The author has granted a non-exclusive licence allowing the National Library of Canada to reproduce, loan, distribute or sell copies of this thesis in microform, paper or electronic formats.

The author retains ownership of the copyright in this thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without the author’s permission.

L’auteur a accordé une licence non exclusive permettant à la Bibliothèque nationale du Canada de reproduire, prêter, distribuer ou vendre des copies de cette thèse sous la forme de microfiche/film, de reproduction sur papier ou sur format électronique.

L’auteur conserve la propriété du droit d’auteur qui protège cette thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

0-612-58944-7
INVESTIGATING RESEARCH AS
A LEARNING PROCESS

Dagmar Berndorff
Doctor of Philosophy, 2001
Department of Curriculum, Teaching and Learning
Ontario Institute for Studies in Education of the
University of Toronto

Abstract

This thesis investigates the research process by deconstructing a research project in which I participated as a member of the research team. This project, which I adopt as a case study, was a quantitative investigation intended to ascertain whether or not integrating the classroom and science museum settings provides cognitive and affective benefits to students' learning science.

My observations of this project led me to reflect upon the ways research practices (the entire series of events from problem setting to the publication of papers) are investigated and conceptualized. My work demonstrates that within the field of educational research, there is a scarcity of studies in which researchers carry out examinations of their own research practices.

Furthermore, my work suggests that there is a common set of beliefs underlying the discourse surrounding research practice which supports a pre-ordinate approach to the development of goals and procedures.

My objective is to explore aspects of the research process frequently neglected when research is viewed simply as a series of procedures and techniques. I adopt the view that, in addition, research may also be an
emergent social and educational process punctuated by many pedagogical moments, shaped by indeterminacy, and influenced by the backgrounds and experiences of individual researchers.

Using aspects of both action science and action research, I investigate the minutiae of the day-to-day activity of working through the specific stages involved in actualizing the research project. I also undertake an investigation of my thesis process, which focuses on my problem setting, layers of knowledge development, and writing process.

Finally, I suggest a more inclusive view of research practice that would combine aspects of the pre-ordinate approach with components of the research process examined in this thesis. I delineate elements that could be incorporated into curricula for students of educational research and professional researchers. I contend that this type of curricula of research could narrow what I perceive may be a gap between the theory underlying much of research practice and the actual practice itself.
Acknowledgements

If it takes a village to raise a child, it takes as many people to launch a doctoral candidate.

First of all, I wish to thank my immediate thesis committee members. Dr. Joel Weiss, my supervisor, with gentleness, intelligence, and humour, allowed me to trust my intuition, constantly pushed me to develop my ideas further, and went to bat for me when I needed a true friend. Dr. Suzanne Hidi always provided warmhearted support, and her valuable critique was an essential part of the process. Dr. Peter Gamlin’s enthusiasm and assistance sustained me from the beginning. Dr. Robert Donmoyer provided me with a thorough and thoughtful appraisal that validated my years of work, and gave me a true sense of becoming a scholar. Many thanks go to Dr. Merl Wahlstrom who honoured me with his presence at my oral defense.

My husband Robert gave me the love, patience, and stability that nourished me in my thesis journey. I wish to thank my parents for their loving dedication, and for modeling the courage to surmount arduous circumstances. Thank you to my brother for his constancy, affection, and understanding.

I am grateful to the principal participants in the original research project on which I based this thesis, Dr. Joel Weiss, Dr. Suzanne Hidi, and Dr. Jason Nolan, who allowed me to scrutinize our efforts as a research team. I wish to thank also the additional participants in that project.

Gratitude goes to Ellen Shearer for the help she gave me that goes beyond her skill as an editor. Through her unfailing optimism and bright disposition, she brought joy into my life.

Finally, heartfelt thanks to all of my friends and extended family who over the years supported my thesis process in many different ways.

I am grateful for financial assistance from the Ontario Institute for Studies in Education scholarship and the Ontario Graduate Scholarship.
# Table of Contents

Abstract........................................................................................................................................... ii
Acknowledgements........................................................................................................................... iv

Chapter 1: Introduction ....................................................................................................................... 1
  Locating Myself as a Researcher ......................................................................................................... 6

Chapter 2: Literature Review .............................................................................................................. 8
  Locating My Study within the Literature .......................................................................................... 8
  Technical Rationality .......................................................................................................................... 9
    Schon’s Perspective .......................................................................................................................... 12
    Borrowing From the Field of Curriculum ....................................................................................... 13
  Elements Not Accounted for by Technical Rationality .................................................................... 14
    Subjectivity ..................................................................................................................................... 14
    Indeterminacy Linked with Social Complexity ............................................................................. 17
    Problem Setting ............................................................................................................................. 18
    Deliberation .................................................................................................................................... 19
  Research as an Educational Activity ................................................................................................. 20
  Social Nature of Research and Co-learning ..................................................................................... 23
  Academic Rationale for This Thesis ................................................................................................. 24

Chapter 3: Method and Background of the OISE Project .................................................................. 27
  Method ............................................................................................................................................. 27
  Background of the OISE Project ....................................................................................................... 30
    Facts About the Researchers ........................................................................................................ 30
    History of the OISE Project Proposal ............................................................................................ 32
    Indeterminacy in Proposal Writing: Political and Economic Circumstances ............................. 32
    The Conception of the OISE Project ............................................................................................... 33
    The Proposal ................................................................................................................................... 34
    Individual Subjectivity and the Social Aspect in Proposal Writing ............................................ 36

Chapter 4: Learning and Co-learning ............................................................................................... 38
  Learning Through Exhibit and Theme Selection ............................................................................. 38
  Commonplaces of Curriculum .......................................................................................................... 38
  Cycles of Learning and Reflection .................................................................................................. 39
  Jason and I Begin Exhibit Selection ................................................................................................. 40
    Reflection-in-action ....................................................................................................................... 41
    Reflection-on-action ....................................................................................................................... 42
    The role of surprise in co-learning ................................................................................................. 42
  Incompatibility Between OSC Exhibits and Curriculum Guidelines .......................................... 45
    Reflection-in-action ....................................................................................................................... 45
    Reflection-on-action ....................................................................................................................... 46
    Task leads to learning .................................................................................................................... 46
    Institutional factors contribute indeterminacy .............................................................................. 47
<table>
<thead>
<tr>
<th>Chapter 5: Indeterminacy</th>
<th>54</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Failed Collaboration</td>
<td>54</td>
</tr>
<tr>
<td>Emerging Difficulties with OSC Collaboration</td>
<td>55</td>
</tr>
<tr>
<td>Difficulties Working Across Institutions</td>
<td>57</td>
</tr>
<tr>
<td>Repercussions</td>
<td>60</td>
</tr>
<tr>
<td>Cascading Effect of Indeterminacy</td>
<td>61</td>
</tr>
<tr>
<td>The Emergent Research Process and Institutional Factors</td>
<td>63</td>
</tr>
<tr>
<td>The Evolving Collaboration with the Teachers</td>
<td>66</td>
</tr>
<tr>
<td>Subjectivity, Institutional Factors, Co-learning</td>
<td>67</td>
</tr>
<tr>
<td>Effects on the Project</td>
<td>69</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 6: Subjectivity</th>
<th>71</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementation of Classroom Instruction</td>
<td>71</td>
</tr>
<tr>
<td>Subjectivity as a Source of Variability</td>
<td>72</td>
</tr>
<tr>
<td>Decision-making for an Instructional Strategy</td>
<td>74</td>
</tr>
<tr>
<td>Researchers' Divergent Views</td>
<td>76</td>
</tr>
<tr>
<td>Diverse Interactive Roles of Researchers</td>
<td>77</td>
</tr>
<tr>
<td>Adapting the Jigsaw Model to Our Research</td>
<td>78</td>
</tr>
<tr>
<td>Learning in the Novel Research Situation</td>
<td>79</td>
</tr>
<tr>
<td>Researchers' Divergent Views Interacting with the Research Process</td>
<td>82</td>
</tr>
<tr>
<td>Adopting the Jigsaw: Effects on the Project</td>
<td>84</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 7: The Emergent Research Process</th>
<th>86</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indeterminacy and the Emergent Process</td>
<td>86</td>
</tr>
<tr>
<td>The Effects of the Unexpected Events</td>
<td>87</td>
</tr>
<tr>
<td>Working through Research Tasks</td>
<td>88</td>
</tr>
<tr>
<td>My Assumptions</td>
<td>89</td>
</tr>
<tr>
<td>The Research Team Responds to the Issue of Target Concepts</td>
<td>90</td>
</tr>
<tr>
<td>Subjectivity : Researcher Behavior Suggests Underlying Assumptions</td>
<td>91</td>
</tr>
<tr>
<td>Deliberating About Researcher Protocol During Data Collection</td>
<td>91</td>
</tr>
<tr>
<td>Researchers' Conflicting Views</td>
<td>93</td>
</tr>
<tr>
<td>Additional Indeterminacy Resulting from Our Compromise</td>
<td>95</td>
</tr>
<tr>
<td>Tasks Drive the Research Process</td>
<td>95</td>
</tr>
<tr>
<td>Conducting the Jigsaw</td>
<td>98</td>
</tr>
<tr>
<td>Subjectivity: Researcher Behaviour</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chapter 8: Indeterminacy and Assessment</th>
<th>102</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of the Pre/Post Test Questions</td>
<td>102</td>
</tr>
<tr>
<td>Elements of Indeterminacy in Developing the Pre/Post-test Questions</td>
<td>103</td>
</tr>
<tr>
<td>Indeterminacy Resulting from Complexity in Science</td>
<td>104</td>
</tr>
</tbody>
</table>
Chapter 1: Introduction

During my doctoral program, I was part of a team of researchers investigating the integration of formal and informal learning settings. The primary purpose of our research project was to assess whether students would gain cognitive and affective benefits from an integration of the classroom and science museum settings. Our research team from the Ontario Institute for Studies in Education (OISE)\(^1\) planned to collaborate with grade six science teachers and staff members at the Ontario Science Centre (OSC). Our intention was to develop, implement, and assess "teaching strategies" and "activities" integrating trips to the OSC with classroom teaching. The research was designed with the intention of giving teachers the opportunity to be part of the curriculum development process and to enable their working together through the means of an electronic network. A pre-test, post-test design was chosen as a means to evaluate the students' learning of core science concepts.

In the process of carrying out the proposed research project, we developed an innovative curricular program that in our opinion successfully integrated the two learning settings. We also carried out statistical analyses on students' cognitive and affective learning of science concepts at the grade six level (Hidi, Weiss, Berndorff, & Nolan, 1998).

Despite the completion of most of our main objectives, we did not implement our plan exactly as proposed. One prominent change involved the role of the teachers in the curriculum development process. We had expected the teachers to take primary responsibility for this aspect of the study (or at least, share in this responsibility with the researchers). However, as it happened, the teachers did not carry out the work of curriculum development. As a result, the primary responsibility for curriculum development fell to the researchers.

For my doctoral thesis, I had originally planned to study the teachers' process of curriculum development. Their inability to participate in this

\(^{1}\) The name was changed to the Ontario Institute for Studies in Education of the University of Toronto (OISE/UT) since the time of our research project.
aspect of our project meant that I could no longer conduct the study I had initially planned. Therefore, I was in the position of having to identify a new thesis topic while the research process was underway.

As I continued working on the OISE project, I became increasingly aware that a certain gap existed between research theory as I understood it and research practice as I was experiencing it. I came to understand research practice as an extended series of various events, from the conceptualization of the project, through proposal writing and implementation, to data gathering and the publication of journal articles. As our research team worked on implementing our proposed research at the school and science museum settings, the reality of carrying out our project stood in contrast to the impression I had obtained from academic journals and textbooks, as well as graduate courses on research procedures. Instead of the neat, linear process portrayed in the literature, the research project seemed to develop in a way that reminded me of certain articles about curriculum development.

For example, Walker (1975) argued that the traditional view of curriculum development as a straightforward translation of a set of objectives does not match the reality of the process in practice. According to Walker, instead of instrumental problem solving, curriculum development should be considered "a genuinely creative task of generating ideas and testing them against available information by arguing their merits in the light of this information" (Walker, p. 126). The results of such a process are not necessarily predictable. While Walker's work pertained to the curriculum development process, it seemed to me that his observations might be applied to our process of carrying out the research project. Although we possessed a general plan, which we had developed in our proposal to the funding agency, our research process began to resemble Walker's "genuinely creative task." That is to say, working out the specifics of our basic plan was a process that involved much discussion and creativity.

Within the field of educational research, there are precious few examples of researchers carrying out examinations of their own research
process (Anderson & Herr, 1999). Educational researchers continue to publish innumerable journal articles on such topics as students' learning, school administration, and teacher practice. In other words, most of the literature in the field of educational research tends to have a focus that is directed outside the researchers' own practices.

Given the scarcity of literature that examines the researchers' own practices and my interest in this area, I decided to investigate the above-mentioned OISE research project as a case study. As a member of the research team, I was both a participant in and an observer of this research process (referred to throughout as the OISE project).

My method in this study is a hybrid of action research and action science. Action researchers focus on inquiry into their own practices. Action science researchers have two objectives: 1) they seek to work with practitioners in order to examine the practices of these practitioners; and 2) they seek to investigate their own research practices in the latter process. In this thesis, the practitioners are the researchers involved in the OISE project, including myself. I am therefore examining their research practices as well as my own, during the course of the OISE project. In addition, I examine my own research processes as the author of this thesis.

Since the research process is too extensive a subject to investigate in its entirety, I have selected certain aspects on which to focus. While I was engaged in the OISE project, I was drawn to certain elements not usually encountered in the discourse surrounding research practice. First, I was struck profoundly by the effects of individuals and their interactions on the research process. Drawing on the works of Kuhn and Popkewitz, I have chosen to adopt the view that research is a social process.

Kuhn (1962) maintained that researchers operate out of communities that "pledge allegiance to" certain paradigms. "To an extent unparalleled in most other fields, they have undergone similar educations and professional initiations; in the process they have absorbed the same technical literature and drawn many of the same lessons from it" (p. 177). Popkewitz (1984)
indicated that the social element is a significant aspect of conducting research. He emphasized that researchers carry out their work within a larger set of social circumstances, which have an influence on the researchers' values, assumptions, methods, and therefore, their findings.

Adopting the view that research is a social process allows me to investigate aspects of the research process that are not examined when research is viewed as a series of procedures and techniques. This thesis will explore the research process in light of the relationships among people, institutions, and the research work itself.

Given that the role of individuals was prominent within my experience of the OISE project, I will adopt the term subjectivity as a concise form of denoting the collection of beliefs, skills, and preferences resulting from participants' educational background and professional and personal experience. In this thesis I examine the way this collection of personal attributes and experiences influences the behaviour of participants -- researchers, teachers, and students -- and therefore influences the research process.

Adopting the conceptual frame of research as a social process also gives me the opportunity to explore overlooked aspects of the research process. The OISE research project was plagued by many unanticipated events that presented serious challenges to the ability of our research team to carry out our work. As the literature review will demonstrate, a number of writers have remarked on the inability of theoretical discussions to take into account the unpredictable, novel aspects that pervade actual working conditions involving specific people in specific environments (Schwab, 1969; Schon, 1983). Addressing this shortcoming, I borrow from the work of Eisenberg (1992) and adopt his term indeterminacy to denote the effects of these unanticipated events on the research process. Eisenberg argued that a fundamental indeterminacy exists in all social phenomena, limiting our ability to know and to predict in advance. With the support of Eisenberg's
ideas, I explore the ways in which unexpected circumstances altered our original plan over the course of the OISE project.

Contrary to what I had anticipated, most of the research tasks required by our project seemed to take on their specific form while we were in the midst of working through the various stages of the process. Although we had established a general outline of how we were going to proceed, the members of our team seemed to need to engage in much discussion and deliberation in order to identify specific research tasks and determine exactly how these were going to be carried out. In addition, faced with many unanticipated events, our research team had to find solutions to the new set of circumstances that these events created for us. As I reflected on the day-to-day work of carrying out our research project, I began to suspect that we were engaged in a learning process. As I paid attention to the specific details of our work, I was impressed by the number of what could be called “pedagogical moments” that seemed to present themselves to the researchers.

Weiss (1989) wrote that a “recent trend in the literature is to view enquiry as an educational process -- a recognition that knowledge generation is a complex pedagogical process” (p. 124). Several authors have emphasized the link between learning and the social nature of research practice (Dalton, 1995; McAlpine & Weiss, 2000; Schratz, 1993; Wasser and Bresler, 1996). Schon (1983) used the terms “reflection-in-action” and “reflection-on-action” to discuss the process in which people try to deal with puzzling or interesting phenomena, by critiquing, restructuring and incorporating it into the understandings that surface during the course of their reflection. In the course of this thesis I investigate numerous moments in our research process in which I believe learning was occurring. I consider these moments in light of various conceptions in the literature about learning. My intention is to develop an understanding of how learning may have occurred during the course of our research process.

Given the scarcity of case studies in the literature exploring the research process, I have undertaken to analyze the OISE project and my own
experience of researching and writing this thesis. My operating conception is that research may be a learning process shaped by indeterminacy and subjectivity.

**Locating Myself as a Researcher**

Part of my inspiration for undertaking this thesis can be attributed to the different influences in my educational background. The scientific paradigm provided the dominant philosophy underlying my undergraduate education. I completed a major in physics and biology as well as an honours degree in psychology from the University of Toronto. In my many years of experience studying science, I was given research tasks already developed by science educators. For example, as an undergraduate I would have been assigned to apply the "scientific method" to study how various chemical combinations produce different results. I was supplied with laboratory assignments already equipped with hypothesis, materials to be used, and methodology to be followed, step by step. If I faithfully followed the process, I was sure to reach the desired results. By the time I had completed my training in the sciences, I had internalized this controlled, predictable process.

During my years as a graduate student at the Ontario Institute for Studies in Education (OISE), my focus on the scientific method diminished. Over the course of eight years I studied the social, political, economic, psychological factors involved in the shaping of people's lives. I studied multicultural, anti-racist, and feminist issues, and I explored global education and qualitative research (in particular, narrative inquiry and ethnography). My learning centered around the complexities of learning and teaching, and I became aware of many assumptions underlying my social environment. Furthermore, my exposure to cultural studies, critical pedagogy, and feminist critiques urged me to search for the implicit "codes" that are powerful in shaping our thoughts and behaviours. This training oriented my thinking
toward actively searching for my implicit assumptions guiding my behavior and that of others.

Although in my graduate studies at OISE there was less emphasis on "the scientific method," it continued to pervade the paid research I carried out during my doctoral studies. All the projects on which I worked as a graduate assistant had a quantitative design; furthermore, it happened that I always joined these projects at a relatively late stage, so that I was never exposed to the research process from the beginning.

Reading innumerable journal articles that discussed quantitative studies did nothing to enlighten me as to the actual process of carrying out research in the social sciences. I retained the notion that the tidy journal articles I had been reading represented a true and complete picture of the research process. In other words, I held a tacit assumption that the straightforward, predictable "scientific method" as I had experienced it in my science training would be the method used in the larger process of carrying out a research project. At the time, I had no reason to doubt that this degree of control would characterize the entire ongoing process, including initial planning, proposal-writing, organizing resources, day-to-day decision-making and carrying out tasks, and writing for publications.

Thus, after years of educational and research experience, I had internalized the notion that research is a pre-ordinate, step-by-step process, and that this is particularly the case with quantitative research. Simultaneously, however, I understood that personal, social and political factors play a role in education. Furthermore, I knew that qualitative researchers acknowledge and sometimes even emphasize the emergent nature of qualitative research practice (Jacob, 1988; Moustakas, 1990). This combination of influences resulted in a degree of tension while I worked on the OISE project. However, my situation also provided me with the impetus to conduct this thesis study.
Chapter 2: Literature Review

Locating My Study within the Literature

In the educational research literature, there is a scarcity of studies in which research practice is investigated. A few such accounts exist in the natural sciences. Johannes Kepler's (1967) autobiographical account of his own work and Watson's (1968) book on the discovery of the DNA molecule are two prominent examples of researchers writing about their own practices. Keller's (1983) account of Barbara McClintock's research into the cytogenetics of maize and Goodfield's rendition of Anita Brito's (1991) investigation of lymphocyte behaviour in cancer cells provide further examples of investigations of the research practices of scientists.

Although, within the field of education, there is little research into research practice specifically, methods for conducting inquiry into professional practice do exist. Action science and action research are two prominent examples (Reason, 1994). According to Argyris, Putman, McLain Smith (1985), "The practice of action science involves working with a community to create conditions in which members can engage in public reflection on substantive matters of concern to them and also on the rules and norms of inquiry they customarily enact" (p. 34).

Action research is a research tradition that is part of a movement within the field of education (as well as others) for professionals to examine and legitimate knowledge produced out of their own professional practice (Anderson & Herr, 1999; Schartz, 1993; Weiss, 1989). Its development is often attributed to the work of Lewin and his colleagues (Schartz, 1993). The terms action research and practitioner research are sometimes used interchangeably, and some researchers also include teacher narratives under the category of practitioner research (Anderson and Herr, 1999). The emphasis of this type of research is on teachers examining their own practices.

Generally, the practitioners with whom action scientists and action researchers work are not researchers themselves. Anderson and Herr (1999)
write: "In the plethora of articles and books on practitioner research written by academics, there are few cases of academics reporting on their own practitioner research" (p. 17).

An example of one of these studies that is of relevance to this thesis is provided by Schratz (1993). He investigates "the dynamic force of the inter-group processes within collaborative research that keep the research process going and steer it into a particular direction" (p. 57). Referring to educational research, Schratz writes: "Although everybody who has taken part in collective research knows how intensely research activities can affect the members of a team, very little research has recently been done on how the interactions within the research group influence the research process itself and vice versa" (p. 56).

Other examples of researchers who focus on the social, collaborative aspect of research include Wasser and Bresler (1996). These authors are mostly concerned with the role that collaboration plays in "shaping the interpretations" that emerge from research. In a search of the literature, these authors identified only one other paper by Liggett, Glesne, Johnston, Hsazi, & Schattman (1994) that examined the process of conducting teamwork in qualitative research.

While these researchers have examined certain aspects of the research process, there is still much that needs to be investigated. Moreover, the information gleaned from the above studies did not provide me with the material I was seeking – an elucidation of the assumptions researchers commonly make about research practice.

**Technical Rationality**

My literature review suggests that there may be a common set of beliefs underlying much of our thinking about research practice. These beliefs support an approach that is characterized by the development of goals and procedures in advance of working in a specific context, followed by a step-by-
step progress through predetermined procedures. Underlying this pre-ordinate approach is the belief that one will achieve goals that have been outlined in advance.

It is not my intention in this thesis to argue against this pre-ordinate approach, since I believe it is certainly useful to have goals and to plan ways to achieve these goals. Similarly, Eisenberg (1992), in his book The Limits of Reason, did not discount a pre-ordinate approach, even though he argued that it has failed to take into account certain factors. My position is similar to his in that I recognize the usefulness of a pre-ordinate approach as a tool in research practice, even though my experience has led me to investigate those aspects of research practice that are generally omitted according to this conceptualization.

The pre-ordinate way of thinking is engrained in Western culture as a whole (Eisenberg, 1992). It affects the way we think about our legal institutions (Eisenberg, 1992), about education in general and curriculum development in particular (Schwab, 1969; Walker, 1975) and, for the purposes of this thesis, about research practice. Different authors refer to this approach using different terms. For example, Eisenberg uses the term “the rational,” and Schwab talks about “the theoretic.” I have adopted the term technical rationality, which I borrow from Schon (1983). I feel the term highlights key elements of a pre-ordinate approach. That is to say, the approach is rational if one can determine or think through all the goals and procedures in advance of the research setting, and technical in that, once this important thinking work is done, the remainder of the process involves a technical course of carrying out predetermined procedures.

Although I borrow the term from Schon, there is a discrepancy between my use of the term and his way of using it. I have adapted Schon's term for my own purposes, using it in the broad sense outlined above, to refer to the general and pervasive application of the pre-ordinate approach in research practice. As will be detailed shortly, Schon uses the term technical rationality as synonymous with the “scientific method,” or the empirical/analytical
approach. That is to say, Schon is writing about the Positivist epistemology of practice. I understand the scientific method as a singularly rigorous application of technical rational ideas. However, technical rational thought, as I am using the term, is not applied to strictly empirical/analytical studies. Rather, the pre-ordinate approach that I have described may be far more generally applied throughout research.

Thus, researchers who work outside of the empirical/analytical tradition may still adopt a technical rational approach in their studies. This approach could be adopted by, for example, researchers using a critical approach to research. That is to say, like researchers who adopt an experimental design, these researchers may set their research goals based on theoretical constructs and develop a set of procedures to follow in advance of working in their research setting.

An additional reason for my use of this broad definition of the term technical rationality is that I examine research practice as an extended process. When I refer to "research practice," I am referring to the entire series of events, from the original conception of an idea, through the writing of a proposal to obtain funding, the development of relationships with schools and teachers, through the actualizing of what is normally called "method," to the publication of journal articles. As a result, I am not thinking in terms of "method" alone, but of the entire progression of different kinds of events involved in launching and completing a project.

Although I believe that setting goals and planning procedures are very important aspects in carrying out research, my experience of working on the OISE project led me to consider elements that are generally omitted in the discourse surrounding technical rationality.

I do not wish my almost exclusive focus on these elements to create the impression that I discount the value and usefulness of the technical rational approach. I do believe that it is possible to predict with some degree of certainty the course of a research project, the goals, the means in general terms, and to be confident that one has a good chance of achieving one's
planned objectives. I support this process as a rational approach informed by theory. However, this description does not fully represent the research process in which I participated.

The following sections provide the sources in the literature that have helped me develop my ideas about technical rationality and elucidate the aspects of research practice that may be omitted from a technical rational way of thinking.

It is important to note that I am investigating research practice within the context of one specific research project, which is my case study. Particularly because a large component of the OISE project was the development of curriculum materials, this project may not be representative or typical of all educational research studies.

**Schon's Perspective**

According to Schon (1983), technical rationality is the view that "has most powerfully shaped both our thinking about the professions and the institutional relations of research, education, and practice" (p. 21). Schon (1995) stated that the adoption of technical rationality was "the price of admission" for professional schools like colleges of education into the research university. "For professional schools this meant that they agreed to view professional practice as though it consisted of the application of science or systematic knowledge to the instrumental problems of practice" (Anderson and Herr, 1999, p. 13).

Writing about the relationship between theory and professional practice, Schon argued that the Western academic tradition is based on the assumption that theory has an uncomplicated relation to practice: the translation from theory to practice is basically instrumental, a matter of applying a technical solution. Schon stated that under this model, "professional activity consists in instrumental problem solving made rigorous by the application of scientific theory and technique" (p. 21).
Schon (1983) traced the origins of technical rationality back to the Enlightenment in eighteenth-century Europe. He wrote: "As the scientific world-view gained dominance, so did the idea that human progress would be achieved by harnessing science to create technology for the achievement of human ends" (p. 31). In Schon's view, by the late nineteenth century this "Technological Program" had become "firmly established as a pillar of conventional wisdom" (p. 31).

Furthermore, according to Schon, "Technical Rationality is the Positivist epistemology of practice. It became institutionalized in the modern university, founded in the late nineteenth century when Positivism was at its height, and in the professional schools which secured their place in the university in the early decades of the twentieth century" (p. 31).

**Borrowing From the Field of Curriculum**

Some of the literature in the field of curriculum is particularly relevant to my investigation of research practice. Since I adopt the view that research practice is a potential learning process, we may consider it as a curricular activity. Furthermore, many curriculum practitioners have subscribed to the technical rational approach as an epistemology of professional practice (Schon, 1983; Schwab, 1969).

Schwab identified a basic assumption underlying the work of curriculum practitioners -- namely, the belief that taking a theory from the social or behavior sciences and translating it into a concrete manifestation will yield predictable results. This assumption indicates a technical rational approach.

The technical rational theory spells out the process for the translation from the abstract to the concrete. If we take an example from the field of curriculum, the technical rational process proceeds as follows: First, one derives one's objectives from social and behavioural science theory(ies) (e.g., theory of mind and knowledge), then one translates these objectives into concrete materials and actions (e.g., curriculum materials, pedagogical
techniques involving sequenced delivery of the materials to children), and finally one acts appropriately upon these (e.g., teaches children using these materials and pedagogical techniques). It is then assumed that one's objectives (e.g., children's learning of specific knowledge or skills) will probably be met. In constructing our proposal for the OISE project, we adopted this technical rational procedure. We selected theories based on the integration of formal and informal learning settings, and derived the objective that from this integration students could be expected to gain affective and cognitive benefits if we were to develop appropriate curricular materials and pedagogical techniques, and expose the students to these. Furthermore, we expected to be able to test the students' gains.

The foregoing description can be regarded as a broad framework representing the technical rational approach in the area of educational research. In this thesis, I will be investigating the minutiae of this larger process, the day-to-day activity of working through the specific stages involved in actualizing the OISE project.

In the following sections, I present additional conceptual sources that have assisted my examination of the research process. Some of these sources contribute to the exploration of the gap that I perceived between technical rational theory and the practices I observed in the OISE research process. Others elucidate those aspects that characterize research as an educational process. A number of these aspects are interconnected, and in the course of my thesis I explore the links between them.

**Elements Not Accounted for by Technical Rationality**

**Subjectivity**

Writing in the field of curriculum development, Schwab (1969) questioned the instrumental model. In his seminal paper "The Practical: A Language for Curriculum," Schwab claimed that the field was "moribund" because of its over-emphasis on theory and its neglect of the practical. He
made a distinction between the common use of the word "practical" ("easily achieved, familiar goals which can be reached by familiar means") and his use of the word, referring to a "complex discipline . . . differing radically from the disciplines of the theoretic" (Schwab, 1969, p. 26).

Schwab's critique of the "theoretic" did not question the use of theory per se, but rather "the dispatch, the sweeping appearance of success, the vast simplicity which grounds this purported solution to the problem of curriculum" (Schwab, 1969, p. 31). The "sweeping appearance of success, the vast simplicity" that Schwab found "fatally theoretic" is inherent in the technical rational assumption that taking a theory and translating it into specific circumstances will yield predictable results.

Schwab claimed that since people are complex social beings, the preordained approach of technical rationality was too simplistic for viewing the work of curriculum. He argued that "learners are not only minds or knowers but bundles of affects, individuals, personalities, earners of livings. They are not only group interactors but possessors of private lives" (p. 32). This description resembles a more recent comment by Cochran-Smith and Lytle (1998) concerning the nature of teaching and educational research, which they claim is about "how teachers' actions are infused with complex and multi-layered understandings of learners, culture, class, gender, literacy, social issues, institutions, communities, materials, texts, and curricula" (Cochran-Smith and Lytle, 1998, quoted in Anderson and Herr, 1999, p. 24).

In this thesis, I take the position that the role of the individual is central to the research process, since research practice consists of people making and implementing decisions. I use the term "subjectivity" to refer to the personal qualities and experiences that an individual brings to any work at hand. An important source for my use of this term is Peshkin (1988). He described subjectivity as "an amalgam of the persuasions that stem from the circumstances of one's class, statuses, and values interacting with the particulars of one's object of investigation" (p. 17). He adds that one's subjectivity is "like a garment that cannot be removed" (p. 17).
Although the word subjectivity captures the idea of the complex make-up people bring to a task, my adoption of the term is not without problems. The term has been at the centre of a methodological and philosophical debate surrounding the question of whether we can know reality in a pure state, free of the influence of our minds. What is usually called "objectivity" and "subjectivity" figures prominently in these discussions (Guba, 1990; Phillips, 1990; Roman & Apple, 1990). Within the context of this debate, subjectivity connotes personal bias as it interferes with the ability to observe phenomena objectively.

