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A SITUATIONAL-INTERPRETIVE STUDY OF THE MEANINGS OF MATHEMATICS FOR JUNIOR HIGH SCHOOL STUDENTS

BY

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled A SITUATIONAL-INTERPRETIVE STUDY OF THE MEANINGS OF MATHEMATICS FOR JUNIOR HIGH SCHOOL STUDENTS submitted by Douglas Roy Franks in partial fulfilment of the requirements for the degree of Master of Education.

K. B. Jacknicke
Supervisor

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Date: October 14, 1986

Abstract

A situational-interpretive study of the meanings that mathematics held for grade eight junior high school students was conducted during the 1984-85 school year. Eight students, all in the same class, participated.

The study was based principally upon two premises. First, meanings arise out of experience. Mathematics-related experiences in all contexts - in Mathematics class and out-of-Mathematics class contexts, and past and current situations - potentially contribute to the understandings that an individual has of the subject. Second, as "emergent" young adolescents in grade eight, the students are in a time of life during which their understandings of mathematics are, potentially, actively developing and changing.

Experiential meanings only were sought. The students were not tested in any way for their formal cognitive mastery or understanding of school Mathematics.

"Intensive interviews," semi-structured student journals, and classroom observations were the principal methods of gathering information. Of these, the interview was the primary data source. The interviews were semi-structured. The interviews were allowed to develop in directions dictated by student responses. Six to eight interviews were held with each student.

The students were each given a journal booklet in which they were asked, on a daily basis, to answer questions regarding their in- and out-of-Mathematics class mathematics-related experiences that day.

The Mathematics class was observed approximately twice per week for a total of twenty-one observation periods. The focus of the observations was the eight participants.

The interviews drew upon all data sources. They focused on three main areas: (1) specific experiences involving mathematics, (2) more general views of mathematics that were grounded in the students' mathematics experiences in elementary school, junior high school, and outside-of-school, and (3) biography.

The structure of the thesis permits each student to remain visible throughout while also providing an understanding of the meanings these grade eight students collectively attribute to mathematics.

A profile of each student is first presented. Schooling background, self-perceptions of ability and achievement level in Mathematics, general interests, interest in school Mathematics, and the research relationship with each student is presented here. The strong individuality of each participant is evident.

Current perceived contexts of mathematics experiences are then explored. The focus is on the contexts and the nature of the experiences themselves. The Mathematics classroom figures prominently in this discussion, but other contexts are also described. The perceived mathematics-related experiences outside of the classroom were quite limited.

Finally, student views of what mathematics itself is, and what they understand to be its value are described and interpreted. Mathematics is generally characterized as "working with numbers." The character of school Mathematics, and the influence of physical and social contexts on conceptions of mathematics are discussed. The "basics" are considered as important in daily life. Some future career value is also attributed to mathematics.

Mathematics is understood in terms of immediate experience. The general societal quantitative pervasiveness of mathematics is not recognized.

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TABLE OF CONTENTS

LIST OF TABLES

Chapter 1: INTRODUCTION TO THE STUDY

General Introduction: Mathematics And The Junior High School Student

By the time young people reach grade eight in junior high school, they have experienced several years of formal school Mathematics education, as well, possibly, as prior or concurrent mathematics-related learning in other contexts. Much of this education has had to do with what is often referred to as basic mathematics, or arithmetic. Conceptually, number has been introduced, and considerable time has been spent learning to perform the four basic operations of addition, subtraction, multiplication, and division. Students have been taught to recognize whole numbers, common fractions and decimal fractions, and to add, subtract, multiply and divide in all these numerical representations. (See the "Conventions" section in this chapter for an explanation of the use of mathematics and Mathematics.)

Symbols - numerical, operational, relational, conceptual - have become a central part of the formal study of mathematics. Thus, junior high school students have encountered mathematical operations in at least two "languages;" their native language, and a specialized mathematical symbolic language - for example, "add," "plus," and "+." Moreover, many mathematics-related words have both operational and conceptual connotations which must be considered. Measurement with its own terminology and call for accuracy, and geometry with its formal representation of familiar, often taken-for-granted shapes and forms also become a part of the child's Mathematics instruction as he or she advances through the upper elementary grades and into junior high school. In the junior high school years of Mathematics education topics such as set theory and condition solving are introduced and the abstractness becomes increasingly apparent.

The classroom has been the place where much of the mathematics the grade eight student knows has been learned. Having had many experiences involving formally "doing Mathematics," what might mathematics mean to the student in terms of how the subject is personally characterized conceptually? What meaning does it have as a school subject?

As Mathematics is developed in school, it may come to be considered as increasingly challenging because of the provision of more diverse and sophisticated problem solving approaches. There may be a (growing) belief in the student that there exists in "doing mathematics" a potential for intellectual growth in ways not encountered before. Then too, having difficulty understanding the concepts taught, and with "doing mathematics," may produce negative interpretations of the subject. Perceiving in certain mathematics little if any intrinsic value, that is, to not believe it's study to have value for its own sake, is an interpretation of mathematics that gives personal meaning to the subject of a still different sort.

Other possibilities for what mathematics might mean develop when the context of doing mathematics is expanded to include experiences outside of the Mathematics classroom. On the one hand, Mathematics as presented in school may provide the junior high school age person with new ways of interpreting his or her surroundings, with new ways of approaching and dealing with day-to-day situations. Conversely, any perceived mathematical experiences beyond the classroom may influence the understanding each student has of the discipline.

It is possible, too, that as mathematics is developed in the classroom, the out-of-class experiences of mathematics may also be perceived differently. For example, as the specialized vocabulary, abstract representation of concrete objects and real events, and stress on detail and preciseness, rigour and structure increases, the subject may be understood by young people to be withdrawing itself from a place of significance in the affairs of everyday life beyond the class. This possible inability on the part of students to relate certain mathematics to everyday life, in effect the "non-experiencing" of mathematics, would also be an aspect of what mathematics means to the person.

Other meanings of mathematics may accrue not from direct personal investments in its use or from acknowledgements of non-use, but through the individual's understanding of how mathematics is generally discussed or portrayed in his or her own social situations, and in society more broadly.

The potential range of meanings of mathematics that may be held becomes a wide, uncertain horizon of possibilities.

Purpose Of The Study

The students in this study are in grade eight in junior high school and still very much in their formative years in many ways. One of these formative aspects is their understanding of mathematics. By the time a student is in grade eight, many hours have been devoted to the study of the subject. It was suggested in the Introduction that potentially, one comes to understand mathematics both through its formal study in classroom experiences and through its use, frequent or infrequent as it may be, in life experiences outside of the classroom.

The young person of thirteen or fourteen is in a particularly dynamic period of life. He or she is at an age when active physical change is common; the limits of intellectual growth are expanding. Psychologically and sociologically early adolescence is generally acknowledged as being a time of actively attempting to develop a sense of self-identity. Relations of "Self" with "Others" are changing. The influences upon the young person, and the possible directions in which she or he may travel, are many. Many of their life possibilities appear as relatively unknown, being seen as new, or anew.

Given that young adolescents (1) are at a significant time in their lives, a time of potentially substantive personal growth in several dimensions, (2) have just recently undergone a major transition in school structures in moving from elementary school to junior high school, and (3) have lived long enough to have experienced at least seven years of informal and formal mathematics education, the latter of which has steadily increased in its range of topics and in abstractness, what meanings of mathematics are held by these young grade eight students?

The purpose of the study was to present a qualitative interpretation of what each person in a small group of grade eight students understands mathematics to mean to him or her, based upon an exploration with the students of their mathematics-related experiences in various situational contexts. The experiential context of the Mathematics class and contexts external to the classroom were both considered, as were both current and past situations of mathematics-related experiences.

Significance Of The Study

Much attention has been devoted to studying how children learn mathematics. The goal has been to seek ways of enhancing this learning. The result of such work has been largely a redressing of the teaching of the subject: methods, sequence, topics, and so on.

Attitudes toward mathematics have also been researched; the result has perhaps been to make teachers more aware of how students in general feel about mathematics, and perhaps has led to a consideration of and change in what has been taught and how it has been taught. Such studies generally do not provide personal context; their aim is to demonstrate opinion on a broad basis. Individual biographies are very seldom apparent. These studies (for example, Carpenter, Corbett, Kepner Jr., Lindquist, & Reys, 1980) provide evidence of attitudes toward mathematics generally and toward subjects within mathematics, toward teacher methods and attitudes, and toward the perceived relevancy or "usefulness" of mathematics. But they seldom attempt to retain the identity of the individual throughout the description and interpretation of the person's stated claims about mathematics.

The study recognizes the prominent place of the current Mathematics classroom in reference to the learning of the subject matter, but it also explicitly acknowledges the historical nature of the student's developing understanding of what mathematics means to them. Secondly, it asserts that the study of mathematics must be understood as taking place in the context of the larger milieu of school learning, which in turn is an aspect of one's entire daily living.

The significance of the study qua study lies in its explicit recognition of the students as persons with a mathematical history whose present experiences of mathematics include, but may extend beyond, those in the Mathematics classroom. It is based on a claim that all of these contexts may contribute to what each individual variously and uniquely understands mathematics to mean. Because of this, individual identities are retained and developed throughout the presentation. The thesis presents an expressly student perspective, and attends closely to their language.

The significance of the study for mathematics education lies largely in its reminder to educators that what mathematics means to young people potentially may vary substantially and for various reasons from person to person. By taking cognizance of this potentiality, and acting upon it in teaching Mathematics, teachers may enhance the teaching-learning experiences of Mathematics for students and themselves.

Orientation Of The Study

This study principally adopted an interpretive-situational orientation (Aoki, 1980). Eight grade eight urban public junior high school students participated in the research. It is a contextual study of the understandings that each of these young people have of mathematics at this point in their lives.

The interpretive-situational stance recognizes the multiple realities of a situation - "there are as many constructions [of reality] as there are people to make them" (Guba & Lincoln, 1982, p. 239). Thus, student interpretations of events within the current classroom potentially will differ from student to student. Secondly, because this study also sought the meanings of mathematics derived from experiences in past classrooms and in situations external to the current grade eight classroom, the situations themselves vary substantially from person-to-person.

This research had an "instance" (Stake, 1978) or case study orientation in two respects. First, the focus was on a group of students in a single classroom. Second, in a very tangible way each individual served as an instance. Each acted as informant in their own study.

Three principal methods were employed: classroom observations, "intensive interviews" (Williamson, Karp & Dalphin, 1977), and semi-structured student journals. In addition, there was qualified access to student records. The researcher also maintained an "events" log and personal journal notes. The collective aim of the methods was to encompass student experiences both physically shared with the researcher, and those not so shared, and to permit and encourage the students to reflect upon and talk about those experiences.

The student reflection upon and discussion of experiences is a major part of the study. There is thus an implicit acknowledgement that young people of this age are capable of stopping-and-thinking, and giving verbal and written expression to these thoughts. Support for this position comes in one instance from an examination of the Mathematics curriculum itself, which, by its content, assumes the young adolescent generally is capable of some abstract thought.

There was a concern that the ability to recall and discuss past experiences and perhaps especially to articulate an understanding of what mathematics means in light of these experiences might be quite variable among the individual students, perhaps to the point of being very difficult for some. Language might be a barrier. This was in part the reason for holding several interviews with each: to provide time for disclosure of more experiences and increasing disclosure and interpretation of previously discussed experiences.

At times during the research, particularly with some individuals, student articulation was brief and fragmentary; researcher interpretations of what mathematics meant to each individual was difficult in these cases. These difficulties are described more explicitly in the profiles of the students.

If language is potentially a barrier, it can also be a revealing. Seeking the student perspective meant in part explicitly acknowledging the language of each individual. Noting the language of description each person used reveals something of the people themselves.

Delimiting Mathematics Discussion

In a study such as this, the scope of which is wide, discussion with each student can potentially lead in many legitimate mathematics-related directions. Discussion of classroom experiences was seen as being well within this research scope. The orientation of these particular discussions was not in the direction of determining the mathematics ability level of each student however. There was no formal or informal testing of the students' knowledge of and ability to "do" the mathematics of specific topics. Nor were they asked to explain or describe specific mathematics concepts, or operations, or laws, or the like.

Time Frame Of The Study

The field research began in the fall of 1984. It was originally estimated that this aspect of the study would last approximately six weeks to two months. However, delays in actually beginning to meet with the students, the number of student participants in the study, other weekly commitments of the researcher, and the nature of the study itself, involving developing relationships, eventually meant a much increased duration for the research. All those involved, the students and the teacher, displayed a positive willingness to continue beyond the originally suggested time frame.

The initial classroom visit was in late October, 1984. The interviews with the students commenced in the middle of November, and continued, although not on a weekly basis, until mid-March, 1985 (see Appendix E). There was a break of three and one-half weeks, from late December to mid-January, when no research visits to the school were made. The final session - the validation of the interpretation of an earlier interview conducted with the teacher - was held during the latter half of March.

Relationship Of Research Period To Subject Matter Taught

There was no pre-determined relationship between the time frame parameters of the study, and the mathematics subject matter being taught. While it was recognized that what was being taught might well influence the students' actions in class and what each might say about mathematics, there was no pre-selection of a mathematics topic and attempt to schedule the research activity while it was being taught. In point of fact, however, almost all the research was conducted during the period in which the subject matter was various aspects of geometry and geometry-related measurement, such as angle measure, and the perimeter and area of polygons.

These particular topics did have a direct bearing upon some of the meanings of mathematics discerned from current classroom experiences.

The Notion Of Interpretation

Ricoeur (1978) describes interpretation that extends beyond that made during the relative immediacy of the person-to-person dialogue or conversation itself - text or symbolic text-analogue interpretation, for example - as a complex process involving the dialectical relationship of explanation and understanding. Rather than viewing these two aspects dichotomously as mutually exclusive poles, they are relative moments in the interpretation process.

To explain an event or phenomenon is to consider it as the consequent effect of some cause. Epistemologically, understanding, in the present thesis context of humans understanding humans, addresses our knowing of the intentions and motives of others.

> Man is precisely that being who belongs at the same time to the regime of causality and to that of motivation, thus of explanation and understanding. (Ricoeur, 1978, p. 158)

Strasser (1985) also describes explanation and understanding as dialectically related. Interpretation becomes "a spiral of understanding." As humans, we have an immediate understanding of each other. He refers to this primary, intuitive understanding of one person by another as "being on the same wavelength" with him or her, and designates this understanding as "Understanding I" (p. 24). This primary understanding is a necessary condition for an adequate theoretical explanation. In turn, this explanation provides a deeper understanding of the individual, an "Understanding II." In principle, Strasser notes, there is no reason why an even more sophisticated explanation could not be developed from which, in turn, an even deeper, refined understanding would be made possible.

As with Ricoeur (1978), understanding, for Strasser (1985), precedes <u>and</u> succeeds explanation. Understanding dialectically surrounds explanation. The interpretive process yields this spiral of understanding.

Analysis Of The Data

Six to eight audio-tape recorded interviews were held with each student. The first interview with each dealt with procedural and administrative matters, and was not transcribed in most cases. All subsequent interviews were transcribed. The student journals were collected approximately every two weeks, although this varied considerably among the students, and classroom observation took place two periods per week. The previously transcribed interviews, the classroom observations, the copied student journal notes, the demographic information, and the personal researcher notes were codified and a preliminary analysis undertaken. The most recent data was integrated with prior analyses and interpretations. In this initial analysis areas of uncertainty, apparent incompleteness or contradiction were noted. From this a series of questions for the next interview was formed to further clarify or explore current areas of interest, or to begin discussion of a new topic.

The aim of all questioning was to explore one of the following three general areas: (1) specific experiences involving mathematics, (2) more general views of mathematics - what the field itself is, what its value is - that were grounded in the students' mathematics experiences in elementary school, junior high school, and outside-of-school, or (3) biography.

The questioning which sought an understanding of what the students considered mathematics to be was not intended to produce a list of topics that constituted the field as a school subject, although elementary school and junior high school Mathematics were discussed. The intent was to gain an understanding of the ways in which the students typified Mathematics at these school levels, and an understanding of how the subject was perceived to have changed, if at all, over the school years.

The study is an integration of description and interpretation as the dialectic of explanation and understanding. Interpretation always had as its aim attempting to explain and understand the ground of the students' positions by remaining at the level of the student, that is, the level of the student's - the young adolescent's - own existential being in the world. There was no attempt, for example, to interpret the student's perceptions, beliefs, and feelings, in terms of psychological or sociological theoretical constructs. This does not mean that the study remains only as a description of each student's sometimes fragmentary, incomplete and contradictory positions. What it does mean is that it is essentially an attempt to deepen each student's own articulation of what mathematics means to him or her, and to organize and present this deepened articulation in a manner which permits both the individual student and the student group to remain visible.

