approximately 40 minutes during their lunch hour. There were six of these sessions in total during those two weeks. Due to equipment limitations, there was only one internet link for the class to access the webCSILE database. Therefore, notes which had been previously posted by students were printed and assessed in their hard-copy form during the first week. New theories and responses to ideas were entered for temporary storage onto four Macintosh computers and later sent collectively to the website. In the second two weeks, due to the small size of the volunteer group, the students were able to work from the website directly.
2.5 Sequence of Activities

The following is a detailed account of the activities undertaken by the Toronto class during the swings unit investigation. The approach was adapted from a method described in Meyer and Woodruff (1997) to support the emergence of consensually driven explanations:

2.5.1 Week One

Day 1

I. Pre-sequenced set of activities
   i. whole-class introduction - students were asked to visualize a time in their past when they played on a swing
   ii. sharing - students turned to a partner and shared their experiences
   iii. prerecorded video - students watched a video of someone swinging in two positions:
       • initially at rest and then working up to a full swinging motion using all parts of the body
       • initially at rest but not using leg power to reach the full swinging motion

II. Recorded predictions
   i. small group discussions - students were asked, in designated groups of four, to discuss the motion of swinging and identify possible variables involved
   ii. constructing an instruction guide - students produced a sequence of steps to be dictated to a novice swinger to teach them how to swing

III. Manipulation of materials
   i. testing of instruction guide - the class went to the local playground to test out their instruction guides on two novice swingers
   ii. small group observations - while one student called out the instructions, the other students in the group watched, evaluated and took notes on how the instructions could be improved
iii. small group conferencing - upon first testing of the instruction guide, the groups immediately discussed and revised their instructions prior to a second testing

**Day 2**

_I. Manipulation of materials (cont.)_

i. reviewing ideas - in a whole-class discussion, students revisited some of the important findings from the last day's activities

ii. demonstration - using the concept of a pendulum, several force and motion questions were posed and discussed in their small groups
   - why does the ball eventually come down?
   - how is the motion of a pendulum related to the motion of a swing?
   - what happens if the string is shortened or lengthened?

_II. Sociogenerative contexts_

i. postulating theories - each group worked on identifying the important variables involved in swinging and proposed theories as to how and why swings work

ii. further materials manipulation - pendulums were set up and used by the groups to aid in their theory constructions

iii. small group sharing - a scout for each small group was designated and travelled among the groups to obtain alternate explanations

iv. large group sharing - when the groups felt that they had a sufficient explanation, they presented their theories to the class and a discussion was generated

v. small group theory revision - theories were further revised; several groups tested their ideas in the playground during extra-curricular times

**Day 3**

_I. Sociogenerative contexts (cont.)_

i. entering theories on the database - two students from each group typed in their theories to be entered onto the webCSILE database

ii. reviewing other groups’ theories - the other two members of the group
reviewed hardcopies of notes which had already been entered onto the
database by the Vancouver students

iii. generating questions - students discussed webCSILE notes and generated
questions to pose on the database

Day 4

1. Extended time frame

i. reviewing responses - overheads of student responses to theories and
questions posed on the database from day 3 activities were prepared and
discussed in a whole-class context

ii. discussion of communication skills - students were asked to consider
appropriate internet communication styles i.e. phrasing their comments in a
positive and constructive way in order to minimize miscommunication and
watching for intonation

iii. further sharing on database - additional comments were prepared in their small
groups and entered on the database

iv. producing coherent explanations - in their small groups, students were asked
to consider their understanding of swinging from all perspectives experienced
over the four days and once again asked to complete a set of swinging
instructions.

2.5.2 Weeks Two and Three

During these weeks, students spent time reviewing the responses posted on the
database. They formed a small research group which met during lunch hours to discuss
further conceptual developments. Typically, they selected new notes, reviewed them
together orally, debated on the knowledge claim, compared it to their understanding and
then formulated a response. Several lunch hour participants independently decided to
investigate their ideas after school in the playground to test the validity of their
understanding.
2.6 Data Sources

The following data sources were collected:

i. Questionnaires
   - What Did You Learn? (Appendix I)
   - Activities (Appendix II)

ii. Instruction guides
   - initial Day 1 group notes
   - To Do; To Notice; To Explain (Appendix III)

iii. Audio tapes
   - two sets of 45 minute tapes of small group discussions

iv. WebCSILE student and teacher generated database notes

v. Recorded small group chart paper notes

vi. Teacher field notes

2.7 Assessment Measures

Of the six data sources, the audio tapes and webCSILE notes were extensively analysed for the purposes of this present study's aims. Six audio tapes, each recording the discussions occurring between groups on Day 2 during the theory generation stage were transcribed and qualitatively and quantitatively assessed for their social and cognitive developments. The webCSILE notes were categorized into four levels of cognitive functioning for a content analysis. The specific details in the development of this instrument follow.

2.7.1 Selecting the Units for the WebCSILE Content Analysis

Cohen (1995) conducted a study focusing on metacognitive, referent-centered and problem-centred discourse in which the data consisted of similar contributions to a
CSILE database. The written discourse was parsed into smaller 'idea units' for analysis, the rationale being that a note could be a short sentence or several paragraphs long with any number of ideas being represented. This seemed to be an appropriate unit of analysis for his study as he was measuring the cognitive growth of students in specific scientific concepts. The aim of this study, however, is to determine what differences in girls' discourse patterns, both social and cognitive, are produced when discursive settings are changed.

Based on previous classroom observations, I found that when students had a weak grasp of a concept, often their interaction with other students in collaborative small groups did not go beyond the level of reiteration or clarification of ideas. It has been documented that CSILE, as a strategy for learning, affords students time to think and allows them to access multiple perspectives which can be used to deepen their own understanding (Scardamalia & Bereiter, 1991). Subsequently, it was hypothesized that this would be a better instructional method for students who have difficulties learning in more traditional settings. In order to measure this, each CSILE note was assessed in its entirety, as a turn that might be taken in oral discussion. This enabled a comparison between the two strategies of oral vs. written discourse. Further, employing the entire CSILE note as a unit for analysis has an additional benefit. In oral discussions, it is easy to determine the intention of an utterance - whether it was meant as a question for clarification or as a statement of new information - from the intonation in voice and the line of reasoning already developed within the group. In other words, one can tell quite simply by listening whether a student has asked a question out of confusion or to advance a theory. However, the structure of CSILE does not afford the same opportunities for analysis. Students can enter into the written discourse and access information at any given time during the investigation. For the researcher, it is difficult to determine which sources of information has informed the thinking of a child without
having background knowledge of the discussion that has come before. Clues may be present in the larger body of the note which might indicate intent and therefore need to be included in the whole unit to improve the accuracy of the analysis. It is however the case that, some notes are only one or two lines in length and may be more difficult to categorize.

2.7.2 Selecting the Categories for Analysis

Watts, Gould and Alsop (1997) explore students' knowledge of scientific concepts through analysing the levels of questions that emerge during classroom discussions. Their findings indicate a correlation between the level of conceptual understanding attained by the student and the types of questions they pose. The three categories of learner's questions used in the study were: consolidation - indicating a movement towards a consolidation of new science concepts, clarifying rationale for classroom tasks, confirming explanations and seeking reassurance of understanding; exploration - reaching a sense of conviction in their understanding, posing questions to others and testing constructs; elaboration - examining claims and counterclaims, elaborating on and challenging previous knowledge and posing new ideas. The same categories were selected to construct the categorization manual to be used in this content analysis. However, the specific operational definitions were slightly altered to suit the purposes of the research question being investigated.

Upon final construction of the categorization scheme found in Appendix IV, 90% percent inter-rater reliability was obtained on twenty percent of the data set by two graduate students who had prior knowledge of webCSILE.
2.8 Methodology for Analysis

The specific content of discussions occurring between members of each group must be examined in order to establish discourse patterns. While it is possible and necessary in some cases to substantiate assertions using statistical methods of analysis, in other cases, eg. when making affective comparisons, anecdotal descriptions may be more appropriate. Thus, in order to give an holistic and detailed account of the patterns revealed in the discourse, a combination of quantitative and qualitative analyses is presented.
CHAPTER 3: RESULTS AND DISCUSSION PART I

The data is discussed within a framework broadly divided into two sections:

I. Small-group or inter-group discourse patterns
II. WebCSILE or intra-group discourse patterns

Each of the sections are further divided into the subcategories of i). social developments and ii). cognitive developments and under these, several variables will be assessed.