Eisner and Peshkin (1990) argued that, historically, "we have all been socialized to believe that persons, processes, and products bearing the stamp of 'objective' deserve acclaim and acceptance, while persons, processes, and products stamped 'subjective' do not" (p. 15). However, this socialized attitude is changing (Guba, 1990). While in certain research traditions the personal has become central to the inquiry (e.g., narrative inquiry), Heshusius (1994) claims that in much current research, subjectivity is still to be eschewed. She states that for many educational researchers "anxiety about how to be as objective as possible has been translated into anxiety about how to manage subjectivity as rigorously as possible. . . . I have come to see the call for 'procedural subjectivity' and its attendant concern (how to be in charge of one’s subjectivity, how to handle it, restrain it, account for it) as identical to 'procedural objectivity' . . . in that both view the self as the fundamental unit for methodological concern and both maintain the belief in the possibility of a regulated distance between self and other" (p. 15). Peshkin (1988) himself uses subjectivity in a way that connotes personal bias as it interferes with the ability to observe phenomena objectively.

In contrast, in this thesis, I am not attaching what has been and still seems to be the negative connotation of bias to the term "subjectivity." I am not interested in "freeing" myself of my subjectivity. Rather, I am investigating the role that people -- as the complex social beings that they are -- play in the research process. I see the term subjectivity as signifying the
personal make-up that inevitably shapes a person's interactions with the world. Despite the problems surrounding the term "subjectivity," I nevertheless believe that the term is useful because it captures in essence the idea of "an amalgam of the persuasions that stem from the circumstances" of one's gender, class, cultural background, education, family history, current personal situation, etc. (Peshkin, 1988, p. 17). Since this application of the term is too broad to be practical for the purposes of my thesis, I focus mainly on the elements of subjectivity that pertain to individuals' beliefs and values surrounding research, education and learning. If the negative connotation of bias associated with word can be set aside, subjectivity will serve as a useful term for my purposes in this thesis.

**Indeterminacy Linked with Social Complexity**

Another aspect of research practice not accounted for by technical rationality involves appreciation of the uncertain or unpredictable elements that arise whenever one is working in concrete situations in a social context. Schwab (1969) noted that, in contrast to the "theoretic," the "practical" involves making choices and taking action in concrete cases. Schwab, writing about the practice of curriculum development, claimed it should be viewed as involving the nonuniformities of real educational events that do not fit neatly into theoretical categories. Similarly, Schon (1983) argued that professionals need to deal with "divergent" occurrences, "situations of uncertainty, instability, uniqueness and value conflict" that are part of "real life circumstances" (p. 49).

These ideas coincide with Eisenberg's (1992) work on the principle of indeterminacy, which serves as a critique of the assumptions of technical rationality. According to Eisenberg, due to the complexity of social activity, a fundamental indeterminacy pervades all social phenomena. Eisenberg's work on indeterminacy emphasized that it is not possible to have absolute advance
knowledge of particular conditions and their interactions. Indeterminacy is apparent in the discrepancy between what we expect and what actually occurs.

As I interpret it, Schon's term "divergent" makes sense when one is adopting the technical rational or pre-ordinate way of thinking. Labeling something "divergent" implies that a particular event was expected to ensue according to a certain theory, when in fact the event evolved differently. Eisenberg gave prohibition as an example of what can occur in the face of our belief in what he called "the rational." Eisenberg wrote that, even though well-meaning people believed eliminating alcohol would solve many of the alcohol-related problems of the day (a technical rational solution), they failed to anticipate the crime wave that resulted from their attempts to make prohibition a reality. The intervention the prohibitionists developed to solve their problem created yet another previously unforeseen problem.

Eisenberg stated that "the rational" model has failed to take into account the factor of indeterminacy; however, he did not discount it entirely. Applying the technical rational model to social phenomena, we can often exert control to some degree and achieve our objectives. Nevertheless, Eisenberg believed that our ability to predict and to know in advance is limited.

**Problem Setting**

Schon (1983) discussed an overlooked distinction between problem setting as opposed to problem solving. The latter aspect is the one that is most commonly acknowledged and discussed. According to the technical rational way of thinking, professional practice is perceived as instrumental problem solving. This approach assumes that a clear-cut problem exists at the outset; in other words, the problem has already been set -- the ends are clear. According to Schon, the difficulty with this approach is that we tend to "ignore" problem setting while placing an emphasis on problem solving.
Schon believes that researchers, like other professional practitioners, are increasingly coming to realize that problem setting is a necessary condition for problem solving -- one that cannot be handled using an exclusively technical rational model. Setting the problem requires that the researcher select what is relevant to the situation, and set boundaries.

Schon claimed that the reason why problem setting is usually neglected in discussions of research is not a matter of the nature of science per se, but rather a consequence of the positivist view of science. According to positivism, science is seen "after the fact"—thereby presenting us with "established propositions derived from research" (Schon, p. 49). However, if we consider science "before the fact," we see a process that generally involves scientists grappling with ambiguity similar to what occurs in professional practice. This process may involve the uncertain, ambiguous, creative work of problem setting.

As Schon argued, since the technical rational model is incomplete, we need to "search, instead, for an epistemology of practice implicit in the artist, intuitive processes" which practitioners bring to professional practice (Schon, p. 49).

**Deliberation**

Adopting the idea that problem setting and problem solving are both important aspects of research practice, the question remains: how do researchers set and solve problems? Writing about problem setting, Schon (1983) stated that researchers may construct problems from situations that are ambiguous and puzzling. They might have to make sense of complex and ill-defined situations in which all types of issues are mixed up together in order to extract a problem that can be dealt with. Schon stated: "Problem setting is a process in which, interactively, we name the things to which we will attend and frame the context in which we will attend to them" (p. 40). This process deals with specifics, not generalities. As I understand it, the type of thinking
involved in problem setting may require more flexibility and inventiveness than the instrumental problem solving approach of technical rationality.

Schwab's (1969) concept of deliberation suggests the type of flexibility of thought and responsiveness required. Schwab offered deliberation as a more accurate model of thinking and acting for the process of curriculum development than the "fatally theoretic" (technical rational) approach. He viewed deliberation as the method of the practical and presented it as a complex and arduous process which treats both ends and means as mutually determining one another. The goal of this method is not to generalize or to explain, as it would be under the theoretical approach, but to make a decision about actions in concrete situations. Deliberation requires looking at various alternative solutions and their consequences, weighing them and deciding on the best solution. Recourse "to accumulated lore, to experience of actions and their consequences, to action and reaction at the level of the concrete case, which constitutes the heart of the practical," was, in Schwab's opinion, the antidote for the field of curriculum's "moribund state" (p. 36). This way of viewing the process of curriculum development coincides with Walker's (1975) view that we should consider it as a creative task of generating ideas and testing them.

Adopting the concept of deliberation as a way of thinking about aspects of the research process may allow us to address some of the shortcomings of technical rationality. Instead of regarding research practice as only a matter of instrumental problem solving, we may also consider it in terms of the creative, emergent process of deliberation -- a process that incorporates individual subjectivities and can accommodate indeterminacy, problem setting and problem solving.

**Research as an Educational Activity**

When we adopt deliberation as a way of describing the research process, we are acknowledging that researchers may not know everything in advance,
but may need to learn from the process as they carry out their research practice. This role of learner is in contrast to the role that researchers are assumed to have, according to the technical rational way of thinking.

Since a pre-ordinate approach assumes that it is possible to predict with a degree of certainty, the researcher appears to be an "expert" who has a reasonable idea of what is going to happen. In other words, a pre-ordinate approach does not foster the idea that researchers may also be learners. If we begin to consider the research process as encompassing divergent and unpredictable elements that only surface when one is working with the specifics of the situation, it is logical to acknowledge that researchers do not begin with all the answers, but are engaged in a learning process. In the ensuing paragraphs, I review the literature for ideas that contribute to an understanding of the way learning can occur within the context of research practice.

Although in the case of the OISE project, technical rationality provided us with a general framework of procedures, the process of actualizing these procedures involved a series of tasks that could not be specified in our proposal. As will become clear presently, the work of identifying these tasks contributed to the learning aspect of our research process.

Tasks have been identified by Moore (1981) as central to the activity of learning in non-classroom settings. Moore focused on "the process by which participants in a social setting organize their interactions in such a way as to make learning possible" in non-classroom environments (p. 288). He contrasted the structure of language interaction in classrooms with interactions among supervisors and students who are learning outside the classroom. According to Moore, studies have suggested that within classrooms, students and teachers often use a verbal sequence of initiation, reply, and evaluation (I-R-E).

In the non-classroom setting, Moore identified a structural analogue to this sequence focused more on tasks than on language. He used as an example a science museum setting in which students perform tasks such as painting.
fossil bones to re-create dinosaur skeletons. Like the I-R-E sequence, the learning process consists of three phases: 1) the task is established for the learner; 2) the task is accomplished by the learner; and 3) the learner's performance is monitored. In a similar way, research consists of tasks that need to be established, accomplished, and assessed. Evidently, in the process of identifying what tasks need to be done (problem setting) and carrying out the tasks (problem solving), researchers may become engaged in a learning process. These tasks may provide "pedagogical moments" for the researchers.

The research process is likely to be emergent because much of the work may be novel. In contrast to the frequently identifiable tasks in Moore's example, the hallmark of a research situation is that often the work to be done is unprecedented. An experienced researcher may have a reasonable grasp of the necessary procedures in general terms, but he may not know in advance what all of the tasks will be. As argued above, research deals with the "practical": it may be only in the midst of the specific circumstances in which researchers find themselves that the tasks may become defined. Given that all of the tasks are not predetermined, the researchers must first identify what needs to be done, then make decisions through the assessment of various possible solutions and their consequences. Furthermore, this work may be accomplished through a process of dialogue within the community formed by the members of the research team. This process is one of deliberation.

Once the researcher is in the realm of the "practical," unpredictable events may arise, adding to the emergent nature of the process. According to Schon, as people try to deal with puzzling or interesting phenomena, they reflect on their implicit understandings, which have guided their actions. They critique, restructure and incorporate into their future action understandings that surface during the course of their reflection. Schon called this process reflection-in-action and stated that it "is central to the 'art' by which practitioners sometimes deal well with situations of uncertainty, instability, uniqueness and value conflict" (Schon, p. 50). From Schon's description, it appears that reflection-in-action is a learning process.
Social Nature of Research and Co-learning

In the process of investigating the learning that occurs within the context of research practice, we consider the work of Weiss (1989), who situated the commonplaces of learning -- teacher, learner, subject matter, and milieu -- in the context of research as an educative process. Although these commonplaces are generally used with reference to classroom situations, they can be applied to aspects of the research process. Weiss argued that this set of commonplaces is a "generative metaphor," which he defined (with reference to Schon [1979]) as "a pervasive, tacit image that influences our thinking" (p. 126). Applied to the context of a research process, this generative metaphor provides us with what Connelly and Clandinin (1988) called "useful analytic tools" (p. 84).

In the research process, Weiss wrote, the subject matter "includes all types of information made available" to the researchers. The milieu "represents the variety of conditions under which learner, teacher, and subject matter interact. This includes those historical forces that helped to shape the context for the evaluation as well as the specific conditions under which the evaluation is conducted" (p. 126). Instead of having teacher-learner in the conventional classroom sense, researchers constitute a group of peers in a non-classroom setting, who may engage teachers, students, and themselves in the learning aspect of the research process.

Co-learning, which includes the components of teacher, learner, and an aspect of the milieu, can be regarded as a refinement of the foregoing model. Weiss (1992) describes co-learning as a teaching/learning process, one in which individuals are willing to learn from each other, "to mutually construct a setting for learning and to co-create knowledge in the form of shared learning" (p. 2). Everyone involved will be learning from the process, though not necessarily learning the same things, or not necessarily learning from one another.
The milieu is specific to the social context created by the interactions of the "teacher" and "learner." Dalton (1995) describes co-learning as "a relational process (Belenky, Clinchy, Goldberger, & Tarule, 1986; Noddings, 1991) where individual voices come to collaboratively make new meaning(s) out of prescribed knowledge" (p. 35). Dalton’s view of the relational aspect of co-learning applies to our research environment. In particular, her description of the classroom resembles my experience of the research setting as "a dynamic learning environment created by participants through a collaboration of voices" (p. 41).

**Academic Rationale for This Thesis**

Eisenberg suggested that it is important for educators to become self-critical and examine their own assumptions. He argues that in education "we should strive to gain an understanding not only of the here and now with generally accepted devices, but to gain an understanding of the devices being used" (p. 167). As applied to academic research, I take Eisenberg’s argument to mean researchers should investigate not only "phenomena" but also the processes, paradigms, and tools of our investigation.

It may be of great benefit to conduct such research for a number of reasons. Most importantly, as Eisenberg (1992) has emphasized, “the rational” (technical rational) is embedded within western twentieth-century ways of thinking and therefore exerts much influence. Schon (1983) emphasizes the dominance of the scientific method within education: "It is implicit in the institutionalized relations of research and practice, and in the normative curricula of professional education. Even when practitioners, educators, and researchers question the model of technical rationality, they are party to institutions that perpetuate it" (p. 26).

The idea that the technology or paradigm we use to learn about something influences what we know about it has had a number of proponents in twentieth-century thought. In the area of quantum physics,
Heisenberg, with his uncertainty principle, contended that nature cannot be known independently of the means we use to investigate it with. For example, inserting a thermometer into a liquid may change the temperature of the liquid. The use of the instruments of measurement and the observations of scientists create changes in the system and therefore are part of the system under study. The conclusion of Heisenberg's uncertainty principle is that indeterminacy is an integral part of scientific understanding in quantum physics.

Similarly, Marshall McLuhan contended that the way we do things determines what we know (Eisenberg, 1992). In his statement "the medium is the message", McLuhan summarized the notion that our perception of reality is influenced by our means of perceiving. From McLuhan's perspective, the technologies used by people in a society affect their perceptions, feelings and thoughts. All humans are affected by an environment resulting from the technology of production and communication.

Eisenberg, working with Heisenberg's and McLuhan's ideas, stressed that "detached observation and reason cannot serve either as reflective mirrors or illuminating lamps of reality. For they are part of reality and make it indeterminate" (p. 3).² For this reason, Eisenberg argued that education and educational research need to develop an understanding of the "generally accepted devices being used" to determine what we know about learning. Technical rationality can be viewed as one of the most important "devices" employed by educators and educational researchers. Eisenberg's point was that a "rational" or technical rational approach has become so dominant that it is ingrained in our way of thinking and often goes unnoticed and unexamined. He argued that we need to become aware of its limitations.

² This is not to say that I take the extreme position of claiming that our day to day world is completely unknowable. I hold the position that we can certainly develop studies and knowledge that help us understand aspects of the world around us.
Given these limitations, my goal in the literature review has been to assemble various concepts that might contribute to my investigation of the OISE project. These concepts were assembled in order to enable me to see aspects of research practice commonly overlooked or regarded as problematic from the viewpoint of technical rationality.

If, as Eisenberg, Heisenberg and McLuhan pointed out, the "tools" or "techniques" we adopt to study phenomena affect what we can know, then adopting a more inclusive perspective on research practice should provide us with different information than what is generated by the current discourse surrounding it. To take an example from the physical sciences, if you begin with the hypothesis that light behaves like a wave, your experiment will give you results suggesting that light behaves as a wave does. Equally, if you structure an experiment under the hypothesis that light behaves like a particle, your experiment will support the idea that light behaves as a particle does. In other words, the way you think about light and the way you structure the experiment influence the type of information you collect. My point is that we will gain new information about research practice if we make reference to a range of concepts about education and professional practice such as I have presented in the literature review, including the idea of the practical, the principle of indeterminacy, and the idea that research is a social and educational process.

For example, subjectivity and divergent phenomena are evaluated differently when we investigate the research process with these concepts in mind. These elements are problematic if one holds a strictly pre-ordinate view of research, because their presence introduces an uncertainty or indeterminacy vis-à-vis predicted outcomes. In this investigation, instead of being viewed as problematic or incidental, these elements will be acknowledged for what they are -- an integral part of the research process.
Chapter 3: Method and Background of the OISE Project

Method

In this thesis, I am investigating research practice. My primary intention is to examine the practices of a team of researchers carrying out a pre-ordinately determined educational research study, which I refer to as the OISE project. The actions of myself and my fellow team members on the OISE project serve as a case study for the principal part of my investigation. My secondary goal is to explore the larger process of social enquiry by investigating the development, research, and writing of this thesis.

In order to meet these two goals I have formulated the following research questions: 1. How can the OISE research process be understood? 2. How can I describe my thesis research process?

My approach in this study is a hybrid of action research and action science. Both focus on inquiry into practice (Reason, 1994). They diverge in the ownership of the problem of inquiry (McAlpine & Weiss, 2000). Action researchers focus on inquiry into their own practices, while action scientists work on investigating the practices of others. Given my interest in examining my practices as a researcher in the OISE project, I bear a resemblance to an action researcher. Given my interest in also examining the research practices of my fellow team members, however, I am more like an action scientist. Furthermore, like an action scientist, I am interested in deconstructing my own process of social enquiry in writing this thesis.

Action research and action science both engage the participant(s) in an enquiry into their practices. Carr and Kemmis (1986) state that "Action research is simply a form of self-reflective enquiry undertaken by participants in social situations in order to improve the rationality and justice of their practices, their understanding of these practices, and the situations in which the practices are carried out" (p. 162). Similarly, action scientists enter into their research with the expressed intention and invitation to engage together in an investigation of their practices (Argyris, Putnam, & McLain Smith, 1985). During the course of the OISE project, I gradually developed such an
intention. However, because of the emergent nature of my problem of inquiry, I did not begin this study by approaching my colleagues and asking them to engage with me in an exploration of our research practices as a team. Instead, I engaged them in a reflection on our research practices during interviews I conducted with them near the completion of the OISE project.

Since my primary goal is to investigate the OISE project, I will focus first on my methodological approach as it relates to that goal. My approach is based on my role as a participant/observer, more specifically, as a research assistant hired to help develop the OISE project and to help conduct the research at the Ontario Science Centre (OSC). The participants for this study consisted primarily of those individuals who conducted the OISE project: the principal research team, consisting of two professors, a second graduate student, and myself. Of lesser importance to my analysis were the auxiliary research team, consisting of graduate students hired to help carry out the data collection within the OSC, as well as the three grade six science teachers with whom we primarily worked and two other teachers whose classes were involved in the project. Six classes of grade six students are indirectly part of my research by virtue of the fact that they were the "subjects" of the OISE project.

My primary data sources include: 1) field notes taken over the course of the project, and 2) interviews with the core research group, with the teachers and with the auxiliary researchers hired to help conduct research at the OSC. My secondary sources include: 1) project-related correspondence, 2) research forms developed to assess students' behavior in the OSC, and 3) pre- and post-tests developed to assess students' cognitive and affective gains. Triangulation of various data sources was used for the analysis.

In order to integrate these data sources, I constructed a retrospective chronological account of the main events of the OISE project, after the project was completed. Key discussions and choices surrounding curricular, pedagogical, and research issues that took place during the course of the OISE project have been included in this account. This chronological account constitutes a research text. Clandinin and Connelly (1994) distinguish between
field texts and research texts, noting that the former "are normally called 'data' . . . . They are texts created by participants and researchers to represent aspects of field experience" (p. 419). "Field texts are not, in general, constructed with a reflective intent; rather, they are close to experience, tend to be descriptive, and are shaped around particular events" (p. 423). In contrast, research texts "grow out of the repeated asking of questions concerning meaning and significance" (p. 423).

My chronological account was shaped by the themes of subjectivity, indeterminacy and learning, which I had identified as important features in the research process. Intensive data analysis was then applied to this account, which involved investigating in detail how one or more of the three themes operated in the specific context of the OISE project.

The chronological aspect of my reconstruction is supported by Schratz (1993) who writes about his own work: "The collected material gave a look into the inner world of the project life, which was only possible if one went through the dynamics of its history again" (p. 66). My strategy of examining the OISE project within a chronology of the events has allowed me to contextualize these events within a temporal frame. Clandinin and Connelly (1994) discuss the importance of the temporal: "Situations do not just happen; they are historical and temporally directional according to the intentionality of the organism undergoing experience. Thus to talk about experience is to talk temporally" (p. 417).

The use of a retrospective account is also supported by McAlpine's similar approach, who writes that she decided to "construct a retrospective account of the experiences that would provide a meaningful coherent image of my practice" (McAlpine & Weiss, 1998, p. 8). My retrospective analysis of my material is also supported by Louden (1991), who discusses various forms of reflection and their temporal distance from action. He creates a set of categories that "represents a range from reflection as a process of thinking or feeling separated from action to reflection as a process which takes place in the moment of action" (p. 164). Louden's category of "introspection" is
relevant to my method, since he defines this activity as "a conscious process conducted at some distance from the stream of action" and involves both thinking and feeling" (p. 165).

In this thesis, I present multiple segments of my chronological reconstruction of the OISE project, followed by discussion, analysis, and reflection. The three elements of learning, subjectivity, and indeterminacy pervaded the OISE project as a whole, and therefore feature prominently in these discussions. Depending on the particular demands of the material, I focus chiefly on one theme at a time. However, my analysis reveals that these themes interact with one another. Thus, these discussion sections bring out the fluid nature of the research process — for example, various sources of indeterminacy take turns, ebb and flow, as dominant influences upon the research process.

In order to orient the reader, I begin my investigation of the OISE project by presenting some of the specifics that shaped the study from its conception.

Background of the OISE Project

Facts About the Researchers

Four individuals formed the core research team. Each member of the group had a depth of experience and training across a number of different specialties within the field of education. Suzanne Hidi and Joel Weiss, the two principal investigators, are both professors on the faculty at OISE/UT. Both have over twenty years' experience teaching and researching in an academic context. Joel’s training includes both the traditional quantitative paradigm and interpretive and critical perspectives. His focus in teaching is action research and learning in informal settings. Suzanne, with a background in cognitive psychology, conducts quantitative research studies, many of which include qualitative components. She teaches courses in the areas of reading, writing, and the role of interest in learning.
As principal investigators, Suzanne and Joel were responsible for the realization of the project as a whole. Thoroughly experienced in the work of designing and carrying out an academic research project, they directed the writing of the proposal and the acquisition of funds, the writing of the ethical review, the creation of contacts with Board of Education officials, and the composition of papers for publication. They were ultimately responsible for handling any obstacles that threatened the viability of the project.

Two graduate assistants, Jason Nolan and myself, were hired to work on the project. Jason has previously taught English and E.S.L. at the secondary level. At the time of the study, he was working on his doctorate in education. He prefers to work from interpretative and critical emancipatory perspectives fostering intentionality and task dedication in education (Nolan, personal communication, June 8, 2000). My background is in the natural sciences and psychology, and I have a strong interest in the critical emancipatory and interpretive perspectives.

While the principal investigators determined the over-all direction of the project and dedicated much time to resolving the serious political problems that occurred during the dissolution of the collaboration with members of the OSC staff, Jason and I carried out the various details to realize the project objectives. For example, Jason was responsible for much of the final curriculum development and I acted as a liaison with the teachers in the schools. Thus the research team consisted of individuals with differing levels of experience and power, who took on different roles as a result.

In general, the members of our research team shared our knowledge and respected one another's contributions. Despite the variations in our expertise, age, and institutionally sanctioned authority, our interaction was distinguished by its democratic nature.
History of the OISE Project Proposal

The Ontario Transfer Grant proposal provided the blueprint for the project. As such, it is a critical point of reference for an understanding of the unfolding of the OISE project, since it governed our decision-making. Our proposal was co-authored by Joel Weiss, Suzanne Hidi and myself. Jason Nolan joined the project after the proposal had been accepted for funding and preliminary work had begun on the project.

In the fifteen years preceding the OISE project, the Ontario Ministry of Education and Training (an agency that provides funding for OISE research) made available to researchers a list of priorities for fundable projects. This list had always been prepared several months before the deadline for the submission of proposals. Unfortunately, at the time that our research team was considering submitting a proposal, provincial politics intervened to delay the creation of a list of priorities. There had been a recent change of provincial governments, which meant that the Ministry was under new direction – by people who had never been in power before. Consequently, by late March, 1995, it finally became apparent that a list of priorities would not be available before the April 4th deadline. We had made a decision to delay writing our proposal until we knew what the Ministry’s priorities were. Our strategy of waiting meant that in the end we had to prepare our proposal over a single weekend at the beginning of April. Ultimately, however, the Ministry informed us that no list of priorities would be forthcoming. The Ministry’s eleventh-hour admission left us with insufficient time for consultation with the OSC staff regarding our project proposal prior to its submission to the Ministry.

Indeterminacy in Proposal Writing: Political and Economic Circumstances

This situation demonstrates that the development of a proposal is shaped by the political and economic circumstances of conducting educational research. A research project takes place within a particular context that
includes political realities, which have an impact on the work of the researchers. Writing a proposal is generally time-consuming and labour-intensive — not a process researchers undertake unless they are reasonably confident that their proposal will receive funding. Without the knowledge of priority areas which the government is interested in funding, writing a proposal that targets solely one's own research interests would probably prove unproductive.

The political realities in which researchers find themselves generate unpredictable circumstances over which the researchers have minimal, if any, control. The political situation in Ontario affected the timing of the transfer grant priorities, the late arrival of which substantially limited the time our research team had to write the transfer grant and made it virtually impossible to consult with the OSC staff about it.

**The Conception of the OISE Project**

The OISE project was conceived as a continuation of the collaboration that had existed between two of the principal investigators, Joel and Suzanne, and members of the educational staff at the OSC. In the case of Joel, this collaboration had existed for a period of fifteen years. For the three years prior to the OISE project, Suzanne and Joel had been collaborating with staff at the Ontario Science Centre (OSC). Given the long-standing collegial relationship that had existed between the principal investigators and OSC staff, our inability to consult with these individuals prior to submitting the proposal, while not ideal, was not unreasonable.

The principal investigators' interest in working on the proposed project grew directly out of their desire to pursue some of the issues uncovered in the course of their previous work. The research conducted by Joel and Suzanne immediately prior to the current project involved studying children's interests, activities, and images of science in the OSC (Weiss, Hidi, Soren and Nagy, 1996). Specifically, the researchers measured children's cognitive gains
and examined their affective evaluations as a result of their involvement with science exhibits. A significant finding had been that, although they enjoyed the exhibits, children were not gaining any understanding of the underlying science concepts. For example, in the OSC exhibit called "Pedal Hot and Cold", children pedal a bicycle and sense that one handlebar is hot while the other is cold. A spray, which is liquid freon vaporizing to gas, can be seen in a glass tube on the handlebars. The exhibit demonstrates how refrigeration works and the properties of a gas under pressure. When asked why they liked this exhibit, children responded that they enjoyed riding the bike or feeling the hot and cold sensations emanating from the handlebars. When the children were questioned about what they had understood from the exhibit, their answers indicated that they did not understand the underlying concepts and did not seem to be interested in them. Suzanne and Joel reasoned that, without any kind of pedagogical intervention, children are unlikely to grasp these concepts. This line of reasoning led to the development of the proposal for our research study.

The Proposal

In our proposal, we hypothesized that by integrating formal (i.e. classroom) and informal (science museum) learning settings, the students would be more likely to understand certain scientific concepts and enjoy their experience at the same time. The idea of integrating the two settings was based on a number of studies (e.g., Falk, Koran & Dierking, 1986; Grossen, Romance & Vitale, 1994; Hurd, 1994; Ramey-Gassert, Walberg III & Walberg, 1994).

Our research team intended to target the integration of these two learning settings when we wrote our Ontario Transfer Grant Proposal. The primary purpose of our proposal was to investigate and develop teaching strategies that would improve grade six students' learning of scientific concepts as defined by the Ministry of Education and Training's Common
Curriculum: Policies and outcomes, grades 1-9, 1995 (referred to as Common Curriculum). The project design included a working partnership with teachers and OSC staff. There were three stated objectives in the proposal:

- To contribute to an outcomes-based science education. By working in conjunction with the teachers, we planned to choose a subset of relevant outcomes-based learning objectives from the math/science/technology general outcomes section of the Common Curriculum; to develop curriculum and instructional strategies to be used during visits to specific exhibits at the OSC, paying particular attention to gender-fair practices; and to create procedures for assessing children's learning from their visit experiences and their post-visit classroom activities. Further, this objective would be met by assisting teachers to reflect on strategies of translating their experiences from an informal to a formal learning setting, and by disseminating the developed strategies to other teachers.

- To continue our previous partnership with the OSC. This objective would be met by expanding our research on student interest and science literacy in the context of outcomes-based learning, and by initiating a process for examining the age appropriateness of OSC exhibits.

- To explore how the technology of the Electronic Village could be utilized i) to enable teachers to volunteer for participation in the research, and ii) as a medium for teacher planning and dissemination of appropriate strategies for other teachers.

In order to assess students' learning we proposed to adopt a pre-test, post-test design. The other design features included in the proposal were:

- choice of a sample of six teachers
- selection of outcomes-based objectives (scientific principles) from the Common Curriculum
- coordination of OSC exhibits with the selected objectives
- development of on-line conferencing procedures and the planning of team meetings at the OSC
• coordination of visits of six classes to the OSC
• data collection on student reactions to exhibits
• analysis of student responses and teacher curriculum making
• report writing

In addition, we included in the Design and Methodology section of our proposal the idea of a sequential progression through the OSC exhibits: "We anticipate that several exhibits will be relevant to a theme, and students' interaction with the exhibits will be in a sequential order based on a progression from concrete to abstract experience." As a result of my familiarity with some of the exhibits, I contributed to the proposal an example of this progression from concrete to abstract, using exhibits that featured centripetal and centrifugal forces. I explained how the students could learn about these forces first from the movements of figure skaters in the Olympic judging exhibit, proceeding from there to the spinning wheel exhibit where they could feel the forces for themselves. These visual and embodied experiences would enable them to interpret what happens in the Free Fall exhibit, which is cognitively more challenging and more removed from immediate experience. They then could extend their knowledge further at the tornado exhibit, and gain an understanding of the behaviour of these forces in the natural world.

We also stated in our proposal that we would "focus the children's attention to particular aspects of the exhibits," and that follow-up protocols would be used "to assess outcomes-based learning."

**Individual Subjectivity and the Social Aspect in Proposal Writing**

The proposal was developed within the context of a set of social circumstances. First, the fact that the principal investigators chose to work together shaped the proposal. The various authors of the proposal each contributed their particular beliefs, concerns, and expertise to the
development of the proposal. While some overlap in the authors' intentions existed, various components of the proposal can be attributed to particular co-authors. A principal concern of Suzanne was that we choose an experimental type design and incorporate gender and interest issues into the project. It was Joel's idea that we work collaboratively with teachers and study their processes of working together via the Electronic Village. Initially my primary interest was in holistic learning principles, especially the way learning through the body might be incorporated with more cognitively-oriented learning.

Second, beyond being shaped by the individual subjectivities of the OISE researchers, the proposal was developed in part because of the long-standing collaboration between the OSC and Suzanne and Joel in particular. The proposal for the project was written on the assumption that a rapport existed and that the fruits of the previous collaborations had been mutually beneficial for partners from both institutions. Under the duress of the time constraints, the decision to submit the proposal without the specific approval of OSC staff was a decision that only made sense within the social context of long-standing relationships.

This section on proposal writing has demonstrated the way in which political, social and personal realities shaped this early stage of the OISE project. My analysis is supported by the view adopted by Clandinin and Connelly (1995) that "practitioners' professional landscape" is "contextual, subjective, temporal, historical, and relational among people" (Anderson and Herr, 1999, p. 15).