Theme development began during the field research, and continued after that phase was completed. In this broadly focused study the mathematics-meanings themes that arose were numerous. The search for a structure with which to organize these themes also constituted a major aspect of the coincident and post-field research analysis and interpretation.

Four organizational areas or thematic groupings that taken together covered the range of themes of mathematics meanings that could be discerned from the students' discussions of mathematics and their experiences with it were chosen. These were:

(i) the contexts, and the existential nature of the mathematics-related experiences;

(ii) the student perceived value of mathematics and its study;

(iii) the student perceived interest in studying mathematics, where interest is meant as "appeal, for its own sake;"

(iv) the characterization of the perceived <u>conceptual substance</u> of mathematics itself that derived from students' experiences in various contexts.

The last thematic area reveals what the students understood mathematics itself to be. This takes two principal forms. Firstly, it is a more general identification or naming of what mathematics is. Essentially, it reveals the students' experientially based, cognitively oriented depictions of mathematics. Secondly, this organizational grouping encompasses participants' perceptions of what school Mathematics is, as well as their descriptions and interpretations of how its character may have changed over the years of schooling. Finally, the physical and social contexts of the experiences influenced the students' understandings what mathematics is, and are thus also integral aspects of the development of this theme.

Format Of The Thesis

As indicated in the Purpose section of this chapter, the choice of junior high school students as subjects for the study was made in part because of some significant, general characteristics of students of this age and at this grade level. Chapter 2 discusses the literature related to young adolescents.

The focus of this discussion is on the general growing, emerging nature of these young people, not the possible formal, theoretical cognitive developmental aspects of young adolescents. This study is grounded in an analysis of what mathematics means to students based upon their experiences with the subject in various contexts. This first section of Chapter 2 develops a view of persons whose perceptions and understanding of their experiences are potentially significantly changing, and who, while being old enough to have already had many life experiences, have yet to live numerous of the general experiences that are common aspects of human living in many parts of North America - entering and completing (or leaving) senior high school, possibly attending a post-secondary institution, and beginning a career, for example.

Secondly, Chapter 2 briefly examines the literature related to junior high school students' attitudes toward Mathematics, including the relevance of studying the subject. While attitudes toward Mathematics is not the principal focus of this present study, attitudes were of course present in some of what the students had to say about the subject. The inclusion of this brief examination acknowledges that attitudes toward mathematics are an aspect of what mathematics means to the individual.

Finally, Chapter 2 explores some of the literature related to the contextual experiencing of mathematics. This literature is supportive of the claim that mathematics is largely learned inside the Mathematics classroom, but has relevance in contexts outside the junior high school classroom. These possible out-of-class experiences potentially bear upon experiences in the classroom. In this section the nature of out-of-class mathematics-related experiences, and what it means to bring these experiences to reflective consciousness, is also explored.

Chapter 3 is an in-depth presentation of the methods of selection, data collection and analysis. Considerable attention is devoted to the research process as it developed over the period of time in the field.

It has been noted that the study has two levels of case study or "instance" focus. The first "instance" is that of conceiving of this research as studies of eight individuals who are all at grade eight in Mathematics. The second level is that of conceiving of this work as the study of a group of grade eight students in a single classroom. The format of this thesis is designed to reflect that duality.

In order to highlight each individual, Chapter 4 presents a profile of each student. These profiles primarily focus on the following:

(a) briefly, some background history vis-a-vis where each went to school, their ages, and their regular extracurricular and out-of-school activities;

(b) how academically "good" each perceived themselves to be;

(c) descriptions of how each generally currently categorized their attitude toward Mathematics as a school subject, including a description of each student's interest in Mathematics;

(d) brief descriptions and interpretations of student-related researcher observations and personal journal notes, including a brief portrayal of the perceived researcher-student relationship, that is, remarks on the research "process" with each student.

Interest in Mathematics (item c) is specifically taken to mean the appeal of the subject for its own sake.

The juxtaposing of the eight profiles permits a comparison of the students' self-attested achievement levels, their self-perceptions of Mathematics ability, and their interest in the subject of Mathematics. These are present among the students in highly varying combinations that speak to the individuality of each of these young people.

In Chapters 5 and 6, where the descriptions and interpretations are presented under thematic headings rather than on a student-by-student basis, the students continue to be identified, and the presentation attends closely to the language of the students. Thus student biographies and the meanings that mathematics holds for any one of the eight people are developed throughout the thesis. At the same time, thematically organizing Chapters 5 and 6 facilitates a greater understanding of how the participants as a group of grade eight students view mathematics, complete with similarities and differences among the group members.

Chapter 5 presents a description and interpretation of the spatiotemporal situations of perceived mathematics-related activity in daily living. The physical/social contexts, the nature of the activity, and the student responses to experiencing mathematics in those contexts are described. The Mathematics classroom figured prominently in the students' experiences. Those aspects of these classroom experiences which were given emphasis by the students are presented in detail.

Chapter 6 first presents descriptions and interpretations of what mathematics means to the students in terms of the subject's conceptual nature. Insights into this matter are again developed in three ways:

(a) through the presentation of the students' general characterization of mathematics;

(b) through the presentation of the students' conceptual description and understanding of the discipline based upon more than seven years of Mathematics classroom experiences; and

(c) through the presentation of the ways in which student conceptions of mathematics shape the interpretation of possible mathematics-related experiences beyond the Mathematics classroom, and conversely, how these activities shape student-held conceptions of mathematics.

Chapter 6 then examines what the students understand to be the value of Mathematics study. To complete discussion in this section, the relationship between the significance or emphasis each student placed on the usefulness of Mathematics and the extent of his or her interest in its study is examined.

The areas which together provide the focus for Chapters 5 and 6 are not logically exclusive of each other. There is a considerable amount of overlap in terms of areas of discussion, interpretation, and meanings. Experience and mathematics are common grounds to them all. Largely it is a question of emphasis. In some cases it is the descriptions and understandings of the experiences themselves that are primarily sought, but always with the understanding that these are experiences of mathematics. In other cases it is the understandings of mathematics itself, based on the experiences, that are uppermost.

Throughout Chapters 4, 5, and 6 the individual-mathematics relationship is always present and visible. Chapter 4 focuses on those aspects of the relationship which give particular prominence to the "individual" side of the relationship. In moving from Chapter 4 to Chapter 6, the emphasis shifts so that, while the individual student is always identified, mathematics itself, as understood by these grade eight students, increasingly becomes the focus. In Chapter 6, for example, there is greater student generalizing or theorizing about mathematics: what it is, how it may have changed over the years of schooling, and the value of its study.

Chapter 7 is a presentation of reflections on the study as well as comments on the significance of the study for mathematics educators, and suggestions for further research.

On The Question Of "Understanding" And "Meaning" Of Mathematics

In the understanding of mathematics, it has been suggested that there is the possibility of a reciprocity. The acquisition of mathematical knowledge may assist one in understanding the world of her or his daily life; experiences outside as well as inside the Mathematics classroom may help give meaning to school Mathematics. In effect, there may be a spiral of understanding of mathematics that changes as one continues to study the subject and at the same time continues to grow and experience life. No claim is made that there is in any sense a balance, or an equality of mathematics-related experiences inside and outside of Mathematics class. The claim is only that it is the totality of these experiences which yield the fullness of meaning of mathematics, no matter what the context may be, and no matter how much some contexts may predominate. What determines one's overall understanding of mathematics is the interactive sedimentation (Schutz & Luckmann, 1973), over several years of living, of experiences both inside and outside of school that in some way relate to mathematics. Reflection upon them yields meaning. Understanding is meaning-related in that implicitly or explicitly, the statement "I understand X to mean Y" is present. As stated, this study is a quest for some of the meanings of mathematics that a group of young adolescents individually hold.

Understanding of mathematics, as used here, is seen in two primary ways. First, there is a sort of theoretical or formal understanding of mathematics, a "second order" understanding based directly on a knowledge of Mathematics curriculum content: concepts and operations known through classroom instruction and practice. Under this broad heading would be such kinds of understanding of mathematics as "relational understanding," "instrumental understanding," and "logical understanding" (Skemp, 1976, 1979; Byers & Herscovics, 1977).

Gaining knowledge of what the individual understands of mathematics in this second order sense consists largely in having the person define or explain mathematical concepts and processes, solve mathematical problems through the application of appropriate axioms, definitions, laws, theorems, operations, and so on.

The second, informal or "first order" understanding of mathematics is a "commonsense" understanding, less exclusively cognitive than the first, in which one is geared into one's environment. To understand mathematics in this way is, for example, to know of its relevance to the daily situations one lives through in any context, to have some sense of its value for oneself, and to know what mathematics is in terms of "to 'do mathematics' means that I <u>characteristically</u> undertake certain kinds of activity." It is to know what mathematics is as a classroom experience, to understand what it means to go to "Math class" and to "study Math." This first order understanding thus in part is an evocative understanding: It evokes emotional and attitudinal responses.

This study is primarily concerned with the meanings which arise from a student's "first order" understanding of mathematics, but it acknowledges an inextricable relationship between the two orders of understanding in together yielding meaning.

In considering "meaning" in the context of the study, the writings of Polanyi, Schutz, and Arendt are invoked. Polanyi wrote,

> man lives in the meanings he is able to discern. He extends himself into that which he finds coherent and is at home there. These meanings can be of many different kinds and sorts. Men believe in the reality of these meanings whenever they perceive them - unless some intellectual myth in which they also have come to believe denies reality to some of them. Men are then in difficulty with themselves about these particular meanings (Polanyi & Prosch, 1975, p. 66).

The meanings sought here are those which the young student is able to discern. These meanings of mathematics may indeed, "be of many different kinds and sorts." They may be born out of a textbook, the message of a teacher, or through personal engagement with the "mathematical" in any number of other contexts. Conflicting beliefs may lead to a difficult discernment. This possibility is acknowledged.

Experiences provisionally yield meaning. The discernment of meaning arises from reflecting upon and thus interpreting past experiences (Schutz, 1973). Furthermore, Schutz claims that, "only experiences which can be recollected beyond their actuality and which can be questioned about their constitution are . . . subjectively meaningful" (1973, p. 210).

Arendt (1978) also informs us that experiences alone yield no meaning; it is the thoughts arising out of the experiences which do. Thinking is the quest for meaning. To think is to reflect; "all thinking demands a <u>stop</u>-and-think" (p. 78). It is this latter comment, built upon the former, which points the way to how the study will largely pursue its program. Students will be encouraged to "stop-and-think," to reflect upon their past experiences, and to attempt to articulate what they understand the discernible meanings to be.

The extent to which, and the ways in which students make sense of their mathematics-related experiences address the questions of the meanings of mathematics. The meanings may not come in the form: "This is what mathematics means to me . . ." and thus it is the researcher's role and responsibility to assist the students, through interpretation, in the articulation of these meanings and to elaborate or deepen the student articulation of meaning.

Conventions Adopted In The Study

The following conventions have been adopted in the writing of this thesis.

(1) The terms Mathematics and Math - capitalized "M" - refer specifically to the subject as taught in school; thus, for example, "Mathematics classroom," and "Math teacher." In the case of elementary school, where there often is no specifically designated Mathematics classroom or Mathematics teacher, these latter terms refer to the place in the school where the subject was taught, and to the school teacher who taught the students Mathematics.

(2) The terms mathematics and math - lower case "m" - refer to the field of mathematics generally, and may include activities which take place in the classroom. Lower case "m" is also used where the context is unclear, such as occurs sometimes during the interviews.

(3) The term arithmetic is not used in the study except

(a) in an initial reference (p. 1) in the General Introduction of this chapter to its being "basic mathematics,"

(b) where the author of a referenced piece of writing uses the term, or

(c) by the researcher on three instances during the course of all the interviews. In each case it directly referred to the basic operations of adding, subtracting, dividing, and multiplying.

No attempt was made by the researcher to pre-determinately equate elementary school subject matter with arithmetic and junior high school subject matter with mathematics.

Summary

The five month study investigated the meanings that mathematics holds for eight young people in a grade eight urban junior high school. It is an interpretive-situational study in orientation, making use principally of classroom observation, "intensive interviews," student journals, and researcher accounts of the research experience.

These meanings were sought primarily through focusing on student reflection upon and discussion of their experiences with mathematics both inside and outside of the Mathematics class. They are presented in the thesis under various thematic headings. Student profiles that help to disclose each person biographically are also presented.

Chapter 2: THE YOUNG ADOLESCENT AND THE EXPERIENCE OF MATHEMATICS: A DISCUSSION OF THE RELATED LITERATURE

Introduction

Junior high school students were chosen as the subjects in this study in part because they are young people who are potentially in a particularly formative time of their lives. An examination of literature related to the young adolescent is presented here. The focus is not on the possible cognitive developmental aspects. The section begins by reviewing the notion of "young adolescent" as signifying a person in a time of change in their lives, and then shifts slightly to consider this change as portraying an emergence of the person in an existential sense.

Attitudes toward mathematics are not the main focus of this study. However, a number of empirical studies, such as the survey research conducted by Callahan (1971), Fraser (1980), Wilhelm and Brooks (1980), and Wolf and Blixt (1981) indicate that the late elementary and junior high school grades tend to be relatively critical years in the development of student attitudes toward mathematics. Thus, there is evidence to suggest that grade eight students are well into a period of significant attitude formation regarding mathematics. Because of this evidence, and because attitudes are closely associated with meanings, a brief review of literature related to young adolescent attitudes toward mathematics, including perceptions of the subject's relevance, is also provided in this chapter.

The final section in this chapter examines some of the literature that relates to the general nature of mathematics, and to its understanding through experiences inside and outside of the teaching-learning environment of the classroom.

The Young Adolescent: Emergent Being

The grade eight student typically ranges in age from twelve to fourteen and is within that period of human life commonly labelled as "early adolescence." This period of human life is widely considered to be one of the most significant, perhaps most complex and trying times in the human growth cycle of North Americans (Bell & Ackerman, 1979; Kaluger & Kaluger, 1976; Lipsitz, 1978; Mitchell, 1974; and Santrock & Yussen, 1984, for example). The appellation "early adolescence" is not accepted by all. Toepfer and Marani (1980, p. 272), for example, challenge it on the grounds that it inadequately acknowledges the uniqueness of junior high school-aged young people as a group. To label them "early anything" is to give these children insufficient recognition in their own right. Toepfer and Marani prefer Eichhorn's concept of "transescence," which, as Eichhorn (1980) states, refers "to the stage of development that begins prior to the onset of puberty and extends through the early stages of adolescence" (p. 59). While this definition itself evokes a search for further definitions, recognizing students at the junior high school level as "transescents" does imply an acknowledgement of these people as being an identifiable group on the basis of their being in a time of life characterized by changes of many types, and at the same time permits diversity of development within the group. Still others, notably Lipsitz (1978, 1980), use the phrase "early adolescence," but strongly resist identifying this time of life solely in terms of its being a period of transition. Acknowledging that many changes do take place in children in this age-range, she (Lipsitz, 1980, p. 22) claims though that "the label 'transitional' is a barrier to the healthy development of young adolescents" because it encourages the perception that it is a time of life known almost entirely in terms of its being one that people "will grow out of," and thus also encourages non-interest and "non-intervention."

Regardless of what, if any, label is used, there is general recognition that this is a critical time of life, that this is "a time of life when the world of childhood imperceptibly blends and overlaps with the world of adolescence. . . . Every aspect of the person is changing, growing and modifying during these critical years" (Mitchell, 1974, p. 1).

For many of these young people, other interests may begin to take precedence over, or increasingly compete for attention with their academic school studies. Kagan (1972) suggests that for eighty to ninety per cent of early adolescents in a "typical classroom:"

> The preoccupying motives . . . revolve around resolving uncertainty over sexual adequacy, interpersonal power, autonomy of belief and action, and acceptability to peers. The urgency of these questions dominates the weaker desire to acquire competence at mathematics, history, or English composition (Kagan, 1972, p. 100).

In the context of this study, the introductory words of Jenks (1982) regarding the child as "emergent being" seem particularly appropriate.

> The child, as the person, can be regarded as project, as imbued with the essentials of choice, creativity and self-determination. In this way we may explore the existential potentiality of each individual forging his [or her] identity within the structured context of collective life (Jenks, 1982, p. 61).