3.1 Small-Group Discourse Patterns

An assessment of the literature focusing on the way students function in small groups suggests that a line of delineation can be drawn between studies addressing social developments and studies addressing cognitive developments. Conducting both kinds of studies is fundamental to provide a picture of the whole learner, the learning environment and how one effects the other. In discursive classrooms, where there is an increased level of student interaction compared to traditional classrooms, the propensity for social variables to positively or negatively affect learning is high. Therefore, in order to reach the end result of improved academic achievement or improved scientific literacy, it is necessary to identify and systematically assess these social variables.

From this perspective, if the social functioning of any small group is maladaptive to the task, it is hypothesized that the elements defining the ‘social destruction of knowledge’ (Coleman, 1992) will infiltrate and characterize the discourse interactions eg. strong criticism, abrupt dismissal of ideas etc. In addition, if we consider small groups as operating as local communities of investigators at a micro level, we can go one step further and suggest that when the positive social elements are not present, those ‘glue factors’ i.e. mutual function, shared values and shared identity (Woodruff &
Chakravorty, (1996), will not be manifested. This will then create a situation where collaboration is inhibited. In order to demonstrate the extent to which collaboration was achieved among the groups in the study, measures indicating each glue factor were employed as the units for analysis of the small group discourse data.

From a cognitive standpoint, in knowledge-building, discursive environments, it is possible to measure the growth of conceptual understanding by determining the extent to which the mechanisms of knowledge-sharing, convergence and coherency (Woodruff & Meyer, 1997) are evident in the discourse. If those mechanisms are being underutilized or not utilized at all, it is hypothesized that conceptual understanding will be inhibited. The extent to which sharing, convergence and coherence occurred was assessed for each of the groups to obtain a measure of cognitive development.

Incidences of both social and cognitive developments will be highlighted and compared within and between groups from the tape recordings of Day 2’s small-group discussions. Their topic of discussion focused on why and how a swing works.

3.1.1 Social Developments in Small Group Discourse Interactions

3.1.1.1 Function
The fundamental reason for a community’s existence can be determined by what function it serves. It is also possible to use the notion of function to define the purpose of any cohesive body. When all members of a group have an awareness of how and why they have come together, it can be said that they have a mutual understanding of what their function is.
Off-task utterances

How well a group understands its function and the degree to which that function is upheld can be measured by how often the group stays on or off task. In order to determine whether there was a difference in gender discourse between the groups with respect to the variable of function, turns in each of the group’s conversations were assessed for the percentage of off-task statements uttered eg, “yo, this Saturday we’re going to have a barbecue” or “lemon-lime, it smells like lemon pinesol, orange candy”.

Figure 3-1 shows the percent of off-task utterances occurring per group during the forty-five minute taped audio session. Groups 2 and 3 (both mixed-gendered groups) had the highest proportions of off-task utterances; 35% and 17% respectively, while group 1 (all-girls) and group 4 (all-boys) were off-task, 8% and 10% of the time. A chi-square test for the three gender groupings showed a highly significant relationship between off-task utterances and gender make-up, $x^2 = 12.16$, p<0.05.
There were also differences evident in the type of off-task utterances made. In the all-female group, these stemmed from incidental interests in the task and not from deliberate efforts to change the subject. For example, during a momentary convergence on a diagram drawn to illustrate their understanding, the following interchange occurred:

Jenny: Look at her afro! I need brown, ask for brown please. Nicole, Nicole...could I borrow your brown please? Pass me the brown under you.
Nelisha: The brown under me? Okay there.
Kim: What does it smell like?
Nelisha: I think sort of like chocolate.
Jenny: It smells like Milo!
(all laugh)

A similar pattern was evident in the discourse of the all-boys group.

Henry: I know it smells good.
Mark: Orange tic tac, cherry.
Aaron: Okay, okay, get back to work, forget about smelling the markers.
Henry: Cherry?
Aaron: Put it back, okay!
Henry: Sorry, Mr. Monitor.

These types of utterances did not appear to affect the momentum and natural flow of the discussion. They represented relatively short segments of the dialogue and there was a responsible, task-conscious member in both groups who always cued the rest of the members to get back on track.

The discourse of the mixed-gender groups showed a very different dynamic. Their off-task incidences took up more extended segments of the dialogue which consequently interrupted the flow of the conversation. Furthermore, the content of their utterances bore little relationship to the task. Following a short discussion on the variables affecting the swinging motion, group 2 veered off in another direction:
Yolanda: How do airplanes fly guy?
Candice: You know what? Airplanes can't go backwards.
Sean: No really, when did you figure that!
Candice: I was watching Bill Nye guy.
Sean: Only helicopters.
Max: Airplanes could go backwards but not when its up in the air.
Sean: Exactly...they can move backwards when they're on the ground.
Yolanda: Okay
Candice: No...I was watching mighty machines
Sean: I know magic eh. Look, my hand's a magnet. Look, everyone is looking at my hand.
Candice: You're so dumb. Don't man!
Sean: You know I have a magnet in my hand and your eyes are attracted to the magnet.
Candice: Oh Canada, our home and native...

Yolanda in this case brought up the topic of airplanes. Candice, who, until this point had difficulties contributing to the swing theory, realized that she had something to offer on this new topic and engaged in the conversation. This, in turn, encouraged another member of the group to veer off the central topic. Note the domino effect which prolonged the off-task behaviour.

In the other mixed-gender group, more so than a domino effect, the persistent determination to put the group off-task by a single member of the group, Al, created this situation where all the members lost focus despite Kay’s efforts to redirect the group’s attention.

Kay: Okay go Haben.
Harry: Okay when you pushing the person, you have to push them at the right time because if you push them at the wrong time they'll stop. Just write that. That's what she told me.
Al: I got pure sellouts for friends!
(Inaudible)
Al: Still how could you guys come up with a name like...
Tammy: Shut-up. How could you come up with the name “the kid”? What is that?
Al: That's my name!
Tammy: That's not your name. You wish that was your name!
Kay: Haben, Haben what did you say again?
Al: Okay when you're pushing the person, you have to push them at the right time because they'll stop.
Kay: Because they don't have the right rhythm?
Al: Yo Haben, did you get stitches right here?
Harry: That's a knife, my cousin put some knife like this.
A: Two of my cousins were in a coma at the exact same time.
Tammy: Adrian, we're not supposed to be talking about this stuff
Al: Alright...and God was a pendulum ha, ha.
Tammy: You...your laugh annoys me you know. That's all I have to say.
Al: Uh huh.

We see that in terms of function, both of the gender-specific groups demonstrated patterns in their discourse which would indicate a better understanding of why they were participating in the study compared to the mixed-gender groups. In addition to possessing a common understanding of the group's function, pursuing the notion of shared-values is also critical in establishing positive social development.

3.1.1.2 Shared Values

Disconfirming statements

A simple measure representing the defining elements of this category i.e. valuing consensus, valuing inquiry and having tolerance for other people's views, is how often disconfirming statements are made - the logic here being that this reverse measure would signal the absence of those elements. Examples of these statements typically begin with the word, "no" or convey the understanding that the idea is not correct or not to be taken seriously. Disconfirming statements work to effectively stop any further exchange of ideas over the course of the conversation. They are also recognizable because they directly oppose statements of inquiry or validation that invite further discussion which begin with words such as "okay" or "yah, but".
The percentage of disconfirming statements was calculated from the transcripts and are reported here in Figure 3-2. The all-girl’s group again showed the smallest percentage in this category at 1% while the other groups had higher scores of 8% and 9%. A chi-square test was performed, the analysis of which showed a significant difference between the percent of disconfirming statements uttered by each group suggesting a gender effect, $\chi^2= 6.4, p<0.05$.