While the previous sections have provided the reader with some background information about the research team members and about the writing of the OISE project proposal, the next chapter explores learning and co-learning at an early stage of the OISE project.
Chapter 4: Learning and Co-learning

In this thesis I am adopting the view that research may be a learning process punctuated with pedagogical moments. In this chapter, I investigate selected events from an early phase of our project in light of the learning that occurred. In addition, I also examine my own learning process later, while I carried out the work of analyzing and communicating about our research process.

Learning Through Exhibit and Theme Selection

At the beginning of the summer of 1995, shortly after we received funding for our project, we began translating the relatively general, theoretical plan of the proposal into the actual situation presented by the OSC. The first task was selecting exhibits that would coincide with grade six science curriculum guidelines and satisfy the other requirements of our proposal. By this time our research team had decided that the Common Curriculum guidelines, which we had originally planned on using, were too broad, and we would instead use guidelines set by the specific board of education with whom we expected to be working. Our work appeared straightforward and uncomplicated in the terms of the proposal; however, it proved to be unexpectedly challenging when put into practice.

Commonplaces of Curriculum

Because I focus on learning in this section, I have chosen to frame this particular phase of our research process as a curricular activity taking place in a non-traditional learning setting. In order to elucidate the learning aspect, I apply the conceptual framework of the "commonplaces of curriculum" (Weiss, 1989) and I also draw on Moore's (1981) work on learning in non-classroom settings, where he observes that tasks are central to learning in an informal setting.

As mentioned in the literature review, the commonplaces include: teacher, learner, subject matter, and milieu. As researchers working in a non-
classroom setting, Jason and I, who were given the task of exhibit selection, were both teacher and learner. We were using "subject matter" composed of a diverse collection of materials, including criteria from our proposal, grade six science guidelines developed by a particular board of education, and the OSC exhibits themselves. Our task was novel, since none of these materials had ever been considered in relation to one another before.

As milieu, I include more than the physical aspects of the space in which we were working. According to Weiss (1989), milieu can be understood as "the variety of conditions" under which the other commonplaces interact. In this sense, our milieu included the time of year (July), and our relative freedom from deadline pressures and other concerns. The OSC collaboration seemed assured, Jason and I were provided with the time, financial rewards, etc., to carry out our task.

Cycles of Learning and Reflection

The events taken up in the following segments begin with one episode of learning that took place during our initial attempts at exhibit selection, as we were beginning to make the transition from the broad terms of our proposal to the actual circumstances in which we were going to be engaged. After an examination of this episode, I present the major hurdle we encountered in our task -- the lack of correspondence between exhibits and curriculum guidelines. I then examine the larger process that Jason and I undertook to resolve the challenging task of integrating these two materials. Finally, I reflect on my process of learning through the tasks of researching and writing this thesis.

My intention is to investigate two phases or cycles of learning occurring in two different time periods: the first occurred while Jason and I attended to the task of exhibit selection at the OSC, and the second occurred over an extended period of time while I worked on this thesis. Borrowing Schon's (1983) terms, the first cycle can be called reflection-in-action, because it took
place while Jason and I were involved in carrying out our research task. The second cycle I will refer to as reflection-on-action, since it occurred while I was working alone writing this thesis at a later time, after the completion of the OISE research project.

The first cycle involved the reflections of Jason and myself about our task at the time -- our knowing-in-action. At this time, our reflections were focused on the completion of our practical task. The second cycle was more elaborate in terms of analysis, using the benefit of my later understanding, after my study of theoretical discussions.

I organize the material in terms of these two cycles of reflection despite the necessary oversimplification involved. In reality, the process was not divided in two distinct halves; rather, it was a cumulative spiral of reflection. My concern is to capture the emergent nature of the process and at the same time ensure that the reader has a frame for comprehending.

**Jason and I Begin Exhibit Selection**

Jason and I approached the process of selecting exhibits in distinctive ways. Jason's first approach was to try to experience the exhibits as if he were twelve years old. Pretending he was a child exploring the OSC, he ran from one exhibit to the next, allowing himself to be drawn to those with sensory appeal and staying with each exhibit only as long as he imagined a twelve-year-old would do. This experiential activity was one of his first modes of exploration.

In comparison with Jason, my initial manner of exploring the exhibits was more cognitive and analytical. I was primarily searching for the cognitive links between the curriculum guidelines and the exhibits. The board of education guidelines were divided into four units: Astronomy, Motion,

---

3 The guidelines we were using were developed by a board of education that was not the same board with which we ultimately worked. The reason that we were working with guidelines from one board and a school from another was the consequence of a political situation that will be described in greater...
Reproduction of Living Things, and Inventing. Each of these units was divided into subcategories -- Matter, Energy, Systems, Life, Models, Form and Function, and Constancy and Change -- each of which consisted of particular science concepts to be learned by students. I regarded this outcomes-based material as the focus of our task, given my understanding of our proposal. I also had in mind our proposed plan to arrange a progression through the exhibits from concrete experiences to relatively more abstract thinking. At the same time, I appreciated Jason's approach, which presented an alternative, sensory-oriented way of going about the task of exhibit selection.

**Reflection-in-action**

This first cycle of reflection is a reconstruction of our knowing-in-action and our reflections at the time of carrying out our task.

On our first day together at the OSC, I quickly realized that I had the opportunity to learn from Jason. His approach to teaching and learning was significantly different from other approaches I had encountered in the past. I was intrigued and felt intuitively that his perspective could contribute to my knowledge; therefore I was open to learning from his ideas. When I observed Jason approaching the exhibits as if he were a twelve-year-old, it arrested my attention and I reflected on what he was doing. In previous years, I had been actively developing my interest in the role played in learning by intuition and the body's knowledge. Despite this profound interest, I initially chose a cognitive approach to the work of selecting exhibits. Faced with Jason's approach, I recognized a contradiction within myself. I saw the task of dealing with the curriculum as taking priority and, out of habit, I was largely locked into a cognitive approach. Although I believed that proceeding cognitively was critical to matching exhibits with curriculum guidelines and therefore a necessary part of the work we were doing, I was interested in Jason's behavior because it surprised me. Furthermore, his behavior highlighted what I felt
detail later in this thesis.
was a limitation in my ability to act outside of my habits of thought: it had not even occurred to me that I could give myself an opportunity to try anything except my usual approach.

Jason's approach was also child-centred, which I appreciated. Again, I saw a gap between my theory and my practice. During the previous year, I had analyzed data from an earlier research project conducted at the OSC; in that case, the analysis suggested that children are particularly drawn to sensory stimuli. Despite having been involved in that earlier analysis, nevertheless I did not immediately bring that knowledge to my present task of selecting exhibits. Once I saw Jason assuming the child's perspective, his approach invited me towards the kind of exploration that I knew was valuable.

Reflection-on-action

The role of surprise in co-learning

Later, in what I am calling the second cycle of reflection, while analyzing and determining how to present this experience, I applied various concepts from the literature, including Schon's (1983) work on reflective inquiry. He wrote that surprise stimulates people to turn their thoughts onto their actions and on discovering the knowledge underlying their actions. According to Schon, as people try to deal with puzzling or interesting phenomena, they reflect on the implicit understandings that have guided their actions. In Schon's view, people will critique, restructure, and incorporate into their future action the understandings that surfaced during the course of their reflection. The events that stimulate people to reflect are the ones that create surprise for them. In other words, precisely those "divergent" events that do not fit neatly into people's existing conceptualizations act as a trigger for reflection.

Observing Jason's distinctive approach to the task provided me with a surprise in Schon's sense, which stimulated me to reflect on my own cognitive approach. As Schon wrote, "when a practitioner reflects in and on
his practice . . . he may reflect on the tacit norms and appreciations which underlie a judgment . . . . He may reflect on the feeling for a situation which has led him to adopt a particular course of action, on the way in which he has framed the problem which he is trying to solve" (Schon, 1983, p. 62). Here Schon aptly described my process of reflecting on the tacit assumptions guiding my research practice.

Another element that promoted our learning was the social milieu that Jason and I created in working together. This element was in part the result of our individual subjectivities, in the sense that we were both eager to learn from each other and strongly committed to the task at hand. I was able to learn from Jason partly because I was temperamentally prepared to appreciate his approach. In addition, I already possessed a conceptual frame for his behaviour, since I had pursued a personal interest in child-centred and sensory learning.

Recent research on interest in learning elucidates my experience at this point. Researchers have demonstrated that "interest has a powerful facilitative effect on cognitive function" (Hidi & Berndorff, 1998, p. 74). A distinction has been made between individual or personal interest and situational interest, in which environmental features are central. My experience here appears to involve some combination of the two. According to Hidi and colleagues (Hidi, 1990; Hidi & Anderson, 1992), "although individual and situational interest are distinct, they are not dichotomous phenomena and can be expected to influence each others' development" (Hidi & Berndorff, 1998, p. 76). The relation between situational and individual interest -- more specifically, "how various levels of individual interest interact with situational interest" -- has not been thoroughly investigated (Hidi & Berndorff, 1998, p. 76). Thus, although we cannot know exactly how my situational and personal interests were interacting, it seems that the situation Jason was creating with his child-centred approach to exhibit selection engaged me, while at the same time, my individual interest
in such an approach invited me to observe him carefully and give serious thought to the different ways in which we were each carrying out our task.

My learning experience also coincides with aspects of Vygotsky's (1986) theories about learning. In Vygotsky's framework, outside influences such as the instructor or materials challenge the learner to move in their "zone of proximal development" (zpd). Vygotsky used this term to mean: the place at which a learner's less well-developed concepts meet the teacher's more sophisticated reasoning, settings which 'stretch' the learner beyond where he/she is.

Vygotsky intended his ideas to pertain to a child's development. His main focus was the interaction between the adult teacher and the child learner, and he postulated that learning leads development. Jason and I were peer adults, but in this situation I was the learner and he was the teacher. Jason was not intentionally acting as a teacher, but in fact in this research situation, he was acting as the instructor who provided me with the opportunity to learn. On the basis of my interaction with Jason, I learned how one can put into practice the child-centred, sensory approach in which I had earlier developed an interest.

Vygotsky's (1986) zone of proximal development pertains to the level of mental development a child has reached. Although I am not discussing child development, but rather conceptual development in an adult, nevertheless Vygotsky's ideas are helpful here. He postulated that learning can occur only when the person is receptive in specific ways that will lead to a readiness to learn. As mentioned earlier, I already possessed a conceptual frame for Jason's approach, and the experience of working with him added depth to my understanding.

Looking at these different contributing elements in my learning experience, we can conclude that the "instructor's" intervention, combined with the surprise on the part of the "student" and his/her interest, may lead to intentional learning in a new direction. This particular episode provides only a small window on the learning that emerged out of the larger process of
exhibit selection. Examining this one episode has allowed me to elucidate significant aspects of our learning process. This detail from our learning experience suggests the eclectic nature of the learning that takes place in a research process. Different circumstances lead to different types of learning.

A series of similar learning episodes contributed to Jason's and my developing understanding of the OSC exhibits and the science concepts that they contained. Because our learning was eclectic, our team was able to draw on the experience of Jason and myself later for the completion of research tasks that would demand a thorough knowledge of the exhibits. Ultimately we were able to acquire an in-depth understanding of the exhibits and the science underlying them that would contribute significantly to our team's ability to prepare curriculum and testing materials.

What follows is an investigation of the unexpected difficulty we encountered in our work with the exhibits, and the learning that occurred as a result of this circumstance.

**Incompatibility Between OSC Exhibits and Curriculum Guidelines**

**Reflection-in-action**

Through the process of exploring the exhibits, it became apparent that a direct match between them and the curriculum guidelines was impossible to achieve. Jason and I realized that much of the material in the curriculum guidelines for grade six was at a level more basic than what was needed to comprehend the exhibits at the OSC. For example, in the astronomy portion of the guidelines, two of the concepts under Energy are "the sun and other stars produce light energy" and "when sunlight strikes objects/materials, some of the light is converted to heat energy." No exhibit at the OSC presents such relatively basic information. An additional and more fundamental reason that we had difficulty matching guidelines with exhibits was that the exhibits covered a broad spectrum of science topics, most of which had no relation to the grade six curriculum guidelines.
Furthermore, we had difficulty because there was no thematic structure to the exhibits that corresponded to the themes within the curriculum guidelines. At the OSC, individual exhibits are grouped in broadly thematic "exhibition areas" such as Sports, Science Arcade, Technology, etc. The different exhibits within each area are conceptually independent of each other and appear to be intended to engage interest as discreet units. For example, in the Science Arcade, exhibits on sound, friction, motion, etc., are located in close proximity to each other without necessarily inviting the viewer to make connections between them. Although there may sometimes be a complementary relationship among neighbouring exhibits, nevertheless, as children go from one exhibit to the next, they are free to interact with each exhibit in any way they choose, without necessarily making any reference to what they have seen before.

Reflection-on-action

Task leads to learning

As I mentioned earlier, our proposal explicitly stated our intention to guide the students through the exhibits in a sequential order. In retrospect, when I reflected on our experience, I realized that only when Jason and I were in the midst of our task did we perceive the organization of the exhibits as problematical -- and it was the requirements of our proposal that made it seem problematic. Although I had casually visited the OSC many times in the past, I had never been struck by such a problem. It was only when Jason and I were trying to carry out our research task that I identified the factor as a lack of conceptual sequence.

In speaking with Joel later, it became apparent that he was already cognizant of this situation. He coined a term for the element that our task was asking the exhibits to provide: a "trail of experience." Joel's term connotes a continuity within and across exhibition areas in such a way that visitors gradually build a thorough understanding of new concepts through their
experience of the exhibits. In general, from the perspective of the typical museum visitor, this type of pathway is not necessarily essential in science museums. Because Joel possessed several years' experience working as an educational researcher within the OSC, he had already discovered that no "trails of experience" exist in the OSC exhibits.

In this example, it was the practical task, involving the specifics of the situation that evoked awareness on the part of the researchers and thus facilitated learning.

**Institutional factors contribute indeterminacy**

The unforeseen lack of correspondence between the exhibits and the curriculum guidelines introduced indeterminacy into our research process at this point. What was originally conceptualized in the general terms of our project proposal as a fairly straightforward task -- simply to match exhibits with science curriculum guidelines -- was revealed to be unfeasible once we were in the realm of actual circumstances.

In the process of reflecting on our situation, I have been able to recognize that institutional factors may have created this incompatibility, in a way that is quite natural. Given that each institution has its own history and raison d'être, it is not surprising that its goals might not correspond to those of other institutions. These goals shape the materials produced by the institutions. In the case of the OSC exhibits and the board of education guidelines, dissimilar institutional goals were responsible for the incompatibility we encountered.

This is not to suggest that I believe these two institutions have equal responsibility for having similar institutional goals. Naturally they tend to carry out their own programs independently of each other; that is to say, boards of education do not generally develop curriculum around science museum exhibits, and science museums generally have not been concerned to meet curriculum guidelines supplied by boards of education. In fact it was this very lack of complementary co-operative work that urged us to design our project proposal in the first place.
If we look at the usual modus operandi of these two institutions, the situation becomes clear. A board of education uses an outcomes-based approach to construct grade-specific curriculum guidelines. Therefore, the designers of curriculum guidelines select science concepts within a certain designated range of complexity, depending on the grade level. In contrast, the OSC (according to a member of the OSC educational staff), regards its role as one of developing a science and technology museum that will cater to the interests of a varied audience -- adults and children with disparate levels of science knowledge. The level of conceptual sophistication required for an understanding of most of the exhibits surpassed the content of the grade six guidelines.

As reflected by some of the comments made by OSC staff members, these informal settings are intended to provide visitors with opportunities to have access to concepts presented in a fun or engaging manner. Given this focus, it is not surprising that the OSC was not designed for learning specific concepts in a specific order and therefore one would not expect the designers of the exhibit areas to create what Joel called a "trail of experience."

At this point, our research process was affected by the inherent difficulty of working across institutions with dissimilar goals. Thus, one institution provided us with outcomes-based, grade-specific materials, and the other presented us with an environment designed for a non-specific learning experience aimed at a broad range of ages and abilities.

Our Response to the Challenge of Exhibit Selection

Reflection-in-action

Given the lack of a direct correspondence between the exhibits and the curriculum guidelines and the absence of a conceptual progression across exhibits, Jason and I needed to invent a way of creating conceptual connections across exhibits that would correspond to elements of the
guidelines and thus satisfy the requirements of our project proposal. We needed to develop a theme around which exhibits could be selected.

This process of exhibit and theme selection involved much thought and creativity. It was challenging because we were not only playing with a variety of themes and trying to match different concepts simultaneously; we were also attempting to integrate a number of concerns arising out of the proposal, such as gender-fair practices and building a sequence from concrete to abstract. In addition, we had to manage certain aspects of the physical surroundings that we had not considered before working in the setting of the OSC -- noise level, adequate space for viewing by a group, and ease of movement from place to place. We wanted the chosen exhibits to be attractive and conceptually clear for grade six students. In addition, we had our own preferences and our own ideas about learning that affected our choices.

At the time of the project, we were aware that the need to develop a unifying theme when no obvious one existed was forcing us to learn thoroughly about each exhibit and its related science concepts. For example, an exhibit about astronomy stimulated us to think about forces, motion, gravity, and friction.

After several visits to the OSC, Jason and I were struck by the idea that gravity might be a possible theme to link the concepts underlying a number of exhibits. This idea came to us after a long period of experimentation in which we tried to respond to all our criteria -- including the new concerns presented to us by the actual physical environment of the OSC exhibit areas. As a theme, the topic of gravity complemented the existing curriculum conceptually and was either explicitly or implicitly an underlying feature of a number of exhibits across exhibition areas. However, the match between curriculum guidelines and exhibits was not a direct linear one. Gravity was not listed under the guidelines' Motion unit, but elements of this unit -- such as the relationship among friction, force, energy, and direction of motion -- fit well with the theme of gravity. Gravity was mentioned as one of the underlying points of the Astronomy unit: "the solar system is held together
by the force of gravity." The theme of gravity was also broad enough to allow us to include exhibits in various exhibition areas. This crossing of exhibition areas meant that we could further respond to gender equity issues and at the same time incorporate holistic learning principles. We initially selected approximately fifteen exhibits that were connected to the theme of gravity.

In the face of the incompatibility between the OSC exhibits and our curriculum guidelines, Jason and I needed to draw on our reserves of creativity and lateral thinking in order to invent a way of linking the two. Jason and I were both aware during this process that we were involved in an enjoyable, improvisational act of creativity. However, at the time, even though I was fully aware that both of us were learning, I did not think of the process in which we were engaged as a learning process.

Although Joel and Suzanne were kept informed of Jason's and my progress and contributed some input, they only came to the OSC to examine the exhibits after we had made a preliminary sampling and had selected the theme of gravity. Thus their involvement in much of the work of exhibit and theme selection was indirect rather than "hands-on".

**Reflection-on-action**

**Subjectivity and task-directed learning in the research process**

The way in which we carried out the translation from the general terms of the proposal into the practical circumstances of the OSC could not have been imagined beforehand. Our selection of gravity as a theme linking fifteen chosen exhibits was a distinctive resolution of the difficulties we faced. It was the product of our individual subjectivities and the social milieu that we managed to create. A different group of researchers faced with the same task would not necessarily have developed the gravity theme.

The challenging task of developing a theme across exhibits served to stimulate our learning. The need to experiment, the intellectual challenge the task presented, and our personal resources in terms of lateral thinking
abilities and curiosity all contributed to the quality of our learning. The task deepened our understanding of the science concepts involved in our project, since the lack of a direct correspondence between the exhibits and the curriculum guidelines forced us to analyze the contents of the exhibits. We needed to conduct this analysis in order to uncover the various concepts such as friction, motion, energy, etc., which were components of the curriculum guidelines. In addition, the creation of a theme involved making a synthesis across exhibits and project proposal criteria. Considering the potential of each exhibit to be selected forced us to learn something distinctive about the OSC presentation in relation to our concerns. For example, the act of working with certain exhibits led us to consider the way the designers had created the exhibit. Working with other exhibits taught us about the limitations of the exhibit design (e.g. cognitive leaps in the text, aesthetic weaknesses, etc.).

The principal investigators, Joel and Suzanne, and the science teachers, did not participate in the tasks of analysis and synthesis surrounding the exhibits. Consequently, they did not have the opportunity to learn the science concepts and familiarize themselves with the exhibits to the same extent as Jason and I did.

**Reflection-on-action: My Thesis Process**

In previous discussions, the reflection-on-action pertained to the "action" of the OISE research project. The ensuing discussion presents my reflection-on-action pertaining to the "action" of researching and writing my thesis.

While we were working at the OSC, Jason and I were learning about the exhibits and the related science concepts, but our task did not stimulate learning beyond what was necessary to link the exhibits and the curriculum guidelines. The task focused our attention, largely limiting our reflection-in-action to the practical work.
After the completion of the OISE project, the focus of my activity altered in accordance with the change in my task, which was to research and write this thesis. At the data-gathering stage, I had not yet formulated my central thesis nor finalized my working themes. However, I was cognizant of my general intention to investigate the process of carrying out research.

It was not until much later, after months of reading, writing, and revising, that I was able to identify the significance of certain reflections of my colleagues. For example, in an interview with Jason on June 19, 1996, I engaged him in a discussion about our work on the exhibit selection. Jason appreciated that our handling of this task was the "opposite" of what is "supposed to occur." Instead of "sitting down with a curriculum development plan and theory," as he told me in this interview, "we've gone to look at the materials and hashed things together." Here, Jason was reflecting on the way our process differed from a theoretical norm. His choice of the verb "hashed" highlights the original creative nature of our work, which resulted in what I believe was a theoretically sound program of instruction.

As a result of the conceptual understanding I have gained through the thesis-specific tasks of analysis and synthesis, I now recognize new significance in Jason's comments that I would not have seen at the time of my interview with him. I interpret his comments as underscoring the emergent quality of our research process at that stage, which involved deliberation in the context of the practical. His remarks highlight the contrast between our approach and Jason's idea of what is "supposed to occur," that is to say, a pre-ordained approach to curriculum development. While Jason's comments may seem relatively minor, they lead us to a larger issue. Walker's (1975) investigation of the curriculum development process is helpful in this regard. He stated that curriculum development "can have a type of rationality, on the other hand, this rationality does not consist simply of deducing or calculating the form of the curriculum from given facts about 'determinants'" (Walker, 1975, p. 132). My point here is that what we did was
rational and correct; in fact I believe it led to the creation of a theoretically sound program of instruction. On the other hand, our process of reaching this goal was not a strictly step-by-step procedure, but rather (to quote Walker) "a genuinely creative task of generating ideas" (p. 126).

Vygotsky's (1986) theories about the "zone of proximal development" are relevant here. My learning process serves to illustrate the cyclical development of understanding that took place in the productive learning experience that ensued during the research process. According to Vygotsky, each cycle of learning takes a person further in his or her understanding. What emerges from the material in this section is that the task can serve to stimulate a further Vygotskian cycle of learning, and so on. The concept of a hermeneutical spiral is relevant here (P. Gamlin, personal communication, February 24, 2000). Jason and I developed new levels of consciousness regarding the relationships of conceptual themes, for example around the theme of gravity. With new levels of consciousness arise new "intentional" as well as "informal" directions for further learning.

The above example is representative of the learning of the researchers in the OISE project, and of my learning during the course of working on the project and on this thesis.

In this chapter, I have examined learning and co-learning in the context of our work of exhibit and theme selection. In the following chapter, I explore indeterminacy. My investigation is situated within another relatively early stage of our research and deals with one major complication that profoundly affected the subsequent course of our research project.
Chapter 5: Indeterminacy

In this chapter, I investigate indeterminacy. Specifically, I explore the progressive breakdown of the collaboration between our research team and certain members of the OSC staff. This breakdown introduced a series of changes to our original plan. Accordingly, this chapter is divided into three parts: first, an examination of the breakdown itself; second, an investigation of the ramifications that resulted from it; and third, an examination of our collaboration with the teachers, which was significantly affected by the earlier breakdown.

The Failed Collaboration

As soon as we had received funding in the spring of 1995, we scheduled a meeting with the staff member at the OSC who had previously worked with Joel and Suzanne as a liaison. At our first meeting, our liaison seemed interested and pleased with our plans. There was no indication that there would be any problem with our research project. At the time, she issued a memo to the OSC security officers informing them that "the OSC and the Ontario Institute for Studies in Education (OISE) are collaborating on an education research project which will be conducted at the OSC. In order to prepare for and conduct this study, the researchers from OISE will visit the OSC at various times during the summer and throughout the next school year" (June 28, 1995).

Although we did not define the specifics of our collaboration, I believe there was a tacit assumption that this collaboration would take the same form as it had in previous years. That is to say, we would consult with our liaison, meeting with her at her convenience in order to obtain information regarding OSC exhibits and programs and to inform her of our progress. In fact, at the beginning it did seem that our collaboration would resemble previous ones: we gave our liaison opportunities to participate, to critique our proposal, to suggest exhibits, to give us background information.
Assuming that we were working in collaboration with the OSC, we began to lay the foundation of our project during the spring and early summer of 1995. Specifically, we made contact with a certain local board of education in order to locate schools and teachers interested in collaborating with us. We also began our investigation of the OSC exhibits, as presented in Chapter Four.

**Emerging Difficulties with OSC Collaboration**

At the beginning of July, our liaison informed us that some of her colleagues on the OSC education staff had expressed concerns about our proposal and had requested a meeting with Joel and Suzanne, the two principal researchers. This request for a meeting was the first indication that some problems might arise with our collaboration, a full two months after the education staff had received our proposal.

At the meeting, it was clear that a serious problem existed in our relationship with the OSC, but it was unclear whether the problem could be overcome or not. Our liaison was not present at this meeting, and a number of concerns were raised by the members of the OSC educational staff. Among them was the criticism that we had not presented our proposal to them before submitting it to the Ontario Ministry of Education and Training. Joel and Suzanne apologized and explained the circumstances surrounding the writing of the proposal. In particular, they mentioned that we had been waiting for the Ministry to provide a list of research priorities before composing our project proposal, and it was only days before the deadline for submission that the Ministry acknowledged that no such list would be forthcoming.

Another issue was the question of whether or not our research staff was covered by Workers' Compensation during visits to the OSC. Joel and Suzanne informed them that consultation with OISE administration was
necessary in order to address this concern. (This request was complied with on July 18, 1995).

A more important problem involved a perceived overlap with our project and the mandate of the OSC educational staff to translate the Common Curriculum into exhibit-related materials. The OSC staff suggested that our project would conflict with their mandate, since a curriculum development component was part of our proposal. Joel and Suzanne proposed that our research team could work in conjunction with OSC staff on this effort. At the time, this suggestion was at least not eliminated.

Finally, Joel and Suzanne received a strong impression that the research we were proposing did not coincide with the OSC staff's idea of research: our curriculum development component was seen by them as "practice," not research. As Joel and Suzanne explained, our research involved not only the investigation of the way teachers create settings, but also the assessment of students' responses to these settings. Joel and Suzanne left the meeting with the impression that they had addressed the concerns of the OSC education staff.

We were greatly surprised when we received a letter on September 25, 1995 from an OSC educational staff member stating that the OSC was unable to participate in our "proposed project" because "elements of the project would interfere with the normal operating activities of the Centre." The letter did not specify what this statement was intended to mean.

At that late date, our research project was no longer "proposed," but rather already in the process of unfolding. Our research team had been working for five months to select exhibits and to develop a set of learning activities with thematic coherence. In addition, by this time we had already met the science teachers who would be involved in the study.

Over the next few months, the situation deteriorated. During this time, Suzanne and Joel were required to engage in negotiations almost continuously in an effort to salvage the collaboration with the OSC staff. The director of OISE was consulted by Suzanne and Joel regarding the situation,
and she began negotiating on our behalf with the OSC educational staff and with the Director-General of the OSC, but to no avail.

This complex, time-consuming political situation continued until the winter of 1995, when it became clear that no aspect of the collaboration was salvageable. At this point, a decision was made by our research team to carry on with the project despite this failure in collaboration.

**Difficulties Working Across Institutions**

The foregoing events highlight the difficulties that arise in working across institutions. From our perspective it appeared that the internal "politics" of the OSC constituted the principal source of indeterminacy in this scene. (For obvious reason, this interpretation is one-sided, since no one at the OSC was interviewed for this thesis). Up until this stage of our research process, we as researchers from OISE were interacting at various levels with different institutions -- the provincial Ministry of Education, the internal administrators at the OSC and those at a particular board of education.

According to Eisenberg (1992), "Participation in the activities of an institution entails at least some commitment to the existing structure." By "structure," Eisenberg meant the "arrangements, the relationships, the rules" constructed in order to carry out the work of the institution. Eisenberg continued: "To live in a society is to function in a network of institutional contexts, and to [do so] . . . is largely to be committed to the codes of those institutions" (p. 36).

Eisenberg's understanding of institutional codes illuminates the situation in which we found ourselves. In this thesis, I am taking the position that research is a social undertaking -- a matter of developing networks and partnerships among people. People are never divorced from the institutions within which they find themselves. Eisenberg (1992) reviewed Goffman (1961)'s research on institutions and their official and unstated goals: "Institutions that were set up to achieve certain goals were found, in actuality,
to be pursuing altogether different goals. And where conflicts existed between official goals or policy and these other goals, the latter took precedence over the former" (p.35). Eisenberg supplied the example of schools, which are "committed to developing the autonomy of students" but "systematically frustrate that development for the sake of order in the classroom and corridors" (p. 35). We can extend this understanding of the unofficial goals of an institution to include its need to protect itself in order to perpetuate itself. Given that the OSC had a mandate to work on curriculum development, it is likely that our project was perceived as a potential threat to the jobs already held by OSC staff. This sample of internal "politics" within the OSC played a major role in shaping the course of our project.

As Eisenberg suggested, the individual is affected not only by the official "codes" of institutions, but also by their internal politics -- which are hidden and/or not acknowledged explicitly. As external researchers, we were not in a position to know the specifics of the internal "politics" of the OSC. The official code suggested that the OSC would be likely to support a project that intended to help students understand the underlying concepts of the exhibits at the OSC. From what we could gather, the internal political situation conflicted with this official "code" and took precedence.

The implications of these ideas about institutions need to be examined in the context of educational research in general. In an interview I conducted with Joel on March 13, 1998, he specified that in educational research, one always begins with certain assumptions about "the territory" -- that is to say, the specific context of relationships, including the history of previous relationships. In this case, we knew we would be working with the OSC, and in particular, with one staff member who acted in the past as a liaison with the institution as a whole, and with whom Joel had a successful, congenial, long-term working relationship. We had substantial confidence from past experience that we would be able to work with this individual for our project. Nothing prepared us for the disintegration of this relationship, which was not personal, but institutional. To a large extent, we can only speculate that
our liaison was caught between her commitment to her institution, the OSC, and her personal history with Joel and Suzanne as researchers. Apparently, "the existing structure" within the OSC had shifted. Our liaison was now accountable to new administrative personnel; this new situation limited her ability to respond to Joel and Suzanne as she had done previously. The nature of the relationship between our liaison and the OISE research team necessarily had to change because, caught between the conflicting needs of the two institutions, our liaison owed her primary commitment to the OSC. During previous research projects, there had been no conflict for her, since she perceived the goals of the two institutions as compatible.