The growing, developing child lives an abundance of experiences on his or her way to becoming the young person met in the grade eight classroom. Included in that totality of life experiences are those which are, for the child, in some way mathematical. How does the young adolescent, as "emergent being," understand these? Within the potentiality of each student are the uniquely developing meanings of mathematics.

Another significant related perspective from which to perceive the developing young person in this study is in terms of what Vandenberg (1974) refers to as the "not-yet" of the child. The child partly appears in various ways to him- or herself, and to others, in pre-theoretical taken-for-granted consciousness, as "not-yet." For example, others commonly see the child-as-"emergent being" (especially those who are older and who are in close association with that person), in a pre-philosophical lived-world orientation as not yet going to school, not yet dating, not yet in high school, not yet going to university, not yet starting a career, and so on. More centrally situating this view of the child as "not-yet" within the context of this study, the young grade eight student also perceives her- or himself to be "not-yet:" not yet a "senior" junior high school student in grade nine, not yet a high school graduate, and not yet an adult, for example.

For Vandenberg, understanding the child existentially as "not-yet" is essential to a full recognition of the child as human. "The not-yet is an essential characteristic of being-child. The appearance of the child as a not-yet is a 'special case' of the 'general case' of the appearance of man as a not-yet" (1974, p. 209). In an educational context, these lived-world self-perceptions, Vandenberg believes, should be viewed as being implicitly understood by the child as his or her <u>wanting</u> to be someone, and serving as fundamental motivations for continuing schooling. Mathematics has been and continues to be at this time for the young adolescent an integral part of the process of the act of receiving school education, and thus of the process of becoming the "independently existing adult."

Ontogenetically, the young person grows in reflective, conscious awareness as well as in changing pre-theoretical aspect. As the child becomes adult, he or she establishes awarenesses and forms concepts "to which the particular circumambient culture and language give access, and in doing so appropriates into himself or herself the past of the species lodged in the concepts, culture, and language" (Ong, 1982, p. 180). The young people met in the study are dynamically involved in the process of these appropriations. The sequence and content of the experiences which yield the appropriations are unique to the individual. In Schutz's (1973) terms, each life-situation the person finds him- or herself in is a "biographically determined situation," and is thus, in terms of its interpretation, ultimately uniquely experienced. The meanings that one discerns, that one makes of one's life experiences, and of the things one has been taught and has learned from those experiences, are unique to the individual. As Ausubel phrases it in somewhat more psychological terms,

> all phenomenological (psychological) meaning is, by definition, idiosyncratic in nature, since no two persons have identical cognitive structures.

> Psychological meaning [as opposed to the "logical meaning" manifest as a property of the particular taught subject matter] never occurs in the abstract sense of the term; it invariably emerges in a particular individual (Ausubel, 1980, p. 237).

This mathematically related study thus focuses on a group of individuals who, simply by virtue of their being human, uniquely interpret or give meaning to their experiences in life, and who, additionally, are within a time of human life recognized as particularly distinctive.

A Brief Review Of The Literature Related To Young Adolescents' Attitudes Toward Mathematics

As noted in the Introduction, the literature suggests that students in grade eight are in a significant period of attitude development toward mathematics. This generalization is made with the cautionary qualification that it may obscure the individual case. Such cautions should perhaps be especially heeded when discussing early adolescents for, as Tanner (1972), Bell and Ackerman (1979), and Eichhorn (1980) suggest, people who are supposedly within this period of human life exhibit a vast diversity in many ways in terms of their development.

Survey and quasi-experimental research into attitudes has been an important part of the study of Mathematics education. Thus, while such research has not been drawn upon directly nor explicitly referenced in the analysis, an overview is presented here in order that the reader may understand its nature. Certainly aspects of attitudes towards mathematics that this past research has explicitly examined are present in many of the eight students in this study.

The relationship between attitude toward mathematics and Mathematics achievement has been examined by a number of researchers, but the strength and causal nature of this relationship is not clear. In an English study, Matthews (1981) found that "on the whole, those who liked mathematics did better than those who disliked it. However, whether they liked [mathematics] because they were better or were better because they liked [mathematics] is not easy to decide" (p. 337). In an address to a conference sponsored by the National Council of Teachers of Mathematics, Gray (1972) agreed that there may be a correlation between the two elements, but seriously doubted the strength of such a correlation. Instead, a negative attitude toward mathematics was more likely to simply prompt students to cease studies in mathematics when they became optional. There is some recent evidence (for example, Wolf and Blixt, 1981), however, that suggests that attitude does have a weak causal effect on achievement in Mathematics.

Curriculum design and implementation, parental attitudes toward mathematics, and especially teacher attitudes have been found to be formative sources of student attitudes, with gender differences also being present in the findings.

Callahan (1971) found that two of the biggest factors contributing to a dislike of mathematics by junior high school students were feelings of inadequacy in the learning and memorization of mathematics and boredom associated with too much repetition. Carpenter et al. (1980), in a national United States survey, found that students perceived their role in the Mathematics classroom to be primarily passive, although it also determined that almost seventy percent of thirteen-year olds claimed to enjoy mathematics. The results of the Callahan survey of grade eight students showed that when students were asked directly (on an eleven-point scale) if they liked mathematics, more than sixty percent indicated they did. However, the results of other questions in the study suggest that this percentage was substantially higher than what might actually be the case. It was Callahan's belief that when left to use self-report methods (as was the case in the Carpenter et al. study), students tend to overrate themselves on their general feelings toward arithmetic. Carpenter et al. also caution that there may have been a strong tendency for students to respond "with what they considered 'correct' answers rather than their true feelings" (1980, p. 532).

An important factor in influencing the attitude of students toward mathematics is the teacher, and especially the ability of the teacher to explain clearly (Kiryluk, 1980). Fennema (1980) strongly expressed the opinion that "it is the day-to-day interaction with teachers that is the most powerful influence on students" (p. 169).

Undergraduate students having an extreme attitude toward mathematics (hating it or loving it) have stated that a major factor in their forming that attitude was a particular teacher they had had in their prior schooling (Ernest, 1976). Ernest found it distressing then that forty percent of a class of future teachers enrolled in a Mathematics course were indifferent to mathematics or actually disliked it. On the basis of a case study of three junior high school Mathematics teachers, Thompson (1984) concluded that, along with general conceptions about teaching, and conceptions about the students (individually and collectively) they are teaching, "the teachers' views, beliefs, and preferences about mathematics do influence their instructional practice" (p. 125).

In an English study of fourteen-year old Mathematics students which employed the qualitative "critical incident technique," Hoyles (1982) found that "pupils wanted to be given mathematics of 'appropriate' standard but quickly lost confidence if teachers left them behind or put pressure on them" (p. 369). Matthews (1981) stressed the point that "teachers must be aware of the importance of the child feeling self-confident and successful so that negative feelings can be avoided" (p. 338).

L.R. Aitken (Ernest, 1976) found that a child's attitudes toward mathematics are definitely influenced by the parents, although according to Wilhelm and Brooks (1980), the relationships are apparently somewhat complex. In a survey of children from grades one to twelve, Ernest (1976) found that mothers were the parent that children most often turned to for help with English homework throughout school, but after grade six, fathers assumed the role of the "authority" on mathematics at home. Thus role models are being formed that may influence a child's attitude.

Gender differences in attitude toward mathematics have been researched in some depth. Full agreement is lacking in several areas, however. The national survey of secondary school students by Carpenter et al. (1980) found that approximately ninety percent of both males and females disagreed with the idea that "mathematics is more for boys than for girls." Only approximately three percent agreed with the statement. The Ernest (1976) survey results seemed consistent with this - in terms of liking the subject, Mathematics was the only subject which exhibited no sex differences. This held at all grade levels. However, in an Australian study of children in grades seven to ten, Fraser (1980) concluded that boys expressed significantly more favourable attitudes toward mathematics than girls. Also contrary to the Carpenter et al. (1980) self-appraisal study, Fennema (1980), in restating a finding from an earlier study of her's, claimed that to some degree, boys particularly had stereotyped mathematics as a male domain. Head's (1981) review concurred with this latter view.

Mathematics is seen as the "critical filter" that often keeps women from many desirable professions and vocations (Fennema, 1980; Sherman, 1982). Gender differences in attitudes toward mathematics are also teacher related. Fennema (1980) claims that at least some Mathematics teachers treat girls and boys differentially, thus quite possibly providing a subtle negative influence on females' studying of mathematics.

A Brief Review Of Literature Related To Young Adolescents' Perception Of The Relevance Of Mathematics

Throughout the literature the preponderant theme with respect to the relevance of mathematics is that of a delayed- or future-benefit. In one of the field studies which Stake and Easley (1978) detail - this in an alternative school where a special effort was made to make the students' studies relevant to them in the present - the staff and students found that "they had not been able to find a way to make Mathematics relevant to student interest in their environment" (1978, p. 13 - 25). Nevertheless, the students did believe that "as future citizens" they would need mathematics.

Often the student view of the relevancy of mathematics was that it was a prerequisite for other courses, with little apparent intrinsic value (Stake & Easley, 1978, p. 13 – 25). Hoyles (1982) drew very similar conclusions on the basis of her study of fourteen-year olds. The subject apparently held no interest for the students, and was seen only as "something to be done, something to be mastered, something with an existence of its own" (p. 369). She also noted that the students did not even talk about how mathematics could be used. The findings of other studies do not particularly bear out this latter Hoyles comment. The Carpenter et al. (1980) survey of thirteen-year olds, and the Callahan (1971) survey of grade eight students both showed substantial numbers of students highly rating the day-to-day usefulness of mathematics, as well as the future usefulness of mathematics. It should be noted that the Stake and Easley, and Hoyles information was obtained through discussion and interview; the survey studies data were obtained through self-report questionnaires with questions regarding the use of mathematics pointedly asked. These methodology differences may be partially responsible for the differences in results.

The extent of the perceived future usefulness of mathematics is somewhat gender-based. Pedro, Daniels, Woolleat, Fennema and Becker (1981) determined that as a group, females perceive mathematics to be less useful to them.

Typically, the most common teacher view of the relevance of mathematics was that through its teaching and learning, students would improve their ability to solve problems, to think logically, and to work hard (Fey, 1979; Shalloe, 1980).

Mathematics And Life Experience

How is the nature of mathematics to be understood? As one considers this, it is important to keep before oneself a distinction between mathematics and mathematics education. It is also important, when one speaks of mathematics, to keep in perspective the degree or level of sophistication, or level of study, which is closely related to the extent of mathematics learning that one has undertaken.

Burton (1980), in writing about mathematical activity in children of ages nine to thirteen, claims that,

> for the child, acquiring information in mathematics is a difficult procedure since mathematics is itself a way of thinking and doing. That is to say, mathematics deals in abstractions and systems of abstractions and the games that are played in relating these (Burton, 1980, p. 45).

In contradistinction to "ordinary language," which is used in everyday speaking and writing, Phenix (1964, p. 72) held the view that "mathematics occupies a world of its own." Mathematics is a language, but one of "complete abstraction;" it is in essence purely theoretical. While both are discursive, according to Phenix one of the most fundamental distinctions between the language of mathematics and "ordinary language" is that the former has "no necessary [emphasis added] reference to actuality" (1964, p. 72). Mathematics is not anchored in the "actual world," and while it has many valuable practical applications, these should be understood as being "secondary and incidental to the essential symbolic meanings."

According to Skemp (1971), this "great abstractness and generality" of mathematics leads to the situation where "mathematics cannot be learnt directly from the everyday environment, but only from other mathematicians" (p. 32). Thus, the learning of mathematics by the young student will be almost entirely done through the teaching efforts of the student's Mathematics teachers serving in the position of mathematician.

Skemp's claims apply in terms of the learning of formal, structured, abstract mathematics; the meanings attributed to mathematics, then, are highly guided by the experiences within the Mathematics classroom. Lippitz (1983), a European educator, expresses a somewhat similar view but from a phenomenological perspective. In using geometry as an example, he writes:

> Mathematical space is essentially other than perceptual space. It is neither bright nor dark, neither practical nor impractical. By the same token, the

> geometrical figure drawn on the blackboard is merely the point of departure for a thought that uses it as the "onerous crutch" for its intellectual operations; it embodies only one of a series of arbitrary, individual examples of a universal geometrical rule which is itself independent of sensuous concretion. This specifically scientific view cannot be developed smoothly and continuously from pre-scientific experiences such as by means of abstractive procedures. What is required is a change of point of view which makes visible the constructivist manner in which science approaches our world (Lippitz, 1983, p. 174-175).

Lippitz would agree, then, that formal, abstract mathematics cannot be learned directly from our everyday environment; it is entirely a human construction. However, these points pertain particularly to the subject matter of mathematics. In terms of mathematics-related experiences, a child in grade eight has spent a large number of hours in the classroom directly engaged in learning this abstract subject matter. When one is scanning the spectrum of possible mathematics experiences, a very significant portion of this range is clearly constituted in these classroom activities.

Nevertheless, the experiences of the everyday lifeworld beyond the Mathematics classroom should be counted among the potentially mathematically meaningful activities. From Lippitz (1983), for example, one also infers that these life experiences must be considered in mathematics education: "bodily-sensuous experiences" are indispensable to its teaching. The pre-scientific experiences that constitute the experiential background which children bring to the

Mathematics classroom must didactically be taken into account when students are confronted with the scientific view of the world.

On the basis of increasing study and interest in child development, Brownell, an educational psychologist with a strong interest in mathematics education wrote in 1954 (reprinted in 1972) that arithmetic had both mathematical and social aims, and that neither could be emphasized to the exclusion of the other.

> Instruction must be meaningful and must be organized around the ideas and relations inherent in arithmetic as mathematics. But . . . [the children] must also have experiences in using the arithmetic they learn in ways that are significant to them at the time of learning, and this requirement makes it necessary to build arithmetic into the structure of living itself (Brownell, 1954/1972, p. 109).

This is not simply an educational convenience, or learning facilitator; the links between the language and operations of mathematics, and the language and spatiotemporal world of everyday life are substantive. Eight years prior to the above writing, in 1946 (reprinted in 1972), Brownell and Sims concluded in an essay entitled "The Nature of Understanding" that in order to understand the world of things, procedures, and relations, the understanding of such symbols as words, numbers, rules and formulas was necessary. These symbols were inseparably associated with the world, people and things, and the understandings of the symbols acquired must include an association with the realities for which they stand. Otherwise the symbols acquired are meaningless.

Much more recently, the noted mathematics educator Hans Freudenthal also expressed the belief that mathematics must be taught in a meaningful manner by teaching even "the most abstract mathematics . . . within the most concrete context" (1981, p. 144). Furthermore, he challenged the commonly held relationship of "from theory to practice:" "The right perspective is primarily from environment towards mathematics rather than the otherway round" (p. 144). The students' pre-scientific experiential base must serve as ground in the developing of the relevant mathematics during the teaching process. Freudenthal provides a further basis for considering a potential connection between mathematics and non-Mathematics class contexts.

For Bauersfeld (1980) too, mathematics education is "deeply related to the man-made world of symbols and meanings, to common sense, and to everyday life" (p. 36). He understands the processes of teaching and learning mathematics to be a distinctive part of both the teacher's and the student's life. The ongoing process of learning mathematics requires the active engagement, from the student's "stock of knowledge," of related subjects and actions.

What emerges from these remarks is that given the breadth and depth of contemporary mathematics, and its abstract nature, it is correct to speak of learning it only in an indirect manner, and only from other mathematicians, as Skemp (1971) has said. Nonetheless, especially for the younger student of mathematics, the revealing of relationships between the everyday environment and that of abstract mathematics is vital to the realizing of a fuller understanding of the mathematics which one is taught. The point to be found in these illustrations is that while mathematics is largely taught in (present and past) Mathematics classrooms, it is appropriate to hold the view that experiences which may give meaning to mathematics also exist beyond the Mathematics classroom.

Something of the extensive nature of mathematics' meanings can be found in Polanyi's (1958) discussion of "existential" and "denotative" meanings.

> We may describe the kind of meaning which a context possesses in itself as existential, to distinguish it especially from denotative or, more generally, representative meaning. In this sense pure mathematics has an existential meaning, while a mathematical theory in physics [for example] has a denotative meaning (Polanyi, 1958, p. 58).