![Figure 3-2 Percent Disconfirming Utterances in Small-Group Discourse](image)

**Ignoring ideas**

Another measure of shared values can be how often ideas are ignored within the group. This may have far-reaching consequences in terms of motivation to participate in the task and how individuals perceive their own membership (also tied to the variable of identity).
Group dynamics on this measure again differed greatly. In the all-girl’s group for instance, although it did not appear to have been a conscious act, the contribution of one girl was ignored several times in the beginning minutes of their discussion. The first incidence occurred just as the girls were formulating ideas on how a swing works:

Nelisha: Number one.
Kim: Rocking back and forth with gravity, your weight...hold on...your weight...write...
Mandy: (adding to Kay’s statement) Your weight has to be equal.
Kim: Oh, we're not...we're not talking about people swinging on a swing, it's how does the swing work...The swing works by...
Mandy: By going back and forth.
Kim: (ignoring Mandy’s statement)...with weight. I don't know...something about weight.
Jenny: What was the first one you said?
Nelisha: Um I forgot.
Jenny: Mandy say something!
Mandy: You guys I said how does the swing work and I said the swing works by you pushing it back and forth.
Jenny: By pushing it back and forth?
Mandy: Yah...you have to push the swing back and forth for it to work.
Nelisha: What about if you can't push it.
Kim: No (agreeing with Nelisha) it's just how does it work. It works because...it works.
Mandy: How does it work because it works? You have to do something for it to work.
Kim: It works like this...
Mandy: You have to either push it or pump it with your legs.
Kim: (ignoring Mandy’s statement again) This is the thing that holds the swing and here is the swing (drawing a picture) then it goes...

As the discussion continued, Mandy’s voice was heard less and less on the tape until finally she ceased to participate altogether. While the ethos of the group was still collegial and Mandy was heard laughing with the rest of the girls during parts of their conversation, ultimately, she was removed or she removed herself from making any cognitive contributions. One of the last interchanges that occurred in their dialogue illustrates what happened:
Kim: It doesn't look too empty. It's alright (laughing)... give me something Mandy...just anything. Hello, are you going to do something? Mandy: I don't know what to say. Kim: Just say anything...whatever comes to your mind. Hello...anyway. Mandy: I'm not feeling good man...my head is hurting me.

The same pattern appeared in the dialogue of the all-boy’s group. However, whereas in the previous group, the act of ignoring was not a conscious act, it was quite deliberate in the all-boys group. In this next excerpt, Mitch tried to make several points which as we shall see had some scientific validity however, his ideas were blatantly and consistently ignored by the other members of the group until Mitch became frustrated and the discussion degenerated into a series of insults:

Mark: Help me people!
Aaron: The swing doesn't really work...we are the ones to make the swing work.
Mitch: Wait...okay...imagine if we go over [the bar that holds the swing] right?
Mark: (ignoring M’s statement) We use our weight and gravity pulls our weight down.
Henry: (writing down what Ma is saying)...and gravity...This doesn't make sense.
Mark: I know
Henry: (reading) We use our weight and gravity pulls our weight down?
Aaron: We use...
Mitch: We use our weight to get up in the air...
Aaron: (abruptly interrupting Mitch) We use our weight in certain ways.
Mitch: And then gravity helps us by pulling us down.
Henry: (writing and reading what he is writing at the same time) We use our weight with...
Mark: How are you supposed to use weight to bring you up when weight is supposed to pull you down?
Mitch: No you use your weight power. You use your energy.
Aaron: (speaking to Mitch) If you're going to debate, we'll debate with all.
Henry: Okay. (reading) We use our weight in a certain way period.
Mitch: (speaking to Aaron) What are you talking you stupid punk! Look...you guys are talking to yourselves too.
Aaron: We're sharing with all.
Henry: We're sharing the wealth man.
Mitch: No...you're not, because I just...that's why you’re...
Aaron: We're sharing with us two. You...you just like markers...you have no idea what's share with all!
Shortly after this exchange, Mitch realized that he did not have membership in the group and attempted several predictable antics to thwart the group's efforts, for example, he began to sing at certain pivotal times in the discussion. In this excerpt, he tried unsuccessfully to pit the other group members against each other:

Aaron: No...there are two rhythms comma...one...
Henry: Oh my god!
Aaron: One belongs...
Mitch: No listen to him (referring to Ma). He knows everything...he's the man.
Okay, share Mark...Aaron is just lost here. He says too many stuff.
Mark: Comma, you gotta copy what Aaron...
Aaron: No
Mark: Get it out! (referring to the misplacement of the comma) [It should be] there are two rhythms that make the swing work. You can't go there are two rhythms (pause) that make the swing work.
Aaron: Okay fine.
Mark: [We have to] worry about the [placement of the] comma.
Mitch: You see people. You're just as smart as [Aaron] is.
Aaron: We all can't be cursed.
Henry: Period

To gain recognition, at other times Mitch was heard appealing to authority by engaging an adult investigator in discussion about his ideas. This too failed however, and he resorted to periodically uttering insults and threats for the remainder of the dialogue.

Although Mitch was unfortunately ignored the most, he was not by any means the only one to be ignored in this group. There were many other overt dismissals of ideas, frequent interruptions and numerous incidences of one person talking over another. The ethos in this group was distinctly competitive.

Interestingly, in the mixed-gender groups, there were relatively few times when a person's ideas were ignored. This may be attributed to the fact that the study was conducted at the end of their grade 7 year and by virtue of their full-blown adolescent status, the students were, simply, hyper-aware of the other gender's presence. Observe the content of the following excerpts.
Group 2

Candice: It seems like the only thing on your mind is fat! You're going to get a fat woman.
Sean: And you're going to get a fat husband.
Candice: Whatever.
Sean: I don't think about that stuff right now. I don't think about husbands and wives right now...think about it later on.
Candice: You think about marrying Nelisha.
Sean: Oh funny...you think about marrying Frank.
Candice: Ooh.
Sean: I know you like him...show your emotions.
Candice: You're getting me mad. I really don't want to hear that kind of thing.

Group 3

Tammy: Good work Harry!
Harry: Thank you.
Tammy: (talking to Al) Harry can dust you...I've seen him fight with Lori.
Al: Lori!
Harry: Oh...don't talk about that fight...that was stupid.
Al: Lori! Lori! I'll [dust] Lori!
Harry: I didn't like that fight.

Despite the fact that all members of both groups participated in the dialogue, their respective ethos' were far from collegial. In fact, most of the time, the tone was argumentative and whenever the situation presented itself, the females in the groups deferred authority to the males. Surprisingly, this continued as the standard even though, particularly in group 3, Kay, the female note-taker's academic abilities were highly regarded in the class.

Similar to the measure of function, the measure of shared values, with all of its indicators, shows a distinct advantage for females to participate in all-girls groups. Their interaction was collegial and non-competitive over-all despite Mandy being eliminated from the dialogue. The next measure, identity, likewise follows this pattern of outcomes.
3.1.1.3 Identity

Identity generally refers to that resulting quality which is sculpted or structured from a set of interactions, relationships and achievements of the group as a whole. The notion of identity is one that obviously requires an investment of a certain amount of time to establish bonds. As the time allotted for the study was short, the groups may not have had enough time to have negotiated an identity distinct from the other groups. It is, additionally, slightly more elusive a characteristic to determine from discourse data than are the characteristics of shared values and function. It is however, possible to detect the level of cohesiveness of a group from a relative or comparative standpoint rather than an absolute one.

Selecting a group name

Selecting a group name helps to illustrate ‘identity’ as an important social development in small group interactions. The discussion that occurred between the groups over what they were going to be collectively identified as, gave valuable insight into just how easy it was to come to consensus and how important it was to the group members to agree on a group name. Groups 2, 3 and 4 all had difficulties on this measure. Presented here are those specific segments of discussion pertaining to this point:

Group 2

Teacher: What is your group’s name?
Candice: You guys made up a name? You guys made up your own name? Group name?
Teacher: Your name is...Stay Silver. Where does ‘silver’ come from?
Max: We had a silver pencil.
Candice: Why didn’t you pick gold guy?
Yolanda: I said pick gold but you didn’t listen to me.
Sean: (sarcastically) Where’s the gold? In your hair?
Group 3

Teacher: What’s your team’s name?
Al: Come on, let’s change our name.
Kay: Fine, let’s change our name.
Al: (repeats himself)
Kay: Tell Ms. Y.
Al: Ms. Y, can we change our name?
Tammy: No!
Mitch: Why...what’s your...
Tammy: I don’t want “The Kid” you know.