These events demonstrated to us that, as Joel expressed it, "no matter how much you try to have things down pat beforehand, given the fact that we're not dealing with physical phenomena in a laboratory, but rather with people, organizations, in complicated situations" -- indeterminacy may pervade the process. You cannot predict the divergent elements beforehand. You might have some idea -- you know you're dealing with organizations, requirements, etc., but the whole point is, as Joel remarked, "you don't know you're in it till you're in it." Here Joel was clearly identifying the principle of indeterminacy as an all-but-inevitable part of the research process. Similarly, Fullan (1993) made the case that "change is non-linear, loaded with uncertainty, and sometimes perverse" (p. 24). Fullan comments also provide support for Joel's insight. He stated that "you don't know what is going to matter until you are into the journey" (p. 24).

Generally, we became aware of problems progressively. We also had to resolve them progressively. In this case, the breakdown of the collaboration was not immediately apparent as such, but rather it was a gradual phenomenon that took time to develop and to clarify. Five months passed before our problems with the OSC staff ultimately culminated in a complete breakdown.

This situation supports Eisenberg's view that "purely academic, rationally conceived programs" may encounter severe challenges "because
they do not, indeed cannot, take into account the intrusion of the institutions and of conflicting moral values that are incompatible with our stated values" (1992, p. 59).

**Repercussions**

A series of unexpected developments resulted from our failure to maintain a collaborative relationship with the OSC staff. As I will demonstrate, the failed collaboration initiated a cascading chain of events: one unexpected circumstance created another unforeseen situation, which in turn generated another unanticipated occurrence.

First, we faced unforeseen complications locating schools and teachers. From the beginning of the project, we were involved in negotiations with the science department of a certain board of education to recruit teachers for our study. Although initially promising, our negotiations were stalled by our uncertainty concerning the OSC collaboration. Establishing a formal agreement at the board level was difficult as long as this issue remained unresolved.

One consequence of the failed collaboration involved cost. We had assumed that the OSC would allow the students free entry for our study, and therefore did not include this cost in our budget. However, if our collaboration with the OSC collapsed, we would need to pay for the students' entry to the OSC. In addition, the school board wanted the OISE project to pay for school buses to send their students to the OSC.

Meanwhile, in July 1995, Jason suggested that we meet with a friend of his, James (not his real name), who was both an elementary school teacher and a graduate student at OISE. We hoped to establish a collaboration with James's school, conveniently located nearby, eliminating the need for buses. This school was not part of the same board of education with which we had been negotiating officially. This informal connection proved fruitful. After

---

4 The events reviewed occurred prior to the amalgamation of numerous
discussing our research with James, we went on to obtain approval for the project from his principal as well as from the board of education in which the school is located.

In September, 1995, we met with three grade six science teachers at this school who agreed to be part of the project. Together these teachers taught science to six classes of grade six students. The number of classes corresponded to the needs of our project; specifically, we needed six classes in order to carry out our predetermined design.

Given our ongoing difficulties with the OSC and the resulting stalemate in the board of education negotiations, it was apparent by December that we needed to work with the teachers and students available to us. I will refer to the three grade six science teachers who participated in our project as George, Peter, and James (not their real names).

Initially, our project proposal included our intention to use the Electronic Village as a source of data about curriculum development by teachers. This objective proved to be impractical, largely because we ended up with three teachers at one school instead of six teachers at six different schools. In any case, as it happened, two of the three teachers were not familiar enough with on-line communications to use this method. Even though James used e-mail as part of his teaching position, in our project the use of e-mail became limited primarily to brief messages regarding practical information rather than theoretical discussions pertaining to issues of curriculum development.

**Cascading Effect of Indeterminacy**

As a result of the time-consuming and complicated negotiations with the OSC, and the unexpected availability of a local school that met our research design needs, a new unanticipated situation arose. We were no longer working with six teachers across six schools. Instead we were working exclusively with three teachers in a single school.
As a result of this situation, we were faced with a paring down of our original conception of the project: as explained above, this downsizing eliminated the usefulness of the Electronic Village component. We had expected this component to aid our investigation of the process of teacher curriculum development.

These events reveal a pattern that became familiar as our project unfolded -- a recurrent pattern of human interaction with events unfolding over time. With reference to Eisenberg’s (1992) ideas concerning the pervasiveness of indeterminacy in social activity, I developed a framework or schema that will identify the recurrence of this pattern in our research process. I present this framework, along with examples from the situation I have been describing, as follows:

- **Unexpected event or circumstance (divergent phenomenon), usually evolving through multiple stages:**
  Here, the failed collaboration with the OSC staff, gradually evolving from the mid-summer of 1995 to the end of that year;

- **New situation:**
  As a result of the problem with the OSC collaboration, we experienced difficulty locating schools through the official channels, i.e., at the board level;

- **Response of our research team via deliberation and the use of available resources:**
  In this case, Jason’s connection with James;

- **Response in terms of actions taken:**
  Here, our decision to work with James’s school, which in turn created another new situation;

- **New situation:**
  In this case, only three teachers in one school, and the loss of the Electronic Village component.
This framework usefully highlights a recurrent pattern; however, it gives the impression of static events unfolding in a linear progression. In fact, the situation was chaotic, fluid, and dynamic, since it involved the interactions of people with events over time. In addition, a single event often had numerous repercussions, which could be regarded as multiple "new situations" that the research team would then be required to assess and manage. For example, in the case of the events outlined here, we not only faced a streamlining of our project; we also emerged from the process with a school whose science guidelines were not the same ones on which we had based our exhibit selection and our gravity theme. In addition, the reduction in the number of teachers gave greater weight to the individual subjectivities of those who were involved.

**The Emergent Research Process and Institutional Factors**

Our informal contact with the local school allowed us to establish our relationship with science teachers before we knew whether or not our difficulties with the OSC staff would be resolved. In contrast, our official negotiations with the school board would have necessitated a definite clarification of our relationship with the OSC.

This contrast provides an initial point for investigating the intricacies of collaboration among institutions. At the time when these events were underway, the pressure of circumstances made it difficult to focus on the possible reasons behind our continuing impasse with the school board. However, the following is my current analysis of the situation as I have tried to deconstruct it.

My analysis of this situation indicates the important role of human relationships within networks of institutions and the effect these may have on the research process. In the course of my analysis, it will become clear that, as Eisenberg has observed, institutions can shape the individual's relations with others.
The hierarchy within an institution has an effect on the interactions among people. At higher levels, the decision-makers in an institution operate according to their roles as heads of the institution; they have their own priorities, involving issues such as the reputation of the institution and its funding resources. These administrators are working in a "top-down" capacity, at a distance from teachers, whom they do not necessarily know as individuals. Board of education administrators often determine general policies (such as grade six guidelines) that are delivered to the teachers. I am speculating that as such, a science department within a board of education would need to know that a project such as ours would be worthwhile in terms of their own agenda. They would probably require an assurance that we had made sufficient and appropriate links between the OSC exhibits and their grade six science curriculum guidelines. In addition, they would probably need to be able to give principals specific information about the teachers' participation, especially the amount of time involved and the workload.

When one considers the situation in these terms, it becomes clear that researchers may need to know many specific details of their project in advance of working in the research setting. However it may be impossible for researchers to work out some of these details beforehand.

As in any large bureaucracy, negotiations at the board level would probably involve an extended time line, because many stages are likely to be involved. One would expect, for example, that the board would first approve the project, then possibly add their contribution (to make it worthwhile for them), before approaching selected schools via principals. Then the principals would invite teachers to join the project, and the individual teachers would then need to make a decision about joining the project. All of these stages of negotiation generally would be carried out at a distance from the researchers themselves.

In contrast to such a time-consuming, elaborate procedure, approaching James's school gave us a direct route to the individuals with whom we would be working. Making connections at the level of teachers in an individual
school, one is immediately involved with the people who will be directly engaged in the project. They are familiar with the needs of their particular school, the preferences of their principal, the "climate" of the school in terms of rapport among staff and between teachers and principal.

This immediacy is beneficial to the research process since it accommodates the emergent nature of the process. Often, although the researchers have a plan, they might not be able to answer all questions regarding specifically what will occur in a given situation, because these specifics necessarily emerge out of the research process. A personal connection enables one to negotiate in a give-and-take process, with enough flexibility to meet other people's concerns. Most important, attention is given to the development of a relationship. Trust is involved, since the participants must allow the process to evolve, when many specific details remain to be clarified. In this way, an emergent process is possible.

Although in this thesis I focus most often on unexpected circumstances that posed unwelcome challenges to our research team, in the case of our relationship with James's school, we were provided with an unanticipated situation that made a positive contribution at this stage to our research process. The informal negotiations that we engaged in at James's school resulted in the principal's support of our request to conduct research at her school. Because of her support, our research team managed to receive approval at the school board in which her school was located.

The informally negotiated collaboration with James's school allowed our research team to engage in an emergent research process, as opposed to providing a professionally presented guess in the guise of fact. In other words, we were free to present our process candidly (as in, "we don't know yet; we need to work this out as we go along"). We were not required to present details as *faits accomplis* (as in, "specifically, this procedure is what we will be following, and it will require X number of classes and X number of teacher hours").
Another factor contributed by our fortuitous connection with James's school concerns the issue of time. We were already behind schedule as a result of our failed collaboration with the OSC staff. It would have threatened the viability of the project if, at this late date, we had been required to wait for negotiations at the board level to be completed. It is likely that if we had not encountered any difficulties with the OSC staff, we would probably have had enough time to go through the official bureaucratic channels, and even to provide the board with some of the specific details they probably would have required.

**The Evolving Collaboration with the Teachers**

In our proposal, we had specified that we wanted the teachers to participate in the development of curriculum. We were using an extended definition of "curriculum" that included a science curriculum unit for the classroom, selection of OSC exhibits, pre- and post-test questions, and structuring the trips to the OSC. We expected the teachers to participate fully; that is, we wanted the contribution of their expertise and we wanted them to act as part of a team on the project.

At the beginning of the fall of 1995, we started to engage the teachers in the research process by asking them to participate in meetings with us and in the final exhibit selection. The teachers informed us about their curriculum and their students. We learned that they had a large number of English as a Second Language (ESL) students whose mastery over English was limited -- something we had not expected. With the teachers' help, we made a final selection of five exhibits (see Appendix A).

Our next task was to develop questions for the pre-test and to develop a curriculum unit on the topic of gravity. Our goal in administering a pre-test was to establish a baseline for the students' knowledge of gravity, locating at least some questions in their everyday experiences. We intended to present the same questions to the students (along with additional ones) at the
conclusion of the project, in order to assess their learning of the concepts underlying gravity. As we talked to the teachers about developing the pre-test/post-test questions, we discovered that the students had little if any experience with formal testing procedures.

Gradually, in the course of working with the teachers at this stage, it became apparent that the full collaboration (as planned in our project proposal) was not going to materialize. During the course of the project, the collaboration altered and became an improvised, uneven, unpredictable arrangement, until we decided that we needed simply to develop the materials on our own. Meanwhile, the teachers became responsible for implementing a curriculum unit developed by the researchers, and for managing school-based details of OSC trips.

At this point, the task of developing the pre-test/post-test questions fell primarily to Jason. Because of his experience in classroom teaching, curriculum development and ESL knowledge, Jason was clearly much better equipped to compose the questions than any of the other members of our research team although, as usual, many intensive hours of group deliberation surrounded the task.

**Subjectivity, Institutional Factors, Co-learning**

The most significant unexpected circumstance we faced at this stage in our project was the collapse of the planned full collaboration with the teachers. I subsequently analyzed the reasons for this turn of events.

My analysis led me towards institutional factors responsible for the teachers' inability to participate fully. Unlike the four researchers, who had a major responsibility for the OISE project, the teachers' primary responsibility lay with their classroom teaching. Without a teaching assistant and time free from classroom duties, the teachers did not have the resources to devote themselves fully to our project, nor did they feel the same degree of responsibility for its completion.
My analysis revealed additional issues concerned with learning. The teachers lacked experiential familiarity with all aspects of the project. The curriculum guidelines that we were using came from a different board of education than their own and thus the teachers were unfamiliar with these guidelines. Furthermore, the teachers could not have a full understanding of the intent underlying the proposal beyond a general notion gained from our verbal descriptions and the written materials we gave them. As a result they had only a vague appreciation of what would transpire and the necessary workload.

Given that the researchers had not only developed the proposal but also had spent several months studying the OSC exhibits, matching these to science curriculum guidelines, and developing the theme of gravity, the teachers could not have had an equally thorough knowledge of the material and of the project as a whole. One could regard this as a handicap that was in place from the outset of our project, destined to limit the nature of the teachers' participation. For example, when they were asked to refine our choice of exhibits and provide reasons for their selection, they found it difficult to comply. The teachers had only a brief exposure to the OSC exhibits, in sharp contrast to the thorough familiarity gained by Jason and myself during our months of studying them and developing the theme of gravity.

Our research team was introducing a considerable amount of change into the working lives of the three science teachers. In addition, we were developing the project at the same time that it was taking place, so that the teachers' regular duties made it impossible for them to join us in such tasks as learning about the content of the OSC exhibits. In his study of educational change, Fullan (1993) has observed that "Even well developed innovations represent journeys for those encountering them for the first time" (p. 25). One could say that the teachers were only "on the journey" in a necessarily partial manner, and therefore could not develop their understanding of the project as a whole. Fullan quoted Stacey (1992), who commented that: "Route and
destination must be discovered through the journey itself if you wish to travel to new lands" (Stacey, 1992, p. 1, quoted in Fullan, 1993, p. 25).

The teachers' level of participation was also limited by their lack of specialized training in two areas. Elementary school science teachers are not required to possess a specialist degree in science. In addition, as Jason observed, most teachers have not taken specialized courses in curriculum development or in incorporating the needs of ESL students into curriculum programs -- skills and knowledge that were central to the writing of tests and developing the gravity unit. Furthermore, most teachers are not familiar with research design issues pertinent to the actualization of the project.

**Effects on the Project**

The unexpected inability of the teachers to collaborate fully had a major impact on the objectives of our project, and on the ensuing workload for the research team. The altered collaboration led to the weakening of one of the originally planned components -- the teacher-participatory component of our proposal. Without our choosing, our project was being re-shaped, transformed from the plan as originally conceived, in which there would be substantial teacher participation, to a more researcher-dominated project. In addition, our project was undergoing another change: instead of including both qualitative and quantitative components, our project was in the process of losing its qualitative component, to become largely focused on a quantitative analysis of students' affective and cognitive gains. Had we been able to sustain our original plan of exploring the ways in which the technology of the Electronic Village could be utilized as a medium for the teachers' curriculum development, our project would have had a more prominent qualitative element.

In practical terms, the altered collaboration had a major impact on the tasks that our team had to undertake. In a teacher-participatory situation, researchers benefit from the teachers' knowledge of their students and of
their existing classroom curriculum. We were now at a disadvantage: not only were we working with guidelines from a different board of education; we also had to write the pre-test and the curriculum unit with incomplete knowledge of the students and their programs. We were beginning to become aware that we might have chosen a topic that was too challenging for students who, as we now discovered, had limited facility with English and had not been formally tested before.

In the course of translating our plans into the actual context of the school setting, we were learning that our project was becoming more challenging than we had anticipated. Our workload increased considerably beyond what we had originally expected. Finally, since the researchers had to develop the curriculum themselves, our views on teaching became more important to the project than originally anticipated.

In this chapter, I have investigated indeterminacy within the context of the failed collaboration with the OSC and the evolving collaboration with the teachers. In the next chapter, I explore how subjectivity may have shaped our research process.
Chapter 6: Subjectivity

The circumstances discussed in this chapter provide an opportunity to explore the effect of individual subjectivities on the research process, both the contribution that individuals made and the amount of variability that was introduced through this factor. This chapter also explores the interconnectedness of subjectivity, indeterminacy, and learning at this stage of our research project, while we were developing pedagogical strategies and fulfilling certain requirements of our experimental design.

Implementation of Classroom Instruction

At an early stage in our research, we had determined that the Experimental Group would have classroom instruction in gravity-related concepts, and that one Control Group would also have classroom instruction, but another would not. We allocated the various science classes taught by the three teachers into these groups.

All three teachers had at least one class in which they were supposed to give instruction on the topic of gravity. We informed them that they needed to teach the curriculum unit on gravity that we had developed and that they could choose their own teaching strategy to do so. As a liaison with the school, I spent time as an observer in their classrooms and found that the three teachers responded to this task in dissimilar ways. Peter was enthusiastic and committed: he started doing extra research to enrich his classroom teaching and then followed through by giving his students opportunities for carrying out experiments and a classroom project. George preferred to have his students working on their own, while he provided supplementary photocopied material. Peter supplied James with his enrichment materials, and James reported that he did experiments with his students. However, James was experiencing discipline problems with his science class. His class was located in a portable, a factor which may have contributed to some of the difficulty in maintaining the students' attention.
As I observed the classroom activities, I realized that variability was being introduced into the study by the disparate ways in which the three teachers were presenting the material in their classrooms. Because Peter was so much more enthusiastically committed to the project than the other two teachers, providing his students with supplementary activities surrounding gravity, it seemed logical to assume that his students would have a better learning experience than the others. Even though Peter shared his enrichment materials with James, given the discipline problems within James's class, it was unlikely that his students experienced the same learning opportunities as did students in Peter's classes.

Furthermore, I was experiencing a conflict in my responses to the teachers' needs, since I was concerned that my actions not introduce variability into our study. On the one hand, I felt I needed to behave consistently in my interactions with all three teachers, but on the other hand, Peter's involvement engaged me more. He asked me more questions about our research project, he wanted to discuss gravity with me, and he was eager to resolve some science-based problems he had encountered. I was afraid of creating a bias in our results if I provided Peter with supplementary help.

**Subjectivity as a Source of Variability**

The unanticipated imbalance among the participating teachers represented a substantial variation from our initial expectations regarding teachers as resources for the project. This unexpected situation arose from the subjectivities of the people involved -- researchers as well as teachers.

We needed to decide how the teachers were going to implement our curriculum unit on gravity. Within our research team, there was a certain disparity in epistemological views among the members. On the one hand, there was a view in favour of the traditional "scientific method," which necessitates significant control over variables. On the other hand, there was a view in favour of allowing -- or almost encouraging -- individual expression
and interpretation on the part of the participating teachers. The deliberations surrounding this issue reflected these two contrasting views. The decision we ultimately made involved a compromise.

As a group we felt that our requirement for control over teacher variability was sufficiently met by the uniform curriculum unit we had developed. We felt this was as far as we wished to go, since we wanted to respect teachers' individual talents, skills and interests. Our decision represented both a moral issue and a power issue. The individual subjectivities of the researchers is a factor here: other researchers might have imposed more conformity. For example, one option would have been to assign one or more members of the research team to the task of teaching the unit in all the science classrooms, thereby limiting some of the variability involved in the implementation of the curriculum.

Our decision to refrain from imposing a rigid control mechanism on the teachers' implementation of the curriculum unit introduced some variability into our study. Because we had three very different teachers, this decision may have resulted in different learning environments for the students in the six classrooms.

Another source of variability lay in the students' learning environment. In this project we had a large difference in the behavior of students in James's class as compared to the others. Here I am making a distinction between what the teacher provides as a learning experience and what the student, because of his/her subjectivity, takes from this learning opportunity. There is a synergy between the two. The case of James's class demonstrated that, even if the materials the teachers provide are similar, the actual learning experiences may not be the same. Even if one of the researchers had implemented the curriculum across all of the classrooms, the students in James's class would probably have had a different learning experience because of the disruptive behaviour of some of the students, which created a very poor learning environment for all of the students in that class.
**Decision-making for an Instructional Strategy**

At this stage of our project, we were in the process of making crucial decisions affecting our research design. Our proposal indicated only that we would have two visits to the OSC, in addition to classroom instruction for some classes. The proposal did not specify pedagogical strategies to be used to promote the integration of the two settings, since the development of these strategies was one of the objectives of our study. In addition, we needed to flesh out our research design in terms of testing the students' response to the pedagogical strategies we devised.

During our deliberations, we decided to use what we called a cyclical rotation for the first visit, in order to familiarize the students with the exhibits. That is, the students would be organized into small groups and rotate through the exhibits we had chosen. We decided to impose a stay of ten minutes at each exhibit. We did not impose any instruction on the part of the researchers who accompanied the rotating groups. Our aim was to keep their visit as close as possible to a "normal" visit, and still satisfy our needs for data collection. Table 1 illustrates the research design at this stage of the project.

Table 1

**Research Design at the Time of the First Visit**

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Classroom Instruction</th>
<th>First OSC Visit</th>
<th>Post-test Same as Pre-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group (2 classes)</td>
<td>yes</td>
<td>yes</td>
<td>cyclical rotation</td>
<td>yes</td>
</tr>
<tr>
<td>Control Group 1 (2 classes)</td>
<td>yes</td>
<td>no</td>
<td>cyclical rotation</td>
<td>yes</td>
</tr>
<tr>
<td>Control Group 2 (1 class)</td>
<td>yes</td>
<td>yes</td>
<td>cyclical rotation</td>
<td>yes</td>
</tr>
<tr>
<td>Control 3 (1 class)</td>
<td>yes</td>
<td>yes</td>
<td>no visit</td>
<td>yes</td>
</tr>
</tbody>
</table>
We found that on this first visit the students interacted superficially with the exhibits and quickly became bored. They did not use the longer time to investigate the exhibits in depth.

Given the results of the first visit, we deliberated about the choice of an instructional strategy that would shape or guide the students' experience so that they might learn science concepts. Jason was confident that the jigsaw technique, a co-operative learning tool, would be effective as an instructional strategy to integrate the two learning settings.

In a jigsaw, students initially form small groups, then are given an opportunity to learn and become experts on a piece of the entire picture. Subsequently, they are required to 'teach' other students through sharing their knowledge. The technique was developed for the primary and early secondary classroom as an alternative method of content delivery and as a co-operative learning technique, which is of particular interest to educators teaching heterogeneous groups (Aronson, Blaney, Stephen, Sikes, & Snapp, 1978; Kegan, 1989; Slavin, 1983).

Before Jason suggested using the jigsaw, Suzanne, Joel, and I were unfamiliar with it both in theory and in practice. We trusted Jason as the curricular "expert," and after listening to Jason's description of the jigsaw, we all agreed that it would serve our needs well as a pedagogical strategy.

Once we had chosen the jigsaw model, we needed to refine the structure of the research design. As mentioned previously, not all the groups of students had received classroom instruction in the science curriculum unit. During our deliberations, we decided that we would test not only the factor of classroom instruction, but also the effectiveness of our instructional strategy, the jigsaw. We refined the research design to include an additional control group. Table 2 provides a representation of our design at this stage of the project.
Table 2

Research Design Prior to Second OSC Visit

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Classroom Instruction</th>
<th>First OSC Visit</th>
<th>Second OSC Visit</th>
<th>Post-test Same as Pre-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group</td>
<td>yes</td>
<td>yes</td>
<td>cyclical rotation</td>
<td>Jigsaw</td>
<td>yes</td>
</tr>
<tr>
<td>(2 classes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Group 1</td>
<td>yes</td>
<td>no</td>
<td>cyclical rotation</td>
<td>Jigsaw</td>
<td>yes</td>
</tr>
<tr>
<td>(2 classes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Group 2</td>
<td>yes</td>
<td>yes</td>
<td>cyclical rotation</td>
<td>cyclical rotation</td>
<td>yes</td>
</tr>
<tr>
<td>(1 class)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control 3</td>
<td>yes</td>
<td>yes</td>
<td>no visit</td>
<td>no visit</td>
<td>yes</td>
</tr>
<tr>
<td>(1 class)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Researchers' Divergent Views

We decided to adopt the jigsaw unanimously. However, much later in the course of our research, it became apparent that different members of the research team valued it for different reasons.

During our early discussions of the jigsaw, Jason, Joel and I realized that the jigsaw would marry the teacher-directed structure of the classroom and the student-oriented learning that is more typical of science museums. The jigsaw model contains an element of structure — which is typically a strength of a teacher-directed approach. At the same time, the jigsaw allows for the flexibility of student-directed learning, since it places the responsibility on the students themselves to determine how best to gather the information and convey it effectively to their peers. An additional point of consideration on Jason's part for choosing the jigsaw was his impression that the teachers were familiar with the jigsaw, and that therefore their students would have some experience with it also.

As became clear much later in the project, Suzanne appreciated the jigsaw for other reasons. When Jason first presented the jigsaw, Suzanne
realized the potential of this tool and connected it with Mitchell's (1993)
research on situational interest, her area of specialization. (Suzanne informed
me of this realization at a later date). Mitchell's study was based in part on her
earlier work (Hidi & Baird, 1986). According to Mitchell, "the essence of
catching interest lies in finding ways to stimulate individuals, whereas the
essence of holding interest lies in finding ways to empower students" (Hidi,
that might be able to empower the students and therefore hold their interest
in the material -- factors she wanted to explore.

**Diverse Interactive Roles of Researchers**

One of the critical aspects of our project was to choose a pedagogical
strategy that would combine the best aspects of the classroom and museum
settings. We needed to assess the best means available to attain our desired
ends.

Without much practical teaching experience at the elementary level,
three of the researchers were in a position where we needed to rely on the
fourth, who was the only one of us who was experienced in curriculum
design and implementation: Jason. Even though Suzanne and Joel were by
far the most experienced in research, in this situation they chose to rely on
Jason's skills.

At this stage of our research process, a situation arose that resembles
Weiss's experience of the way his role as a thesis supervisor oscillates
between expert and novice. Weiss (1992) wrote about "diverse interactive
roles of teacher, learner, and knowledge" (p. 5). He argued that in order to
understand the complexities of this interactive situation, one can look at the
roles played in a learning context and recognize that "the potential exists to
oscillate from role to role, both within a particular learning engagement as
well as from situation to situation" (p. 5). He supplied examples from his
teaching experience to illustrate the oscillation: "In my work with thesis
students, there are areas where I am the expert, but equally there are areas, especially over time, where the student is more expert and I the novice, and times when we act as co-learners trying to co-create knowledge and the context for such creation” (Weiss, 1992, p. 6).

This oscillation of roles corresponds in many ways to what occurred during our research project. The project required different types of knowledge, and different team members possessed the necessary knowledge at different times. For example, we needed statistical knowledge in order to structure the analysis of the data. We needed curricular expertise to assemble the instructional materials. We needed specific information about school-based conditions experienced by the teachers. No one single person had all of these different types of knowledge. We respected one another’s information, skills, and expertise.

**Adapting the Jigsaw Model to Our Research**

Once we had chosen the jigsaw model as our instructional strategy, we needed to select and allocate students across jigsaw groups so that gender, ability, ESL, and behavioural issues would be balanced. This task was necessary to meet the statistical demands of our experimental design.

We therefore asked the teachers to structure their students into expert and sharing groups according to our criteria, and in their hesitancy we recognized their inexperience with the implementation of a jigsaw. Subsequently, it became clear that they had only a superficial theoretical acquaintance with the idea. When we began to understand that neither the teachers nor their students had any practical experience with the jigsaw, we recognized an unanticipated and inconvenient situation.

As a result, we took on numerous additional tasks in order to make the jigsaw effective within the context of a research study. First of all, we needed to provide extra support for the students. Since the students had never used the jigsaw before, we had to teach them how this strategy operated, to ensure
that their learning of science concepts would not be inhibited by their unfamiliarity with this instructional strategy. We also decided to supply them with photocopies of the OSC texts accompanying the exhibits we had chosen.

Meanwhile, we had to attend to other, more specialized needs of our experimental design. First, we needed to balance the jigsaw groups (as described above), as well as the students within the cyclical rotation Control Group, using information about their abilities, etc., supplied by their teachers. Second, we needed to ensure that the data collection would be carried out properly while the jigsaw groups were in action. Since we had a number of small groups of students, we needed more adults in addition to the research team for this task. At this point, we made the decision to hire auxiliary researchers for the data collection, leaving the teachers responsible only for the tasks surrounding practical administrative details and basic supervision of the students. The rationale for our decision to hire new researchers was largely a function of our need to accommodate our research design. We needed to feel confident that the people who would be collecting data would have the necessary skills for this task. Given that the three science teachers did not have specialized training in this area, it seemed sensible to hire graduate students from OISE for the data collection component.

**Learning in the Novel Research Situation**

In choosing to adopt the jigsaw technique, our research team was learning from Jason; however, there was a limit to what the other researchers could learn from him. Jason had experience with the jigsaw -- but in the context of a classroom setting with students who were familiar to him. Although Joel and Suzanne had considerable research experience within the OSC, they had no experience with the jigsaw. The situation was novel for everyone because no one had ever experienced this combination of elements before -- that is to say, the pedagogical tool of the jigsaw within this context of a research project. Therefore there was an element of indeterminacy
introduced into our process by the adoption of the jigsaw for our research purposes. None of the four researchers could predict accurately how the jigsaw would work in our specific circumstances. Thus, at this stage we collectively learned about the practical implementation of a jigsaw within the challenging specifics of our particular project.

As a group, what we learned in this particular phase was just how complicated it was to make the jigsaw work within our project -- specifically, within our particular project design, within the particular setting of the OSC, and with our particular student population, a majority of whom had ESL status. In order to accommodate the jigsaw to our quantitative research design, we were faced with considerable additional work.

I believe that when carrying out research, an inquirer is generally involved in a 'novel' undertaking, where one may not predict with total accuracy how things will unfold. Survival in the indeterminate process of research may require creativity and improvising -- seeing what is out there and making decisions and taking action. Gilbert Ryle, in The Concept of Mind (1949), makes a distinction between "doing something by pure or blind habit" and learning. Unlike the adult walking on pavement, a mountaineer walking over ice-covered rocks in a high wind in the dark does not move his limbs by blind habit; he thinks what he is doing, he is ready for emergencies, he economizes in effort, he makes tests and experiments; in short he walks with some degree of skill and judgement. If he makes a mistake, he is inclined not to repeat it, and if he finds a new trick effective he is inclined to continue to use it and to improve on it. He is concomitantly walking and teaching himself how to walk in conditions of this sort.

Ryle's mountaineer, learning as he goes, is deliberating in a way that is analogous to the process Schwab (1969) describes -- a process that treats means and ends as mutually determining one another. In other words, Ryle's mountaineer must assess each placement of his foot, taking into account the specifics of one part of the terrain as well as his own capacity (means) before he can take the next step forward (ends). In much the same way, our research
team needed to assess the terrain, as well as our own abilities, before we could take the next step.

While Ryle's example treats learning as a solitary enterprise, his description of the process suits the interactive learning of our research team, operating in the constantly changing, unpredictable context of implementing our research project. We were concomitantly carrying out research and teaching ourselves how to do it "in conditions of this sort." Our research team was like the mountaineer who, with the same destination in mind (end), has several options (means) -- to ford a stream or climb an escarpment. But once he has made his choice, he has committed himself to a certain terrain and must now deal with the specific challenges it presents. Similarly, we could have chosen from several pedagogical strategies (means) in order to achieve the integration of the two learning settings (end). However, once we had adopted the jigsaw, we had committed ourselves to a certain set of new challenges.

Theoretically, the option existed to scrap the jigsaw structure altogether. In practical terms, we were not able to turn around and undo the decision to use the jigsaw. We did not have enough time to develop a different instructional strategy that would cover as many of our criteria for integration as did the jigsaw. We never even considered this option. We were only now beginning to understand the level of difficulty that this strategy presented, given our circumstances.

Ideally, we would have taken the students through a "dry run" of the jigsaw model, using material with which they were already familiar. However, because we lacked sufficient time, only a scaled-down jigsaw workshop was provided for the students, in the classroom setting.