A consideration of school Mathematics reveals, in light of the fore-going discussion, both meaning-types. And with respect to mathematical theory, Polanyi felt that "mathematical theory [which in fact grounds even the most elementary mathematics taught] can be learned only by practicing its application: its true knowledge lies in our ability to use it" (1966, p. 17). In an elementary way, the process begins with the earliest applications of mathematics in a student's mathematics education. Polanyi's statement further reinforces the claim of the study that investigation of the meanings of mathematics must of course include but not be strictly limited to the activities of the Mathematics classroom.

Burton (1980), to whom reference has previously been made, speaks to this duality of meaning in addressing mathematical activity in children. She believes that mathematics (1) is linguistically dominated, is embedded in the language development of children, and is itself a language, and (2) is environmentally-based. By the first is meant that a dependent relation between the notions and the language used to describe them is due to the very abstractness of mathematics. As well, mathematics has all the vocabulary, symbols, and rules of grammatical construction to justify being considered a language in its own right. "An important part of children's mathematical development is to learn the correct use of mathematical language <u>and</u> to learn to use mathematics itself correctly" (p. 47). With respect to the second point, Burton claims that for the young student, the mathematics of the world about us is part of his or her understanding of that world. The type and variety of experiences through which learning can take place are restrained by the child's "dependency upon concrete experience or, at least, upon oscillation between symbolic and concrete" (p. [illegible]). Thus, for learning to take place, the perception of "appropriateness, utility and structural relevance" must be present.

Educators and others with an interest in mathematics envisage the fuller understanding of mathematics as requiring and inseparably involving links to concrete context. But is this context encountered solely in the Mathematics classroom through the description of problems in the textbook, the diagram on the board, or the provision of mathematical equipment such as geometrical shapes and counting devices? The response, "No," was suggested in the Lippitz (1983) and Polanyi (1958, 1966) discussions. The pre-scientific experiences of the student, those which give rise to the identification of "practical" and "impractical" for example, and upon which many of the above authors believe the teaching of mathematics should be based, do lie largely outside the Mathematics classroom. Here there is a reciprocity at work though: Clearly the application of learned mathematics to the "environment" outside the Mathematics classroom may also be considered to (partially) ground the meanings given to these "application" experiences. Still further, both kinds of mathematical experience shape the meanings that mathematics generally has for the student. There is thus a spiral effect, where one's pre-scientific background continually undergoes change, and is increasingly shaped by one's education, including Mathematics education.

Broudy (1972) pursues Polanyi's notion of tacit knowing in an examination of "the uses of schooling." In his view, there are four principal ways in which "a person (P) uses learnings (L) to respond to situations (S)" (p. 221). These four uses of schooling are: replication, association, application, and interpretation. Often, several of the uses are co-present in any situation, however, in the language of Polanyi, one tends to be focal, while there is only a subsidiary awareness of the others. In the context of the practice of learning the subject matter, replication and application occur a great deal in the classroom. Broudy considers the "received doctrine" of school education to be: Successful replication implies learning, and only that which can be replicated need be taught. In contrast to this accepted assumption, Broudy believes that beyond the school the replicative use of school learnings is seldom what one is called upon to engage in. Rarely, for example, is one confronted with a situation beyond the Mathematics classroom that finds the individual explicitly being asked only for the answer to a problem such as "7 + 6 = ?". However, the need to know the answer may in fact arise in the context of other situations, thus putting learnings (L) to work in other uses. Central among the uses of schooling, in Broudy's opinion, is that of interpretation. This pre-eminent life use of schooling involves the tacit use of school input that "once was learned focally and explicitly . . . in order to further the understanding of a life task" (1972, p. 225).

From the above, it is clear that Broudy (1972) is writing from the perspective of someone having completed school, and who is now using his or her schooling in the course of everyday life outside of the classroom. There seems little reason to suggest that his analysis would not apply to the current school-goer in the course of the individual's activities outside the school environment.

A principal issue is the bringing to consciousness of these events of mathematical activity in order that the student may reflect on the extent to which mathematics may in some way be an aspect of his or her daily acting in the world, in the Mathematics classroom and outside of it. As Arendt (1978) has indicated, this is the point at which meaning is given to these mathematics-involving experiences.

The experiences may involve what Luijpen and Koren (1969) refer to as "an implicit, non-thematic, non-reflective consciousness, which consists of a simple presence to what I am doing" (p. 54). They use as an example the everyday-life activity of the routine counting of some set of objects encountered in the course of the day. The counting itself may not become thematic, only the "terminus" of that counting, the arrived at total, does. However, as Luijpen and Koren write,

> I know what counting is because I am present to my act of counting. . . . In counting, I am present to my counting, but when I am asked what I am doing, I place myself explicitly in the presence of my counting and give expression to it (Luijpen & Koren, 1969, p. 54).

This state of pre-reflective consciousness, the "natural attitude" in the language of Schutz (1973) (following Husserl), in which the act of counting is tacitly present, serves to "feed" reflective consciousness, a level of conscious awareness which thematizes life and on which, for example, there is a "consciousness of counting."

Strasser (1985) suggests that in a given problem requiring mathematical solution, the method be seen as a means to "'bridge' an intellectual distance" in order to achieve some particular goal. One may be explicitly aware of the employment of these mathematical methods, as for example, in the solving of a given problem in a mathematics text, or its conscious recognition may be "omitted," as in the case of Luijpen's (1969) counting.

Markovic (1984) distinguishes between empirical thinking and theoretical thinking, claiming the major distinction, or "qualitative leap" separating the two is that with theoretical thought "the very forms of language and thought become the object of study. Concepts of concepts and symbols of symbols emerge" (p. 359).

Empirically, we may count or we may measure, for example, in the Mathematics classroom, in other classrooms, or in activities that occur outside of school. During the learning of mathematics, such empirical concepts as counting and measuring are organized, systematically placed in an ordered network of such concepts, and subsumed under an organizing system of theoretical concepts. Thus, mathematics encompasses counting and measuring, but it is more. "Mathematics teaches us that the symbols we use in counting and measuring are positive and negative whole numbers, fractions, triangles, rectangles, etc." (1984, p. 359). The important point to be taken from Markovic is the link that exists between activities that may occur in a variety of experiential contexts, and the formal Mathematics that can only be learned from other mathematicians. The question arises as to the extent of the fusion of these forms of thinking in considering what meanings are held of mathematics while reflectively discussing the subject.

Greene (1978) notes in reference to Merleau-Ponty, we are beings-in-the-world, and it is the reality of everyday life that serves as ground for all our knowledge: "The lived world must be seen as the structuring context for sense-making of any sort . . ." (p. 17). In fact, for the school-aged young person, formal Mathematics classroom experiences are a part of the everyday life experience. Formal Mathematics may be, as Phenix (1964) has stated, only secondarily related to the "actual world." And certainly the experiences in Mathematics classrooms present and past potentially have yielded much of the meaning that these young people are able to discern of the subject. However the literature suggests that in the learning of mathematics, involving as it does the subject as human being-in-the-world, potential relationships exist between formal Mathematics experiences and everyday life out-of-class experiences and these may also contribute to the meanings the individual has of the subject.

Summary

This chapter has presented a portrayal of a number of mathematics-related issues the study is concerned with. A brief phenomenologically-oriented description of the mathematical experience in and out of the classroom, especially as it contributes to the development of the meaning of mathematics, was given. The fact that the subjects in the study are junior high school students, "early adolescents" to use the more common phrase, is significant; their emergent character was discussed, as was the literature relating to their attitudes toward, and their perceived relevance of, mathematics.

Chapter 3: METHODOLOGICAL CONSIDERATIONS

Introduction

This chapter presents an in-depth description of the research undertaking, including the participant selection methods, the methods employed in gathering information, and the concerns that arose regarding methodological relationships and student-researcher relationships. The latter concern refers to the possible perception of the researcher as stranger/authority, and to the ability to build a sustained discourse on the students' mathematical experiences.

Selecting The School

A university professor in the Department suggested a grade eight mathematics teacher who might be willing to permit the study to take place in his classroom. As the intent of the study implied that it was not necessary to search for junior high schools or students with particular characteristics, the suggestion was accepted. The professor initially made contact with the teacher, Mr. V., and confirmed his willingness to participate, subject to a more detailed discussion of the study - its nature, its length, the potential for disruption, what was to be asked of the students, and so on. A meeting was held with the teacher at the school, at which time such details were discussed. The arrangements were satisfactory, and so the next phase of the study was initiated, that of formally applying for permission from the school board.

Entering The Classroom

Once such permission was received, the processes of selecting the students and classroom observation began.

The interviews were to be audio-tape recorded, and Mr. V., also a school administrator, agreed that informed parental consent should be sought, in addition to seeking student participation on a voluntary basis.

There were four Mathematics periods per week, with no class Thursdays. Because of other researcher commitments, only two of the four periods could be regularly observed. The first such observed class (in October, 1984) was marked by a brief introduction by the teacher. The students were told that a research project in mathematics was to take place in their class, that "Mr. Franks" would be a regular visitor, and that volunteers would soon be requested. This period, and one Mathematics period following, served three important purposes: (1) to begin the process of having the researcher's presence become taken-for-granted by the students and teacher; (2) to begin the process of recognizing the problems of observing, and of formulating possibilities for overcoming these difficulties; and (3), related to this, to develop a satisfactory method of recording the observations.

Selecting The Students

At the beginning of the third observed Mathematics class, one week after having been introduced to the students, the entire class was addressed and the nature of the study was described. It was emphasized that in the study they were not going to be tested on their understanding of particular mathematics concepts, or on their ability to perform various mathematics operations; they were not going to be taught. The students were told that the participants would be asked to keep up a brief journal of mathematics-related events, and that they would also be interviewed individually on an approximately once per week basis. This might mean missing a small amount of class time each week (perhaps twenty minutes), and should this occur, they would be responsible for the material missed. It was stressed that participation was strictly voluntary, and that anyone could withdraw at any time. Fourteen students indicated a desire to take part, and each of these students was given the parental/guardian consent form (see Appendix A) to take home and discuss with their parents. Participation was contingent upon the receipt of the signed form.

The return of the forms was slow, but two weeks following this initial classroom meeting, eight of the fourteen students had confirmed their status as prospective participants in the study.

At this time, a group meeting was held with all eight students. The voluntariness of participation, and the ability to withdraw at any time were again stated. A review of procedures was also undertaken; the students were reminded of the intended weekly interviews that were to be scheduled, and of the request for each of them to maintain the journal which would be given to them at the next (and first individual) meeting. At this group meeting it was also indicated that the study might have to be extended beyond Christmas into January, 1985. It was requested that they carefully consider the strength of their desire to participate over a period of perhaps two months. While the voluntariness was again emphasized, it was also urged that any who had reservations about continuing for an extended period of time would hopefully decide then, or very soon, to withdraw. None of the students did so.

The original intent was to seek six students as participants and when eight volunteered, six were going to be randomly selected from among them. It was felt that while six would likely be manageable in a study such as this, more might begin to present interview scheduling problems, transcription delays, and difficulties with observation in the classroom. The strength of the desire of all eight students to take part forced a rethinking, and all remained throughout the duration of the study.

The selection of the students was not made on the basis of achievement in mathematics, sex or age. Of the eight students, six were girls. Seven of the students were thirteen years of age during the period of the field study, one of the girls was fourteen.

The participants' mathematics achievement levels, on the basis of past grades and class test results for this year, ranged from "poor and having difficulty" to what would likely be considered "excellent."

The criteria for selection, then, were essentially those of volunteering and expressing a willingness to continue over a period of time, and parental consent. Having selected a grade eight Mathematics class, no other criteria than these were imposed on the selection of the students.

The Teacher

The focus of the study is on the meanings mathematics has for the students; the Mathematics teacher, Mr. V., was not a principal participant in the study. However, the Mathematics classroom is central in the explicit learning of mathematics; Skemp (1971) claims that one can only learn mathematics from other mathematicians; that is, primarily the Mathematics teacher in this case. The literature indicates that student perceptions of mathematics are likely to be significantly influenced by the methods and attitudes of the teacher. Thus, it was deemed appropriate to note and analyze, at least in a limited way, his actions and attitudinal stance on matters related to the class and to Mathematics education. General noting of the teacher activities was made in the classroom observation notes. In addition, at the end of the field research, in March, 1985, a forty minute audio-tape recorded interview was held with the teacher to obtain his views on (a) the school, (b) junior high school Mathematics education, and (c) the Mathematics class of students involved in the study.

The interview was transcribed, an interpretation made of the discussion, and a follow-up validation session held a few days later. A typed copy of the interpretation was given to the teacher at the validation session, and this was read over and discussed. This session was also tape recorded.

Implicit in the above comments are two points which should be made clear. First, informal, quite brief, in-the-hallway and after-class discussions were occasionally held with the teacher during the time of the research. However, the recorded interview was not held with him until after the research with the students was almost completely over - four of the students were completely finished before the initial interview with Mr. V.; the final validation/interview sessions with the other participants were held between the first and second teacher tape-recorded meetings. Secondly, during the interview, the teacher was asked to comment on the students in the Mathematics class as a group, but was not asked to provide his perceptions of each of the eight participating students. The rationale for both was essentially the same: Reduce the influence of the teacher's understanding of the class and participants on the researcher while field observations, interviews, and ongoing analysis were taking place. The interpretations were to be as much as possible an outgrowth of the developing researcher-student relationship. To seek the teacher's descriptions and perceptions of each of the eight at any point was considered to be interpretively inappropriate, to be moving beyond the intent of the study which is to reveal the meanings mathematics has for each of the students, and thus to explore the student's perspective of her- or himself mathematically.

The Principal Sources Of Information

As noted in Chapter 1, three principal means of gaining insight into the questions at hand were adopted. These were: (1) classroom observations, (2) one-to-one semi-structured "intensive interviews," and (3) semi-structured student journals. On the one hand, they cannot be said to be of equal weight. On the other hand, each can be said to be of quite a different nature than the other two, thus allowing the possibility of gaining insights that might otherwise not be available. In attempting to gain knowledge of how each of the young people experience doing school Mathematics, and of the understanding that these people have of mathematics in their lives, it was recognized that methods that strive to retain situational context were important. The methods employed in the traditional model of science which strongly reduce the influence of context were judged to be inappropriate (Mishler, 1979). The young students' unique social (classroom) and biographical contexts were important areas of exploration, description, and interpretation. Observing and describing some of the actions of the students during the process of doing school Mathematics, gathering the students' own reflections on their daily activities in and out of class which they perceive as being in some way mathematical, and thirdly, engaging in spoken discourse with them regarding their perceptions of mathematics were seen as significant aspects of the total process of information gathering.

The three principal methods will be described in greater detail later in this chapter; other sources of information, the student records on hand at the school and the Student Background Sheet (see Appendix B), are described below.

Student school records generally provided information related to past academic achievement. However, these data are not reported verbatim. They were used primarily as a check on some of the information provided on the Student Background Sheet. This sheet was completed at the first one-to-one interview held with each student.

Information from all sources is integrated in order to enrich the biographical picture presented of each student.

The Events Log And Personal Journal

The researcher kept a log of all activities related to the research: all visits to the school, meetings with the advisor and others regarding the research, and so on.

A personal journal was also kept wherein reflections on the study - its nature, the shape of its unfolding, consultations with others, and feelings as a researcher - were put to paper. This was not maintained on a daily basis, but rather was taken up when there was a felt need.

In addition, following each observation period and interview, personal notes expressing immediate reactions to and impressions of the event just experienced were made on the observation notes and the researcher interview question sheets.

Classroom Observation: Introduction

The first of the three main approaches, classroom observation, focused on the actions of the participating students, although the general classroom activities were also noted in order to help provide contexts in which to interpret the actions of the eight students. Observation provides one with information regarding the external behaviour of the students, although interpretation can, and does, become a considerable part of the note-taking process. External behaviour refers to physical actions observable by an individual sitting within a few metres of the person and having a relatively unobstructed view, and to any speech or other sounds made at such a level as to be audible to that same individual again sitting within a few metres of the person.

Ideally, it would have been useful to be present in every Mathematics class to observe the activities of the students in the study. There were four Mathematics classes per week; conflicting schedules limited the regular observing to two Mathematics periods each week (see Appendix D). A total of twenty-one Mathematics classes were observed, sixteen of those following the selection of the eight participating students. Observations were discontinued at the end of January, 1985.

The purpose of the observations was to provide further information on and insights into the junior high Mathematics classroom experience generally and for each of the participants particularly. From the observations were to arise contexts, event descriptions, and interpretations upon which to ground the informal interviews with each of the students. The actual Mathematics material content of the class was in many ways only incidental to the study, although its potential for influencing the attitudes and actions of the students is acknowledged.