Group 4

Mitch: Put down “District Five”
Henry: I don’t want to embarrass myself.
Mitch: That’s our group. Put down our names [then].
Henry: I’m betraying myself by writing “District Five”.
Mark: Put down our names.
Henry: Just put down “District Five”. Oh my gosh, I’m so embarrassed.

We can see that the discussions are marked with put downs and an argumentative tone. The strong sense of disagreement and also the lack of willingness to resolve the issue demonstrates disunity in the groups. Conversely, when the teacher asked the all-girl’s group to identify themselves, there appeared to be no contentious debate and all of the members in the group called out the name at the same time signalling their individual approvals. This group had engaged in negotiations about the group name as one of their initial collaborative tasks which implies that it was important to them to have a collective identity from the beginning. It is noteworthy once again to point out that this was the all-girl’s group. The results are consistent with the low number of disconfirming utterances made on the measure of shared-values. Both suggest that putting girls in all girl’s groups has a positive effect on collaboration. These results also seem to correspond with the results obtained for the mixed gender and all-boys groupings with respect to the measures of shared-values and function where collaboration was inhibited.
Dunbar (1995) defines collaborative discourse as a kind of collective problem-solving, the corollary being individual competition. The amount of collaborative discourse occurring between groups can be a strong indicator of identity in that when groups are operating under a common awareness of unity, the members are working with each other, rather than against each other to accomplish a set goal. The transcripts of each of the groups were analysed in order to assess the extent to which collaborative discourse was achieved. Collaborative phrases were measured in any or all of the following three categories: i). the number of like-minded occurrences - marked by members finishing off another member’s sentence or the simultaneous utterance of the same idea by two or more members of a group; ii). how often members explicitly validate other members’ ideas - marked by acknowledgements or statements of positive reinforcement eg. “You know like what Kay said, you know when you’re all the way up, gravity pulls you back down”; iii). the number of helping phrases uttered - marked by overt gestures of members assisting other members in the group. An example of this type of collaborative discourse can be seen in this excerpt:

        Kim: Okay, I might as well draw the rest with a pencil. I don’t know what I’m doing.  
        Nelisha: Pencil?  
        Kim: I got one.  
        Jenny: And I’ll do the marker part

A frequency count of the entire number of collaborative phrases uttered in each group was made. The all-girl’s group again outperformed the other groups. Their collaborative discourse utterances comprised 7.4% of their total utterances while one mixed-gender group had no collaborative utterances, the other at 2.1% and the all-boys group at 2.4%. Figure 3-3 shows a histogram the discourse results. A chi-square analysis revealed that
The differences in the levels of collaborative statements made were significant, $\chi^2_{2} = 6.13$, $p<0.05$.

![Figure 3-3 Percent Collaborative Utterances in Small-Group Discourse](image)

Qualitatively there were a number of additional striking dissimilarities between the kinds of discourse emerging within the groups which would likely have affected their ability to work collaboratively. In the all-girls group, fewer interruptions were made, there were more incidences of congenial exchanges eg. laughing, more polite words spoken such as "please", and there were more phrases that invited group sharing or inquiry such as, "let's choose our favourite colours" or "okay let's do that then..." In both the mixed-gender and all-boys groups, numerous personal insults were made and members appeared to be either impatient or aggressive during on-task times. This discursive pattern was most prevalent in the all-boys group likely due to the competitive nature of their interactions as this next excerpt illustrates:
Gender Roles

Gender roles have an important effect on a group’s identity and the perception of individual expectations. As previously noted, in the mixed-gender groups, the girls often deferred authority to the males. For example, the boys made all the administrative decisions such as who would be the scout in the group and who would type the group’s theory into the computer. Moreover, following, Peltz’s (1990) assertion that the females always performed the role of note-taker in group activities, this was observed to be the case in both mixed-gender groups. Stereotypic gender roles were also apparent in that the boys dominated the discussions and dictated their ideas to the females. In this next excerpt, Yolanda, is the note-taker and Sean dictates his ideas to her.

Yolanda: So how does gravity make a swing swing?
Sean: By pulling the weight.
Yolanda: How does it pull the weight?
Sean: I don’t know
Yolanda: (reading) Gravity pulls the weight. I don’t know what you’re saying but oh well...you’re right.

Yolanda in this case is a hard-working individual but has had difficulties performing on academic tasks in general which might have accounted for her lack of cognitive participation. A similar situation occurs in group 3, the other mixed-gender group in that
a female becomes the note-taker and the two males in the group become the idea
dictators. However, Kay in this case does exceptionally well on all academic tasks and is
among the highest achieving students in the class while the boys are average achievers.
Still, the discourse interactions of this group reveals a counter-intuitive dynamic. In this
next excerpt, we see Kay pleading with Al to participate. We get the impression here
that Kay is suppressing her academic status to please Al. Feeling important, he then
takes advantage of this and responds aggressively.

Kay: What’s wrong with you? Please...please work with us...we need your help.
Harry: I’ll go...I’ll go over there.
Kay: Because there’s gravity?
Al: (interrupting and speaking very aggressively) It’s because of weight. It’s all
because of weight. When you go back, the weight of the person’s body...it pulls
them forward.
Tammy: I’m surprised you said something.
Kay: (figuring out how to write down what A has just said) Okay, okay, okay...um.
Al: You see, I just came in and you have to be on my case man!

On another occasion although we get the sense that Kay already possesses an advanced
understanding of how a swing works, she appears to humour Al in such a way that he
receives an inflated or perhaps artificial validation:

Al: Listen, I’m trying to explain this. Alright so...listen right...so if a person is on
here, they’re using weight. A pendulum, that pendulum that we have right
here...it’s using the weight of the playdo...when it comes forward, it’s using
the weight of the playdo to take it back. So it works...
Kay: So you’re saying this is the person’s weight and this is the...
Al: It works exactly the same way. A swing is like a pendulum...it uses the weight
of the object that’s on...I don’t know what you call this...it’s the stage, to
bring the thing back and forth.
(pause in the discussions)
Al: Did you get my explanation?
Kay: Yes. I understand it.
Al: Finally someone gets my explanation.
All indicators of identity showed that the all-girls group possessed a higher level of cohesiveness than the other groups. Moreover, the girls in the all-girls group fared better than the girls in the mixed-gender group in terms of gender roles and collaborative discourse. Therefore, on all three measures of social development, the all-girls group operated at an advanced level.

3.1.2 Cognitive Developments in Small Group Discourse Interactions

A central aim in knowledge-building communities is to move the conceptual understanding of the individuals and of the whole group to a deeper level. Constructing knowledge, as the term implies, requires students to be cognitively engaged and participants themselves in their own learning. The extent to which knowledge-building can be achieved in discursive classrooms can be dependent on a number of factors. Of primary importance are the social variables discussed in the previous section. If those are not stable, it is not likely that there will be positive outcomes on measures of participation, inclusiveness and motivation. And this in turn can have profound effects on the level of cognitive functioning occurring as we have seen. It is also possible to assess the level of cognitive functioning by observing to what extent groups engage in inquiry discourse i.e., as Woodruff & Meyer (1997) outline, those mechanisms of mutual knowledge, convergence and coherence. The premise here is that if inquiry discourse is utilized effectively, knowledge-building will be working and therefore a greater level of conceptual understanding achieved. The discussions of the four groups will be assessed with respect to these mechanisms. The transcripts were studied to determine the level of inquiry discourse engaged in by each group and to identify the effects that gender-specific discursive styles may have on cognitive development. In the previous section on social development, the discreet categories were presented and each of the groups were assessed on those measures. However, in this section, because the categories are
linked to each other in a linear progression from least to most developed i.e. mutual knowledge being less complex a mechanism to establish than coherence, it is more appropriate to present the analysis in terms of which groups underwent the least cognitive development to the most rather than in distinct categories. The postings to the WebCSILE database of their working theories on how and why a swing works indicated that the mixed-gender groups had the least cognitively advanced theories followed by the all-girls group and then the all-boys group.