We were limited in our ability to predict the practical usefulness of the jigsaw because of certain limitations in the backgrounds of the research team members. Jason provided a teacher's perspective on the use of the jigsaw structure, free of the demands of an experimental design. One of his main points was that our workload surrounding the use of the jigsaw would not
have been so cumbersome without the demands of our research design. He commented that in his own teaching practice, he was free to use semi-random groups, without the careful balancing of various factors that were required for the purposes of our statistical analysis. In his classroom teaching, Jason had been free to re-group his students many times. In addition, he had been able to go through the jigsaw with the students repeatedly, allowing them to learn "the ropes" of this strategy. For example, if students chose not to learn the concepts during the "expert" stage, they soon discovered they would face the consequences in the "sharing" stage. He stated that our students did not have the opportunity to gain this understanding before engaging in the jigsaw.

It is important to consider how practical the jigsaw actually was within our research design. Ideally, in theory and in teaching practice, according to the aims of our project, the jigsaw seemed an excellent choice, in terms of providing the integration of the two different setting. However, within the realities of our situation, i.e. working with teachers and students (who were inexperienced with the jigsaw) within the confines of an experimental design and given the time and money restrictions of the project, the jigsaw complicated the research and added a huge burden of work. The human factor in terms of the teachers' and students' inexperience with the jigsaw was a "curve ball:" this situation was a divergence from what we had anticipated.

**Researchers' Divergent Views Interacting with the Research Process**

While we were engaged in the additional tasks that we had undertaken in an effort to make the jigsaw serve our needs, an interesting divergence of views among the members of our research team emerged. This divergence became clear while we were developing a form to help the students gather and share the information to which they would be exposed while participating in the jigsaw. This unexpected difference of opinion became evident while we were discussing the layout of this student form. Suzanne
wanted lines on the page, to be filled in by the students in response to a specific directive. Jason argued that an unlined space would allow students to draw diagrams, to move the page sideways, etc. -- that is to say, to be creative with their responses. In the end, the forms were set aside.

Our discussions revealed that within our research team there existed two substantially different preferences for student learning. Jason’s argument in favour of an unlined space was related to his strong preference for student-directed learning. Flexibility in the form would allow students to express their own individual learning aptitude or style. In contrast, Suzanne saw the need for guiding the students through a series of stages -- where to start, how to proceed -- in order to help them gather and share the science concepts underlying the exhibits.

It was evident that both researchers, Suzanne and Jason, were interested in helping students learn science concepts. Suzanne’s concern was to provide the students with structure to enable their learning, while Jason championed student-directed learning consistently throughout the project. In addition, Suzanne’s experience as a researcher probably influenced her preferences. She was alert to the potential use of this form as a tool for data collection, in addition to its purpose as a student aid. For this reason, she wished to design a form that would elicit clear, fairly consistent, and easy-to-code responses from the students.

Our experience working on the student forms is one illustration of the impact of the researchers’ divergent views on our research process. In addition, this situation was typical of how we as researchers argued our positions regarding the degree of student-directed, as opposed to teacher-directed, learning that would be included throughout the project.

Although it was not clear at the time, much later it became evident to me that the different concerns were indicative of different interpretations held by the researchers of our goal of combining the classroom and science museum settings. Some members of the research team understood this goal to entail a straightforward joining of the benefits of the two settings. From
this perspective, we would utilize the motivating and interest-generating power of the sensory, three-dimensional exhibits at the OSC, but in addition we would provide the students with outcomes-based instruction that would guide their learning of the science concepts. Other members of the research team came to understand the goal of combining the two learning settings principally to mean an integration of two learning styles -- teacher-directed and student-directed learning.

**Adopting the Jigsaw: Effects on the Project**

To conclude this chapter, in the novel situation that was our research project, the jigsaw strategy introduced unforeseen factors that had an impact on both our project objectives and our day-to-day practical work. What began as a project that attempted to include a large teacher-participatory component was continuing to evolve progressively into a researcher-dominated project. At earlier stages of the research project, we were still trying to involve the teachers in the development or selection of pedagogical materials and strategies. Now that we had adopted the jigsaw, we had new concerns surrounding data collection. In order to address these, we realized we needed to hire additional researchers, relegating the three science teachers to a purely supervisory role on our trips to the OSC.

In terms of practical considerations, the adoption of the jigsaw introduced considerable indeterminacy into our work, since we could not fully predict how the adoption of this instructional tool would affect the research process. Several areas were liable to be affected: the students' motivation and learning, and thus also our testing results; our workload, in terms of many new tasks, which in turn took time away from other research-related work.

In this chapter, I have explored how the various teachers shaped classroom instruction and how the researchers' ideas influenced certain research decisions. In addition I have also investigated learning in our novel attempt to adapt the jigsaw to our research needs. In the following chapter, I
will discuss the emergent nature of our research process as our research team continued to prepare for the second visit to the OSC.
Chapter 7: The Emergent Research Process

The events in this chapter provide an opportunity to explore the emergent, task-related nature of our research practice. Once again, indeterminacy was a significant factor while we were in the midst of our preparations for the second visit to the OSC. This visit was the critical one, since we were going to put our jigsaw into action as an instructional strategy. I discuss the researchers' different perspectives on researcher protocol, and the implications of these for our research practice. My analysis of the unfolding events reveals that the practical research tasks were driving the research process to a large extent. This chapter incorporates subjectivity, indeterminacy, and learning as inter-related aspects of the emergent research process.

Indeterminacy and the Emergent Process

Once we were in the process of completing the adaptation of the jigsaw to our research situation, we scheduled the students' second visit to the OSC for February 20 and 21. However, we subsequently learned that a large proportion of the student population would be absent on these days because they coincided with the beginning of Ramadan, a major Muslim holiday. Therefore we decided to re-schedule the second visit to the OSC for two weeks later.

A couple of days before the newly re-scheduled second visit, we were informed that the OSC was being picketed as a result of a province-wide attempt to protest government cut-backs. The trip would have to be postponed until the strike was settled. We were unable to re-schedule our second visit, since we had no way of knowing how long the strike would continue.

We were aware that the strike could prove to be extremely problematic, since the students were in the midst of the research process when our schedule was disrupted. By now we had administered the pre-test to establish a baseline of the students' general knowledge of gravity, and the students in
the instructional groups had completed learning about this topic in their science classrooms via our curriculum unit. In addition, the students' first visit to the OSC had taken place as planned in January.

Finally, the strike was resolved and we scheduled the second visit for April 23 and 24, a full two months later. We intended to administer a post-test to the students after their second visit. Because of the unexpected lapse of time, we decided to look for ways of minimizing the effects on students' memory of the interruptions and delays. Accordingly, we asked the teachers to refresh the students' knowledge of gravity in their science classrooms before the second visit to the OSC.

The Effects of the Unexpected Events

The social context of our research project is prominent in the foregoing events. Personal and political factors combined to have a distinct impact on our process at this stage. We were faced with the results of the students' religious affiliation, on the one hand, and with the political turmoil of the province of Ontario, on the other. As a result, our situation within the research project became an indeterminate one in which we could not predict the future of our project nor fully manage practical aspects of our work.

The cumulative effect of the interruptions and obstacles was to increase the distance in time between the classroom instruction in the gravity unit, and in the jigsaw technique, and the second visit to the OSC. There was now a distance of two months between these two, thereby potentially compromising the students' ability to learn effectively. This element would add to the already potentially overwhelming load on the largely ESL students of an unfamiliar instructional strategy (the jigsaw) and the complexity of the concepts underlying gravity (a theme developed in accordance with the science guidelines of a different board of education). The cumulative effect of all these factors could have compromised our statistical research findings. As a result, we had to find effective strategies for "damage control."
Meanwhile, we were aware that these interruptions condensed the time available for the complex analysis of the results and for the writing of papers based on the project.

**Working through Research Tasks**

In the circumstances, however, the strike was to some extent a mixed blessing. We now had extra time to work through unfinished tasks surrounding the second visit. Heavy resources had to be allocated to the mechanics of actualizing the project. Because of the workload, different tasks were allocated according to individual strengths and skills among the four principal researchers.

By this time in our research process we had determined that the Experimental group consisted of students who had received classroom instruction in the gravity curriculum unit and who were to participate in the jigsaw. Control Group 1 was made up of students who had not received classroom instruction but who were to participate in the jigsaw. Control Group 2 consisted of students who had received classroom instruction and would be involved in a simple cyclical rotation of the exhibits. And the students in Control Group 3 had received classroom instruction, but were not taken on any visits to the OSC.

We had a research design that required the researchers to follow a different set of procedures depending on whether they were working with a jigsaw or a cyclical rotation group and a tight time schedule in which to move a number of small student groups through select exhibits distributed across several different exhibition areas at the OSC. Given all of these factors, I felt that the researchers -- both our team members and the new, recently hired researchers -- needed to know exactly what to do moment by moment while the visit was underway. I therefore decided to prepare a detailed agenda outlining researcher protocol at the OSC. In the process of developing the agenda, I was discovering new, previously neglected areas that required further deliberation and decision-making on the part of our research team.
It was only at this point in our research process that I felt we needed to clearly identify the specific science concepts that we wished to target within the exhibits. Although, at least implicitly, we had been considering target concepts when we selected the exhibits, we had never formally agreed on these concepts nor had we written them down. Even though I felt it was critical to develop these target concepts, I did not at the time reflect on why.

**My Assumptions**

An analysis of my reasons to develop target concepts reveals that I held certain tacit assumptions surrounding our intention to test the students' knowledge after the completion of the second OSC visit. At the time of the OISE project, I held a number of general assumptions about how our process of testing would proceed. I believed that we would be testing the students on their comprehension of certain specific concepts underlying gravity. I reasoned that we needed to identify these concepts in advance of taking students to the science museum. Since we were going to test for these concepts in our post-test questions, we needed to ensure that students had an opportunity to learn these concepts while at the OSC.

I was concerned that students may not get the opportunity to learn these specific concepts because gravity-related concepts were not always the major and obvious elements of the OSC exhibits we had selected. Therefore, it was quite possible that students might focus on concepts unrelated to gravity. Most OSC exhibits have a substantial amount of text accompanying them, covering various science concepts related to the exhibit. Some exhibits are large and consist of several components on which students might choose to focus. Knowing that our results depended on our future statistical evaluation of the students' understanding, I felt strongly that it was crucial for us to determine the concepts to be tested later. In other words, some focusing of the exhibit material would be necessary if we were to satisfy the demands of our research design.
In addition to this concern of narrowing the scope of some of the exhibits, I was also concerned with the instruction that the students would potentially receive at the OSC. At the time I was preparing the agenda, I believed that the student groups whom we referred to as "instructional" (i.e., they had received classroom instruction in our gravity unit) would also receive instruction during their visit to the OSC exhibits. My assumption was created partly by our use of the label "instructional groups"; this term could be interpreted as meaning that students in these groups would receive instruction in all research settings. Had we labeled these groups more cumbersomely, but more accurately, as "the groups who had received classroom instruction," we would have removed the ambiguity. If, as I assumed, the researchers were going to instruct in the "instructional groups," then they needed to know which concepts to teach. In my desire to develop target concepts, I was trying to make sure that when instruction occurred, each researcher would focus on the same points.

The Research Team Responds to the Issue of Target Concepts

At the time, I was puzzled to find that none of the other researchers had seen the need for developing target concepts, whereas I felt strongly that it was critical to our study. When I presented the idea of developing these concepts to the research team, there was a mixed response. Suzanne readily agreed that it was necessary. Jason and Joel, while not objecting, did not seem particularly concerned. Jason and I went about the task of selecting target science concepts underlying the exhibits we had chosen. We then deliberated together on how to communicate these target concepts to the rest of the research team and to the new researchers. Jason felt that simply providing the researchers with an information sheet at the meeting would be sufficient, since most of the researchers had substantial science training.

I wanted to talk through the target concepts with the researchers at the meeting we had already scheduled for informing them of the jigsaw
technique and practical matters surrounding the visit to the OSC. I wanted to ensure that none of the researchers would fail to give sufficient attention to the information sheet, and to make sure that if any unforeseen interpretive problems existed, we discovered them at this point, rather than later.

In the end, we decided to follow Jason's plan, since providing the researchers with a sheet of target concept seemed already enough of a compromise.

**Subjectivity: Researcher Behavior Suggests Underlying Assumptions**

The various responses of the team members indicate that the members of our research team were working with different ideas about instruction and testing. Joel's and especially Jason's lack of concern about developing and conveying target concepts to our recently hired researchers suggested that they did not share my assumptions about the issues of testing and uniformity of instruction. Suzanne's ready acceptance of my suggestion regarding target concepts indicates that her assumptions may have been more consistent with mine.

**Deliberating About Researcher Protocol During Data Collection**

I had raised the issue of instruction during our research team meetings. Specifically, I felt we needed to decide how the researchers should handle instruction within the jigsaw and cyclical rotation groups containing students who had received classroom instruction. This issue had not yet been resolved at the time of our arrival at the OSC on the day of the second visit. In our previous meetings, we had been addressing major conceptual issues pertaining to data collection, at the same time that we had to tackle a host of practical details. In particular, we needed to design a data collection form for the researchers.

During our deliberation at the OSC that day, Suzanne emphasized that she saw a clear necessity for the students in the so-called instructional groups
(who had received classroom instruction in the gravity curriculum unit) -- both those participating in the jigsaw and those involved in a simple cyclical rotation -- to receive additional instruction from the researchers while exploring the exhibits at the OSC. This position seemed logical to me given my understanding of testing in an experimental research design. Suzanne seemed concerned with the effects the complex learning setting (i.e. jigsaw within a science museum) and the conceptual difficulty of the science concepts would have on the learning and motivation of the students. She probably felt it was important that we provide instruction (in the "instructional groups") to help orient students in the development of their understanding of the complex science phenomena. Suzanne also expressed her belief that this strategy was necessary to meet the statistical requirements of our study.

Both Jason and Joel disagreed about the need to instruct our "instructional groups" at the OSC. Joel had a different interpretation of the criteria for statistical analysis and he felt that instruction at the OSC was not essential. Jason, as usual, was arguing in favour of retaining the freedom and flexibility that the jigsaw technique could provide students. Although he did not use the term "student-directed," his comments were consistent with this approach. Jason argued that in a jigsaw, students are supposed to have the freedom to learn what they are ready to learn, or find engaging, and may choose their own way of learning and sharing. Within a jigsaw, Jason argued, the adult is serving as a resource person for the students as opposed to teaching them, and therefore should not be engaged in direct instruction.

Both Jason and Joel argued that by providing additional instruction at the OSC for the groups of classroom-instructed students, we would be compromising our results; that is, we would end by creating "flattened" statistics. If students in Control Group 2 (who had received classroom instruction and were about to do a cyclical rotation instead of a jigsaw) also received instruction, as did their classroom-instructed peers in the jigsaw
groups, it would be difficult to determine whether or not the opportunity to participate in the jigsaw made a difference in their learning experience.

Since teachers and students were waiting for us, there was an urgent need to make a decision about instruction. Our heated deliberation ended in a compromise: in the groups consisting of classroom-instructed students, researchers would engage in direct instruction only if the students could not adequately carry out the information sharing of the target concepts. In groups consisting of uninstructed students (those who had not received classroom instruction in the gravity unit), the researchers were to remain as neutral observers, regardless of what happened in terms of the students' learning. Table 3 illustrates the research design at this stage of our research process.

Table 3

<table>
<thead>
<tr>
<th>Study</th>
<th>Classroom Instruction</th>
<th>First OSC Visit</th>
<th>Second OSC Visit</th>
<th>Instruction at OSC</th>
<th>Post-test Same as Pre-test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experimental Group (2 classes)</strong></td>
<td>yes</td>
<td>yes</td>
<td>cyclical rotation</td>
<td>Jigsaw</td>
<td>yes</td>
</tr>
<tr>
<td><strong>Control Group 1 (2 classes)</strong></td>
<td>yes</td>
<td>no</td>
<td>cyclical rotation</td>
<td>Jigsaw</td>
<td>no</td>
</tr>
<tr>
<td><strong>Control Group 2 (1 class)</strong></td>
<td>yes</td>
<td>yes</td>
<td>cyclical rotation</td>
<td>cyclical rotation</td>
<td>yes</td>
</tr>
<tr>
<td><strong>Control 3 (1 class)</strong></td>
<td>yes</td>
<td>yes</td>
<td>no visit</td>
<td>no visit</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Researchers' Conflicting Views

The deliberations described above can be regarded as the culmination of opposing positions among the members of our research team. The difference
of opinion was present from the beginning of the OISE project, but the issue of on-site instruction served to bring it into prominence.

Throughout the project, Suzanne consistently supported an outcomes-based approach. In our deliberations, Joel generally seemed to be less concerned with the outcomes-based aspect of our study than Suzanne was, and he also seemed clearly interested in providing a degree of student-directed learning. Jason strongly argued for a degree of student-directed learning, expressing his belief that it is more important for students to use their own judgement, and to be critical, than it is for them to learn "facts." In other words, his position can be viewed as the polar opposite of an outcomes-based approach. I straddled both realms. As mentioned earlier, I am keenly interested in student-directed learning, but at the same time, during the OISE project I was governed by the needs of our experimental design, as I understood them.

Our discussions surrounding the selection of target concepts and on-site instruction brought to the fore the different views of the members of our research team. However, it was the issue of whether or not to adopt instruction at the OSC that sharpened the opposing positions of the four researchers.

Suzanne felt that if no on-site instruction occurred, students' learning would be jeopardized and the resulting statistical analysis would be compromised. Suzanne's view of statistical rigour was an interpretation not shared by Joel. Meanwhile, Jason saw the ramifications of on-site instruction as modifying our initial project goal of integrating the two learning settings, since he interpreted this goal as including an integration of learning styles - that is to say, direct instruction as in a classroom versus student-directed learning at the OSC. Jason's intention in selecting the jigsaw model was to bridge these two approaches, and he felt that the addition of direct instruction within the jigsaw would shift the balance.

At the time of the crucial decision-making meeting, our ability to reflect on our deliberations was limited by the pressure of the circumstances, as
described above. The interest that Suzanne and I had in determining target concepts and using on-site instruction stemmed from our shared concern to meet what we felt were the needs of students and the requirements of our experimental design. At the time, I did not perceive these strategies as affecting the students' learning experience in a way that would potentially compromise what I understood to be our stated project goal of integrating two different learning settings. Even though our intention was not to suppress the non-structured components of the students' learning experience, in retrospect, I realize that we were inadvertently, through the modification of the jigsaw with instruction, supporting this trend.

**Additional Indeterminacy Resulting from Our Compromise**

The outcome of our heated deliberation was a compromise: the researchers would instruct, in the "instructional groups" -- but only if they saw that the students were experiencing difficulties in learning or conveying the target concepts. This solution embraced a modified version of Jason's view of the researcher as a resource person who does not intervene; however, our solution also provided some control over the students' learning of the concepts.

By adopting this strategy, we introduced a degree of indeterminacy into our research process. Unavoidably the researchers would need to apply personal judgement and interpretation to our directions, since they were being told to step in and instruct only when the students appeared to be in need of help in gaining an understanding of the target concepts. It is likely that the researchers would differ in their estimate of when students needed assistance, how to give it, and how much assistance to give.

**Tasks Drive the Research Process**

The preceding discussion "begs the question" of why our research team left the issue of on-site instruction literally to the last minute. A number of
factors may lie behind this situation. The most significant was our inability to see the issue as an issue that needed to be resolved until we had reached this moment in time.

Given Jason's and Joel's behaviour during our deliberations, it seems likely that they assumed no instruction would be taking place within the jigsaw and cyclical rotation groups. On the other hand, I, and most likely Suzanne also, had been operating on the assumption that the "instructional groups" would receive instruction. All of the members of our research team were probably working under the impression that we shared the same assumptions about on-site instruction. Thus, no one saw it as a problem that needed to be resolved.

Furthermore, the amount of work involved in organizing this second OSC visit had kept the researchers thoroughly occupied and their focus was elsewhere. The additional work was the cumulative effect of adopting the jigsaw within the novel research situation, the altered research time line, and the ESL status of the students. In the midst of numerous tasks and many complex details that needed attention, our assumptions about the issue of instruction were left unexamined until circumstances forced them out into the open.

In the meantime, however, my task of developing the researcher protocol helped me to identify the need to attend to this question; yet, when I raised this issue at an earlier meeting it was not resolved. In retrospect, I suspect that there were at least two major reasons for our delay in resolving this issue of instruction at the OSC. First, it is likely that this issue was less significant to my researcher colleagues than it was to me, since they had not been involved in the specific circumstances of working out the details of the researcher protocol. Hence they were probably not as attuned to its import as I was. Second, because the members of our team held strong attachments to different views of research practice, our deliberations did not lead to a resolution until the pressure of circumstances absolutely forced us to resolve the issue.
In the foregoing events, to a large extent the practical work was driving the research process. For example, it was only when we were approaching the time at which a post-test would be administered that I realized we needed to resolve the issue of on-site instruction for the sake of the evaluation component of the experimental research design. At the time I was surprised that I needed to take the initiative for a research design issue. In retrospect it is clear to me that carrying out a research task often creates the awareness of an uncompleted element, as in this case.

The foregoing events represented a major learning episode for me. I had assumed that Suzanne and Joel, as principal investigators and experienced researchers, would consistently be the "experts" -- that is to say, I felt they would know what to do and how to do it ahead of time. Although they were responsible for major decisions affecting the research process, they delegated many research tasks to Jason and me. As a result, Suzanne and Joel were at times unaware of certain practical steps that needed to be taken -- steps that became apparent only when one was working within the specific circumstances of the tasks. It seemed that the nature of the research process itself -- the interaction between researcher and task -- was creating this situation, not a lack of knowledge on the part of any researcher. In other words, even very experienced researchers were necessarily learners.

As the foregoing events clearly demonstrate, many of the researchers' crucial tasks were not predetermined in this study, as I originally assumed. The researchers often had to identify the tasks while in the midst of specific circumstances. This proved to be the case even within the confines of a research time line and a predetermined pre-test, post-test structure. Although certain tasks were set in advance, as a result of the research design, our research team was largely proceeding step by step, learning through the actual tasks themselves, as these grew out of tasks and resolutions that had come before. This situation highlights the emergent nature our research process.
Conducting the Jigsaw

Once the compromise position on instruction had been created by our research team, we faced a complex practical situation. Researchers struggled to fulfill their roles as instructors and data collectors. A considerable amount of work was involved simply in running the jigsaw in a setting as large and complex as the OSC. Because the jigsaw groups worked across exhibition areas, the researchers and students had to be very faithful to the time schedule. Another large complication involved the re-grouping of the students. Organizing the students was particularly difficult for the researchers because they were unfamiliar with the students.

Not only did the researchers have to manage the above practical challenges and collect data, but they also had to follow different procedures for different groups of students. In the "instructional groups," they were expected to make a decision about whether or not to intervene and help the students learn the concepts. Thus, in these groups, they had to play the dual role of teacher/data collector. Each researcher was dealing with five or six students at a time.

Although there were exceptions, in general, the students in the Experimental Group seemed to respond well to the jigsaw strategy. This group consisted of students who had received classroom instruction in the gravity curriculum unit and who participated in the jigsaw. During the sharing phase of the jigsaw, most students were able to convey aspects of the science concepts to their peers. Some needed help from the researcher.

Generally speaking, the experience of the students in Control Group 1 seemed to be similar to that of those in the Experimental Group. Control Group 1 consisted of students who had not received classroom instruction but who participated in the jigsaw.

Control Group 2 consisted of students who had received classroom instruction and were involved in a simple cyclical rotation of the exhibits.
These students seemed less focused than their jigsaw peers, and therefore the researchers often stepped in and provided instruction.\(^5\)

Despite all our preparations aimed at a uniform procedure, a few researchers departed somewhat from our chosen target science concepts. According to Jason, who documented the visits on videotape, the individual researchers varied in their approach to their interaction with students at the exhibits. For example, at one exhibit where researchers were supposed to focus on the link between gravity and potential energy, some researchers chose to emphasize the quality of the two landing surfaces (rubber and metal). In addition, at another exhibit, which was rich in folklore about the moon from different cultures, one researcher chose to focus on legends about werewolves as non-scientific lore, rather than focusing on the moon's effects on the tides, which was a target concept at this exhibit. In the "noninstructional" groups, where the researchers were supposed to act as objective observers and refrain from active instruction, a number of researchers (notably Jason) felt and acted upon their moral sense of obligation to teach the students when they appeared to be struggling with their comprehension of the concepts. The completion of the data collection for this second visit to the OSC covered two days.

Most of the researchers felt that the jigsaw succeeded in focusing the students' attention and that it appeared to motivate them to learn the material and to share the information with their peers. The researchers also observed that the cyclical rotation strategy, which involved little direction, seemed to be much less successful at enabling students to learn the concepts on their own.

\(^5\) Control Group 3 received classroom instruction but did not go to the OSC and therefore is not discussed here.
Subjectivity: Researcher Behaviour

The researcher factor introduced some variability into the data collection. Given the novelty of conducting the jigsaw within the OSC, with a group of students unfamiliar to the researchers, and with complex procedures for instruction only recently altered, the researchers were labouring under a heavy load. It is not surprising that certain researchers departed from the procedural criteria laid out for them. The data collection may have been compromised by the complexity of the researchers' many simultaneously performed tasks. For example, the researchers' ability to collect data about the students' interaction with the exhibits and with their peers may have been compromised by the need to perform the role of teacher in the "instructional" groups.

Furthermore, our decision to instruct the students in groups that had previously received classroom instruction (the "instructional" groups) meant that Control Group 2 probably ended up with additional instruction at the exhibits. Because students in Control Group 2 did not have the benefit of the jigsaw, it would have been reasonable to expect that they may have done less well than the students involved in the jigsaw. However, since the students in the cyclical rotation were less focused than their jigsaw peers, it was more likely that the researchers would have stepped in and instructed with this group. The quality of the instruction received by Control Group 2 therefore was probably higher than the "teaching" provided by student Experts in the jigsaw groups.

In this chapter, I have focused on the ways that the project emerged over time. More specifically, I investigated how we progressively developed some of our procedures and our research design as we worked through the research tasks. The manner in which we approached these tasks reflected our individual assumptions (e.g., the integration of the two settings, the best way to support student learning, statistical rigour, etc.) and hence, researcher subjectivity was particularly important at this stage of our study.
In the next chapter, I will investigate indeterminacy and our process of testing the students’ knowledge of certain science concepts.
Chapter 8: Indeterminacy and Assessment

Because assessment is a crucial aspect of the research endeavour, an analysis of our assessment procedures and tools is in order. In this thesis, I use the term assessment to refer to the testing of students in order to obtain measures of their affective and cognitive gains. In our project, we needed to determine what information the students had acquired during the OISE research project, how much they had enjoyed the experience, and whether their enjoyment had affected their learning.

In the OISE project, our results were largely dependent on the questions we developed. We composed five questions that served both as a pre-test and as a component of our post-test; I will refer to these as the pre/post test questions. The post-test also included exhibit-specific multiple-choice questions and a narrative question. Our questions varied in the degree to which they produced statistically significant results in assessing the students' learning (see Hidi, Weiss, Berndorff, and Nolan, 1998). An analysis of the questions and of the process involved in creating them reveals that substantial elements of indeterminacy were involved in our assessment of the students' learning within the OISE project.

Development of the Pre/Post Test Questions

At the beginning of the project, we needed to create questions that would enable us to acquire a baseline of students' general knowledge of gravity. We intended to include these same questions as part of our post-test at the end of the project in order to measure an anticipated cognitive gain.

At the time the first five questions were written, in the fall of 1995, we had not yet finalized our choice of exhibits, nor had we developed the curriculum unit for the classroom study of gravity. Because of these factors, we could only develop questions based on the information we had at the time -- the objectives of our project proposal, our chosen theme of gravity, and the fifteen exhibits we had studied. Because of his experience in classroom teaching and curriculum development, Jason was given primary
responsibility for developing the questions. (For the completed pre/post test questions, see Appendix B).

After the students had written their responses to the questions, Jason and I developed a coding scheme with which to evaluate students' answers. We worked out the scheme by looking at the students' responses in light of our need to rank these in terms of their conceptual level and accuracy. The process of developing the coding scheme clarified some problems with the questions.

**Elements of Indeterminacy in Developing the Pre/Post-test Questions**

There was an element of indeterminacy built into the creation of our pre/post-test questions. At the time the pre/post test questions were written -- an early stage of the OISE project -- we had not yet developed our curriculum program. We therefore could not predict precisely which concepts would finally be taught and learned.

Even when teachers or researchers have completed their development of curricular materials, the task of creating test questions may contain elements of indeterminacy. It may be impossible to know in advance how students are going to respond to questions; more specifically, what range of answers students are going to generate, and where misunderstandings and difficulties are going to occur. In an interview in June, 1996, Jason remarked: "A lot of teachers will go out and write a test . . . they'll give the test, then realize they've just confused the hell out of the students." This situation illustrates the indeterminacy that may permeate the task of writing tests.

Jason and I were able to further our co-learning about creating tests through the process of developing the coding scheme and through subsequent discussions about our research practice in June, 1996. Jason realized that only after the project was completed had he acquired the knowledge he needed to write the best possible test for our specific student population. He acknowledged the shortcomings of the test and attributed
these to his lack of familiarity with the students and their level of language difficulty. Looking back, he realized that he had made the questions too dense: "The questions were too compacted, too complex. I would have broken down each of those questions into maybe three questions, so they could elicit the response."

**Indeterminacy Resulting from Complexity in Science**

Another problem with the development of the pre/post test that Jason and I discussed pertained to the complexity of scientific phenomena. Science concepts rarely occur in isolation, but are inter-related in their actions and effects with other concepts. As a result, it is possible that one will create a misleading or incomplete picture of a given concept when attempting to teach (or test) it in isolation from other concepts or phenomena.

My discussion with Jason about Question #2 serves as an example of the way the complexity of scientific phenomena can introduce indeterminacy into the assessment process. We had worded Question #2 as follows: "How does gravity influence the waves and tides?" The answer we sought concerned the gravitational influence of the Moon. However, there are many gravitational sources affecting tides. The Earth's gravitational field has a major influence on the oceans and therefore on the waves and tides. The Sun also has an influence on tides. Despite this complex situation, our question did nothing to invite the students to focus on the Moon.

During the course of my interview with Jason in June, 1996, after the OISE project was completed, we spent several minutes clarifying the true situation involving the tides and gravity before we could begin to imagine a better way to ask the question. Jason was looking for a way to compose the question so that it would not misrepresent the phenomena. Jason said: "Okay, as we work through it, it would be: 'which gravity source has the greatest influence on the tides?' or, 'which gravitational interaction has the greatest influence?', or, 'rank the amount of influence -- is it Earth, Sun, Moon?'...
We're really nit-picking and we should be. . . . This gets back to my original point that all science taught at school is useless because we have to simplify it to the point of being wrong in order to actually communicate it to them."

Although I believe that Jason is overstating his case for dramatic effect, he has identified a valid point: the danger that inheres in the attempt to reduce science concepts to manageable entities for practical purposes. From my perspective, with my concern as to the role of indeterminacy in research, it could be said that Jason was trying to minimize the indeterminacy that arises from asking imprecise questions within the context of science concepts.

Assessing the Students' Learning -- Writing the Post-test Questions

After the students had been on their second OSC visit, we needed to assess their learning by means of a post-test, which we needed to develop. We planned to include the questions from the pre-test. Beyond that, we knew that we needed to test both affective and cognitive gains acquired during the course of the project. A considerable amount of deliberation was spent on the question of how we were going to achieve these goals.

We were by now very conscious of the extent of the students' English language limitations. Furthermore, we had become more appreciative of the complexity underlying the concept of gravity, and we had determined that it was a challenging topic for grade six students.