The Observation Recording Forms

Before the eight participants were selected, classroom time was spent devising and trying out possible forms on which to record the notes. What evolved was a form which permitted the temporally-based recording of the actions of each of the study participants, along with provision for description of the ongoing general classroom activity context. This in turn was broken into two parts: (1) The formal, or teacher-prescribed activities, and (2) The "actual" student activities (in a collective context).

Student And Researcher Positions During Classroom Observation

The eight selected students all sat in the same half of the room, and several in fact sat in two adjacent rows. (See Appendix C for a sketch of the classroom, the location of the eight students, and the observation position.) The observational post was in the back of the room; most of the eight were in proximity to this position. From this vantage point most of the students could be seen quite well, and only those who sat near the front in the observer row provided a significant problem. It was possible to move to the adjacent seat in the next row in order to observe these people better. This was occasionally done, although at the recognized expense of the sacrifice of some observational quality of those who now sat directly ahead in this new row. It was not easy to see - and write - what all were doing at any given time, but the procedure was felt to be quite adequate. This was considered to be the best position available for observing the class.

Observation Note-taking And Interpreting The Notes

The notes taken in class tended to be quite brief, usually describing the perceived actions of each student at that time, along with, as noted earlier, a short description of the formal classroom activity, and occasional notes on what the general student group appeared to be engaged in doing. There was not a continuous stream of notes in every column; often the nature of the activity of the teacher and students did not vary greatly for a period of minutes. The amount of student activity did vary substantially at times between the eight participants; the level of observed activity was characteristically higher for some than for others.

The personal questions of what to note and how to note arose frequently. It was difficult at times to adequately describe what a student was <u>thought</u> to be doing. Often, interpretations of student actions were recorded along with brief descriptions of behaviour; these seemed more meaningful than noting only actual physical behaviours. On the other hand, one has to be cognizant that these are interpretations. The "wonderful human quality" of "assigning meanings to what we see going on around us" can pose something of a problem for the researcher (Wolcott, 1981). In this capacity "we" have to be able "to recognize the difference between what we have <u>actually</u> observed and what we <u>think</u> it means, what we <u>hope</u> it means, or what we insist it <u>ought</u> to mean" (p. 261). In other words, one must be consciously aware of what one is writing in regard to those student actions observed and ask: actual behaviour or interpretation? McCutcheon (1981), following Ryle and Geertz, refers to the description of student physical behaviour as "thin description," while the possibilities of "thick description," the interpreted social meaning of the student actions, are many. These were certainly issues which confronted the researcher during the field study and could not be avoided. Interpretation was the critical action here, with the researcher the "perceptual lens through which [the] observations are made and interpreted" (McCutcheon, 1981, p. 9).

Notwithstanding the concerns regarding the note-taking and their interpretation, to reiterate, one of the purposes of classroom observation was to provide a near-immediate, concrete context in which to discuss the nature of mathematics, and the student's doing of mathematics. They were to provide a partial basis upon which to carry on the weekly semi-structured interviews, and it is this, the second of the principal means of gaining data, which is now taken up.

Semi-structured [illegible] Interviews: Introduction

The interviews with each student were the primary source from which an interpretation of the student's first order understanding of mathematics was developed.

The potential difficulties of an adult stranger in a school setting attempting to develop a rapport with each of the young adolescents, especially when the focus of the conversations was to be one such as mathematics, were recognized. There was a definite personal concern about possibly being perceived in a quasi-authoritarian role, closely tied to the teacher, perhaps even seen as "teacher." It was recognized that time to establish relationships was going to be required. A second, related area of concern was the question - no matter how strong the student-researcher relationship became - of the ability of the students to express themselves, to reflect upon and talk at length and in depth about their experiences, both the very recent and those of the more distant past; to talk about "doing mathematics" in class and at other times. The type of interview, the timing of these discussions, their setting, and the particular way each meeting evolved were among the issues seen as critical to the successful unfolding of the research.

With respect to the discussions held in this research, as much as informality was strived for, a certain formality remained: They were scheduled, audio-tape recorded, and each session began from (although it did not necessarily proceed according to) a pre-established agenda. The form of interviews held are best described in Williamson et al. (1977) as "intensive interviews." Within the range of interviewing techniques which they consider as "intensive" are the semi-structured interviews, "inquiries in which certain questions are asked of all respondents (either in structured or nonscheduled form) but also other unstructured questions may be asked as well" (p. 176). A sense of trust and a continuously developing rapport between researcher and those being interviewed are important aspects of intensive interviewing. In addition, intensive interviewing may involve holding several such sessions. Flexibility is another major feature: What questions are asked, when they are asked, and how they are asked are all matters left to the discretion of the interviewer. A "sense of reciprocity" is considered vital between the two participants; it is in this sense that one may envision the interview as discussion also. As Williamson et al. state, "The quality of the incipient relationship (or emerging relationship) between interviewer and interviewee is the cornerstone of the intensive interviewing method" (1977, p. 165).

Patton (1980) provides further insight into conducting qualitative interviews. The incorporation of several of his ideas into the discussions was attempted. It was difficult to do this on a consistent basis, however, and while, for example, a strong effort was made to question in a "truly open-ended fashion" (p. 212), and avoid leading and unnecessary "dichotomous response [yes/no] questions" (p. 213) as much as possible, that effort was not always completely successful. Indeed, at times questions of this form seemed useful and necessary.

Five, fifteen to twenty-five minute interviews were held with six of the students; six such interviews were held with one, and seven with the eighth person (see Appendix E). In addition, a thirty to forty-five minute final validation interview session was held with each of the students. More will be said about this final session later.

Scheduling The Interviews

The two days of observation per week were separated by one day. It was originally planned, then, that on the day immediately following a classroom observation, half of the students in the study would be individually interviewed. That is, in a sequence of four consecutive days, the pattern was to be: observation, interview four students, observation, interview the remaining four students. Each student was to be interviewed for approximately twenty minutes once each week, and the observation in the Mathematics class of the afternoon before would serve as at least a partial basis for the discussion. However, the enlargement of the study group size from six to eight, the restrictions placed by the teachers on which classes the students could be excused from, and the administration's request to juggle or rotate the interviews in order to reduce the frequency with which a student was taken out of a particular course meant a substantial revision of those original plans. Personal researcher scheduling problems also played a role. Nevertheless, the intention to interview all students (at least) once each week was still pursued.

Out-of-class times, such as before and after school and at lunch time, would have been preferable in order to reduce the disruption, and reduce the feeling that the student was missing class. It was pointed out at the beginning by Mr. V., though, that the students regarded the out-of-class time, especially before and after school, very much as their own and scheduling interviews at such times would probably not meet with much success. This essentially proved to be correct, although some limited success was had with holding lunch-time discussions.

As the field-work progressed, another problem arose that was to affect the interview schedule: the time involved in transcribing and analyzing eight tape recorded interviews each week. Twenty to twenty-five hours was required for the transcription alone. Keeping up proved difficult, and an alternate interview schedule plan was invoked after the first [illegible]s: Four of the eight students were met with on alternating weeks.

Interviews: Their Changing Relation To Observations

The necessity of having to hold the interviews on a "whenever-they-could-be-scheduled" basis had more important ramifications for the nature of the relationship between the classroom observations and interviews. The close relationship originally envisioned became strained. Furthermore, even when the subject of conversation was some aspect of the previous day's observed class, it was often found that the students' recall of particular events that occurred was rather limited, unless it happened to be extraordinary in some way. Their ability to recall and verbalize what they had been thinking about at any point in time during the class was decidedly limited. What tended to happen was a dealing in quite general recollected impressions of the class during various periods of its duration.

Thus, the relationship between interview and observation had to be somewhat reconceptualized; increasingly the field notes on the observed classes came less to be seen as a source of events upon which to base the interviews. The focus of the continuing observations shifted more to ways in which they provided a developing view of the student as an individual in the Mathematics class. This picture was used to help in deciding the particular nature of some of the questions asked at the interviews. The ongoing observations also served as a means of acknowledging the researcher's continued presence and interest in the students between interview times.

The Interview Setting

Something of an evolution took place in the manner in which the settings for the interviews were arranged. Initially they were conducted in an empty classroom around the teacher's desk, but this soon was recognized as being too formal. Rather than breaking down possible barriers, there was concern that the arrangement might be reinforcing them. To aid in the reduction of the impression of adult researcher-as-stranger/teacher/authority, the interview venue was shifted to (1) an empty classroom with both the student and researcher sitting out in the student desks, or

(2) a small teacher workroom, with the student and researcher seated around a table. To what extent the desired reduction was effected was difficult to discern. Undoubtedly, it varied from person to person. It seemed though, that any impact such an environmental shift had on the relationship, on trust and openness, was positive.

The First Interview - Beginning the Relationship

By the time of the first individual interviews, the class had been observed six times, and one group meeting had been held the previous week. The first interview with each was an introductory one, dealing almost entirely with two topics: handing out and explaining the journals, and having each complete the Student Background Sheet. The nature of the study was again reviewed. In addition to covering some of the basic "groundwork" of the research process at this meeting, it also provided an opportunity to experience the interview situation; the incipient relationship, complete with tape recorder and microphone, was underway.

The Ensuing Interviews

The second one-to-one intensive interview was the first time the students were extensively engaged in conversing and answering questions about mathematics. Prior to the meeting there was a considerable amount of reflection on the important questions of where and how to begin the discussion of mathematics. It seemed a reasonable assumption that the subject alone might not be sufficient to sustain or encourage ongoing discussions. The nature of the interviews, their setting, their conduct, what was said and how it was said all appeared as vital issues to e attended to.

This reflection meant drawing upon a "primary intuitive understanding" which Strasser (1985) refers to as "Understanding I", gained through those past pre-theoretical experiences one has had with young adolescents. It meant reflecting upon what one has seen and heard of these particular students as one has sat in the classroom observing them, and has talked with them, first at the group meeting, and then at the previous week's individual interviews. These were young teenagers who, although they had volunteered to participate, were to be confronted by an adult stranger who wished to talk about mathematics experiences. The underlying question was always: What were the possibilities for extended, meaningful discussion?

This was not to be a single structured interview during which the students answered a series of attitude-to-mathematics type questions. A relationship had to be established. This first meeting devoted to discussing mathematics had to continue to establish that relationship and to evoke continuing interest in the study. Fifteen to twenty minutes passed quickly; it seemed very little time during which to probe those mathematics experiences. Yet for some perhaps it would be ample. Still, there seemed definite limits to how slowly one could move in conducting the research; there were practical limits to the length of time of the field work. The students, many at least, might tire of the process. This process had to evolve, yet at the same time it had to appear to be evolving - positively. These young people must be made to feel that they are really doing something; ideally they should reach the point where they <u>want</u> to share their experiences with, and ideas about mathematics. The interview discussions were critical to the study. Where does one begin with the interview process in order that such a point is reached, and reasonably quickly?

The second interview itself started slowly. Some time was spent describing the way in which these sessions would be carried out, emphasizing their informality and encouraging each person to take their time in replying if need be. As it was considered important to begin this interview with each student in a similar way, each was then presented with a familiar scenario, one which occurred each school week for them:

> Suppose you are sitting in another class, and the bell goes to end the period. You pack up your books, and leave. You realize the next class is Math; a minute or so later you arrive in the Math class and take your seat. The teacher steps forward and begins to talk. I would like to stop things at that point, and ask you, What's going through your mind probably at that time? How are you feeling about the fact that you are in Math class and about to begin another period of it?

This scenario served as an opening gambit, one which hopefully was concrete enough that the students could relate to it, yet which required some reflective thought on their part. The intent was to provide a common point from which to start and which related to the research. On the basis of the responses, further questions were formulated and asked; further aspects of the scenario were developed when it seemed necessary in order to maintain the discussion. Such an approach was used because it did not seem too threatening. To begin with direct questions about this Mathematics class was considered as posing more of a possible threat, thus being counter-productive to a developing rapport. Whether or not this last premise was valid is an open question however, inasmuch as attempting to place oneself into a hypothetical - even if often similarly lived - situation is definitely a challenge for anyone.

Considering the fledgling nature of the relationship, the approach taken seems to have been adequate. The responses varied, as did the openness and ease with which the students replied, but it appeared to have provided a common means of beginning ongoing interview situations with all of them.

For reasons of mathematically-related biography, one of the major tasks was to get to know the student, to know something of his or her interests and activities outside of class - including those outside of school - that he or she took part in. This extended to knowing such things as when and where they did their homework, whether or not they had a computer, and if so, how, and to what extent they used it. These topics were seen as serving at least two important functions. First, most of these areas were thought to be topics on which the students could talk relatively easily. They were seen as means by which that vital sense of trust and feeling at ease would be developed more quickly. It was hoped that in some way they conveyed a message of interest in the students as persons.

Secondly, such knowledge was considered to have a direct bearing on the research aims. It was of value in terms of coming to know more of each person, of enabling the creation of a picture of each person for the reader. Additionally, such information had the potential for revealing the "places" of mathematics and for further probing; it was considered that the responses might serve as a basis for more questions. This proved to be the case often.

At least one observed Mathematics class was specifically discussed with each of the students. This discussion was begun by asking each student to briefly describe their whole day at school, and then the Mathematics class in more detail. The intent was two-fold: to gain further knowledge of some of their in-school activities and their feelings about some of their other subjects, and to provide a means by which a discussion on such matters could be more easily, concretely, entered.

When the Mathematics taught in the class was discussed, an attempt was made to get from them an understanding of how they perceived their history in terms of mathematics learning. The talk extended to what it was like doing Mathematics now and what it was like doing it in earlier years. They were encouraged to reflect upon the current experience, and to relate that to past experiences, in order to provide some indication of how the continuing experience of "doing" mathematics may have changed with time, and of how their understanding of what mathematics is may have also changed over the years of schooling.

This was found to be a very difficult task, and one of the major challenges. Coupled with a degree of unnaturalness about the interview situation was the students' apparent difficulty in recalling and reflecting upon their past experiences, even those as recent as the day before. Recollection of detail, and especially of how the person was feeling as a consequence of what he or she was doing, was problematic. It is questionable, though, whether it was totally a matter of the students' not being able to remember. It is possible that in some part the problem lay in their struggle to search for the words with which to express themselves, and in feeling that they must in addition search for the words they thought were the right ones to give, the words they perhaps believed were wanted. Searching for the words to use in response to the questions relied upon adequate understanding of what was meant by the question. This too was possibly problematic. (See Appendices I and J for examples of "intensive interviews.")

Retrospectively considered, there were four main types of questions that were generally asked of the students:

(1) general framing questions, introductory to a theme that was to be pursued;

(2) questions which sought student interests, activities, and background, i.e., biographical information;

(3) questions which arose directly out of previous observations, interviews, journal entries and personal researcher notes regarding the particular student, and interpretations of that information; and

(4) questions which arose out of the research activities with one student which seemed appropriate to ask of the others.

The researcher-perceived fruitfulness of a particular line of questioning or discussion varied with the student and with the question itself.

The Semi-structured Student Journal

The journal served as the third major source upon which an interpretation of the person's understanding of mathematics was based.

The journal was a small booklet. (See Appendix G for a reduced version of the study journal and an example of each student's entries.) It was designed to be written in daily, in part by answering the specific questions asked, and in part by making any comments the student wished on any matter.

The journal specifically asked the students to discuss their experiences with mathematics outside and inside the Mathematics class. Initially it dealt only with external experiences, however, it was modified shortly after the research got underway to ask students to also describe and react to the daily undertakings in class. In addition, there was a place for the researcher to make comments and ask questions.

As with the other two principal means of gaining knowledge of the student, the journal was an independent source, capable of providing information not (readily) available through observation or interviews. However, one of its purposes was also to serve in part as a basis on which to conduct the intensive interviews with each student. It emphasized the brief description, the capsulized reaction and feelings about a matter. Thus it was seen as having value principally in its ability to provide the seed - the "object" to be placed at the centre of the conversation, as Gadamer (1984, p. 341) recalled in the Greek sense - to be discussed more fully in the interview.

The journal had a strong similarity to the teacher-student journals now found in some classrooms. Craig speaks of the value of these latter journals thusly:

> By making written comments in student journals, asking questions and encouraging written response on the part of the student, the teacher can make the journal experience a two-way street and enter into conversation with the student in a manner which may help the student to think more deeply and respond more honestly (Craig, in Dillon, 1983, p. 377).