3.1.2.1 Mixed-Gender Groups

The discourse of both mixed-gender groups revealed few attempts to establish mutual knowledge. However, near the beginning of group 2’s discussion Yolanda and Candice *did* try to engage in some preliminary level before being abruptly cut off by Sean:

Yolanda: Okay, how do you think a swing swings?  
Sean: How do I think a swing swings? It swings because of the gravity pulling the weight.  
Candice: We’ll just say gravity  
Yolanda: I know you keep on saying gravity...  
Sean: (interrupting abruptly) But that’s...that’s why. Right now we’re doing how.

After this exchange, there was no further elaboration on how gravity affects the swinging motion. Neither of the boys in the group made any attempts. Similarly in group 3, near the beginning of the discussion, as Kay and Tammy tried to understand Al’s idea about weight being an important variable, Al suddenly became aggressive halting the process of mutual knowledge sharing:

Kay: Why do you say because of weight?  
Al: Because, you see like...here’s the swing right? You see, first when you swing it goes up right? What brings it back over here...weight...the person's body weight brings it back and it goes up and then after when it's up here the person's body weight brings it back. What guy you brainiac. So you explain it guy, you little brainiac. (it is not clear who he is speaking to)
Kay: And gravity?
Tammy: Gravity pulls the weight down.
Al: See it has something to do with weight...mind your own business...mind your own business, shhhhh.

In Woodruff and Meyer (1997), there is initially a linear progression between the stages of inquiry discourse, then increasingly more sophisticated standards of evidence are introduced, the progression becomes cyclical, each time, moving towards reestablishing the group’s mutual understanding. It is evident that both groups could not move beyond the mechanism of mutual knowledge and therefore could not proceed to the higher-level mechanisms of convergence and coherence. Consequently, upon completion of their respective discussions, the theories which were entered onto the webCSILE database had undergone minimal conceptual development. Recall Group 2’s initial reference to gravity and weight in their small-group discussion compared to their resultant database entry:

Why does a swing work?
Swinging works because of numerous things--for instance, gravity. It makes you come down instead of staying up. A swing is a pendulum it goes back and forth so when you’re swinging you pump. The chains are the objects that really support the swing. So that’s how the swing, swings!

How does the swing work?
The swing works by you and your weight. If you don’t have weight you won’t be able to make a swing go back and forth. To make your swing go you have to move your legs back and forth.

The ideas are elementary, lack detail and there is little evidence of a synthesis of understanding.
While Group 3 also began their discussion with the notions of gravity and weight, they were able to move their theories slightly further than group 2 however, there was still a lack of coherency in the note. It is also very important to recognize, similarly with group 2’s note, that all of the recorded information resulted from the ideas of only one person in the group.

**Why does a swing work?**

A swing works because of gravity and the gravity pulls the swing down and rhythm because if you don’t push the swing at the right time the swing will stop. Pumping is also important to make a swing work because it helps you make the swing work and the last thing is weight, because if you don’t shift your weight on the swing it won’t work.

**How does a swing work?**

A swing works because it is just like a pendulum and that uses weight (of clay or whatever) to work and the swing uses the weight of the person to work. Air is important because it helps the swing to move back and forth and gravity helps to make the swing move faster.

### 3.1.2.2 All-Girls Group

By contrast, the girls did initially invest time in establishing mutual knowledge. The first variable they discussed was the swinging motion of rocking back and forth. This quickly moved to exploring the notion of rhythm. Nelisha then began to formulate an hypothesis as to why rhythm would play an important role in swinging. The next excerpt depicts Nelisha’s trying to convey her idea about rhythm to Kim. We see Kim’s determination to see Nelisha’s perspective despite being interrupted by Mandy.

Kim: And by swinging with a rhythm...
Jenny: (writing) So by swinging with a rhythm...
Mandy: (singing the phrase) You have to swing with a rhythm.
Nelisha: I guess like a pattern.
Mandy: What colour is a giraffe’s thingy?
Kim: What? A giraffe’s what?
Mandy: The...the thing. Black?
Kim: It has to have a...
Mumbling
Kim: Okay, opposite...
Nelisha: Okay...K right. You know when um when you're pushing a ball right?
Kim: Uhmm.
Nelisha: It's like this (all laugh) and then...but not like completely up so it's like half way... and you push it, then...
Kim: I don't know...
Mandy: Can I borrow this please? Can I borrow that please?
Kim: Okay explain that again.
Nelisha: (drawing a diagram) Okay you know how you watch the thing. Like it's a swing right and then it [comes] back all the way up here. And halfway on it [if] you push it and it stops a little bit, it won't continue moving smoothly. It'll be shaking a little bit. Like if you swing [and] up here you push...it shakes. (at this point Kim understands what Nelisha is saying and signals her agreement)

There were numerous exchanges between Nelisha and Kim in this group that appeared to show a cycling between mechanisms of mutual knowledge and convergence. For example, they refer back to their previous day’s activities to reconfirm their understanding and then converge on further variables that were not addressed in earlier discussions eg. the notion of opposites. In addition, their tools or methods for problem-solving differed from their mixed-gender counterparts; they frequently used diagrams to illustrate their arguments and also used analogies in their explanations. This group did not appear to achieve the level of coherence, that is, trying to establish a fit between their theory and the theories in the rest of the class. We do see that their final entry was conceptually more sophisticated than the gender-mixed groups. Although the points were listed slightly out of order and they did not delineate their answer between the questions of why and how, the elements presented show an advanced understanding eg. the understanding that the body and the swing work together to obtain the swinging motion.
The swing works:
- the body rocks back and forth with gravity (it pulls you back down)
- the body and the swing work together
- a swing works when there is gravity, weight, balance, and rhythm
- when the swing moves backwards, you move forward keeping your legs in
- when the swing moves forward you move backward with your legs out
- it works like a pendulum
- gravity helps you move faster

3.1.2.3 All-Boys Group

It is difficult to imagine the boys coming to consensus on anything judging from the competitive posturing that occurred throughout their discussion. However, this group produced a marginally more sophisticated theory compared to the other groups. A closer look at the discourse shows that although it was marked by many interruptions and overt disregard for a particular member’s efforts, the ideas were still being heard and we see that they were often repeated later on by someone else. For example, Mitch explained to the group that there’s a certain time during the swinging motion that one must begin to pump. He said:

On the swing right...on the swing when you’re pumping, you have to pump at a certain spot right? Because if you don’t it’ll make you go slowly because you’re not using your weight at a proper time so instead of pumping the middle right...you have to pump at the top and at the back right...and then you’re getting higher.

This statement was promptly ignored by the rest of the group however, moments later, when one of the investigators questioned the group about this notion of pumping at the right time, Aaron responded with:

Ya...you have to start pumping when you go all the way back and you’re ready to come back down. You can’t just pump in the middle or else you’ll stop.
Note the similarities between the two statements yet despite Mitch continuing the conversation with the teacher after Aaron responded, his ideas were again dismissed.

Teacher: Yah...that's what E was doing wrong. He was doing exactly what you were saying...
Mitch: He was pumping in the middle right?
Teacher: And his timing was off.
Mitch: Because he was pumping in the middle and the reason why he was doing that and he wasn't moving anywhere...the middle...he was rocking like that.
Teacher: Yah so the rhythm has to be right and the rhythm is timing.
Mitch: And using your weight at the right time.
Teacher: Same as rhythm in music. It's all according to being timed (she leaves) (pause)
Henry: What else...we use our...

This line of inquiry eventually led the group into developing a 'two rhythms' theory.
Mark wrote:

One rhythm is you and the other rhythm is the swing itself and you put two rhythms together, it makes two.