Developing Exhibit-specific Multiple-choice Questions

The task of writing the multiple-choice questions was exceedingly difficult. Again, although we all contributed to the task of developing the material, in the end Jason did the writing of the final version of the questions (see Appendix C). Jason designed multiple-choice questions, reasoning that this approach would minimize difficulties posed by the students' unsophisticated language skills. Five questions were written, each targeting the science concepts underlying an exhibit.
Indeterminacy in assessing learning in a science museum setting

In an interview (June, 1996), Jason remarked: "I'd rather be getting all my teeth pulled out, one by one, than be writing these [multiple-choice] questions." During the course of this research, I undertook a detailed analysis of the multiple-choice questions to determine why they were so difficult to develop. My analysis suggested that -- particularly in the context of learning within a science museum -- there may be a problematic relationship between science phenomena and a verbal testing format.

To illustrate this point, I have selected a discussion about the underlying challenges of working with language and science that took place between Jason and myself after the completion of the OISE project in June, 1996. Our discussion will also serve as an example of some of the more sophisticated forms of co-learning that can take place during reflection-on-action.

Our discussion was focused on the Dance of the Planets exhibit. This computer simulation models visually the effects of gravity on celestial bodies in a number of situations (including solar systems, binary stars, etc.). The observer can see the trajectory of a moving object, such as a planet, altered by another moving object and vice versa. The effect of mass, distance, and speed can be observed as the objects move and appear to "interact" with one another across the computer screen.

During our discussion in June, Jason and I attempted to explore what type of learning might be experienced by an observer of this exhibit. We wanted to gain a better understanding of the learning experience in order to know more about the challenge of assessment. I told Jason that when I first saw the Dance of the Planets at the OSC, I felt I had an instantaneous, intuitive grasp of the phenomena even though my verbal expression of the experience was limited. Jason responded by saying, "It's a gestalt perception."

During our discussion in June, we attempted to find words to describe this experience. Jason said, "It's almost like a non -- how do you describe it? It's almost like it is non-conceptual. Like a psychic, you recognize something
that cannot be known." From there, he made a distinction between a "perceptual" understanding, as when a person is able to grasp in an instant, intuitively, what is involved in a science event or phenomenon, and a "cognitive" understanding, when a person is able to express what he/she understands verbally (or in some other medium). I disagreed with Jason's distinction as it applied to my experience, because I knew, as I told him at the time, that "I understood what was happening at a level that was certainly rational and conceptual." Jason said, "How rational is it if you can't express it?" I replied, "I think it's rational. It's just when you have to put something into words, you have to make it linear." Jason said, "Okay, so you're saying it's not verbal."

I remarked that so much is happening simultaneously in the Dance of the Planets that language fails to capture it fully, since language is linear. Jason agreed that the experience was "too rich" to be adequately handled verbally. Jason linked our discussion to his knowledge of the history of chaos theory and fractal mathematics. He explained to me that some of the concepts were unknown until computers could model them in a visual format. He continued to explain that people did not recognize that there were patterns representing order until a technology existed that could express the patterns visually.

This discussion led to the acknowledgment that the medium of expression affects what we know, and what we can know. Specific media are better suited to express certain relationships. Jason introduced the elegance of mathematical representation through two or more dimensions in graphs. This form of representation is capable of expressing complex interactions over time. I pointed out that the expression of complex phenomena by means of a graph with three axes would not translate easily into verbal form, "because in words it's very difficult to describe the interactions. But [the interactions are] capable of being apprehended visually." Jason agreed that "we can feel it and learn from it without really having a verbal capacity to express it."
As a result of this discussion with Jason, I was able to understand aspects of learning in a science museum that may have contributed to our difficulty with writing the multiple-choice questions. An informal learning setting such as a science museum offers multiple possibilities of interaction with materials, and opportunities to learn in different modalities. It provides models that allow for direct physical engagement and visual comprehension, as well as texts that enable cognitive understanding. Verbal expression is generally not the dominant mode of exploration in science museums. Furthermore, exhibits differ in their complexity and in the ease with which the science concepts can be expressed verbally. The task of writing the questions reflected the conceptual complexity of the exhibits. For example, writing the multiple-choice question for the exhibit called the Balancing Act (perhaps one of the least conceptually difficult of the exhibits) was easier than composing the question for the Dance of the Planets exhibit.

The Dance of the Planets in particular posed a challenge in the development of the exhibit-specific multiple-choice questions. When the members of our research team looked at the computer screen in the Dance of the Planets, we were observing the interactive movements of a number of celestial bodies. As my discussion with Jason suggests, just by looking at the activity on the screen, we may already have learned something at a sensory and/or intuitive level. That is, we may have gained an intuitive understanding of the manner in which the gravitational fields of moving celestial bodies mutually affect their trajectories, without being able to express it in so many words.

It was not until Jason and I were given the task of writing exhibit-specific multiple-choice questions that we were forced to find a precise verbal expression of our knowledge of the science concepts underlying the exhibit. At this point we discovered the peculiar difficulty of such a task.

Our experience suggests that people may learn some science concepts at science museums that they may not be able to put into words. Particularly when the exhibits deal with complex and difficult concepts, language may not
be best suited to the type of intuitive, sensory experiences that characterize visitors' interactions with exhibits. Thus, our team members' attempt to use only words as the medium for testing the students' knowledge may have been problematic, since the students' learning may have been taking place in dimensions other than that of language.

The verbal format of a test question may not be ideally suited to elicit the non-verbal understanding that a student may acquire from interacting with some science museum exhibits. Consequently, using a verbal format may not have provided us with the degree of control we would have liked in attempting to develop ways that would adequately test students' knowledge of the science concepts. Thus, in using only language, we may have introduced some degree of indeterminacy into our assessment process.

**Narrative Question**

The third portion of the post-test consisted of the narrative question designed by Suzanne. The question invited students to demonstrate their affective gains in combination with their cognitive gains in the context of their personal experience at the OSC. The question required a narrative response on the part of the student:

Pretend that you are talking to another person your age. Perhaps this person is your cousin, or neighbor, or friend in another class. Your friend asks you about your visit to the Ontario Science Centre, and wants to know about what it means to be an expert. Write down everything that you can think of about what happened when you became an expert. Write down what you learned. Write down what you felt. Write down what you shared. Write down what you taught. And don't forget to write down which exhibit you became an expert on.

In order to reflect the nature of their experience, the wording of the narrative question given to the students in Control Group 2, who did a cyclical rotation while at the OSC, differed slightly from the one used in the groups who had experienced the jigsaw.
Allowing for Indeterminacy in Student Responses

In my interview with Jason in June (1996), he remarked that the narrative question was "the most important one," and that, furthermore, by giving it to the students, our research team had managed to look at students' experiences at the OSC in "a very rich way."

The discussion that I had with Jason suggested that, in adopting the narrative question, our team was able to integrate aspects of student-directed and teacher-directed learning in our assessment procedures. Achieving a measure of student-directed learning was not explicitly one of the goals of our project as laid out in our proposal. However, over the course of the project, Jason and I came to understand the integration of the learning styles as a worthwhile objective in our efforts to integrate the two learning settings.

Unlike the multiple-choice questions, the narrative question allowed for the student-oriented learning aspect to be accommodated within a quantitative research design. This aspect may have introduced a different degree of indeterminacy into the assessment.

The multiple-choice questions were content-based, aimed at specific correct answers. Content-specific questions focus overwhelmingly on one isolated aspect -- that is, the student's cognitive gain and specifically, whether or not he/she acquired the particular piece of factual information that the teacher intended to impart. It is a teacher-directed approach, geared to meet the teacher's needs for assessment -- in this case, the researcher's need for assessment.

Instead of targeting specific concepts, the narrative question asked more general questions: what did you learn? what did you do? what did you feel? These types of questions respect students' individual learning experiences. However, this freedom of choice introduces indeterminacy into the assessment process. The OSC exhibits present the observer with multiple science concepts, and, in writing their narratives, the students could focus on any of these. As a result, the students' responses to the instruction, "Write
down what you learned", generated a broad range of answers on many different topics within the exhibits. Coding this broad range of topics is a less accurate process than coding the smaller range of answers generated by content-specific questions.

It would appear that there are benefits to be gained and prices to be paid in making decisions concerning assessment in educational research. For example, allowing for student-directed learning introduces indeterminacy because it makes the student responses more difficult to code, whereas reducing the indeterminacy by asking multiple-choice questions may sacrifice the student-directed learning.

I believe that a more complete understanding of the above issues at the time of the OISE project would have changed some of my research practices. Earlier in this thesis I have written about the technical rational concerns I held regarding assessment that drove the development of the target concepts and the desire to instruct in the "instructional" groups. Some of my concerns might have been lessened had I realized earlier that, by adopting a narrative question, we could meet the statistical requirements of the project and simultaneously allow for some of the student-directed learning. I believe that I would not have felt so adamant about ensuring the development of target concepts and providing uniform instruction for the "instructional" groups.

Given what I understand now, I would probably also have taken a different position about some of the research decisions we had been deliberating on. For example, I might have argued differently about how we implemented our jigsaw. More specifically, I would have allowed the students to become "experts" on, and then to "share," any gravity-related concept in the selected exhibits. In this way, I feel that we would have integrated the formal and informal learning settings better, allowing the students to experience more of the freedom of choice that is associated with student-directed learning.
Validity and Generalization

The findings of this thesis raise certain concerns for some of the tenets of quantitative inquiry. On the basis of my deconstruction of the OISE project, it would appear that it may not always be possible to meet one of the criteria of external validity. According to Heron (1996), one such criterion is that the research "must be designed so that it can be replicated by others with similar results thus establishing the reliability of its findings, their consistency or stability" (p. 159).

Although I would argue that our study investigating the integration of formal and informal learning settings produced useful information and might be of assistance to other researchers and educators interested in carrying out similar projects, I believe it would be practically impossible to replicate the OISE project. As I have argued in this thesis, the project was developed within the conditions of a specific research context that involved individual researchers, teachers and students, specific board of education guidelines, and exhibits accessible at a particular science museum. Furthermore, a number of unanticipated events occurred during the course of the project. Given the specificity of all the elements involved, researchers attempting to replicate our procedures at a different science museum would almost certainly not succeed.

Furthermore, such an attempt at the replication of our procedures would probably not make sense in a different research context. The decisions we made were largely a function of choosing the best alternatives for the various research situations in which we found ourselves. Researchers facing a different set of circumstances may decide that different solutions would be more appropriate to the specifics of their research setting.

This is not to say that the results of the OISE project are not important. Certainly we found "significant gains for experimental and control groups 1 and 2. Control group 3 (the class that did not go to the OSC) had no such gains" (Hidi, Weiss, Berndorff, & Nolan, 1998, p. 223). Thus we learned that
visits to the OSC were more critical in terms of the achievement tests than either instruction or the Jigsaw technique" (Hidi et al., 1998, p. 223). In our analysis of the narrative question, we discovered that girls wrote 30% more and produced compositions of higher quality than boys across all groups. We also found that "Whereas the Jigsaw technique did not seem to further improve girls' writing scores, it greatly facilitated the boys' performance" (Hidi et al., 1998, p. 224). Qualitative analysis conducted on the responses to the narrative question demonstrated that "despite the challenging subject matter, many of them [students] had learned a substantial amount about gravity. . . . The results also indicated that students enjoyed the learning aspect of their trips to the OSC" (p. 224). "Perhaps the most interesting findings of this study were the dramatic differences between Jigsaw and no-Jigsaw groups in the emotional quality of children’s experiences, as indicated by the protocols" (p. 224). The results suggest "that participating in a Jigsaw group provided children with a sense of empowerment, and that their interest was elicited as well as maintained through this technique" (p. 225). (See Hidi et al., 1998 for a more detailed discussion of the results).

I believe that the results I have briefly described provide information about various aspects of our project, such as gender differences in science writing, and the effectiveness of the Jigsaw technique for students' learning and motivation. However, given my concerns about replication, I am not convinced that one could, in a statistical sense, generalize from our findings.

Thus I speculate that the type of generalization that one can make from the OISE project is akin to what can be done with the information gathered in a case study. Although one cannot generalize in the statistical sense from a case study, researchers have argued that generalization is possible. Donmoyer (1999) stated that many qualitative researchers have attempted to reconceptualize the idea of generalizability. For example, he referred to the work of Lincoln & Guba (1985), who "have argued that because of the idiosyncratic nature of social contexts, generalizability questions are best
answered not by those who do research but by research consumers” (Donmoyer, 1999, p. 625).

Furthermore, what could be referred to as personal generalization can be made from a case study (Weiss, personal communication, November 12, 2000). When an individual reader recognizes the value and potential usefulness of the ideas generated by a study, it can be said that information gathered in one setting can be usefully applied to other settings or circumstances.

Similarly, Eisner (1985) considered how it is possible to generalize from “a nonrandomly selected single case.” Referring the reader to the work of Donmoyer (1980), Eisner writes, “Generalization is possible because of the belief that the general resides in the particular and because what one learns from a particular one applies to other situations subsequently encountered” (Eisner, 1985, p. 195). More specifically, Eisner argues that “The expectations we acquire from our examination of the particular become a part of our anticipatory schema; we shape our information pickup system by what we learn from individual cases. . . . The ability to generalize from particulars is one of the ways whereby humans cope with the world. I know of no one who forms the generalizations that guide his or her actions through a technically rigorous process of random selection” (pp. 195-196).

Summary

In this chapter, I have investigated indeterminacy in our process of assessment. In my deconstruction of our writing of the pre/post test questions, I observed that indeterminacy entered the process. I came to understand through my analysis that the source of the indeterminacy was the necessity of having to develop these questions early in the research project in advance of working out the details of our pedagogical intervention, and in advance of developing an adequate knowledge of the students’ abilities. I also raised the idea that the difficulty we encountered in writing our multiple-
choice questions may have been in part a consequence of the conceptual complexity of the science concepts with which we were working. In addition, I discussed the idea that language may be limited as a medium for describing science phenomena, particularly when the individuals being tested developed their knowledge of the phenomena through some nonverbal means. Finally, in terms of indeterminacy and assessment, I investigated the narrative question and observed that the question allowed for the flexibility of student response, which also introduced some indeterminacy into the coding process.

This chapter on indeterminacy and assessment concludes my detailed analysis of the OISE project. Having completed the analysis of the OISE research project, I now turn to the second smaller component of this thesis, an examination of my own thesis research practice.
Chapter 9: My Thesis Research Process

In this Chapter, I present my thesis research process with particular attention to the learning that I experienced. Inevitably, my own individual subjectivity was an integral part of this unpredictable process. My research process was distinctively influenced by the set of expectations that I brought to the undertaking, my previous experiences with writing, my dedication to the themes of this thesis, and the consistently active behaviour of what I have come to call my "idiot perseverance gene." My expectations were predominantly based on my training in the "hard" sciences, my exposure to the theory of research practice, and my reading of a multitude of published research studies.

The first portion of this chapter examines the process of problem setting as I experienced it during the early stages of researching and writing this thesis. I believe that I paid particular attention to this issue as a result of the discrepancy between what I was experiencing and the technical rational expectations I had developed during my exposure to the formal and informal academic curriculum of research. The remainder of this chapter focuses on writing. In particular, I deconstruct some of the challenges I encountered writing about both the OISE research process and my own thesis process. I was led to focus on this area because I was surprised to discover certain limitations of the approach that I had successfully used in the past for my academic writing.

My Process of Problem Setting

The Beginning of the Thesis Process

When as a Ph.D. candidate I first began working as a researcher on the OISE project, my intention was to investigate the teachers' process of curriculum development for my thesis. The teachers' inability to participate in this aspect of our project put me in the awkward position of searching for a new thesis topic while the OISE research process was already underway.
My situation took me by surprise. I had expected that I ought to know from the outset what my research topic would be. I held the view that the researcher begins with a problem and pre-selects a method, and then proceeds in a straightforward manner to collect and investigate the data. Instead I found myself in the unenviable position of not having a thesis topic in the middle of a challenging research project.

**Problem Setting**

The unforeseen elimination of my originally chosen topic landed me in the position described by Schon (1983) in his discussion of problem setting in research. He maintained that researchers must construct problems from situations that are ambiguous and puzzling. They must make sense of complex and ill-defined situations in which all types of issues are mixed up together in order to extract a problem that can be dealt with. According to Schon, technical rational theory ignores this stage of problem setting. In emphasizing problem solving, technical rational thinking does not consider "the process by which we define the decision to be made, the ends to be achieved, the means which may be chosen... In order to convert a problematic situation to a problem, a practitioner must... make sense of an uncertain situation that initially makes no sense" (Schon, 1983, p. 40).

Schon wrote: "When we set the problem, we select what we will treat as the 'things' of the situation, we set the boundaries of our attention to it, and we impose upon it a coherence which allows us to say what is wrong and in what directions the situation needs to be changed. Problem setting is a process in which, interactively, we name the things to which we will attend and frame the context in which we will attend to them" (Schon, 1983, p. 40).

**Developing the Themes**

Initially, without a topic to focus my attention, I felt I needed to experience everything that was happening during the OISE project. As I
continued to observe the OISE research project, I noticed that certain aspects of the process did not "feel right." Somehow, it was not unfolding as I had expected it to do. My initial foray into the literature generated some clues about what I was sensing. Walker's (1975) study of curriculum development was important in this respect. I began to realize that the way we think about research practice may not be the way it actually takes place. This observation led me to start thinking about investigating the research process.

Although I had started to set my problem, my rather broad intention to "investigate the research process" still left me with a myriad of potentially relevant aspects to observe. Slowly I began to focus on certain aspects that impressed me as significant. The first of these was the degree to which the researchers as individuals shaped the course of the research process, contributing distinctive influences to our choices and decisions as a research team. I also noticed that we constantly needed to respond to unexpected circumstances, and that throughout the course of the OISE project, we were learning. During my period as a participant/observer, all of these observations coincided and competed with many others.

Later, after the OISE project was completed, I was able to develop my thesis problem further and limit the scope of my investigation. Once the demands of the project had abated, I had the opportunity to study the literature in depth. I was struck by the vast quantity of reading material that potentially could have been relevant to my investigation. As I read the literature, I did not know specifically what I was looking for. However, I had the sense that what I was reading felt either "right" or "wrong." That is to say, it either coincided with what I had observed about the research process, or else it did not provide me with any guidance or help to clarify my experience. For example, when I read John Eisenberg's *The Limits of Reason: Indeterminacy in Law, Education and Morality*, it felt "right." I was excited by his concept of indeterminacy because I felt it coincided with some quality I had intuited about the OISE project. This process enabled me to select certain ideas and discard others. Ultimately, I identified indeterminacy, subjectivity
and learning as important factors in the research project that should be investigated.

**Intuition, Reason, and the Emergent Aspects of Problem Setting**

The initial stage of my research process resembled Moustakas' (1990) description of the beginning of the research process, which he compared to swimming into an "unknown current." Faced with trying to develop a thesis topic in the midst of the OISE project, I did not have a clear sense of direction and found myself in situations that were often puzzling. Under these circumstances, I discovered that I needed to rely on my intuition for guidance. According to Moustakas, it is intuition, bringing us "hunches and vague, formless insights," that leads the researcher in unexplored directions.

The workings of my intuition seemed to indicate that I was operating on the basis of tacit knowing. Polanyi (1983) stated that comprehension is rooted in tacit knowing: "We know more than we can tell . . . Take an example. We know a person's face, and can recognize it among a million. Yet we usually cannot tell how we recognize a face we know . . . this knowledge cannot be put into words" (Moustakas, 1990, p. 20, quoting Polanyi, p. 4). Accordingly, "the tacit dimension underlies and precedes intuition and guides the researcher into untapped directions and sources of meaning" (Moustakas, 1990, p. 22).

Similarly, in the field of philosophical hermeneutics, Gadamer (1975) stated that "when we understand a text, what is meaningful in it claims us. . . It has asserted itself and claimed us before we can come to ourselves and be in a position to test the claim of meaning it makes" (p. 446). Gadamer recognized this claim as the result of "some sort of initial primal tuning" (Karnezis, 1987, p. 2). His idea points to the existence of an initial feeling or intuition that impels us to articulate the meaningfulness or significance of the work we have encountered.

My analysis demonstrates that while my intuition provided me with a form of "felt" guidance, it worked in tandem with my cognition. My reading
of the literature provided me with tools to explore and build on a knowledge base that I initially experienced in a largely nonverbal form. As Moustakas argued, "From the tacit dimension, a kind of bridge is formed between the implicit knowledge inherent in the tacit and the explicit knowledge which is observable and describable" (p. 23). As I read the literature, the ideas I encountered began to assist me in identifying earlier observations. For example, when I read Eisenberg's work (1992), his ideas helped me identify an important aspect I had observed during the OISE project. Reading about his principle of indeterminacy resonated with my tacit knowledge and gave me a term that brought my understanding into the realm of the explicit. His concepts also extended what I had intuited. By providing me with new insights about indeterminacy, which I could then apply to my analysis of the OISE project, Eisenberg's ideas served as conceptual tools that advanced my thesis process.

Eisenberg stated that our society generally "seems to reflect a cautious, controlled rationalism in which there is a fear to trust one's intuitions" (p. 145). The rational is an essential component of the technical rational approach. The term "rational" means based on reason. The theory underlying technical rationality does not account for the felt sense derived from intuition or affective faculties that might also be at work in the research process.

The emphasis on the rational is not surprising given the history of Cartesian dualism, the philosophical separation between the brain and body within Western thought. Damasio (1994), neuropsychologist and author of *Descartes' Error: Emotion, Reason, and the Human Brain*, argued that psychology's separation of reason from emotion is incorrect. He critiqued the idea that the brain occupies a hierarchically privileged place and posited a powerful interdependence between the brain and body in which physical experience of the world is central to the creation of our sense of self and affects our behavior. Damasio's argument for the democratic relationship between our body and brain supports my position that more attention should
be paid to intuition and other affective faculties, rather than limiting our ideas solely to "the rational."

**Writing**

In this thesis, I used writing as a tool for reflection and learning. I was aware that through the process of writing I was developing increasingly sophisticated levels of understanding. Björk and Räisänen (1997) stated that writing is a learning tool which promotes critical thinking. Bereiter and Scardamalia (1987) argued that writing can be seen as a problem-solving endeavour demanding effort and the strategic use of cognitive resources. In particular, for expert as opposed to novice writers, these researchers describe writing as knowledge-transforming. I shall return to these ideas in the course of my analysis of my writing process.

In the following sections, I refer to certain ideas usually encountered in the discourse of art criticism, aesthetics, and literary criticism. These ideas are helpful in articulating aspects of my research practice as I developed and wrote this thesis. In applying these ideas to my research process, I am in line with other writers in the area of educational research. Donmoyer (1980) and Eisner (1985) use the metaphor of evaluator/researcher as artist in order to generate different types of information about educational research. As Eisner (1985) stated, "The issue is not qualitative as contrasted with nonqualitative or quantitative, but how one approaches the educational world. It is to the artistic that we must turn, not as a rejection of the scientific, but because with both we can achieve binocular vision. Looking through one eye never did produce much depth of field" (p.199).

**Overview of My Writing Process: Consonance Between Form and Content**

When I began the process of writing, I felt strongly that I needed to present the material in a way that was consistent with my experience of the whole research process. I felt committed to the McLuhan adage, "the medium
is the message," and I therefore set out with the intention of presenting my thesis in a way that I am calling "experiential" -- that is, in a way that would preserve evidence of the process as it actually occurred -- a learning process in which subjectivity and indeterminacy played major roles. My desire to include an account of my learning in the thesis text I was creating meant including some of the complexity and untidiness of the process. For example, I initially organized my Literature Review and Method chapters so as to lead the reader through my gradual process of developing my understanding of the concepts.

I felt that if I did not provide the reader with this experiential sense of the research process, I would perpetuate the misleading impression that research is a tidy, predetermined impersonal process -- thus contradicting the very arguments I was constructing based on my observations about the OISE project, namely, that the research process may be an emergent learning process shaped by indeterminacy and subjectivity.

My initial strong intuition was that the medium of writing that I was going to use needed to support my themes. In other words, I had an intuition that my thesis demanded that I create a consonance between form and content. Hough (1966), in his classic book on the principles of literary criticism, stated that "the formal organization of prose arises directly out of its meaning" (p. 100). That is to say, just as in architecture and design, form follows function, so in a work of writing, the formal elements (the writing style; the tone of the writing; the types of words chosen, etc.) serve the author's meaning; the form is not at odds with the meaning or content. The second of Hough's three principles of literary criticism is "consonance -- the demand for coherence and proportion, the Coleridgean demand that the work 'shall contain in itself the reason why it is so and not otherwise'" (p. 18). In referring to the Romantic poet and literary critic Samuel Taylor Coleridge, Hough is arguing against the imposition of an external, ready-made or artificial form on the written work. Similarly, I felt strongly the necessity to develop a form that would provide the "consonance" that Hough described.
In my case, the form of writing ready for my use was expository writing. Expository writing is a form in which I am thoroughly experienced. My academic training and socialization ingrained in me the expository approach as a habit of thought and of writing. I have experienced it as a good tool for developing knowledge and conveying information -- a tool that I never questioned. However, in deciding to explore the themes of subjectivity, indeterminacy and learning for this thesis, I set myself an unexpected challenge: I inadvertently chose themes that did not seem to be well served by expository writing. The realization that the form of writing with which I was familiar had limitations for my thesis engaged me in an intense learning process about writing.

**Congruence between Academic Writing Conventions and Technical Rational Theory**

In this section, I discuss what I believe was at the center of the difficulties that I experienced in writing a thesis on the indeterminate, emergent, subjective, and learning aspects of the research process. Based on my analysis, I argue that the academic writing conventions that I was familiar with did not support these themes. Instead these conventions seem to support a technical rational interpretation of the research process.

Gadamer (1975) argued that we are always confronting language as the vehicle of meaning. Our meaning making is conditioned by experience, particularly the experience of language, which tends to mold the developing subject in conformity with the traditions encoded in linguistic utterances and in the language itself. Gadamer's view affirms the position that thought and reason are always determined by the historical traditions of a linguistic community.

Boscolo (1990) stated that expository writing “represents almost prototypically the peculiar type of ‘academic’ language children learn at school” (p. 218). According to Boscolo, expository text is “a text of which the primary objective is to express factual information or theoretical ideas” (1990,
p. 217). However, in research on writing the term may also refer more widely to include argumentative text (e.g., Bereiter & Scardamalia, 1987; Hidi & McLaren, 1988). Some of the structural properties of the expository text include topical relatedness, superordination, and cohesion (Garner et al., 1986). That is to say, the parts of the text “belong together,” the main ideas are supported by detailed statements, and cohesive ties make the text “hang together.” In terms of style, the distinguishing traits of the expository text include a predominantly analytical, impersonal mode in which the passive voice is often employed. The clarity of the information is uppermost.

Expository writing is an important tool of the academic trade. It is an effective way of conveying information clearly and concisely, and it can be a valuable means of knowledge development for the writer (Bereiter & Scardamalia, 1987). Expository writing is the dominant convention in academic writing. My experience has suggested that expository writing may serve to reinforce the impression that the research process conforms to a technical rational epistemology of practice.

Upon analysis, it would appear that several qualities of expository writing contribute to supporting this impression. Expository writing is built on the superordination of ideas, thereby excluding the experiential presentation of the writer’s process of knowledge development. The emphasis on thematic organization in expository writing invites a tendency to de-contextualize the information and moreover does not allow for an illustration of the cyclical building of knowledge that may unfold over time during the course of the research project. In its tendency to favour an impersonal mode of expression, expository writing downplays the role of the individual. In its emphasis on economy of expression, it discourages a full treatment of unexpected complications, thereby minimizing any indeterminate aspects of the process. In addition, the focus on precise, formal words, economy of expression, and the avoidance of ambiguity and colloquial expressions in the expository style limits the writer’s ability to present, should she wish, the sense that she is at an early stage in her knowledge
development, and only beginning to understand a given idea. Thus expository writing does not accommodate the intuitive, fluid nature of an emergent learning situation.

The convention of expository writing has been adopted and thoroughly regulated for the presentation of research studies in academic journals by style manuals such as the Publication Manual of the American Psychological Association, (American Psychological Association, APA, 1994). The manual details a range of concerns from writing style to the content and organization of journal manuscripts. According to the OISE/UT Guidelines for Theses and Orals (2000), this manual presents one of the standard style guides that must be followed for the preparation of doctoral theses and proposals. The APA style is the one that I adopted for this thesis.

Radloff and Styles (2000) claim that one of the reasons postgraduate students have difficulty writing dissertations is that they must conform to what are often implicit discipline conventions. I have come to understand that some of the difficulties I experienced in writing this thesis grew out of my misunderstanding a particular aspect of the academic writing convention that I was using.

More specifically, I was under the impression that the “scientific” writing format of presenting introduction, method, results, and discussion (as outlined in the APA manual), was suppose to be a fairly accurate representation of the research process. This format led me to believe that the chronology of the research process was as follows: at the beginning of the study, the researcher determined his/her problem of inquiry, method and type of analysis, then carried out his/her pre-determined procedures and analysis. Once these tasks were completed, the researcher summarized the knowledge that came from the analysis in the conclusion.

My undergraduate training in the physical sciences contributed to the belief that the writing process represented the research process. In the laboratory experiments that the students had to carry out, we were given a “ready-made” hypothesis and set of procedures to be followed. Once we had
completed our laboratory work, we were expected to write a report that reiterated our hypothesis, detailed our methods, documented the results and presented a discussion. Thus the chronology of the research process as I experienced it reflected the process I went through in the writing of the final scientific report.

Instead of believing that the format of introduction, method, results and discussion, necessarily represents the research process, I have come to understand the format to be a specialized rigorous form of exposition. In an exposition a writer begins by introducing the topic and outlining what he or she will write in the body of the text. Similarly, in a scientific paper, the introduction “presents the specific problem under study”; it “gives the reader a firm sense of what was done and why” (APA, p. 11).

Thus, a congruence exists between technical rational theory and “scientific” academic writing conventions, since the theory and the “writing tool” both support a pre-ordinate approach. Papers written according to the scientific model of academic writing outlined by manuals like the one produced by the APA may instill a strong impression that the researcher knew in advance more than he or she actually did know at the beginning of the research process. The reader may develop the impression that the researcher started out with a pre-determined problem of inquiry and a pre-ordained set of procedures when in fact this may or may not have been the case.

The convention on writing the method section may also serve to promote a technical rational impression of the research process. This convention may have less to do with expository writing per se and more to do with guidelines for writing scientific papers. According to the APA (1994) guidelines, the method section of an academic paper “describes in detail how the study was conducted. Such a description also permits experienced investigators to replicate the study if they so desire” (p. 12). Although the method section is supposed to be detailed, the manual also states that the writer should “weed out overly detailed descriptions of . . . procedure” (p. 26).
My understanding of the APA guidelines for the method section is that they present somewhat contradictory instructions. My experiences as an undergraduate in science may again have shaped this understanding. In my years of training to conduct research in the fields of biology, chemistry and physics, I was instructed to record meticulously the detailed steps that I took in carrying out laboratory work, since I was led to understand that even minor changes in procedure may have major consequences on the outcomes of a study. Thus, on the one hand, the idea of presenting the information in enough detail to allow the study to be accurately replicated suggests to me an extremely detailed presentation of everything that happened. On the other hand, it is clear that the guidelines for publication instruct the writer to present more of a skeletal rendition of the procedures of the study, since a more complete presentation of the research process would be too long for what the APA manual states is an editorial concern with “limited numbers of printed pages” (p. 26).