The journal used in the study was more structured than the Craig journal, with the same questions being asked daily. Nevertheless, it was conceived of as an opportunity for the students to reflect upon and respond to their mathematical experiences in an environment of their own choosing, one that was away from the possible pressures of the interview. It was also an opportunity to daily capture the experiences of mathematics, something which the once-per-week, and then once-per-two weeks interview did not especially lend itself to. Thirdly, it was seen as an opportunity for the students to write rather than speak about their experiences, to have the time to search for the words, and then to put them on paper. It was thought that for some this might be an easier medium than the oral, "on-the-spot" tape recorded interview.

The journal was laid out in sections, and during the first individual interview, each section was carefully explained as to what was meant by the questions and statements found there. The general nature of their responses was discussed, and it was requested that as much as possible, entries be made on a daily basis. While they could be brief, the students were encouraged to be thoughtful. No criteria were provided to guide the participants in deciding whether they had "done mathematics" that day. There was no discussion with the students either about the possible uses of mathematics. The understandings of "doing mathematics" were left to the individual, to be taken up later by direct questioning in the journal, or during the intensive interviews.

Other important matters taken up dealt with what might be the best time of the day to write in the journal, and whether they should carry it with them or leave it at home. The choice was again left to the student. As well, its private nature was stressed; the students were requested not to discuss with the other students what they were writing in it.

The intent was to take the journals in each week, and they would be returned as soon as the student-written contents had been copied. In actuality, these collection times varied substantially from student to student.

The Student Journals: Reflections on Their Use

The extent to which the journal fulfilled its intended purpose varied considerably among the participants.

While no one wrote in it every day, some did keep it up reasonably diligently. In these terms, possibly the best record was approximately seventy-five per cent of the time the student had the journal. Some made very few entries; one individual made only one entry (see Appendix H). Leaving it at home, leaving it in the locker, or simply not having time to write in it were some of the reasons for its not being maintained daily. Almost from the beginning the task of keeping up the journal was problematic for some. Others attempted to maintain it reasonably well throughout.

The degree of success of the journal as a methodological tool depends, of course, not only on the frequency of entry but also upon what the student writes. Here too, there was considerable variability among the students.

In general, the comments were very brief. Very often only a few words were entered and frequently the students indicated that no mathematics was done outside of class. This prompted the consideration of such questions as the following:

(a) Was this really the limited extent to which they "saw" mathematics outside of class?

(b) To what extent was this claim an artifact of a possible limited skill and interest in writing, and a lack of taking "adequate" time for reflective thought?

(c) How compatible was the methodology with the interests and abilities of young adolescents?

The degree to which the nature of the methodology encouraged limited student response is open to question. On the other hand, there was no way of actually determining the nature of any such limitations, and it must be remembered that it was the student perspective, in the language of the student, that was sought. Also, it did satisfy the intention of providing the students with an alternate means of discussing mathematical experiences. And of course, it was the intent of the interviews to try and resolve such issues by focusing directly upon such statements in the journals.

The issue is considered at greater length in Chapter 5.

The Methodological Relationships

The journals, the observation notes, and the interviews all served as independent sources, each unique in some way. There were, for example, substantial differences in the nature of the journal and observation notes data. First, the researcher had first-hand knowledge of the classroom activities which became the subject of observation notes; they were shared, albeit from different perspectives, with the students. Only a very limited number of the activities in which the student engaged and which became the subject of the journal entries were directly accessible to the researcher, on the other hand. Secondly, the journal entries were considered to be derived from reflective acts on the part of the student, while the observation notes were "second party" entries about the students' actions and activities. However, the interview, in relation to the other two methods, stood as the central method of coming to know each person, and the meanings of mathematics each student had. Topics, issues and questions which arose from the classroom observations and from the students' journal writings were followed up in the semi-informal discussions.

A "spiral of understanding," a reference that is reminiscent of Strasser's (1985) interpretive dialectic of explanation and understanding, is the way Lacey (1976) describes the methodological relationships in a study of school life that he undertook. A continuous spiral of understanding that found him "moving backwards and forwards between observation and analysis and understanding" (1976, p. 78) led to an "escalation of insights." "Observation" in Lacey's context served as a general descriptor of several methods, from classroom observation to school records to questionnaires and diaries to case studies within the school. The methods were unique, yet each in its own way provided an infusion of insight into the understanding of the totality. In this present study the unit of analysis is the individual not the school, yet the notion of a "spiral of understanding" addresses the research intent here, and is appropriate.

The various methods used in this study, taken together, increased the breadth, depth, and confidence of final interpretations. The methods complemented, yet somewhat checked each other, serving to strengthen the research process. Lacey (1976) stressed the relationship between research methods and the nature of associated insights and levels of understanding. He felt "very strongly that the world under investigation seen through one method of collecting data becomes enormously distorted by the limitations of that data and the available methods of analysis" (p. [illegible]9).

Reliability

Reliability must be thought of in different terms in a qualitative study than in quantitative research. In a qualitative study there is an assumption that the context in which the research is undertaken is unique. There is also an assumption that the participants in the study, because of their individuality, arrive at the research situation with understandings of the notion to be explored that are in some way unique to them. Changing the participants will yield some different understandings of mathematics. Thus strict replication of the results in another spatiotemporal context with different students is not possible.

The reader can expect consistency in data collection and interpretation from the researcher however. This does not mean that the same things are said and done with each participant. Nor does it mean that the interpretations arrived at with each young subject are the same. It means rather that there is a stability (Guba & Lincoln, 1982) in the researcher's attempts to establish a relationship with each of the participants, a stability in the methods and the processes by which the researcher attempts to gain access to each participant's understandings of the subject being explored, and a stability in the interpretive processes through which the researcher articulates the various participants' understandings. The presentation of those interpretations should also reflect that stability. It is incumbent upon the researcher, therefore, to make the research process clear to the reader.

Validity

Validity in a qualitative study is based upon shared understandings. In this study of the meanings young people have of mathematics, validity is established by returning to the students to seek confirmation (Guba & Lincoln, 1982) that the researcher's interpretations appropriately represent the participants' understandings.

Generalizability

The participants in a qualitative study are typically not selected through a random sampling of some reasonably well defined larger population. Therefore, generalizability in terms of sampling theory is not possible (Stephens, 1982). This is the case with this present study. However, some generalization to other contexts is possible if sufficient "thick description" of the research situation is present to permit the reader to see much of his or her own situation in that description (Guba & Lincoln, 1982). In addition there is a foundation of commonality among many junior high school Mathematics students and classroom environments for example that permits more general inferences to be drawn from the particular situational-interpretive study.

Analysis And Validation

Following the completion of each interview, it was transcribed, and the data - the student's and related researcher's remarks - were then extracted and entered into categories on the left facing pages of a notebook. As the initial discussion focused on experiences in the current classroom, the categories reflected this orientation: "Math class - general," "Math class - challenging Math," "Math class - boring," and so on. As the focus of mathematics-related experiences expanded, so did the coding categories:

"math - using it," "Math - school history," "math - interest," "math - importance," and "math - its nature" are examples of these categories. Each student's views of other subjects was also sought in a limited way to provide some sense of how the person felt about school in general and the relative position of Mathematics vis-a-vis these other subjects. The present and future interests of each student were also obtained to deepen his or her biography and to see the possible place of mathematics in these interests. Thus, these also formed categories. There was some variation in category headings among the participants. As the interviews continued, some categories were subdivided to narrow their focus.

After the data from each interview were coded in the above manner they were preliminarily analyzed for their clarity, for the apparent depth and breadth with which they seemed to address the particular issue, and for possible implications they held for further areas of exploration in discussion. On the right hand facing page of the notebook comments and interpretations were made and questions were posed regarding the student remarks.

Approximately every two weeks the student journals were collected and the comments were transcribed. Often the remarks were repetitive and brief, however comments considered significant were either directly entered in the coding notebook, or entered in summary form. Classroom observations of the students, where they had a direct bearing upon student views of mathematics that were arising from the interviews, were also noted in the coding book.

The result of the preliminary analysis stated above was the formation of questions, if they were considered necessary, to clarify or further develop the particular category. Questions opening up new areas of investigation were also developed. At the next interview with the student these matters were taken up. Some categories were discussed at almost every interview, others, less frequently.

Interpretation and validation of the interpretations, then, was continual. Validation extended beyond this ethnographic-like process, however. A final validation/interview session was held with each of the participants. Four to five page descriptions of the interpretations and of the conclusions that had been drawn, were composed, photocopied, and presented to the particular student involved. Further clarifying questions, written on the sheets, were occasionally asked (see Appendix J). The description was slowly read aloud. Students were strongly encouraged to interrupt at any time to question, confirm, qualify, clarify or refute the interpretations being presented. Pauses were frequent to check that the student understood, and to again make it clear that interjections were welcome. These final validation/interview sessions lasted from thirty to forty-five minutes and were also audio-tape recorded.

This chapter has presented in depth the methods used and the perceived relationships between them, both as conceived prior to the commencement of the field work, and as they evolved during the field experience. As well, the strong concerns regarding the appropriateness of the methods as the research unfolded, the possible perception of the researcher as stranger/authoritarian, and the general ability to build a sustained discourse on the "mathematical experience" were described.

The principal field methodologies were "intensive interviews," classroom observations, and quasi-structured student journals.

A log of research related events, and personal researcher notes were also maintained.

Analysis, interpretation, and validation were ongoing throughout the field research. A final, summative validation/interview session was also held with each of the participants.

Chapter 4: PROFILES OF THE STUDENTS

Introduction

This chapter focuses on each individual. Brief profiles of each of the students who participated in the study are presented.

The students are introduced in terms of:

(a) Demographic data.

Brief summaries are given of the students' schooling backgrounds in order to facilitate a limited consideration of prior curriculum experiences among the eight participants.

The ages and sex of the students are given. Brief presentations are also provided of the activities each student engages in on a regular basis.

These types of data enable the reader to better envision each individual as a young adolescent in junior high school. Secondly, they directly contribute to a basis or context for a student's understanding of mathematics. For example, the out-of-school activities of some students had an explicit bearing upon attitudes towards mathematics and upon conceptions of what mathematics was. Analysis of these latter points is presented in chapter 5.

(b) Student perceptions of their Mathematics and overall academic capabilities.

These perceptual statements broadly speaking take two forms: perceptions of general academic and of Mathematics achievement levels, and perceptions of personal ability in Mathematics. The sources of these student self-understandings are principally the Student Background Sheet (Appendix B) and related interview discussions. The Student Background results are summarized in Table 1.

The students were not given criteria by the researcher with which to decide whether they were "POOR," "FAIR," "GOOD," or "EXCELLENT." The basis(es) for their decision was sought after they had made their choice.

The grade seven and grade eight marks in Table 1 are also from the Student Background Sheet. The grade seven recollected marks were compared with their official final grade seven marks. These latter marks are not provided, however there is close agreement between the two sets of marks for all students with the exception of Ted, whose estimates were approximately ten percentage points high. The estimated grade eight marks were not checked against the teacher's records. These latter marks, then, should be treated with some caution. They were obtained to provide some expression by each person of what they believed their achievement level to be during the period of the research. These marks should also be seen in juxtaposition to each student's claim of being "FAIR," "GOOD," and so on.

The aim of the interpretation of each student's perception of her or his Mathematics ability was to seek the ground of the perception itself. In some instances the perceptual basis, to the extent that it could be discerned, appeared rather straightforward. At other times the roots of the perception seemed more intricate. In the case of some of the students, the perceptions of personal ability seemed consistent with the student's statements of "level of achievement." This was not always the situation, however, and the understanding of why this apparent inconsistency existed forms part of the interpretation of the basis for the student's perceptions.

(c) Student attitude to Mathematics as a school subject.

The students' general attitudes to Mathematics are described here. This includes a discussion of each person's interest in Mathematics.

Some description of attitudes toward school in general is also provided in this chapter.

(d) Student behaviour in the Mathematics class.

A synopsis of researcher observations and interpretations of the actions of each student in the Mathematics classroom is given.

(e) Researcher perceptions of the research relationship.

This includes a presentation of the perceived ability and willingness of each student to engage in discussion with the researcher on matters related to their mathematics experiences. This is important because it reveals the extent to which the researcher believes a productive relationship was established, and hence, the extent to which it was perceived possible to acquire valid in-depth data.

The nature of the student-researcher relationship varied considerably with the different participants. For any given relationship there was also variation from interview to interview.

Some relationships changed little over the period of the research. Some of these in turn began well and continued to be positive throughout the field period. Some did not. Others began hesitatingly, and improved through time. As noted in Chapter 3, considerable time and thought were devoted to ways of enhancing or encouraging the growth of a positive relationship.

The relationships with Ted and Karen were seen to be the least productive. The researcher-student relationships will be developed more fully in the profile descriptions.

Each student profile represents an integration of data description and interpretation from each of the above areas. Not all areas are given equal treatment with each student.

The Participants - Names, Ages And Schooling Background

The six girls have been given the fictitious names Anne, Verna, Donna, Carol, Pamela, and Karen. The two boys are identified as Ted and Peter. All of the young people in the study were thirteen years old throughout the duration of the field research with the exception of Verna, Karen, and Carol. Verna turned thirteen very soon after the study began in November of 1984, and Karen turned fourteen just as the field study drew to a close in March of 1985. Carol was fourteen throughout the time of the field study.

Carol had gone to school in City School District since the beginning of grade five. All of the other students attended public school in City School District for all of grades one to eight. Thus seven of the eight participants have been subject to much the same curricula-as-plan for all of their schooling. Of course, the curricula-as-experienced in the classroom may have varied considerably.

Several of the students attended one elementary school for all six grades. Only Verna and Carol attended more than two elementary schools.

All of the students except for Carol had attended City Junior High School in grade seven, although they did not all have Mr. V. as their teacher.

City Junior High School is an urban residential junior high school for students in grades seven, eight, and nine. Mr. V. categorized the student-body in general as coming

STUDENT RECOLLECTED MARKS AND SELF-ASSESSMENTS

GRADE SEVEN Recollected Final Marks*

NAME	Overall (%)	Math. (%)	NAME	Overall (%)	Math. (%)
ANNE	78	79	DONNA	57-70	60-71
VERNA	73	78	TED	68	78

Note:
* These recollected marks concur within close approximation to the actual marks in school records. The exception is those recollected by Ted, which are approximately ten percentage points above the actual.

****

GRADE EIGHT

NAME	November, 1984** Self-Assessment Overall	Math.	Est. Math Mark (%)	March, 1985*** Self-Assessment Overall	Math.	Est. Math Mark (%)
ANNE	GOOD	GOOD	83	GOOD	GOOD	"around eighty"
VERNA	GOOD	GOOD	79	GOOD	GOOD	"low eighties"
DONNA	GOOD	EXCELLENT	60-80	FAIR	EXCELLENT	"between sixty-fives & seventy-fives"
TED	FAIR	EXCELLENT	78	GOOD-EXCELLENT	EXCELLENT	"in eighties"

Notes:
** Self-Assessments made during Interview 1, November 19-21, 1984.

*** Self-Assessments made during final Validation/Interview sessions, February 27 - March 12, 1985.

Table 1

STUDENT RECOLLECTED MARKS AND SELF-ASSESSMENTS

GRADE SEVEN Recollected Final Marks*

NAME	Overall (%)	Math. (%)	NAME	Overall (%)	Math. (%)
PETER	85.75	95	PAMELA	65-70	60
KAREN	83	92	CAROL	see Note +	

Notes:
* These recollected marks concur within close approximation to the actual marks in school records.

+ It was agreed that Carol's recollected marks would not be published. In 1983-84 school year she had done very poorly in Mathematics.

****

GRADE EIGHT

NAME	November, 1984** Self-Assessment Overall	Math.	Est. Math Mark (%)	March, 1985*** Self-Assessment Overall	Math.	Est. Math Mark (%)
PETER	GOOD	EXCELLENT	94	GOOD	EXCELLENT	"in nineties"
KAREN	GOOD	GOOD	89	GOOD	GOOD	"roughly eighty-five"
PAMELA	FAIR	GOOD	60	FAIR - GOOD	FAIR - GOOD	"in sixties, seventies"
CAROL	GOOD	GOOD	60	FAIR	POOR	"at forty"++

Notes:
** Self-Assessments made during Interview 1, November 19-21, 1984.

*** Self-Assessments made during final Validation/Interview sessions, Feb. 27 - Mar. 12, 1985.

++ This self-assessment by Carol was made at Interview 7, February 20, 1985. At the final Validation/Interview 8, March 8, 1985 she said she was passing. See her profile for further discussion.

Table 1 (continued)

"from a higher socio-economic area than probably what is average for the [school] system" (Int. 1).