Mark initially made this comment with some uncertainty in his voice. But upon further elaborations, began to feel more confident in his understanding:

Henry: Okay, should I put the title, “Why does the swing work?”
Mark: No.
Mitch: Okay, okay write this down...there are two rhythms...
Henry: There are...hold on...slow down...there are two
Mark: No, no.
Mitch: Yah
Mark: There is also the part of how the swing works. There are two rhythms the person and swing itself and you put both of them together.
Mitch: Slow down and tell him then.

Here, working in a competitive modality, Mark's concern for getting his ideas written down actually worked in his favour because it forced him to repeat himself, each time
rephrasing the statement which helped to solidify the concepts in his mind. One further point of interest in need of mention is the fact that all four boys in the group had experienced a high degree of success in their academic histories and they were well aware of each other's intellectual 'status' in the classroom.

This group made the most utterances in the transcripts - 411 in all compared to 155 by group 2, 243 by group 3 and 229 by group 1. This high number can at least be partially attributed to the repetitive nature of the discourse - no doubt a phenomenon created by the members' unwillingness to acknowledge responses. It is hypothesized that this repetitive dialogue served as a mechanism for advancing ideas rapidly. This essentially replaced the mechanisms of mutual knowledge and convergence and brought them to a level of coherency sooner than the other groups. Here is their resulting theory:

**Why does a swing work?**

There are two rhythms that make the swing work. The first rhythm belongs to the person and the second rhythm belongs to the swing. In order to make the swing work, you must combine both rhythms without one cancelling the other one out but making the two rhythms work together as one.

**How does a swing work?**

You have to pump your body (moving your legs back and forth and moving your body in the opposite direction) at a certain time (at the peak) in order to make the swing rock back and forth. You also have to keep repeating the rhythm over and over again.

To this point in the analysis, the focus has been on exploring the first two research questions which were, if we recall, identifying discourse patterns emerging from differently constructed gender groups and how the patterns compared across the groupings. We have seen for the most part that both social and cognitive developments are enhanced for girls when they are placed in gender-specific groups. The next section addresses the third exploratory question which aims at searching for alternate
instructional settings to promote collaboration. A micro-analysis will be presented on the
discourse data obtained when a small group of girls came together to discuss their ideas
during several of the lunch hours immediately following the swings study in their small
groups.

3.2 WebCSILE Discourse Patterns

Recall that the main aim of the investigation was to study the discourse patterns of girls
and boys in discursive classrooms. Recall also that two discursive settings were
structured for the students to participate in. The small group setting, detailed above, was
organized as such to identify differences in patterns emerging in intra-group discourse,
while the webCSILE environment was employed to observe differences emerging from
inter-group or large-group discussions.

A number of discoveries were made in terms of how webCSILE facilitates the
acquisition of a scientific discourse, how it offers opportunities to explore the language
of communication and how it can foster the development of a community of learners
beyond the normative parameters of a single classroom. These have been documented
elsewhere in Meyer, Woodruff, Erickson, Yoon and Haskell (1998). In this present study
however, there was one interesting phenomenon involving gender-related practices that
presented itself during the post-study webCSILE phase which warranted further
consideration.

We witnessed the relative success of the all-girl's group in maintaining increased social
and cognitive development in small group settings compared to the other groups.
Despite their over-all success, it was observed that one member of the group, Mandy,
had difficulties obtaining membership. Although the relationship remained positive, she
made no significant cognitive contributions in the end. Additionally, another member of the group, Jenny, while fulfilling her role as the recorder, did not make any significant cognitive contributions as well. In both of the mixed gender groups a similar pattern of cognitive participation occurred with the girls in the group even though there was a very different social dynamic in operation. Both Yolanda and Candice in group 2 and Tammy in group 3 contributed no substantial ideas to their respective discourses.

The educational histories of these five girls reveal several things in common. Based on their report cards from previous years and anecdotal comments from former teachers, all had experienced difficulties in learning prior to the grade 7 year. Generally, they received low grades across subject areas but most notably in math and science and showed low motivation on academic tasks. With consistent interventions and alternative methods of instruction, these girls were able to improve their academic standing and interest in school to a certain degree although they still remained among the lowest achievers comparatively in the class during this current academic year. Another important factor in their learning was that the parents of at least three of the five girls held very high expectations for their academic success which greatly affected the girls’ confidence levels. Consequently, their lack of academic success caused great anxiety and fear of failure to the extent that none of the girls participated in oral whole class discussion.

Of particular interest here is how these five girls functioned in a small lunch-hour group that had developed on a voluntary basis for six sessions after the formal part of the study was completed. Initially the team of investigators had hoped that a greater proportion of the class would offer their time in developing the ideas on the database. However, as the study occurred near the end of the year, there was little in-class time that could be allocated for this purpose. The lunch hour seemed to be a reasonable
alternative time to access the database. Interestingly, it was these five girls who eagerly and consistently volunteered to continue on in the study and the results of their participation show remarkable changes in their social and cognitive development.

3.2.1 Social Developments of the Lunch-Hour Group on WebCSILE

In and of itself, the fact that these five girls wanted to participate in the lunch-hour investigations depicted a sharp contrast in behaviour from their interactions in the small-group discussions. A typical session would involve the group reading the newly posted notes, taking some time to individually formulate an opinion, debating the content of the note in twos or threes and then electing one of the members of the group to type in their response. There were also times when more than one note was being discussed. Observing their interactions, it was evident that they felt very comfortable with each other. They were genuinely happy to be there. Turns in the discussion and turns on the database were taken democratically and they remained on task most if not all of the time. Further, this behaviour occurred independent of any adult or teacher intervention. They had essentially self-organized into a mini science research group. They were serious about what they were doing, understood why they were there and participated in collaborative discussions. These observations demonstrate that the girls had a strong awareness of their function and identity and they were operating under a set of shared values - those glue factors indicating a successful community of learners. The discourse on webCSILE depicted patterns of increased self-confidence, motivation and interest. In this next excerpt, Mandy shows her confidence in what she is presenting by addressing the note to everyone who is involved in the study:
Dear all,
You remember when you said that if you put your hands on the top, it also doesn't make a difference if you put it on the bottom and swing. I went on a swing and tried it and I fell off. I tried to swing but I couldn't because my hands were at my waist and I couldn't push off properly. Then after, I put my hands at shoulder length and I swung. I went up in the air and I started swinging.

Moreover, she has taken some independent initiative by looking for some empirical evidence as to where one might position their hands on a swing and testing her hypotheses on her own. Recall that Mandy was the one female in the all-female group who quietly removed herself from the discussion by the end.

Yolanda and Candice also show increased self-confidence when they invite one of the students in the Vancouver group to engage in discussion. The note is titled "Debate":

Dear Brad,
We would like to just debate this situation. Yes you are absolutely correct about vibrations, but we think you always need balance because if you did not have balance you would obviously fall off the swing.

The fact that they refer to the exchange of ideas as a "debate" is noteworthy. Yolanda was the note-taker in her small-group who despite not understanding what the boys were dictating to her to write down, did so anyway without asking for clarification while Candice, in the same group, made few on-task contributions to the discussion.

In another entry posted by Tammy, she decides to respond to a question which was posed by one of the adult investigators: Note the confident tone and the invitation in the last sentence to engage in a discussion:

Dear K,
Your question is good. So I will explain it to you. Air helps to push the swing as you shift your body and pump your legs. If there was no air, it would be much harder to swing. If you were swinging under water, it would be harder to move because there is less gravity. What do you think?
Yolanda, Tammy and Candice had participated unsuccessfully in the two mixed-gender groups during the in-class portion of the study. In the lunch-hour group, they were engaged in discussions with other females. Based on the results of the first part of the study, this gender-specific grouping may have played a significant role in enhancing collaboration. It is not surprising, then, that with respect to social developments, these three girls showed a marked improvement. Mandy, on the other hand, had participated in the all-girls group however, was much more successful using WebCSILE as a learning tool. This result may lend support to the notion that electronic learning environments are a good alternative to face-to-face interactions with respect to the social aspects of learning in discursive settings.