I now return to Radloff’s and Styles’ (2000) claim that students who write dissertations must often conform to implicit discipline conventions. Although I find that the APA guidelines are thorough, there is still room for ambiguity. One such area concerns the information to be omitted in the method sections of scientific papers. In their directive to “weed out overly detailed descriptions of . . . procedure,” the writers of the manual imply that there are aspects of the procedure that are not to be included. They specify that “gratuitous embellishments; elaborations of the obvious; and irrelevant observations or asides” are to be omitted (APA, p. 26). In addition, the writer is not to employ any devices that might “confuse or disturb readers of scientific prose,” such as setting up ambiguity, inserting the unexpected, or using colloquial expressions (APA, p. 25).

I suspect that the very aspects of the research process that I studied in this thesis are generally considered, implicitly if not explicitly, to fall under the category of “irrelevant observations or asides.” I base this conclusion on my experiences reading published papers, as well as writing method sections of
papers submitted for publication. When writing papers for publication according to APA guidelines, the writer generally makes no attempt to evoke what it felt like to be in the midst of the process, nor to include the unexpected events that may have occurred along the way, nor to re-create the deliberations and developing understanding of what may have been going on during the research project. My impression is that this type of information is considered to be extraneous.

I have come to understand that a paper or thesis written according to APA guidelines is a particular presentation of an "end product" that may or may not reflect the actual process that resulted in the manuscript's final incarnation. In my experience as a doctoral student, graduate assistant and research officer, I have observed that once the research project is completed, a paper may be written and reworked and rewritten numerous times before a final manuscript is considered "finished." The problem under investigation is generally neatly stated right up front with the problem setting stage only briefly discussed or ignored altogether. The methodology may consist of a streamlined version of what actually occurred, designed to give the reader the important essentials. In the course of reworking the paper, the researcher may re-conceptualize some theoretical problems. Aspects of the study that did not work out may be dropped. Analysis that did not bear fruit may be re-evaluated and different analysis selected.

A paper or thesis written according to APA guidelines may be well suited to a presentation of the "product" -- that is, the end result of a research task or an arduous process of knowledge development through writing. I am not suggesting that we change the APA guidelines, since I believe them to be useful in the task of effectively communicating knowledge to an academic readership. I am however arguing that there exists a potential for confusion in the academic writing conventions that I have been discussing. I contend that the congruence between these conventions and technical rational theory may convey the impression that this final product captures the chronology of the research process. In some cases, the academic paper or dissertation may
well represent the course of the research process. In others, however, the paper may present a process that appears to be more determinate than it actually was.

The academic writing conventions not only support a technical rational view of research practice but also discourage the writer from presenting other aspects of the research process. Consequently, certain aspects of the research process may be omitted both from technical rational theory and from the written productions of academics who follow such conventions as the APA manual.

The academic writing convention of presenting the "end product" as opposed to revealing the research process left me with a challenge, since the purpose of my thesis was to investigate research practices. Eisenberg (1992) wrote: "Education . . . never deals with the dealing, the process of doing as doing -- not as done, analyzed, and classified" (1992, p. 166). In retrospect, I can see that I took on Eisenberg's challenge to "deal with the dealing." I decided to investigate my thesis process and the OISE project as "processes of doing as doing -- not as done."

In both studies the research practices in which I was involved seemed to be emergent and contextual, and they involved subjectivity, indeterminacy, and learning. This situation left me with two questions. In what way could I write my thesis when the chronological unfolding of it seemed at odds with the conventions governing the manner in which the dissertation was to be written? And, how would I write up the OISE project in a way that would allow me to investigate my themes? Since the treatment of these themes did not seem to be supported by the academic writing skills that I had developed over years of schooling, I felt I needed to develop new writing strategies that would be more consistent with the themes of my thesis.
The Challenge of Change: Going Outside Expository Writing

Initial Experimentation

Like a classically trained ballerina trying awkwardly to execute a modern dance performance, I felt that my training had shaped my ability. Given the focus on expository writing in most of my educational experience, I possessed a certain set of criteria or rules about writing that made up my knowledge base. At the same time I had no writing skills in other genres. I was aware that expository writing was my point of departure. Thus, even though I wanted to experiment, I realized that I was going to feel drawn back into the habits of thought and writing that accompany expository writing.

Initially I felt I had to experiment fully with my writing in order to overrule my expository training. I wanted to write in a way that allowed the reader to see that my subjectivity was part of the process, and that my research process was an emergent learning experience. Initially I was convinced that I needed to present the reader with the experience of my knowledge development during the research process. However, I did not have ready at my disposal a writing technique that could evoke the experience as I knew it. My difficulties were largely associated with the attempt to capture aspects of the learning process using the medium of writing.

The Difficulty of Trying to Capture the Learning Process Through Writing

Why is the learning process difficult to capture with writing? Trying to capture the constantly changing development of understanding is extremely difficult. I realized gradually that, because of my ongoing learning process, my relation to my materials was constantly changing as I wrote. At early stages of my research process, I sometimes lacked the readiness or receptivity necessary to grasp fully the import of relevant concepts and theories about research. My learning developed as I worked through the thesis, especially when I returned to reread or revise portions of my thesis on which I had already worked.
Gadamer (1975) addresses the constantly changing nature of understanding. He contends that interpretation is ongoing. For Gadamer, a person has certain horizons of understanding that are a function of his experience and the historical traditions in which he/she is socialized. When reading, an individual repeatedly transcends his/her own horizons by pulling the text beyond its original horizons until a fusion of the present and past horizons occurs. Accordingly, Gadamer argued that the meaning of a text is not fixed, but necessarily changes over time according to the way it is received and read. To understand is to understand in a different way than we understood previously, transcending even our own earlier interpretations -- precisely because the process of understanding is the creation of new horizons. For example, I re-read the work of Schon a number of times, discovering new relevance in his work at different stages in my research process.

I initially wanted to preserve evidence of the successive cycles of learning and revision that accrued along the way. Yet it was impossible to capture the various layers of interpretation that happened over time. Communicating coherently and in retrospect about a learning process is extremely challenging. Wilcox (1994) addresses such a challenge:

The transformation of perspective that comes with learning makes it difficult to recapture with exactness all the peaks and troughs along the road. . . . With the passage of time and in the process of writing up 'history', the detail blurs into something which may well sound more long-sighted, organised and orderly than it could have been. . . . at the time. (p. 14)

Another challenge that I faced when writing concerned my attempt to recreate the intuitions that exist in non-verbal form before they emerge as completely formed concepts. My experience suggests that when one attempts to capture one's intuitions in words, they receive a circumscribed, definite form that does not represent the original fluid, mixed, amorphous experience -- for the simple reason that the very act of writing itself is a process of clarifying, defining, selecting, and delimiting. The modern British novelist
and painter Joyce Cary (1958) observed: "The moment the artist expresses his intuition in any formal terms, this expression tends to destroy for him the force of his intuition" (p. 101). Thus as I wrote, I necessarily created a representation of the experience that was different from the original experience itself. My interaction with my materials is reminiscent of Eisenberg's (1992) ideas concerning indeterminacy and the effect of human interaction with phenomena: when one interacts with a situation, the situation necessarily becomes something different.

Despite the challenges I faced, I nevertheless persevered with my attempt to capture in writing the learning process that occurred during the course of my research and the creation of this thesis. A large part of the work of my thesis was the development of writing strategies that would serve my purposes.

**How I Developed My Writing Strategies**

The work of developing my writing strategies evolved over the course of writing my thesis. Initially I was mostly concerned with going beyond expository writing in order to experiment fully with an experiential approach. It may be that, in order to invent new techniques, I needed to go through an initial stage of rejecting the familiar as a means of changing my habits of thought, thereby redirecting my efforts toward the creation of new writing strategies. Judging from my experience, it would seem that going to one extreme and discarding the "old" approach might have been a necessary aspect of my process of change.

Near the beginning of this process of experimentation, I used an emergent, experiential approach in writing my literature review and method sections. My intention was to present my knowledge development as it unfolded over time while I studied the literature and prepared a method. However, when I presented these sections to my thesis committee, the feedback I received directed me to re-assess my writing goals. I interpreted the comments of my thesis committee members to indicate that my attempt to
present the course of my knowledge development impaired the conceptual clarity of my discussion, which was a priority in these two sections. Consequently, I abandoned the attempt to give an account of my learning process as it related to the literature review and method sections of my thesis. I decided to rewrite these sections using an expository approach.

Nevertheless, I remained convinced that an experiential approach had an essential contribution to make to my thesis, and I continued to look for ways to include it in my writing. My original, strong intuition that I needed to keep a consonance of form and meaning led me to persevere in the effort to develop a way of writing that would include the emergent, subjective, unpredictable learning experience that was my thesis process. Cary (1958) wrote: "the most vivid and continuous experience of all artists is the gap between their intuition and its expression, and all great artists, all great writers, seek continually to overcome it. It's quite easy for any experienced painter or writer to avoid that troublesome problem and use his technical skill to write or paint works which do not attempt to express any intuition at all. . . But the great master is perpetually concerned with intuition. It is his primary task to keep in touch with it" (p. 101-102). Had I ignored my intuition, the writing of this thesis might have become a more straightforward use of my "technical skill" as an expository writer. However, I believe this strategy would not have yielded the knowledge about research practice that I sought.

"Trial and Error"

When I wrote the body of my thesis -- the deconstruction of the OISE project -- my process of deliberation involved considering simultaneously a number of frequently conflicting goals. At this stage of my work, I knew that I needed to be faithful to my intuition and ensure that form and meaning continued to support each other, and I also realized how critical it was to write in a way that would support conceptual clarity. In addition, I had recognized the importance of my audience's training and expectations. An
experiential approach requires the reader's patience, since the material unfolds gradually and knowledge is built more slowly than in expository writing, in which the main points are highlighted for the reader in an immediately accessible manner. Since the expository method is dominant in the academic community, I was concerned that my text might be dismissed.

Juggling these sometimes divergent goals meant that I was in the position of identifying the places in my thesis where a given approach was more appropriate than another, and places where I might try to create some combination of different approaches.

Writing with an expository method had always seemed relatively straightforward, since I could rely on the existing set of criteria or rules I had internalized through my training. Now that I had decided to go outside the parameters of expository writing, I no longer had these established rules, nor did I have any sure way to measure the relative effectiveness of my writing. Consequently, at any given time, there were no clear-cut answers to the question of how I should be writing. The challenge I faced was to invent strategies that would enable me to remain true to my original "intuition." This effort required me to be flexible, and not adopt a single strategy at any one time, but revise the strategies to meet the immediate needs of the research.

My process of developing writing strategies to suit the needs of the moment can be compared to Cary's (1958) description of the emergent process of expressive or creative work:

The work of art as completely realised is the result of a long and complex process of exploration, as well as construction. This is true even of a painter. . . . however experienced he is, he does not know exactly how to get the effect he wants, or even if it is possible within the limits of his material. He proceeds by trial and error. . . . Manet would scrape off his paint day after day until, after fifty trials, he could satisfy himself that no further improvement was possible. That is, he was not merely expressing an intuition, he was continually discovering new possibilities in his own work . . . Poets gradually construct both their verse and their meaning by continued test and alteration; novelists discover new aspects of
their theme, and also new limitations of their technique, as they work (p. 103).

**Stages of My Process in Developing My Writing Strategies**

From the beginning, a chronological skeleton seemed essential to my analysis of the OISE project. In this way, I could see connections and find correspondences between situations within a temporal context. The chronological frame also allowed me to document and analyze the gradual, often non-linear accumulation of knowledge that I had observed developing during the course of the research. Initially I set out to write the circumstances of the OISE project in chronological order based on my field notes and interviews, and on the accumulation of research materials that our team had created, including our proposal, pre- and post-tests, and curriculum unit. I was however faced with the difficulty of choosing which events to present, since I could not afford to cover all the events that occurred during the course of the OISE project. More important, at any given point I had to make decisions about the content of my conceptual analysis.

After many trials and errors, I realized that I might separate the events -- "what happened" -- from my analysis of them. In order to assist this process, I decided to organize my account of the OISE project into a format of Event, followed by Discussion. This format enabled me to present first the experiential aspect of a situation in the complexity of its relation to surrounding events. Here I could adopt more colloquial language than that required by expository writing, I could record some of the intuitions, hunches, ideas that may not have been well developed at the time. This approach allowed me to represent the knowledge level of individuals at a given moment more accurately than I could have done with expository writing.

Following the Event section, I used a more expository style, in order to analyze the circumstances within the Event and demonstrate their significance in terms of the themes I was pursuing. I used my three themes as tools for the analysis of the circumstances presented in the Events sections.
For each set of circumstances described in an Event, I asked a number of questions. For example, in that moment in the OISE study, who were the individuals involved and in what ways did they affect the research process? What were their immediate concerns? What might they have been considering in terms of meeting future research requirements? Are there any unexpected events that figure prominently in what was happening and if so, what were the repercussions of these on the research project? How did the research team respond to these? Did researchers give any indication that they were engaged in learning during this event? What can I discover about the ways in which these pedagogical moments unfolded? What materials in the educational and research literature may support, clarify, or extend the ideas with which I am working?

The strategy of Event - Discussion helped to determine my selection of events. A dynamic interplay was constantly taking place between my gradually improving ability to select material, and my analysis of it. My first "rough" selection of events was largely based on my three themes. These themes, in turn, were gradually becoming more sharply delineated and enriched as I continued to do more analysis in my Discussion portions.

I organized my material in chapters with large thematic units such as "indeterminacy." However, I discussed and analyzed the information within the overarching chronology of the OISE project, so that I was able to avoid decontextualization. I could focus on one theme and discuss it in depth -- but with reference to a specific stage within our ongoing research process where this theme assumed distinct prominence. For example, the stage of our project when we faced the break-up of our collaboration with the OSC was clearly a point at which indeterminacy was the major factor affecting our research process. The use of this strategy meant that even while I singled out one theme to discuss in depth, I was still consistently able to remain true to the dynamic interplay of indeterminacy, subjectivity, and learning throughout the course of the OISE project, because the temporal context remained in place.
To sum up my writing strategies: I used a chronological arrangement of events; I developed what I call an experiential writing style, which is relatively personal, colloquial, and informal; I developed an Event-Discussion format in order to separate the experiential and analytical modes; and I maintained the integrity of the interaction between my themes while giving the reader the benefit of focus that large thematic units provide.

The writing strategies I developed were critical in the work of this thesis. They were an instrumental aspect of my method, assisting my investigation of the central issues in this thesis and developing my knowledge. Bryson & Scardamalia (1991) have discussed "the knowledge-transforming model of expert writing," in which "problems arising in the 'rhetorical space' are often translated into problems requiring solution in the 'content space.' New decisions arrived at in the content space also create new problems in the rhetorical space, and so on in a dialectical fashion. The result often will be that by the end of the composing process, both the writer's ideas and the nature of the written product have evolved in unexpected ways. Hence the experience of writing as discovery" (p. 49). The knowledge-transforming model aptly describes the dialectical process I underwent while writing my thesis.

Bryson, Bereiter, Scardamalia, & Jordam (1991) have argued that "the dialectical processes that underlie a knowledge-transforming approach to composing are probably responsible for the learning that can occur as a by-product of writing. In contrast to 'writing as dialectic,' a more linear approach to writing (such as is often recommended in composition textbooks) would settle all the content issues first, after which the composition would be planned and carried out in a straightforward manner" (Bryson & Scardamalia, 1991, p. 51).
Conclusion

As an individual researcher, my thesis process serves as a case study in the attempt to take a step beyond the technical rational approach. Going beyond this approach required me not only to make changes in my thinking: I also had to modify or change my tools.

My process of experimentation was a new approach, since I had not come across any guidelines or models on which to base my writing strategies. These strategies were critical in enabling me to realize my intention of giving the readers not only a cognitive understanding of the OISE research project, but also an experiential one. I felt that it was crucial for me to provide readers with an experiential sense of my research process in order to support the central concept of my thesis, that research is an emergent, and sometimes unpredictable learning experience. Thus in reference to Eisenberg's (1992) challenge, I feel I have succeeded in dealing with the dealing, that is to say, learning as process rather than product.

Although I remained faithful to my original intuition, it was critical for me to maintain my ability to compromise when the circumstances warranted it. That is to say, I was able to maintain conceptual clarity and carry out extensive analysis of my material within the combination of strategies that I developed. The ability to combine an experiential approach with expository writing formed the major innovative endeavour of my thesis process and generated most of the knowledge.

Developing this combination of strategies was a time-consuming process fraught with uncertainty, which sometimes seemed to demand "a tremendous investment of mental effort in the elaboration, co-ordination, and execution of complex goals and subgoals" (Bryson & Scardamalia, 1991, p. 41, reviewing the work of Flower & Hayes, 1980). Remaining true to my intuition resulted in the development of new knowledge about the research process -- knowledge that I contend may not have been available had I imposed a strictly expository framework on the content of this thesis.
Chapter 10: Conclusion

Overview

Although much has been written about educational research in theory and in technique, researchers themselves rarely investigate the whole course of the research process. Given the amount of time and energy that educational academics spend researching other individuals, such as teachers and students, it would seem incumbent upon researchers to examine their own practices. To this end, I have performed a deconstruction of the OISE project, in which I participated. I adopted the perspective that carrying out research may be an educational activity and I explored aspects of the learning experience that may take place for researchers when they are engaged in research practice.

Traditionally, we recognize that researchers learn about the phenomena they are studying. But generally research practice is not considered to be educational beyond that activity. I argue, however, that during the research process, pedagogical moments are constantly available to researchers. My experiences indicate that researchers learn something beyond what the textbooks teach us about the procedures to be followed when conducting research, particularly quantitative research. Discrepancies may exist between the way research is taught and the way it actually proceeds. At the time of the OISE project (in which I was a participant/observer), I was also a graduate student and therefore well positioned to observe these discrepancies.

In my experience in graduate school, much of the formal and informal curriculum supports technical rationality as the dominant epistemology of research practice. This academic experience supplies the student with a constellation of expectations. Among these are the ideas that the researcher is an "expert" who has worked out his or her procedures in advance, independently of the context in which the research will be conducted. From this perspective, conducting research is a matter of walking step by step
through one's predetermined procedures. This process is assumed to be orderly, predictable, and context-independent.

I have come to understand that research practice of whatever epistemological base is likely to involve instrumental problem solving. Yet we may also need to concede that it can still be considered to involve genuinely creative activity in which one often proceeds by trial and error. Schon's (1983) views are helpful here. He maintained that when we look at science "after the fact" -- that is, after the actual research is finished -- it presents us with "established propositions derived from research" (Schon, 1983, p. 49). However, if we were to investigate the research process itself during its unfolding, we would see scientists grappling with ambiguity, with novel and uncertain situations. As a result they are engaged in innovative and intuitive processes (Schon, 1983).

In practice, my experience with the OISE research project indicates that although researchers certainly have planned objectives and a general set of procedures, once they find themselves in the specific research context, there can be a whole series of unpredictable or novel events and situations that arise. These elements may challenge researchers to deliberate, invent new solutions, and resolve problems as they emerge. When viewed from this perspective, research practice can be seen as an educational process and sometimes a creative activity.

Viewing research as an educational activity does not discount the value and usefulness of teaching the technical rational approach. Rather, I argue that we need to develop a more inclusive understanding that would acknowledge certain aspects of research practice that are usually ignored.

Among these is the social aspect of research practice. Research is carried out by specific individuals who bring with them their own ideas and values about education and educational research. Throughout the course of the OISE project we were learning about the social nature of research practice -- the kinds of human resources needed to carry out a project such as ours, the distinctive skills and experience of team members, and the nature of the
social milieu that facilitated our work. Our research team overcame the demanding challenges of the project largely by capitalizing on the different distinctive skills and expertise of the individual team members. Through the process of working with one another, the members of our research team learned about team dynamics, co-learning, and each other's educational views and epistemological beliefs about research. These views and beliefs had a profound impact on the course of the project. More specifically, my analysis has revealed that the researchers' educational views and epistemological beliefs about research shaped the unfolding of our research process.

Since educational research involves people, as opposed to phenomena in a laboratory (Kuhn, 1970), there may be a limit to how much one can predict, since every research situation involves some measure of novelty. Thus, although researchers may have extensive familiarity with a given setting, and with the people involved, nevertheless there may be a measure of indeterminacy in the work they carry out.

Many unexpected circumstances may arise during a research project, primarily because researchers may be attempting something that has never been done before. In our project, we took on a number of challenges, such as working across more than two institutions, including a teacher development component as well as trying to create a novel program. These elements created considerable potential for indeterminacy, since the process of developing an educational program without precedents is necessarily an emergent one.

Researchers and their participants work and study in institutional settings. The political and economic circumstances of these institutions may strongly affect these individuals, and therefore the research process. Our research team discovered the complexities of working across institutions -- the science museum, OISE, school boards, and schools. The failed collaboration with the OSC, the teachers' inability to carry out curriculum development, the predominantly ESL status and Muslim background of the
student population, the Ontario civil service strike -- all of these factors greatly affected our research process.

During the course of the OISE research project, I found myself observing an emergent process in which our research team continually revised our expectations and modified our procedures. Although we had formulated a basic plan, working out the specifics involved much discussion and improvising. For example, the project design acquired a significant amount of specific detail as we worked through the particular stages of our research process. As soon as we became engaged in the particularities of the tasks, the setting, the students, the exhibits, the teachers, we were faced with circumstances that we could not have known in such a specific way when we initially formulated our project in general terms. As a result, we constantly had to discover new ways of managing our situation.

What I have called the "cascading effect of indeterminacy" describes the process I observed. Judging from my experience, once faced with a problem, researchers may need first to resolve it to the best of their ability, and then deal with the altered situation that their resolution has created. This phenomenon may become a concatenation of altered circumstances. For example, we adopted the concept of gravity because it appeared to resolve our problem of joining the science curriculum to the OSC exhibits. Then we gradually discovered that this resolution created unforeseen complications, because the concept of gravity was challenging for our particular student population, which was largely ESL. Yet once we adopted the gravity theme, we could not choose another, nor could we, at a relatively late date within the course of our project, find another school with which to work. New unforeseen difficulties arose and additional work was required as further consequence of the situation our decisions had created.

It is in the particularities of a research project that one may need to make use of "artistic" or "creative" skills in order to invent solutions to unforeseen situations. For example, in developing the gravity theme, we were creating a unique solution to the problem of connecting the OSC exhibits to the grade
six science curriculum. Similarly, in developing a way to conduct my analysis of my thesis material, and at the same time communicate a sense of the experience of working on the OISE project, I created my own writing strategies.

Action research served as the method I adopted in this thesis. According to Lewin, action research occurs in cycles (Adelman, 1993). Part of the goal of action research is to generate knowledge that can inform future practice. It can be argued that our past training and experience form a predisposition to act in the future (Louden, 1989). In his classic work Truth and Method, Gadamer (1975) supplied us with insights about our predispositions and past experiences as they affect our present and future endeavours. He maintained that people possess a range of interpretive tendencies -- a forestructure of understanding already in place -- that dominate their meaning making. He called these tendencies our "horizon of understanding."

I argue that engaging researchers and student researchers in a discussion of the ideas generated in this thesis would broaden their horizons of understanding and enable them to see possibilities for change in their research practices. Consequently, in this chapter, I make suggestions for revising the current curricula of research. When I talk about research practice within the context of this discussion, I am talking in general terms. That is, I suggest that these ideas may apply to research models of any epistemological base. Since the larger "culture" of academic research has a great influence on research practice, it figures prominently in this discussion. I speculate about potential changes that might occur in the larger "culture" of research as a result of the knowledge developed by revised research curricula. Finally, I discuss future directions in research based on the ideas generated by this thesis.
Revised Curricula of Research Practice

The curricular problem that I will examine is the question: How can we effect a curriculum of change about research practice? I contend that we need to develop an understanding of research practice that is more inclusive than what is usually taken up in the discourse surrounding research practice. By “more inclusive,” I principally mean two things.

First, the revised curricula of research practice might address the entire series of events, from problem setting to the publication of papers. That is to say, such curricula would deal with issues such as the social aspect of locating, for example, teachers with whom to work and the political and economical aspects of obtaining funding for one’s research.

Second, by “more inclusive,” I also mean that, in addition to some of the features of the technical rational approach, such a representation of research practice would acknowledge the social and educational aspects that I have investigated in this thesis. Table 4 includes the principal technical rational tenets, and also the additional characteristics of research practice that I have examined in this thesis. I envision a more inclusive view of research practice as including some features from each column.

The features in Table 4 bear some resemblance to the typology of the scientific and naturalistic paradigms as outlined by Guba and Lincoln (1981). These authors set up an opposition between these “paradigms” in research practice (see also Lincoln & Guba, 1985). While not identical to Guba’s and Lincoln’s typology, the tenets of technical rationality in the left column of Table 4 are similar to aspects of their scientific paradigm, and the characteristics I have listed in the right column resemble aspects of their naturalistic paradigm. For example, my position concerning subjectivity bears a resemblance to Guba’s and Lincoln’s (1981) contention that the individual is essential to the process of enquiry. It has more in common with that concept than it has with the stance of “objectivity” that they attribute to their scientific paradigm. My finding that indeterminacy was a part of the process
and that aspects of the OISE project and my research process were emergent is also consistent with their idea that a naturalistic design emerges in part because elements of the research are unpredictable.

Table 4

A Listing of the Qualities of Research Practice

<table>
<thead>
<tr>
<th>Tenets of Technical Rationality</th>
<th>Characteristics studied in this thesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>learning from the &quot;end product&quot;</td>
<td>learning through the process</td>
</tr>
<tr>
<td>researcher as expert</td>
<td>researcher as learner</td>
</tr>
<tr>
<td>context independent</td>
<td>context dependent</td>
</tr>
<tr>
<td>procedural</td>
<td>social</td>
</tr>
<tr>
<td>objective</td>
<td>subjective</td>
</tr>
<tr>
<td>technical process</td>
<td>creative process</td>
</tr>
<tr>
<td>rational</td>
<td>intuitive</td>
</tr>
<tr>
<td>predictable</td>
<td>indeterminate</td>
</tr>
<tr>
<td>pre-ordinate</td>
<td>emergent</td>
</tr>
<tr>
<td>straightforward</td>
<td>messy</td>
</tr>
<tr>
<td>theoretical</td>
<td>practical</td>
</tr>
<tr>
<td>problem solving</td>
<td>problem setting</td>
</tr>
</tbody>
</table>

However, in their discussion of the aspects of the two paradigms, Guba and Lincoln presented extreme positions. For example, when categorizing methodological characteristics, they opposed pre-ordinate and emergent. Guba and Lincoln stated (1981):

In scientific inquiries, designs must be constructed preordinately, that is, before the fact. Moreover, once a design has been implemented, it is important that it not be altered in any way, since such an alteration would confound the variables and thus make a meaningful interpretation of findings impossible.

Within the naturalistic paradigm a design can be specified only incompletely in advance. To specify it in detail would be to place constraints on the inquiry that are antithetical to the stance and purpose of the naturalist. The design emerges as the investigation proceeds; moreover, it is in constant flux as new information is gained and new insights are achieved (p.73).
These positions may create dichotomous interpretations. According to Donmoyer (1999), “The literature about research methodology suggests that a major problem with the sort of Kuhnian-inspired paradigm talk exemplified by the discussions of Lincoln and Guba is that it assumes a priori that different research perspectives are incommensurable and, hence, often needlessly exaggerates differences between and among research orientations” (p. 616). Donmoyer’s comments support my view that there may be more similarity between these positions than is generally acknowledged in the discourse surrounding research practice. Rather than thinking of scientific and naturalistic as separate and opposed paradigms, I suggest that we begin by thinking that these research orientations potentially include aspects of each other.

By arguing in favour of a more inclusive view of research practice, I do not wish to fall into what Donmoyer (1999) has argued is another “weaker” form of paradigm talk. In this type of discourse, “different paradigms or schemas are seen as complementary rather than competitive” (p. 617), and researchers who are working out of different paradigms are viewed as “simply studying different topics” (Gage, 1989, p. 141). According to Donmoyer, the danger of this weaker type of paradigm talk is that it “tends to underestimate and even, at times, to overlook honest-to-goodness differences” (p. 618). Similarly, I believe that the characteristics in Table 4 are not always complementary. Later in this chapter, I argue that future research should be dedicated to developing more refined models of research practice that investigate more closely the ways in which the characteristics in Table 4 manifest themselves in projects carried out of various research orientations. It is beyond the scope of this thesis to develop such models.

Nevertheless, I see the “more inclusive” view of research practice as a starting point for a discussion about a revised curriculum of research practice. In the discussion that follows, I focus on the elements of research practice that are generally omitted from the discourse on technical rationality. However, I do not wish to create a fallacy in the opposite direction by overemphasizing
these elements in my discussion of this revised curriculum of research practice. The reader should understand that even though I focus almost exclusively on these elements, by my omission I do not intend to discount the main features of the technical rational model, nor do I intend to convey that there necessarily exists an easy complementary relationship between the traditional tenets of technical rationality and the characteristics I discuss.

**The Commonplaces of Curriculum**

As a structure for my discussion of a revised curriculum of research practice, I will use the commonplaces of curriculum, which are: learners, teachers, milieu, and subject matter.

**Profiles of Potential Learners**

In order to discuss the features of a new curriculum of research practice, it would be useful to consider the various attitudes and expectations presently held by researchers. To this end I present a selection of possible attitudes about research practice on the part of researchers and students.

To begin with, the novice researcher will have been formally educated predominantly with technical rational ways of thinking, but he or she will have had little practical experience conducting research. This researcher may expect that the technical rational approach fully describes the actual conditions of carrying out research in social settings. A person with such a view will experience many surprises when unexpected "messy" events occur and may experience stress when these events threaten to disrupt the planned procedures.

Slightly more experienced researchers may be aware that a discrepancy exists between technical rationality and research practice. We can suppose that such researchers have an intuitive sense that the technical rational approach is not without problems when applied to the actual conditions of conducting educational research. However, they may not be able to articulate the reasons
for this gap between theory and practice. This position can also be stressful, since the problems cannot be identified or labeled. Finding oneself in this position can stimulate one's reflection-on-action on the gap between technical rational theory and research practice.

An experienced researcher committed to a technical rational approach of conducting research may remain faithful to technical rationality as a way of getting things done, knowing that in practice there are always considerable amounts of "divergent phenomena." Other experienced researchers may engage in reflection-on-action to explore the causes behind the discrepancies between the technical rational epistemology and research practice. They are drawn to the challenge of making an informed critique of the technical rational paradigm. Yet other experienced researchers, familiar with both the technical rational paradigm and its limitations as a picture of the research process, choose to adopt a position of flexibility and practical accommodation, without engaging in epistemological speculation in the midst of the research process itself. Finally, there are experienced researchers who may feel that qualitative research methods provide them with a tool more suited to their type of investigation and who therefore decide to abandon quantitative research altogether.

The "learners" for the revised curricula can be identified with reference to the foregoing array of graduate students and professional researchers whose attitudes and expectations about research practice I have attempted to characterize. While it would be useful for "teachers" of revised curricula of research to keep in mind the broad range of possible attitudes, nevertheless for practical purposes, it is convenient to think in terms of two basic groups of learners -- graduate students and experienced professional researchers. A revised curriculum of research would need to be responsive to the different sets of experiences that these individuals bring to the learning situation. Consequently, we would have at least two curricula.
Teachers

The teachers of the revised curricula of research practice could be professional researchers who have themselves become aware of the issues surrounding research as an educational activity. Professors who teach courses in research methods and forms of inquiry would be ideally suited to such discussions.

Milieu

Existing undergraduate and graduate courses in research methods could include aspects of the curriculum of research practice that I am suggesting. Practicums could offer students the ability to experience working with professional researchers in ongoing research investigations. Professional development workshops and conference presentations could provide the settings for revised curricula of research for professional researcher interested in these issues.