The Students

Anne

The activities Anne participated in on a regular basis generally involved athletic or physical activity. After school she spent several days each week involved with competitive swimming. This activity was significant in terms of her consideration of mathematics outside of school.

Anne claimed that much of the time she found Mathematics to be easy, meaning that she often learned what was being taught quite quickly and "without much trouble" (Int. 3). She considered Mathematics to be her "best" subject in terms of marks. Did that mean she also liked the subject the most?

> Well[. . .]guess it and Science. 'Cause I do pretty good in Science too. I like a subject if I do good in it.
>
> (Int. 3)

(Details of the conventions adopted in presenting transcripts of interviews are listed in Appendix H.)

She found junior high school Mathematics more to her liking than that in elementary school which, from her grade eight vantage point, she considered rather boring.

The nature of Mathematics also was more appealing than that of several of the other subjects:

> . . . you do things in [Mathematics] class. . . . it's not all writing. I don't like to write [which she felt she was required to do more of in classes such as French, Language Arts, and Social Studies]. Like, you get to figure things out. . .
>
> (Int. 2)

The choice of GOOD on her self-assessment was made on an interpretation of the marks she received. Like many of the students in the study, marks were important to Anne.

There appeared to be two principal standards by which she assessed herself in terms of her achievement. Both of these were grounded in a subtle competitiveness: competing against herself, and against others. There was respect for those she perceived to be better students than herself, and some disdain for those whom she thought were less capable, or who did not seem to try.

Firstly, there was a measuring of her current efforts against a personal standard of what she believed herself to be capable of achieving. She was quick to downplay her accomplishments if she believed it necessary, and to always keep them in perspective. In a major Mathematics test the class had written in December, 1984, she was clearly one of the top students in her class in terms of achievement on the examination. [The test was written by all grade eight classes.] In discussing the test one week after it had been written, there was an ambivalence in the expression of her attitude about how well she had done on it.

R: How did you do on it?

A: I did O.K. I guess.

R: What/

A: I got seventy-eight percent. I could've done better though. I just left angle symbols off - just like a bent over "L." Could've had eighty percent but. [*] I did pretty good. It didn't seem like I got many wrong, but when I added them up, I did.

R: Umm.

A: Like, I did pretty good on definitions - for every one. In general, I did pretty bad.

R: I understand class average was quite a bit lower than what you got though.

A: Fifty-seven percent.

R: So you must have been one of the top students in the class regardless of[. . .]

A: I dunno.

R: Not sure?

A: Uh-uh. [No; in a low voice]

R: Well, you're twenty points above it, so/

A: [brief embarrassed laugh]

R: /can't be too many more that got a lot more than you[. . .]

(Int. 4)

During the final interview, the December Mathematics test and her desire to achieve in terms of getting good marks again arose.

> R: . . . I remember myself thinking "Well, that was pretty good [receiving seventy-eight percent]." But my reaction to what you thought was, "Well, I don't think she thinks she did very well on it."
>
> A: I didn't think I did very well on it because two more percent would have given me honours, and that really made me mad. [. . .] But really, it wasn't a good Math mark for me. I usually do pretty good in Math.
> (Val./Int. 6)

The second of her personal self-assessment "guides" was a measuring of her present results against a perceived standard set by those she believed to be more capable than herself. This appeared to be primary in terms of her self-assessment. Anne was very conscious of her position relative to others she knew.

> I don't consider my marks bad or anything, but I wouldn't put EXCELLENT down because I know there are a lot of kids do a lot better than I do.
> (Val./Int. 6)

She had a strong personal understanding of what those marks represented in terms of her ability to achieve in Mathematics relative to what others could do. She had comparatively defined her place.

These external standards were set by few others in her own grade eight class however. She spoke of her present class as being the "dumb class": "We have the lowest average and everything" (Val./Int. 6). She expressed amazement at the marks some of her current classmates were receiving and at the attitude of some members of the class.

> Like in our class in Language [Arts][. . .]they get thirty percent and they're all sitting there! Like on our report one of the kids in our class got fifty instead of forty like the teacher had told him, and he was jumping for joy because he got fifty percent. And I would not be jumping for joy if I got fifty percent. Marks are really important to me.
>
> (Val./Int. 6)

In grade seven she considered herself to be in the "smart class;" many of her classmates continued on to the "smart" grade eight class, while she was placed in the "dumb class." Did she consider herself to be "dumb?"

> A: Umm, well, I don't feel that I'm dummmb really [drawn out]. Maybe not as smart as they are, but I don't think that I'm dumb either.
>
> R: Okay. Smart[. . .]you mean, because you don't get as good a mark?
>
> A: Yeah.
>
> R: They get a better mark?
>
> A: They get a better mark. Like, I pretty much get honours most of the time, but they get ninety honours and that stuff, and I don't get that high.
>
> (Val./Int. 6)

The initial discussion (Interview 4) regarding the all-class test took place prior to her comments about the "dumb" and "smart" classes. The question of her knowledge of how well she did relative to what some of her friends in the "smart" class had achieved was not taken up. It is quite possible that for Anne, doing comparatively very well in her own class had to be balanced by the understanding she had of her class, that is, its perceived poor position relative to other classes. Certainly her self-assessment of just GOOD - while nevertheless achieving approximately eighty percent and considering seventy-eight percent as not a good mark for her - bears witness to her quite definite opinion that she was not in the same category as those who achieved "<u>ninety</u> honours."

A strong desire on her part to do well, and a sense that she was in fact doing well, was tempered by a feeling that she was in the "dumb" class. There was disbelief at the attitude and low achievement of some members of her class, those who perhaps served as the basis of her "dumb class" label. She did not count herself among their number, yet she perceived that she was not considered - by both the school and herself - to be among the ranks of the highest academic achievers in the school.

The feeling of not wanting to be "dumb" seemed to be deep-seated, and because of this, was motivational. When asked what she hoped to do in the future, prominent among the short list of items were "finishing school[and] going to university." While increased employment opportunities was later given as a reason for continuing her education, Anne's initial response to why she wanted to go to university was "I don't know, just[. . .]I don't want to be dumb" (Int. 4).

In class Anne could probably best be described as an "average" student. She was generally attentive, and took part in the class activities. There were times when her interest did appear to wane and she would then sometimes become involved, usually briefly, in other "non-Mathematics" activities - quietly talking to a neighbour, doodling, and so on.

Almost always it was noted in the personal observations following each interview with her that it "went well." She appeared to make a genuine attempt to answer questions and was able to engage in exploration of her feelings about Mathematics.

Verna

Verna was the only one of the eight participants who openly, without reservation, expressed a real liking for school. For Verna, attending school offered a variety of opportunities: a chance to learn things in the various subjects, most of which she liked, a place to be with her friends, and an opportunity to participate in many extracurricular activities, such as house league, year book, dance club, and even bake sales.

Out of school she was also active in regularly scheduled events like dancing.

When Verna was asked whether taking her elementary education at several different schools had affected her opinion of going to school, and of Mathematics education in particular, she was quite firm in her feeling that it had not. To the extent that the matter never arose in any discussion of Mathematics experiences, her convictions seem to have been borne out.

Verna was an attentive student in class. She was often among those who raised their hand to answer Mr. V.'s questions. She would occasionally ask a question herself when she was uncertain.

Even when she did claim to have been bored during a specific Mathematics class, such as when Mr. V. was reviewing in detail material she felt she knew, she attempted retrospectively to consider the experience in positive terms: If the activity itself was somewhat boring, at least the intent of the activity was good.

R: . . . What was your opinion of yesterday's Math class?

V: Boring. [*]

R: Was it? Why was it so boring?

V: Well, we reviewed. We went quite slowly when we were marking[. . .]and[. . .]like he said, the people who don't know it, listen; the people who do know, it's a good review. So I guess it was a good review then. [*]

R: Did you follow what he was saying?

V: Umm, well, sometimes I did. [*]

(Int. 5)

For Verna, Mathematics was her "best" subject. By this she meant she usually got her highest marks in the subject, and, unlike many of the other participants, was unequivocal in also meaning that of the subjects she was taking, Mathematics was the subject she most liked. Right from the beginning of the interviews she made it clear that "I really like to do math, . . . I like to do math a lot." "I want to go [to Mathematics class];" it was her favourite subject, and it had been for as far back in school as she could recall (Ints. 2, 5). Verna enjoyed solving problems, and Mathematics offered many opportunities for her to engage in this activity. It was "like a game" to see if she could get the "right answer." She particularly enjoyed topics such as "condition solving" (her favourite topic) for which there was only one, quite definite, right answer for each condition. Obtaining this answer, which she claimed was easy to do - "it just comes to me" - was rewarding and made her "feel good" (Int. 2, Val./Int. 6).

Verna considered herself to be GOOD both in general academic terms and with respect to Mathematics in particular. Moreso than Anne, she adopted an analytical stance in determining her self-placement: "I would say[. . .]seventy-five to eighty-five is GOOD" (Val./Int. 6). Her criterion appeared more institutionally-based and less personal than Anne's, who in contrast seemed more acutely aware of the higher marks some her friends getting.

There were mixed feelings about Verna as a study participant. Often she appeared a little nervous and she would fidget. She frequently punctuated her comments with short nervous or embarrassed titters or laughs. When there was an attempt to explore more deeply some aspects of her initial feelings or opinions on mathematics, she would frequently find it difficult, and occasionally end up stating that she just did not know. It seemed clear that she was trying to think, and on these occasions that sense of exasperation that often accompanied her "I dunno's" was probably directed at least as much at herself as it was at the question posed to her.

The researcher's reactions to Verna's apparent difficulties were multiple. There was empathy for Verna, and for others who also found themselves feeling self-conscious and perhaps uncomfortable at times in the discussions. It was realized that they were sometimes being placed in a difficult position, yet it was a position that was felt to be unavoidable if there was to be a deeper elucidation of the meanings of mathematics through a discussion of their experiences. Secondly, there was some concern and frustration at this inability of Verna's to sometimes go much beyond her initial remarks on a topic, and at an inability to help her open up. It was felt that this was where the essence of the research was situated, and the inabilities of both parties were hampering its unconcealment. Yet while there was a strong attempt not to convey this feeling to Verna, and while the search went on for ways to overcome the problem, the concern was evident, as shown by this personal observation made after a January, 1985 interview with her.

> The interview went reasonably well . . . but I find we often skirt around things. Or, [have difficulty] trying to find the things to say, to ask, that will bring out what they really think of something. I think she was honest with me, and when she says "I don't know," she really doesn't know 'the answer' to my question. I still believe she has feelings regarding the various matters discussed that she has not expressed, however it's not that she is holding back, so much as direct questions asking her to reflect back on matters that occurred in the past - from a few hours to years - are difficult to speak to except in very general terms. I find I'm running out of things to ask, to talk about.
>
> (Comments, Int. 5)

At other times there was a directness, a certainty about what she said that was refreshing. When she did feel able to respond, and discussion did open up, it was often with a definiteness, a conviction, that left little doubt that these were thoughts which she held close to her.

Verna alone among the eight students questioned the research itself beyond that taken up in initial group meetings. At the beginning of Interview 2 she asked what was hoped to be found through the study, and at the end of the final meeting, the validation/interview session, she asked if similarities between the various students had been found.

Donna

Donna, like Anne and Verna, was an active participant in an individually-oriented, organized out-of-school athletic/physical activity. She devoted several hours each week, after school, to gymnastics training.

Donna's perception of her ability to "do mathematics" was both similar to and yet significantly different from those held by the previous two girls. Donna did profess a liking for mathematics. As with Anne and Verna, she claimed Mathematics was her easiest subject. What set her apart primarily was the strength of the confidence she had in herself to "do mathematics."

The following illustrative remarks are from the second interview, the first in which mathematics was intensively discussed:

D: Like, I can do the things. Like, if he asks me a question, I could probably be answering it even though I didn't hear it.

R: Even though you/

D: /like, just heard it in through the background of my conversation I could probably answer it.

and a few minutes later:

D: Like, I have no trouble at all by understanding it [Mathematics]. In Social [Studies] you have to really listen, except in Math you just have a one-time explanation and you've got it. Like, that's for me, like I've got it for life.

(Int. 2)

Clearly there is an element of overstatement in her description of the ease with which she learned Mathematics, yet that overstatement highlights her unstinting belief in her capacity to learn Mathematics quickly and with little effort. She was undaunted by the subject.

As can be seen from Table 1, Donna's récollections of her marks was always in the form of ranges. She was the only student to consistently express her marks in this way. Stating marks in terms of a range is not unreasonable. What is interesting is the perception of herself as an EXCELLENT Mathematics student in light of the value of the marks she claims she has received. Some of the ranges Donna gave were wide, with the lower limit being quite low. She stated when she gave the final estimate of her Mathematics mark, ". . . it's between sixty-fives and seventy-fives, which is really good for me [emphasis added]" (Val./Int. 6). The Mathematics marks she claimed to have received were certainly no higher than those which GOOD students Verna and Anne said they were achieving.

The question becomes, On what basis, or bases, does an individual who generally received marks that were less than eighty percent consistently judge herself to be an EXCELLENT Mathematics student? The criteria, in fact, for assessing herself overall and in Mathematics seem to differ at least to some extent. Marks appear to weigh more heavily in the initial overall assessment of GOOD, and then in the drop to FAIR. Her marks in some of the other subjects had declined. The decline was a signal that she was not doing as well currently in some subjects. Thus, a change in self-rating was necessary.

Donna did speak of having a "standard."

> I guess my standard is being able to at least achieve a seventy percent. Seventy percent or over. So whenever I'm getting approximately seventy percent or over I feel that's my standard. . . . If I get any lower I feel really bad, and I have to work a lot harder. (Int. 5)

Although it was not pursued, the question arises as to the possible relationship between having a "personal standard" in Mathematics and having "personal standards" in individualistic athletic activities such as gymnastics.

Notwithstanding her "standard," the influence of Donna's mark seemed less dominant in the Mathematics rating. With Verna and Anne, their personal assessment was derived from a conceptualizing of a relative placement; Anne largely with respect to others, Verna by positioning her mark on an imagined numerical rating scale. In relative terms, a mark in a school subject of between seventy and eighty percent might reasonably be labelled as GOOD. Traditionally, schools have reserved their label of EXCELLENT for those who achieve grades of at least eighty percent, that is, those who are "honours" students.

The sense of feeling EXCELLENT was more complex than simply achieving a mark of seventy percent or more. History played an important role in guiding Donna's sense of her mathematical self. She spoke with pride about consistently being one of the first to finish her work in grade three, and then being able to help others. That same year her teacher gave her grade seven Mathematics material to work on. On at least two occasions, she recounted the story of having forgotten to study for a major grade seven Mathematics test and, much to her pleasant surprise, still having received the highest mark in the class.

When Donna was asked how long Mathematics had been her best subject, she replied emphatically, "Always!" By "best" she meant she had gotten the highest marks in the subject, and she understood it more quickly than some of the other subjects. But she also said she enjoyed doing it. Donna liked Mathematics. While her opinion of different topics and procedures within Mathematics varied she acknowledged that "I like Math in general better than any other subject all the time . . . at least among the core subjects" (Val./Int. 6). Feeling personally successful in turn had given her the confidence to help others, such as those in grade three, and then, at the time of the study, her friend in grade eight whom she said had difficulty. Her enjoyment of the subject and her willingness to help others was reflected in her stated desire to become a Mathematics teacher.

For Donna, a history of succeeding at Mathematics, of being able to quickly comprehend and do the work had developed in her a confidence that was not easily shaken by any particular test mark she might receive. That confidence did not exist with the other subjects. The long consistency of success that anchored the self-perception of excellence in Mathematics seemed to be missing with the other subjects. Perhaps here relativity did enter her self-assessment decision: Comparatively, she perceived herself to be better, sometimes much better, in Mathematics than in the other core academic subjects. Thus, if she considered herself to be FAIR or GOOD in those, then in Mathematics she was EXCELLENT. But unlike Verna and Anne, who relied substantially upon an interpretation of their marks in an externally relative sense to position themselves on the self-assessment rating scale, Donna understood her Mathematics marks as serving primarily as signals of applied effort that were to be weighed against her personal "standard." She already knew herself to be EXCELLENT.

Donna came to Mathematics class with an energy that was not as apparent in many of the others. While she was generally quite quiet in class, she often found other things to do when the lesson did not appear to hold her attention. Yet she could very quickly move from engaging in an activity that appeared to have nothing to do with the lesson at hand to volunteering to answer a teacher question, or asking a question about some aspect of the Mathematics topic being presented or reviewed.