3.2.2 Cognitive Developments of the Lunch-Hour Group on WebCSILE

In assessing the cognitive developments of the inter- or face-to-face small-group discussions, the mutual knowledge, convergence and coherence coding scheme was readily employable due to the nature of oral discourse interactions. In oral discussions, one can easily track the thought process of individuals and the collective over a period of time because the exchange of ideas occurs almost immediately with a controlled number of participants. On a database such as WebCSILE, it is difficult to determine the line of thought from which each posted note came from as the exchange in a sense is happening with an indeterminate number of sources. Therefore, a different webCSILE coding scheme was used to determine the cognitive levels of each note posted on the database. The database notes were carefully assessed and placed into one of four categories described below, each one with a higher complexity of development.
Clarification - C
Statements that fall under this category would include ones that; seek clarification of intentions, tasks, vocabulary, semantics and concepts

Example
Why do you go forwards when you pump backwards?

Exploration - E
Statements that fall under this category would include ones that: seek confirmation of their understanding; indicate a progression towards consolidation of understanding; reiterate statements made by others; indicate no integration of ideas in a theory.

Example
A swing and a pendulum are alike because they both move in a circular shape but usually you get just up to half a circle or a little more maximum, on a swing.

Consolidation - S
Statements that fall under this category would include ones that: indicate a sense of conviction in their understanding; evaluate statements made by others; posit suggestions to aid others in their understanding; show an integration of ideas into a framework or theory.

Example
Our theory is that by applying force to the air (by pumping your legs) you can gain amplitude and get to the peak. You also have to shift your weight and move your upper body, you are mainly shifting your weight along your legs.

Expansion - N
Statements that fall under this category would include ones that: attempt to reconcile diverse claims; resolve conflicts; consider the limitations of the theory; possibly offers new directions for inquiry; use metaphors or other applications to direct further investigation of the topic; challenge the validity of claims.

Example
Explain to us what is fighting gravity. We think the speed changes because first you’re going really fast then it slows down. We think gravity is flowing it down. The force of the swing is stopping because there’s nothing pushing it.

Notes posted by adult investigators were not included in this measure. For the purpose of this investigation, the coded notes were then divided into two groups i.e. notes that were posted specifically by the lunch-hour group and notes that were posted by the rest of the study participants. Table 3.1 shows a frequency distribution of the results.
Table 3.1 Frequency distribution of codings for a cognitive categorization of webCSILE notes.

<table>
<thead>
<tr>
<th>Sub-group type</th>
<th>Clarification</th>
<th>Exploration</th>
<th>Consolidation</th>
<th>Expansion</th>
<th>Row totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large group</td>
<td>17 (27.4%)</td>
<td>15 (24.2%)</td>
<td>22 (35.5%)</td>
<td>8 (12.9%)</td>
<td>62</td>
</tr>
<tr>
<td>Lunch-hour group</td>
<td>1 (4.8%)</td>
<td>4 (19%)</td>
<td>9 (42.9%)</td>
<td>7 (33.3%)</td>
<td>21</td>
</tr>
<tr>
<td>Column totals</td>
<td>18</td>
<td>19</td>
<td>31</td>
<td>15</td>
<td>N=83</td>
</tr>
</tbody>
</table>

Particularly in the last two categories, we see definite differences in the proportions of consolidation and expansion statements made. This suggests that the lunch-hour group had progressed to a more advanced cognitive level, certainly than they were previously at and perhaps greater than the collective contributions of the class. They were able to formulate coherent theories and further, to push the boundaries of their knowledge to a deeper level which may have had the effect of pushing the boundaries of the whole group’s knowledge in general.

To see whether there was a statistical relationship between the observed frequencies of cognitive levels of notes and the two groups that created them, a chi-square test was performed. It was found that the results were indeed significant, $x^2 = 8$, $p < 0.05$.

Two examples of expansion notes posted by the lunch-hour group are presented below. This first excerpt was posted by Mandy who wanted to debate an idea, posed earlier by another student, which stated that it was the force of gravity that created the possibility for continuous motion on a swing:

Dear Karen,
I want to talk about the hypothesis that Mitch said that if the swing goes up, the gravity pulls it back in the air the other way. When you sit on the swing, you start pumping your legs and then the force of your body weight goes up and down. That’s how come you don’t just stop - you keep on going.
Her idea is that it's really the mechanics of the swinger pumping his/her legs that allows one to keep on going. This shows that she has the ability to evaluate others' ideas as well as her own understanding in addition to having the ability to present an alternative. She also uses of more scientific vocabulary such as the word 'hypothesis', 'force' and 'body weight' - a significant departure from a comments we had made earlier in the small -group discussions eg. “What if I don’t know what to say, there’s no sense in saying something.”

In another note, Yolanda, Kim and Jenny challenged an idea posted by Mitch, a male who had joined the lunch-hour group for one session. Recall that Mitch was the boy in the all-boy’s group whose ideas were consistently ignored. He wrote:

...At the peak, the seat is still trying to hit the floor but the chains are stopping it so it will go back up the other side...

Yolanda, Kim and Jenny responded with:

Dear Mitch and Karen,
When you are swinging backwards your legs go inwards. When you change your body position you go higher in a backwards movement. The speed makes you go higher. The speed goes against the gravity.

They are talking about sustaining momentum - that in their conception, speed overcomes or counteracts gravity. Therefore, there is a discrepancy between what they believe and what Mitch has posited. Again based on the results of the first part of the study it is likely that had the girls been engaged in a dialogue with Mitch face-to-face, this exchange would not have occurred.

The WebCSILE database appeared to improve both the social and cognitive developments of this lunch hour group which was composed of students who had the
greatest difficulties contributing in the inter-group setting. A great proportion of their success may have been attributable to the small, gender-specific grouping. However, a definite consideration must be given to the act of database conferencing itself. The fact that the lunch-hour group made a considerably higher proportion of consolidation and expansion statements compared to the total group’s contribution is evidence for the potential that this alternative method of instruction and learning holds.
CHAPTER 4: DISCUSSION PART II

The recent movement towards a social constructivist epistemology in education has created new and exciting avenues to explore in the way students ideally think and learn. Knowledge-building research has thus been a forerunner in revolutionizing classroom pedagogy focusing on creating an environment that will support and encourage students’ active participation in the construction of knowledge. A component of this research has currently been aimed at acknowledging science’s implicit nature of the centrality of discourse. When this perspective is advocated in the classroom an issue arises as to how girls and boys function in discursive settings. This study has endeavoured to illuminate gender differences in discursive styles and patterns with an eye to creating knowledge-building environments which will produce optimal social and cognitive effects for all students.

4.1 Summary of Findings

On all of the social development measures i.e. function, shared values and identity in the small-group discourse we observe a similar pattern of the all-girls group outperforming the others. While it is conceded that the specific variables studied to obtain scores in these categories eg. off-task utterances, may be a limited set and one could conceivably have selected numerous other ones to test, we are nevertheless struck with the consistency of outcomes for all groups.

At the cognitive level, the all-girls group outperformed the mixed-gender groups in their ability to synthesize a theory and more so to push their understanding further from any other group than where they began. Their ability to participate in inquiry discourse,
appeared to be superior to the other groups which may have influenced their cognitive development a great deal. Although the all-boys group did not appear to be operating in the realm of inquiry discourse much of their patterned behaviour took on an element of repetition which may have served to strengthen arguments and to produce a higher quality of idea generation. Their competitive natures and perhaps individual academic egos being on the line are also likely to have enhanced the rate at which they were able to construct a theory. Still, the girls were able to move their ideas further than the boys from their initial conceptions.

In the webCSILE data we see increased performance levels on both social and cognitive development measures in the five low achieving girls selected to investigate. Compared to their participation in the small-group discourse, these girls demonstrated improved motivation, participation and confidence. Dividing the notes into two groups; ones posted by the lunch hour group and ones posted by the other participants in the study, it was found that the lunch-hour group posted more higher level thinking notes.