Subject Matter

For both novice researchers and experienced professionals, the revised curriculum of research could have learners reflect on the informal curriculum of research practice. In addition to formal courses in research practice, researchers engage in a set of research practices governed by the broader academic culture. As a result, this informal curriculum of research -- that is, the culture of research in which learners work and study -- appears to be pervaded by technical rationality. These practices include writing papers for publication, and writing proposals for funding of research projects and for the presentation of research at conferences. These research-related practices are governed by rules and conventions, which are sometimes explicit and sometimes implicit. These practices involve the researcher in interacting with the epistemological theories and practices of the larger academic community (Kuhn, 1970). Succeeding at these tasks is critical to survival, in terms of tenure, and to the reputation of academics (Schon, 1995).
Consequently, these research-related practices form an informal yet very powerful "curriculum" of research practice.

Learners could reflect on how and to what extent certain conceptions may be institutionalized within academic practices. For example, the learners could discuss and attempt to identify the epistemological beliefs of individuals who choose reviewers for journal publications and conference presentations. Under what criteria are these individuals chosen? What are the guidelines for proposal writing within granting agencies such as The Social Sciences and Humanities Research Council of Canada and the Ontario Ministry of Education? To what extent are the guidelines and criteria reflective of respect for alternate epistemologies of practice, and to what extent do they restrict thought and research practice to the technical rational approach? All of these considerations shape researchers' ideas about research practice and the research practices themselves.

**Curriculum of Research for Professional Researchers**

It is likely that professional researchers are familiar with many of the issues I raise in this thesis. For these individuals, these issues may be so much a part of their research experience that they no longer stand out as issues per se. In some ways, what I have done is akin to the child's pronouncement in the story of the Emperor's New Clothes. Given the generally unarticulated nature of these issues, it could be possible to bring the issues out of the tacit level of knowing through their identification and examination.

If our intention is to broaden the horizons of understanding about research practice for expert researchers, Gadamer's (1975) work suggests that we invite these researchers to reflect on their previous experiences. Gadamer's ideas contain the dialectical movement of the hermeneutical cycle (Murray, 1987). According to Gadamer, true experience leaves individuals open to new experiences. However, each new experience also influences our understanding of previous experiences, a process which, in turn, widens even
more the horizon within which we may have more new experiences. Thus, knowledge gain can be viewed as a refocusing of the past within the present situation.

For experienced researchers then, the type of curricular activities that could be beneficial might involve having the instructor stimulate their recollection of instances from their own research experience that resonated with the ideas raised in this thesis. When did they experience research as a social activity? When were they faced with unexpected circumstances and how did these affect the research process? How did they deal with these instances? Were they aware of circumstances during their research practice that provided them with pedagogical moments? To what extent did they feel that the guidelines and criteria of funding agencies, research review committees, reviewers for journal publication etc. constricted their research practices?

Professional development seminars could be an appropriate setting in which researchers could reflect on the extent that epistemology influences the academic context in which they work. These seminars could be used to stimulate discussion on possible ways to negotiate some flexibility vis à vis alternative epistemological thinking and practices within this context or culture.

**Curriculum for Student Researchers**

The curriculum of research practice I am suggesting for student researchers could be incorporated into already existing courses on research at graduate and undergraduate levels. In the following sections, I make reference to a number of ideas and some materials within the literature. My intention is to begin to articulate some of the curricular content such courses might include.
Research as an Educational Activity

I would suggest that we encourage students to consider that research practice is an educational and social activity (Weiss, 1989). The process of carrying out research can provide investigators with many pedagogical moments. During the research process, the researcher can play the role of learner, teacher, as well as "expert." The following theoretical material could be incorporated into a discussion about the ways in which learning may occur during the research process.

- The commonplaces of curriculum -- the "learner," the "teacher," the "subject matter," and the "milieu" -- can serve as a way of contextualizing learning in the nontraditional learning setting of a research project (Weiss, 1989). The commonplaces can also be used as a tool for analysis (Connelly & Clandinin, 1988). For example, students can reflect on the social milieu of a team of researchers in order to determine what helps or hinders learning during the research project.

- The indeterminate aspects of research practice may serve as a stimulus for learning. Schon's (1983) work on reflective inquiry suggests that surprise stimulates people to turn their thoughts onto their actions and on discovering the knowledge underlying their actions. This process of reflection-in-action and reflection-on-action is integral to the learning that occurs during research practice.

- Tasks have been identified by Moore (1981) as central to the activity of learning in non-classroom settings. In the process of identifying what tasks need to be done and how to carry them out, as well as actually carrying them out, researchers may be engaged in a learning process. As discussed above, Schwab's (1969) concept of deliberation is an essential part of this process.
Researchers have demonstrated that "interest has a powerful facilitative effect on cognitive function" (Hidi & Berndorff, 1998, p. 74). As a psychological state, interest also involves focused attention, affective involvement, and persistence on task (Hidi, 2000). Individual interest, in the form of the personal interests that researchers bring to their work, as well as situational interest elicited by the environmental features of the research task, may play a role in the knowledge researchers develop as they carry out their research activities.

Vygotsky's (1986) theories help illustrate the interactive role of "teacher" and "learner" in the development of knowledge that takes place for researchers as they carry out their work. Vygotsky recognized that outside influences such as the instructor or materials challenge the learner to move in their "zone of proximal development".

Vygotsky's (1986) theories also elucidate the cyclical development of understanding that takes place in the research process. Learning can be understood from the concept of a hermeneutical spiral in which the research task can serve to stimulate a further Vygotskian cycle of learning and take a person further in his or her understanding (Gamlin, personal communication, February 24, 2000).

**Epistemological Beliefs**

I would suggest that we encourage students to reflect on the epistemological assumptions they bring to their research practice and the ways in which these assumptions may support or hinder their practice.

Kuhn's (1970) work on the structure of scientific revolutions, communities of scholars, and the role of paradigms could be discussed. For example, Kuhn wrote: "A scientific community consists, on this view, of the
practitioners of a scientific specialty. To an extent unparalleled in most other fields, they have undergone similar educations and professional initiations; in the process they have absorbed the same technical literature and drawn many of the same lessons from it" (p. 177). Kuhn's ideas could help students reflect on the influence of the culture of research in which they have been socialized.

A discussion could be fostered about what Donmoyer (1999) calls the "Kuhnian-inspired paradigm talk" in educational research. The typologies developed by Guba and Lincoln (1981) and Lincoln and Guba (1985) could be used to illustrate work which may create the impression that certain research orientations are inherently separate and opposed. A listing of the qualities of research practice such as the one I have provided in Table 4 could be discussed in light of the observation that there may be more similarity between research orientations than is generally acknowledged in the discourse on research methods.

Aspects of Research Practice

I would suggest encouraging students to consider that when research is seen as an educational and social activity, certain aspects of research practice become prominent. The ideas in the following sections could serve as a basis for discussion. Given students' lack of direct experience with research practice, they could benefit from practical illustrations drawn from actual research situations. Thus, the students could read deconstructions of research projects, such as this thesis, to help clarify the following conceptual points.

The reader should be aware that the points are not organized in a hierarchical order. While I have grouped certain concepts together, many of them could be organized differently, since there exist many conceptual connections between the ideas.
Subjectivity

- Researchers, teachers, students, and a variety of other individuals who become involved in research projects may shape the unfolding of these investigations. Individuals may contribute their abilities, skills, and resources to the projects on which they work. Individuals also possess assumptions, beliefs, and values, all of which may have an impact on the decisions they make within a research context.

The beginning of the research process

- There may be different points of entry into the research process. Researchers may find that their first task is problem setting, rather than problem solving (Schon, 1983).

- Tacit knowledge and intuition may play a role in problem setting.

- Research generally does not begin with the implementation of the research design. Rather, preliminary discussions with principals and teachers can play a major role in determining aspects of the research process.

Indeterminacy and the emergent nature of research practice

- In the case of some research projects, the inability to predict with certainty how a research project will unfold may be largely due to unexpected circumstances occurring during the research process.

- Many of these indeterminate circumstances may be the consequence of the social nature of the research. That is to say, a certain amount of indeterminacy may be introduced into the research process because researchers must create partnerships -- if not officially, then unofficially. The researcher cannot predict with certainty how people will behave,
whether they are students, researchers, administrators, or fellow researchers.

- Many aspects of the research process may be emergent. Often researchers are in a position to identify what needs to be done only once they are at work in the actual research setting. Even if researchers know the research "territory," there may be a limit to what they can know (predetermine) about the research process in advance of conducting the research. Fullan's (1993) work on the topic of educational change could be applied to the context of research. He wrote that change is a journey, not a blueprint: "you don't know what is going to matter until you are into the journey" (Fullan, 1993, p. 24).

- Research projects take place within a given political and economic context. Institutional factors may contribute indeterminacy in the form of internal politics and/or economic circumstances. These factors may create situations the researchers cannot predict, which may have an unforeseen impact on the unfolding of the research process.

- Indeterminate circumstances may be the consequence of the novel nature of conducting certain types of research projects. Particularly in projects that involve the researchers in the development of novel intervention programs, one cannot predict with certainty all the ramifications of adopting new procedures, pedagogical strategies, etc.

**Deliberation**

- Students should understand that deliberation may be the modus operandi of research practice. Once researchers are working in the context of the research setting, they may need to make decisions about actions in concrete situations.
In particular, the presence of novel or unexpected circumstances may make it necessary for researchers to deliberate. That is to say, they may need to discuss possible solutions, make decisions by choosing the best alternatives, and translate these decisions into action.

Once researchers make a decision, they may be committed to the outcomes of that decision and to dealing with the specific challenges it presents.

Just as Walker (1975) viewed curriculum development as "a genuinely creative task of generating ideas and testing them against available information" (p. 126), we can consider the process of deliberation during research as an innovative, creative activity.

Writing

Students could reflect on the forms of expression in which academics are trained. In particular, the use of expository writing as the dominant mode of writing in academia could be discussed in terms of its strengths and limitations. Students should understand that the writing conventions outlined in books such as the Publication manual of the American Psychological Association (1994) may require the writer to present a distillation of the research process; that is to say, it may present the research process efficiently, without giving attention to the unpredictable elements, the learning that took place and the emergent nature of the process. Students should be encouraged to pioneer their own writing strategies, if a given research project seems to warrant it.

The knowledge-transforming model of expert writing could be explored by students to build their understanding of the dialectical processes underlying composition, which are thought to be responsible for the learning that grows out of the writing process (Bryson, Bereiter, Scardamalia, &
Jordam, 1991). Such discussions could help students recognize the
collection of their own writing processes to the development of their
knowledge.

It is my contention that the type of curricular content of research that I
have been proposing would help "learners" develop a more inclusive view
of research practice -- one that would narrow what I perceive to be a gap
between theory of research and actual research practice.

**Other Learners**

The previous sections have discussed the curriculum of research for
professional researchers and student researchers. Other individuals who
work in the area of research could also benefit from a curriculum of change
about research. These individuals include people who work for funding
agencies, ethics review committees, school board research review committees
and even teachers or pre-service students who might be in the position of
working with researchers in the future.

It is likely that all of these individuals will have experienced a
curriculum of research shaped both by the formal curriculum -- courses at the
undergraduate and graduate levels -- and also by the informal "curriculum" --
the institutional culture in which they work. Some of these individuals
might have direct experience working in research, while others might be in
positions where their experience is indirect. For example, a member of a
school board research review committee might have extensive experience
reviewing other people's research without having conducted research
himself/herself. In particular, those individuals without direct research
experience, or with only limited research experience, might be heavily
influenced by the practices of their institutions. If educational institutions are
"mired in technical rationality" as Anderson and Herr (1999) state, it is likely
that the people who work in them have technical rational assumptions about
research practice.
Professional development seminars would be the most likely venue for a curriculum of change about research for this group of "learners." Accommodating the paucity of time available in seminars would be a challenge in developing such a curriculum, particularly since many of the "learners," unlike professional researchers, would probably not have direct research experience to bring to the issues raised. The activities in this type of seminar therefore might include descriptions of research instances that illustrate the issues raised in this thesis. Particularly useful might be the discussion of real instances when aspects of researchers' work conflicted with research assumptions of the review committee members, teachers, etc.

Another research project in which I was involved could serve as an example of the types of research narratives that could be discussed. In the project in question, our research team had submitted our ethical review indicating that our method of contacting teachers and students would be determined after a discussion with the principals at the particular schools with which we would be working. Our reasoning was that these individuals would be in the best position to make suggestions regarding their own schools. Our submission to the committee was not passed because the members of the committee were of the opinion that we, the researchers, should be able to determine this procedure independently of the research context. An exploration of this type of example might prove useful in discussing the social nature of research and how the ethical review committee who evaluated our work did not acknowledge this aspect of educational research practice.

Implications of the Implementation of the New Curricula of Research

The previous segments of this chapter have presented suggestions for various curricula of research that could be developed on the basis of the ideas raised in this thesis. I have suggested that these curricula be developed for the different groups of individuals involved in matters of educational research,
to help them broaden their understanding of research. Meeting this educational goal is obviously a long-term project. However, at this point, we can speculate about what would happen if such a new knowledge base were developed in these various groups of "learners."

One crucial area of change would involve the academic protocol involved in writing proposals for research projects. Granting agencies, ethical review committees, school board research review committees, and teachers have great influence over the destiny of a research project, since they act as "gatekeepers" whose approval or rejection can often seal the fate of research projects. If a more inclusive view of the research process were shared across the various groups of people involved, proposal writing would necessarily change.

**Proposal Writing**

Typically, at present, there is a certain format and tone in which researchers need to present their projects if they want these to be approved. This format is governed by technical rationality: one presents the outcomes one wants to achieve and the methods one is going to use to achieve these with an air of certainty and clarity about the specifics of the project.

The implicit technical rational "code" underlying the writing of proposals has two interconnected consequences. First, in order to "play the academic game," researchers must make what is indeterminate appear to be determinate. The writing of research proposals can be compared with the construction of a standardized bridge. Researchers tend to continue to "build" research proposals in the same manner often with minimal reference to the context in which their projects will occur. This situation is comparable to an engineer designing a standardized bridge without considering the various conditions, winds and forces that would buffet it (Weiss, personal communication, July, 1997).
Second, in order to convey the requisite professionalism and confidence, researchers must make themselves appear more knowledgeable about the projected work than anyone could be, since it has not yet been completed. The researchers are often asked to provide a degree of certainty and specificity that is unrealistic at the early stage of the research process. For example, a researcher may need to write up a detailed chronological plan of the proposed research activities, and he/she may need to include specific references to student or teacher time involvement, etc. -- specifics rarely known at the time of proposal writing. At the proposal writing stage, it would be more accurate to say that the researcher can provide projections, rather than predictions. What the proposal omits is the acknowledgment of the indeterminate factors that may surface in the course of implementing the theoretical design into a specific context.

If the various groups involved in educational research were to adopt the more inclusive view of research practice for which I have been arguing, proposal writing might undergo significant changes. Researchers would certainly continue to need to develop proposals based on a knowledge of the research "territory" and to develop appropriate procedures. However, if researchers, agencies, and institutions were all to adopt a more inclusive perspective on research practice, researchers would be able to acknowledge that they necessarily know only a limited amount about the project at the proposal writing stage, and that they do not in fact have the kind of control over the conditions of research that the academic "game" puts them in the position of maintaining they do. Under this view researchers could include the discovery aspect of their work. They could present themselves as learners engaged in an emergent, and at times unpredictable, social process.

**Modification of Procedures**

A critical aspect of the political and economic realities of conducting research involves an agreement or understanding regarding researchers'
obligations to conform to the content of the proposal. Depending on the view of research practice that one adopts, the act of modifying procedures may be evaluated differently. For example, under the technical rational paradigm, a change in procedures may have a negative connotation, implying that the researchers failed in some way to live up to what they proposed. In contrast, if we subscribe to the more inclusive view of research practice that I have been discussing, a change in procedures need not be viewed as a negative occurrence, since researchers are not necessarily at fault when events do not occur as expected. Indeed, this situation is often the norm: as Eisenberg (1992) stresses, indeterminacy is an inherent part of all social phenomena.

Several consequences may accrue from the acknowledgment that some degree of deviation from the original proposal may be practically inevitable. One consequence would be relief from the potential stress that strict adherence to a pre-ordinate approach can induce in some researchers. I am speculating that when researchers find that they need to re-adjust some elements of their projected design, within the current technical rational "culture," they encounter some degree of cognitive dissonance. In terms of psychological theory, cognitive "dissonance arises in this context from a person holding the belief 'I performed action A' at the same time as the belief 'Action A was inconsistent with my attitude' " (Eiser, 1990, p. 56). Dissonance is an unsettling state because the perceived inconsistency is undesirable. Applied to the field of educational research, an example of cognitive dissonance might involve the expectation of strict adherence to the tenets underlying the technical rational approach, leading researchers to feel they need to engage in "reconstituted logic" when reporting the results of their research. That is to say, once the research has been completed, they feel a certain pressure to organize their process into a progression of developments that is far more orderly and predetermined than the unfolding of these events actually was in reality. I would speculate that a state of cognitive dissonance is probably more common among novice researchers, since experienced researchers are likely to have developed the awareness that
research practice does not absolutely conform to a pre-conceived model and therefore no longer feel troubled by the inconsistency.

In addition, when we acknowledge that some deviation from the initial proposal is practically inevitable, there may be a further consequence. With acceptance of this situation, researchers may be able to take a different view of making modifications in their procedures during the course of a research project. We can expect that researchers who have developed a more inclusive view of research practice will be open to making changes in their procedures when circumstances lend themselves to these changes. Instead of feeling as if the research process is faulty, researchers could interpret the need for readjusting procedures in a positive light, for example, as an opportunity for learning, or as a chance to take the project into a different direction – one that may be better suited to the specifics of the research setting. Ideally, such an inclusive view of research practice would be useful for researchers to hold. However, it is not enough that researchers alone are familiar with this view.

**Implications for Granting Agencies**

Creating change in research practice would require that the professionals who work in granting agencies are also familiar with this more inclusive perspective on research practice. A dialogue could be opened between funding agencies and researchers to discuss the potential necessity of altering procedures in response to the changing circumstances that invariably emerge, once the general terms of a proposal are translated into the specific particulars of an actual research setting. The dialogue would need to consider the question: To what extent are researchers obligated to be faithful to their original proposal? Out of this dialogue, criteria might emerge that would delineate researchers' responsibility in terms of their adherence, or not, to their initial proposal.

Such discussions could also enable researchers and funding agencies to develop new, mutually-acceptable ways to write proposals that are more
reflective of the nature of research practice. I suggest that we develop strategies acceptable to both parties for writing proposals that take into account the contingencies of an actual context. For example, Robert Donmoyer has developed a way of structuring his sentences in proposals with a preliminary "If . . ." clause, followed by "then . . ." (personal communication, April 20, 1999). In this way, Donmoyer is able to cover some of the contingencies and unforeseen factors, while communicating a sense of competence and "expert" skill. Although many circumstances cannot be foreseen and therefore cannot be captured by the use of "If . . ., then . . .," nevertheless this type of presentation has its strengths. In some ways, this candid approach may inspire trust because one can recognize the truthfulness of it.

Implications for Review Committees and Educators

An understanding of the more inclusive nature of research practice may also have implications for members of ethical review committees and school board research review committees who evaluate prospective research projects and for teachers who decide whether or not to commit their time to a research project.

Given the technical rational bias in most educational institutions (Eisenberg, 1992), it would be helpful if the individuals who work in them understood that proposals generally represent an estimate based on previous projects. An understanding that it is often necessary for researchers to work with educators in order to develop programs and procedures that are responsive to the specific needs of the students and the teachers would be useful. Furthermore, these individuals need to understand that if proposals must be written in advance of such a collaborative consultation, it is unlikely that the researcher can accurately specify many aspects of the procedures involved.
In some cases, the system would appear to be organized in such a way that it is impossible for researchers to have access to the teachers with whom they will work until their proposal has passed a research committee's approval. For example, it is standard practice for researchers to present first their proposals to a board's research review committee. If the committee accepts the proposal, the board then locates schools and teachers to participate in the research project. This procedure has disadvantages, since the proposal must be developed independently of teachers and students.

Although this procedure is official practice, it is not the only way for researchers to engage in preliminary discussions with teachers or principals. Researchers often rely on personal connections with educators to find out whether they would be interested in participating in a study and to begin discussing the research procedures in the context of these teachers' experience with their students and their curriculum. Once these preliminary discussions have taken place, there is a greater probability the researcher's study will be approved by the board. There is also a greater likelihood that the proposal will more accurately describe the research procedures that will be followed.

Finally, benefits would accrue to researchers if teachers became familiar with the more inclusive view of research practice. Understandably, when approached for a research project, they are interested in knowing what their specific responsibilities will be and how much of their time the project will take. Again, if teachers held an inclusive view of research practice they would understand that the researchers can only provide them with an estimate of these specifics in advance. Teachers could also understand that the researcher will at times be a co-learner in the research process and that the teacher -- who is more familiar with his/her curriculum and students -- will at times be the "expert" during this process.
**Future Research Directions**

**Toward More Refined Views of Research Practice**

Future research could investigate other projects that are representative of a diversity of research orientations. In this way, a knowledge base about research practice could be expanded further, and, consequently, researchers could continue developing a better understanding of their own practices.

Researchers could further develop the ideas about subjectivity, indeterminacy and learning as these pertain to research practice. For example, in the area of researchers' subjectivity, I have focused largely on individuals' epistemological views about research practice; however, future research could explore other aspects of subjectivity that shape people's choices and actions. For example, the images of education that individuals bring to research could also be investigated. Researchers have noticed that research practice, as well as educational practice, is "infused with complex and multi-layered understandings" involving issues of class, gender, race, and power (Anderson and Herr, 1999; Cochran-Smith and Lytle, 1998; Schratz, 1993). These issues could be further explored in future deconstructions of research projects.

In this thesis, I have brought attention to certain areas of research practice that could also be developed further. In particular, researchers could pay more attention to issues of how investigators cope with change. For example: How do researchers make use of their intuitive faculties beyond just the problem setting stage? In what ways, beyond those discussed in this thesis, could research practice be considered a creative activity?

Beyond the aspects of research practice discussed in this thesis, researchers could choose to examine other aspects of the research process that I have not mentioned, but that nevertheless would need to be accounted for in a more inclusive way of understanding research practice. For example, the role that time considerations play in shaping research decisions could be examined.
As I stated earlier in this chapter, I see the "more inclusive" way of thinking about research practice as a starting point. Future research could contribute by developing more refined views of research practice that go beyond this inclusive conceptualization. The discussion that follows explores what such an understanding might entail. In order to help clarify my discussion, I refer to Table 4 which was presented earlier in this chapter, and in which I have listed certain qualities of research practice. Over the course of working on this thesis, I have come to understand that research of whatever epistemological base may include aspects of both instrumental problem solving and educational/creative activity. That is, it may include elements from both the left and right columns of Table 4. Future researchers could investigate the following question: What is the nature of the relationship between the qualities listed in the two columns?

Certain items in these columns may at first seem at opposite ends of a spectrum. However, my work suggests that they may function side by side in the practical world of research practice. Some of the recognized, articulated features of the technical rational model may be supplemented by the characteristics I have been studying. An example would be the idea that researchers, in addition to being experts in their field of research, are also learners engaged in a pedagogical process throughout the course of their research practice. The idea of supplementation may be sufficient for certain items, but not all.

For other items in Table 4, I suspect that some form of integration may describe the relationship. For example, earlier I raised the idea that intuition may play a role in problem setting. Acknowledging that one may use intuition in setting the problem does not take away from also acknowledging the important role of one's cognitive faculties in such an endeavor. Some kind of interplay between the two may be at work. Further research could investigate such an interaction between cognition and intuition by focusing on questions such as the following: Under what circumstances in the research process and to what degree does one rely on cognition and/or intuition? How
do these two ways of knowing interact? What might be the variables that could mediate such a relationship?

While in certain circumstances the relationship between the qualities listed in the two columns of Table 4 may be one of supplementation or integration, the relationship may not always be complementary. For example, if one is carrying out an empirical/analytical study, in which a strict application of technical rationality is required, indeterminacy may interfere with control and therefore become a problem. Thus the particular study and, more specifically, its particular research orientation, may play a role in determining the nature of the relationship between certain aspects of the two sets of items in Table 4. The work of investigating, within the context of diverse research projects, the relationships between these two sets of items could contribute to elucidating the complexity of the issues involved. Consequently, such work could contribute to developing, beyond just a “more inclusive” view, a more refined understanding of research practice.

**Investigating Evolving Trends**

Another avenue for future research would be to assess some of the changes occurring in the dominance of the technical rational approach in academic culture. While this culture is still dominated by technical rationality (Eisenberg, 1992; Schon, 1995), there are indications that this dominance is decreasing. For example, the American Educational Research Journal has traditionally been limited to publishing experimental studies; but more recently, it has decided to broaden its publication program to include other methodologies (Urban, 1990). Studies could be developed that would assess the degree to which the criteria for submission -- whether it be for research funding, journal publication, or conference presentation -- support the technical rational approach and the degree to which other approaches to research are valued. For example, a textual analysis of criteria that are used by
different funding agencies and by different review committees could be
carried out.

Future research could also investigate existing research practices that
successfully negotiate around the technical rational paradigm. For example,
to be carried out with educational researchers like Robert
Donmoyer who has developed a way of structuring his sentences in proposals
with a "If . . ." clause, followed by "then . . ." (personal communication, April
20, 1999). Investigation of such strategies could prove extremely useful to
researchers seeking to establish some flexibility in their research practice.

In Conclusion

Gadamer (1982) has argued that we must be aware of our own historical
situatedness and the ways in which it influences what we choose to study. He
asks us to understand that "[tradition] is not simply a permanent pre-
condition; rather, we produce it ourselves inasmuch as we understand,
participate in the evolution of tradition, and hence further determine it
ourselves" (p. 293, Gadamer, 1982). Although "All of us who live in research
universities are bound up in technical rationality (p. 32, Schon, 1995), in
writing this thesis I have developed a critical understanding of the research
process that has advanced the "problem along an infinite path" (Peshkin,
1993, p. 28, quoting Vidich & Bensman, 1968). It is this type of critical
understanding that Gadamer believed has the capacity to move a person past
the old habit of thought to a consciousness that "rise[s] above that of which it
[was] . . . conscious" (p. 341, Gadamer, 1982).

I believe the academic community would continue to benefit greatly
from acknowledging, as many members of this community already are, the
perspective that research is a deeply-layered social, educational, and emergent
process -- one that allows researchers to display their creative as well as their
technical skills.
As a final thought, our research team got the job done and suffered the scrutiny of my analysis. It is not easy to put one's own work under a microscope and critique it. It requires bravery to undertake such an analysis. Nevertheless, as Weiss (1989) points out, researchers who routinely investigate others and their practices, should have "the audacity to live up to their principles" (p. 131). Ultimately, there may be large benefits from conducting these types of investigations.
References


Kepler, J. (1967). In E. Rosen (Ed. and Trans.), Somnium; the dream, or posthumous work on lunar astronomy. Madison: University of Wisconsin Press.


Appendices

Appendix A

Selected OSC exhibits: The effects of gravity across various contexts

1) Balancing Act: This exhibit has visitors kneeling on the floor, putting their hands behind their backs and trying to touch their noses to a button on the floor. The exhibit is meant to illustrate that men and women have their centre of gravity in different places in their bodies. Women tend to have their centre of gravity lower in their bodies, while men have their centre of gravity higher in their torso. The women's centre of gravity acts as a counterweight when they are touching their noses to the button on the floor. The men's centre of gravity tends to unbalance them, making them fall toward the button on the floor.

2) Rhoads' Sculpture: This exhibit is a large dynamic sculpture created by artist George Rhoads. Visitors are directed to lift balls to the top of any of several tracks and observe the balls as they descend down various paths. While rolling down the pathways, the balls do a number of things such as hitting other balls, bouncing off of different types of surfaces, making noises or musical sounds in the process. As a person lifts a ball, he/she works against gravity and gives the ball potential energy. The potential energy gets transformed into kinetic energy as the ball rolls down the tract. Some of the potential energy is also transformed into vibrations and sounds and is used to overcome air resistance and the friction of rolling along the track.

3) The Tides: This exhibit models the effects of the gravitational pull of the moon on the Earth's tides. Turning a handle makes the moon in the model go around the model of the Earth. The model of the Earth is
made out of flexible rubber and, as the 'moon' goes around it, the 'Earth' bulges as if in response to the gravitational pull of the moon.

4) **Gravity Well**: The gravity well is a large inverted cone with convex sides. As balls are released at the top of the well, they travel in elliptical trajectories around the well until finally they drop through the hole at the bottom. The gravity well serves to model three situations: elliptical trajectories of planets orbiting around the Sun; satellites falling into tighter orbits until they hit ground; and black holes (for this project, we were not expecting the children to deal with the concepts underlying black holes).

5) **Dance of the Planets**: This computer simulation models the effects of gravity on bodies in a number of situations (solar systems, binary stars, etc.). A moving object can have its trajectory altered by another object and vice versa. The net effect of mass, distance, and speed can be observed.
Appendix B

Pre- and Post-test Questions

1. What is your favourite sport? How does gravity affect you when you play your favourite sport?
2. How does gravity influence the waves and tides?
3. What would our lives be like without gravity? List as many things that you can think of that would be different if there were no gravity.
4. What is Gravity?
5. If there were no gravity, and you dropped a basketball from the CN-Tower, what would happen? What would happen if you threw the same ball off the CN-Tower towards the ground?
6. Based on your study of plants, why do trees stand tall? What is the force that keeps them standing? How do trees get food?
Appendix C

Multiple-choice Post-test Questions

Question #1:
Think back to your visits to the exhibit called "A Balancing Act." It is usually easier for females (girls, women) to successfully touch the button with their noses. Males (boys, men) have a lot more difficulty. Circle the letter beside the explanation that you feel is most correct.

a) It is easier for females because of the extra weight on their chests.
b) It is easier for females because their centre of gravity is in their hips.
c) It is harder for males because their centre of gravity is in their hips.
d) It is harder for males because they are not good at balancing.

Question #2:
Remember the "Rhoads Sculpture"? How do the balls get the energy to start their journey through the sculpture? Circle the letter beside the explanation that your feel is most correct.

a) Gravity gives the energy.
b) You give the energy by lifting the balls.
c) The electric motors give the energy.
d) All of the above.

Question #3:
Think of the exhibit called "The Tides" while you answer the question "What causes the tides on earth?" Circle the letter beside the explanation that you feel is most correct.

a) The gravitational pull of the sun on the oceans causes the tides.
b) The gravitational pull of the earth on the moon causes the tides.
c) The gravitational pull of the moon on the oceans causes the tides.
d) The force of the wind on the water causes the tides.
Question #4
Circle the letter beside the explanation that you feel is most correct. The exhibit called the "Gravity Well" shows:

a) The pull of gravity on an orbiting body.
b) How friction can slow an orbiting body.
c) That a black hole pulls everything into itself.
d) All are correct.

Question #5
Consider the "Dance of the Planets" exhibit.
Rule: Things do not like to change. If a planet is moving, it will keep on moving in a straight line. However we know that planets do not just move in a straight line. How does gravity make the planets circle the sun? Circle the letter beside the explanation that you feel is most correct.

a) The orbit results from the pull of gravity and the direction the planet wants to go.
b) The sun tricks the planets to think that an orbit is a straight line.
c) The planets circle the sun because they always have circled the sun.
d) None of the above.