4.2 Small Group Discourse Evaluation

Given the limitations of this study, it is not possible to make absolute conclusions as to how gender differences are manifested in discursive settings. However, there are a number of findings which indeed have merit and deserve recognition. Firstly, we see that the discourse of the all-girls group had the greatest propensity towards establishing a community of learners. That is, their interactions were well on their way to developing an environment where they were mutually supportive of each other's ideas, collaborative and highly productive. Had they been given more time to work jointly in this way, it is hypothesized that we would have seen significantly more advanced concepts emerging from the discourse as compared to the other groups. Secondly, the
discourse of the mixed-gender groups gave overwhelming evidence as to the disfunctionality and/or 'social destruction of knowledge' (Coleman, 1992) characterizing their interaction. We observe this in both their abilities to assimilate on a social plane as well as their cognitive productivity. It is likely that had these groups been given more time, their ideas would not have advanced much further from their initial conceptions. Moreover, while the boys were given opportunities to formulate some ideas on the subject matter, none of the girls in these groups made any substantial contributions although it was quite evident that they possessed the academic capacities to do so. These findings certainly corroborate other studies which suggest that girls function best in gender-specific environments such as all-girls schools and single-sex classes (Eccles, 1992). Based on the finding, we can go one step further in suggesting that within heterogeneous classes, gender-specific groupings may improve the social and academic success of females.

At this stage, it would be useful to make some conjectures as to why this general trend in the data exists. The adolescent years have been characterized as a period of physiological and psychological change during which students become increasingly focused on their peers and are concerned with social acceptance and relationships (Eccles, J., Wigfield, A., Midgley, C., Reuman, D., MacIver, D. & Feldlaufer, H., 1993). They are particularly more vulnerable to environmental pressures which in turn have an effect on the perceptions that they have of themselves. Also, as stated in the introduction, girls are generally more attuned to their leaning environment. In this study, we observed in the discourse of the mixed-gender groups, an awareness of each other which could be attributed to these gender effects. This may have made it substantially more difficult for the students to function in a collaborative mode. From the discourse of the all-boys group we saw patterns of competition, repetition and aggression emerging. Whereas in the all-girls group, we saw patterns of collaboration, support and helping.
Although it would not be entirely fair to point to the boys in the mixed-gender groups as the barriers to learning, these findings lend further support to the research suggesting that girls fare better in gender-specific groups (Eccles, 1992).

With respect to the results obtained for the cognitive developments in the small group interactions, the fact that the all-boys group produced the seemingly more sophisticated theory, despite the group's obvious social disfunction, may be attributable to a socially learned characteristic. Tannen (1998) suggests that males, in general, function better in what she has termed "The Argument Culture". This is one that assumes that in order to accomplish anything, there must be a fight between two opposing sides i.e., the best way to discuss an idea is to set up a debate. She illustrates how our culture and system of education are deeply entrenched in this way of thinking. She writes:

Our schools and universities, our ways of doing science and approaching knowledge, are deeply agonistic. We all pass through our country's educational system, and it is there that the seeds of our adversarial culture are planted. Seeing how these seeds develop, and where they came from, is a key to understanding the argument culture... (p. 257)

The all-boys group argued competitively and produced a slightly better explanation. Why they were able to do this is beyond the scope of this study. Suffice it to say that there may have been other cultural elements, such as the one presented above, that could have given the boys an initial advantage.

However, the more interesting result is that the girls in the webCSILE group ultimately produced the far superior explanation. It is my conjecture that they did this by moving out of the argument culture and into the larger knowledge-building community - an opportunity which would not have happened without the novel web environment.
4.3 WebCSILE Discourse Evaluation

The analysis of the data for this segment of the investigation provides some evidence which supports the use of electronic, collective database environments for students who may have difficulties learning in more traditional settings. It was demonstrated that the lunch-hour group was able to produce significantly higher numbers of cognitively advanced statements compared to the larger group. Although it could be argued that the lunch hour group had access to other notes that had addressed the foundational aspects of a swing theory prior to their participation and this would account for their increased success, it is nevertheless the case that they were more successful. Furthermore had they not been given this opportunity to participate on the database, their conceptual understanding would not likely have improved any time after the small-group discussions.

A preliminary look at understanding why and how webCSILE facilitates the learning of girls shows that there are substantial overlaps between the benefits offered by this environment and those qualities recommended for gender-inclusive curricula. Firstly, CSILE allows students an extended time frame to assess their own level of understanding before having to respond or contribute to a discussion - recall the specific note that Mandy, one of the lunch hour participants, had posted after testing out her idea about where to place your hands on the swing’s chains. Secondly, CSILE offers a non-threatening environment, where students can explore previously recorded notes anonymously. In the small-group discussions, the ownership of ideas was unavoidable and for those students who did not feel academically confident, it was easier to abstain from discussion and/or divert discussion to other more familiar topics than to participate appropriately.
It also provided opportunities for cooperation and shared learning - two important qualities for gender inclusive programming (Tobin, 1997). As the database offered a permanent record of the accumulated discourse, students could enter the discussion at any point, use others’ ideas to substantiate their arguments and had the time to consult and debate their understanding with other students. Lastly, it is possible that the girls had achieved some success because they could choose who they were collaborating with, they could choose which notes or assertions they wanted to respond to and they could choose when they wanted to respond. Essentially, the power and control of their learning was in their own hands and this may have given them the motivation and will to continue participating long after they were required to do so.

4.4 Concluding Reflections

Science education has been in the midst of reform for some time now. As new strategies arise in an effort to ameliorate the scientific literacy crisis and the lack of female interest in science endeavours, more and more new considerations come to light. The gender equity problem is by no means a new issue however, the notion of science as a discursive activity is a relatively new and extremely powerful way of conceptualizing school science.

This study has endeavoured to portray gender differences in discourse styles to be a crucial and therefore necessary factor to consider when planning science in discursive settings. It is acknowledged however, that the findings may be restricted to this data set only due to the small number of subjects in the study, the fact that only one class from one school was selected and although great caution was taken to assess the data free of bias, the fact that the researcher was also the teacher of the class may have skewed the results. This study, as stated from the outset, should be considered an exploratory one. In
order to be able to make more generalizable claims, many more groups from several
different socio-economic schools and perhaps other middle school grades need to be
studied. This notwithstanding, there is evidence to show that girls produce
comparatively better results in all-girls groups, their motivation and participation
improves when working in collaborative knowledge-building environments such as
webCSILE and they demonstrate the ability to acquire advanced conceptual
understanding when these two elements are combined. This study is, in part, moving
beyond the argument culture, as described by Tannen (1998), into a more modern realm
of knowledge-building. If we are serious in our desire to produce a knowledge,
conscious, scientifically literate citizenry - one that recognizes the need for a strong and
robust pool of both males and females to fill science-related careers, we must address
gender differences in systematic investigations and begin programming mindfully from
the premise of inclusion in order to equalize inequities.
References


Appendix I: Swings Questionnaire

What Did You Learn?

1. In our study yesterday, you and your team wrote a series of steps to instruct someone who has never been on a swing before, how to swing. What were the important variables you needed to consider?

2. Why was swinging more difficult when you were on your stomach?

3. Is there any one thing that affects swinging the most? Tell why or why not.

4. At this point, is there anything you are wondering about?
Appendix II: Science Questionnaire

Activities

1. We did many things to help us understand how swings work. From the list below, please tell us which activities helped you the most and why.

   a) Using the swings outside

   b) Class activities

   c) Talking and listening to others

   d) Writing and reading notes on the computer (your school and the other school)

2. After working together on the swings unit, how do you feel about the students at the other school? (Did you feel like they were classmates of your?)

3. Was this a fun way to learn? Should schools teach science this way more often?
Appendix III

To Do; To Notice; To Explain

To keep swinging or to go higher, the rhythm of the swing (back and forth) and the rhythm of the person (pumping, shifting weight) must work together.

Can you think of a way to show how this happens on a swing? These will be instructions for someone else.

<table>
<thead>
<tr>
<th>To Do (detailed instructions)</th>
<th>To Notice: (what to observe)</th>
<th>To Explain (how &amp; why it happens)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>