This energy appeared in the interviews also. There was an excitedness about the way Donna spoke that led at times to a language of exaggeration, as evidenced by the earlier claim that a single explanation was all she ever required in order to understand the Mathematics topic "for life." Perhaps partly because of that energy, there was a struggle during Interviews 2 and 3 to establish a relationship, to reach a point of calm that would permit a greater opening up to discussion. What follows is an excerpt from the personal observations written immediately after Interview 3.

> Donna appeared generally nervous or anxious throughout. Often an embarrassed or nervous little laugh or smile. Sometimes struggling for things to say. Fidgetty. Perhaps had something to go to (e.g. friends). I don't feel I did a very good job either. Often struggled to get the discussion going. Feel I sometimes asked leading questions, or, often found myself checking something I had started to say. When she was hesitant, and obviously uneasy, I felt the uneasiness transfer to me - a sense of urgency - what can I ask that will allow us to kind of forget being uncomfortable, and really get into something.
>
> (Int. 3)

That calming gradually occurred, with the interview sessions improving. The personal observation after Interview 5 with Donna was:

> I felt quite relaxed this morning with this interview. I think she felt fairly comfortable with me - could say things that perhaps she wouldn't say earlier.
>
> (Int. 5)

Ted

As noted in Table 1, Ted's initial overall academic self-assessment was only FAIR, however, as with Donna, he also considered himself EXCELLENT Mathematically. Approximately three and one-half months later, during the final validation/interview meeting, he continued to consider himself EXCELLENT in Mathematics. In addition, he perceived himself to have improved to the point that he was now somewhere between GOOD and EXCELLENT overall. He believed his then-current Mathematics mark at the end of the study to be "in the eighties." How valid his perceptions of his November, 1984 and March, 1985 grade eight marks were is uncertain. Evidence in the school records indicated that his recollected final grade seven Mathematics mark was approximately ten percentage points higher than what it actually was. The information for verifying his November and March claims regarding his Mathematics marks was not collected as it was not considered necessary or relevant to the research. Still, there is some concern as to the accuracy of and the commitment that Ted in general had to his comments.

The possible lack of accuracy with which he recalled his marks does not interfere with or invalidate an examination of the relationship between his level of achievement and his self-assessment.

Ted was a student who clearly did not consistently achieve high marks in Mathematics. His final grade seven Mathematics mark was less than seventy percent. In a major, all-grade eight class Mathematics examination written in mid-December, 1984, his mark was less than sixty percent. By his own estimation, he was achieving at less than eighty percent in November, 1984. Nevertheless, like Donna, he considered himself to be EXCELLENT. His understanding of what constituted being EXCELLENT extended beyond a correspondence with marks. This matter was pursued in the final validation/interview session.

R: All right now, what means are you using, how are you deciding that you're EXCELLENT? Are you basing that on a mark, or just how you feel about Math?

T: | How I do it.

R: How you do it?

T: Uh-huh.

R: The fact that it doesn't come too hard for you? That it's fairly easy?

T: Uh-huh.

(Val./Int. 6)

Ted understood himself to be "good with numbers and stuff. And shapes." When asked to try and explain what he meant by being "good with numbers," he responded,

> Oh well, I use numbers a lot. Like I know what's going on. I just . . . do good in Math, I dunno.
> (Int. 2).

Ted claimed Mathematics was his best subject. By this he primarily meant that he generally got his highest marks in the subject and that he could "pick up on it faster." Considered in these terms, Ted felt that Mathematics had always been one of his best subjects.

While marks were undoubtedly interpreted by Ted as supportive of his claim of being EXCELLENT, such a perceptual self-evaluation must have as its ground something more than the placement of marks upon a scale.

As with Donna, success over time had convinced him that he could "just do it;" from that it apparently followed that it was not necessary to continuously obtain marks in the eighty to one hundred percent range to substantiate a claim of excellence. Unlike Anne, who expressed annoyance with herself at not achieving an honours level mark in the December examination, and who readily acknowledged her place as "honours" but not "ninety honours," and thus only as being GOOD, Ted expressed no such regret with himself. Neither did there appear to be a reasonably well-formulated personal "standard," such as Donna relied upon, against which to measure his achievements. There seemed an element of indifference on Ted's part to what his Mathematics marks were. On a day-to day basis

> he [Mr. V.] says that we have to learn it, and there's no way to get out of it, so you learn it, and it just happens that I like to learn it. That kind of stuff. I like working with numbers, so that's why I like it. (Val./Int. 6)

He seemed to have adopted a very pragmatic, quite uncritical and accepting view of being taught Mathematics:

> . . . We're getting taught it. [Emphatic] Like, they wouldn't teach us [this Mathematics] if we were never gonna use it.
>
> (Int. 5)

Ted's claim of liking Mathematics, one which he made on more than one occasion, seemed to be drawn largely from his feeling that he was able to quite quickly grasp the Mathematics being taught, and that he was in general able to solve the problems he was presented with in his assignments with little effort, that is without having to think too much about how to solve them. The degree to which Ted's "liking" of Mathematics extended to a genuine interest in the subject was difficult to determine. Frequently the questions of "liking" and "being interested in" were probed; his opinion of other subjects was often sought in an attempt to open avenues that might have led to clarification about Mathematics specifically.

One matter about which there was no question was Ted's interest in sports, even to the extent of his considering a career in some athletic field. He claimed to participate in a number of in-school and out-of-school athletic activities of both the team and individual variety. Physical Education was one of the subjects he enjoyed most at school; other option courses such as Industrial Arts and Band were also considered more interesting than the core subjects, which included mathematics. For Ted, it was only after the options had been discounted that one considered the relative degree of interest that the core subjects held. His remark that "you can't avoid it, so you have to do it. So you might as well just do it," while spoken specifically about Mathematics, was telling with regard to all of the core academic subjects [Mathematics, Language Arts, Social Studies, and Science]. His expression of real interest in any of them was underlined with ambivalence. At best they appeared to be "O.K." Perhaps because the overall interest in any of one of them was generally low, he found it difficult to speak with much certainty or conviction about such interest in them. Ted may have found himself juggling small degrees of interest.

Ted's opinion of which subjects were interesting also changed over the duration of the research. This appeared to be the result of a perception that combined two aspects: an overall impression of the particular course, which in turn seemed derived from a mix of such elements as mark, teacher, his view of the subject based upon having studied it for up to seven years, and so on, and secondly, the <u>current</u> topic of study. When a topic held little intrinsic interest for Ted, some interest in the school subject generally seemed to be sustained by his perceiving that the topics of study changed frequently.

In all of the interviews he did claim some interest in the geometry topics he was being taught for much of the duration of the field work. The following is representative:

T: It's a different problem. It's not like the same problem written out all the time, you just got to get a different answer [such as he finds is the case when doing "condition solving."] It's always a different problem, it's like, a paragraph question, instead of just numbers.

- - - - -

R: You're still working on geometry then. It must be two or three months since you started. How do you find it now?

T: Well, it's not boring, because . . . you do something for about a week, or week and a half, and then you move on to other things. Like, you learn new stuff all the time, so, like, we just got to circles now, so, it doesn't get boring.

(Int. 5).

But that professed interest is tempered by his remarks only a few minutes later:

R: There are some interesting things, and there are some things that aren't quite so interesting, but generally, Math seems to be, over a long period, the better subject[. . .]for you/

T: Yeah.

R: Is that right, or not?

T: Well, not now.

R: No?

T: Well, sorta[. . .]Science is still boring, and not so boring sometimes, and L.A. is okay, but now we're doing Africa in Social [Studies], so that's different. It's gonna be a bit better.

R: A little more interesting, is it? . . . At one point you said Math was your best subject.

T: It still is . . . for marks.

R: For marks?

T: Yeah.

R: But would you say, for most interesting?

T: [. . .] Uh-huh. [Yes]

R: Now? Still one of the most interesting subjects is it?

T: Umm. ["Yes," but with little apparent conviction]

R: Okay.

T: Except for Gym. And Band. My options.
(Int. 5)

The above exchange indicates the ambivalent nature of Ted's interest in the core subjects and in Mathematics specifically. While the perceived ability to "do Mathematics" appeared to be the principal criterion upon which his attitude toward Mathematics was based, there did also seem to be some interest in the subject.

The computer was also an area of interest to Ted. He claimed to use his home microcomputer's word processing capacity quite extensively. He expressed a career interest in the computer area also.

Ted acknowledged that he often found it difficult to concentrate on the class lesson for more than a few minutes at a time. When he wrote the major December Mathematics examination, he himself moved his desk up to the front of the classroom to the point of actually touching the wall in order to reduce the amount of his looking around the room at the other students.

As referred to earlier, there was some concern throughout as to the commitment he had to many of his statements. During the interviews he appeared to be disinterested at times, and there was a sense of a lack of conviction often in the way he spoke. His responses were typically quite brief; he was not easily given to elaboration. Probing for clarification often seemed to require the posing of dichotomous response questions. This in turn sometimes meant pondering the depth of the "Yes" or "No" response.

Ted turned in his journal only once. One daily entry was transcribed at that time.

Peter

Peter appeared to participate very little in organized extracurricular activities at school. After school, one of the principal activities he engaged in on a frequent basis was using his family's microcomputer. Although he said that "I usually just play computer games," it was clear that he considered himself reasonably knowledgeable about computers. He had taken a Computer Science course in grade seven, and claimed to have also learned about them while still in elementary school. He did enroll in a second semester grade eight Computer Science course which began in February, 1985, but during a December, 1984 interview it was his feeling that "this stuff here, that we're ever gonna learn in school, I already know" (Int. 4). His father's career was computer-related, and Peter thought that he too would pursue "something to do with computers."

Peter was not taciturn, generally being quite expansive and detailed in expressing his opinions and the reasons behind them. His remarks typically reflected a cautious, in-depth weighing of the posed questions. His comments often appeared as logical outcomes that followed from a deductive analysis based upon the understandings he had and the assumptions he made regarding the various matters that were discussed.

Peter had a definite concern for preciseness and clarity. This was evident even in terms of how the interviews were conducted: he wanted to be certain of understanding the questions that he was asked. For example, several lines of discussion developed in response to the somewhat casual question of how much time he spent each day on his twice per week music lessons: Was travel time to be included? Was the time to be for one day, or for both days?

In terms of academic achievement, Peter was one of the most successful of the eight students. Certainly he received the highest marks in Mathematics. That he should record his recollected grade seven Mathematics mark as 85.75

is not only indicative of his achievement level, but is also further suggestive of his concern for preciseness.

Perhaps not surprisingly, as noted in Table 1 Peter considered himself to be EXCELLENT in Mathematics. Even though he felt his overall average mark continued to be between eighty and ninety he believed it was his high Mathematics mark that was largely responsible for that fact, and thus an overall self-assessment of GOOD (as opposed to EXCELLENT) was considered warranted.

Peter exhibited a quiet confidence in his ability. The activities of Mathematics class seemed to all be taken quietly in stride. Although he was explicitly recognized by some of the other participants as a very capable Mathematics student, his actions in class were neither attention-getting nor on the other hand those of someone who shrank from attention.

When Mr. V. asked the class a question, Peter was sometimes among those who raised their hand to answer, and he occasionally asked a question if something needed clarifying. On two recorded occasions his questioning led to Mr. V. concluding that (a) Peter's answer was a somewhat novel yet perfectly correct alternative to his own, and (b) Peter's answer was correct and his was wrong.

As may be inferred from some of the above comments, Peter found that he quickly grasped the subject matter that was taught. In fact, the ease with which he understood in a second order way negatively affected the interest that he had in class, particularly in light of Mr. V.'s approach of detailed explanations and reviews. This is highlighted in the following exchange, which also illustrates the cautious, thoughtful, analytic manner in which Peter seemed to approach Mathematics study, and the interviews.

> Pe: . . . sometimes I feel the class is moving a bit slow you know. Like maybe we could go a bit faster and, you know[. . .]
>
> R: You mean it goes too slow for you?
>
> Pe: Yeah, a bit.
>
> R: Why does it go too slow?
>
> Pe: I dunno, well it's/ Well, I can understand the stuff, right, so I don't really have any problems that way, and then, like, I understand a bit of the stuff that comes later, right, and sometimes, you know, like it's not really that challenging, right, so like sometimes a bit of a challenge is pretty good.
>
> R: What do you mean by chal/ What would something be if it was challenging?
>
> Pe: Well, a bit harder.
>
> R: Harder for you, hey?
>
> Pe: Uh-huh.
>
> R: Harder in the sense/ I mean[. . . . . . .]if something was harder, what would that mean? . . .
>
> Pe: Not longer questions, but like different kinds of questions.
>
> - - - - -
>
> Pe: It seems that, like, when he's/ The teaching, like I don't really have any problems, like, getting some of the concepts, you know. Like learning how to do this, like, . . . it's not that hard, right. So, and if nothing's hard, sometimes it seems a bit boring. Or if sometimes it's too hard it seems boring too.
>
> (Int. 2)

Although being bored at times led to some self-professed inattentiveness in class and to having his mind "sort of drift away," when new material was being introduced, he paid attention.

> Well, like, . . . I'm usually thinking about it and trying to like, think, "What's he saying?" and not just, like, the words you know, . . . like, the point of the thing.
> (Int. 2)

On several occasions he claimed that what they were doing in Mathematics class at the time was not interesting. Often he was cautious in his declarations, using such phrases as "not really [interesting]," "not particularly," and "kind of boring," but in all the probing for Mathematics class periods or topics in Mathematics that might have stirred him and aroused his interest, not once did he allow that he was interested in what he was being taught.

When questioned about Mathematics study in junior high school and earlier in elementary school, there was "not really" anything he could ever recall that had been interesting or challenging (Int. 4).

In customary logical fashion, Peter explained why it was necessary to pay sufficient attention to learn the material even though it was uninteresting and lacked challenge.

> Well, it's just that like, sometimes, like, when you learn something, next year it'll just be a

continuation, and if you don't understand it fully, the first thing you know your mark kind of starts slipping. (Val./Int. 6)

His lack of enthusiasm for school Mathematics extended to much of what was studied in school.

R: . . . Do you generally enjoy going to school, taking Math, or is it just/

Pe: Well/

R: /frustrating, or satisfying, or/

Pe: Okay, well, school isn't frustrating, but it isn't that satisfying. Like, I guess, if you didn't have to take school, I guess I might not go. Like, if you didn't have to take all the subjects, I probably wouldn't take all of them . . . that we're taking right now.

R: Right.

Pe: But, like, I guess I would take Math.

R: You would take Math.

Pe: Yeah.

(Val./Int. 6)

Mathematics rated at least as high as, and higher than most other subjects because he believed it to be one of the most important. As indicated earlier, Peter was often analytical in his discussion and understanding of whatever was topical. The matter at hand was carefully weighed in terms of criteria that seemed to him to be relevant. In the case of school subjects, their importance seemed to be considered largely in terms of their usefulness. Those for which he could see practical value were seen as "good to know," while others were rated as "sort of useless."

Peter's record of maintaining his student journal was the highest of the eight students (see Appendix G(v)). There was often an economy of words however, and his entries tended to vary little from day-to-day. Nevertheless it was possible to extract significant inferences from his journal, particularly with respect to his views on mathematics outside of the classroom.

Karen

As noted in the introduction, the researcher-student relationship with Karen was problematic. There was a substantial lack of a positive relationship conducive to a developing trust and to encouraging a willingness to engage in easy and open discussion about matters related to the research topic.

Some interviews with Karen were better than others, however they were all marked by what appeared to be considerable nervousness, much shifting in her seat, and no eye contact. Her comments about many of her teachers and school subjects indicated a quite limited tolerance for and dislike of matters which did not hold her interest or appear relevant and meaningful to her. This same attitude was perceived to be reflected in her response - including the manner in which she responded - to some interview questions and topics. Her comments frequently were brief and abrupt, necessitating extended questioning to encourage elaboration and clarification. Occasionally conflicting, seemingly quite contradictory remarks about a matter would be made at different interviews. Attempts to encourage her to relax and to better understand the nature of the research by changing the interview situation and explaining (a) that the research was not intended to test her, (b) that there was no necessity to respond quickly, (c) that her understandings of the matter were what was important, not what she might have thought was wanted, and (d) why there was a need to ask apparently "silly" questions in general had little discernible positive effect. Unfortunately then, interviews were generally conducted in an atmosphere characterized by some resistance, tension and pressure.

In addition to the problematic interviews, there was also little success with the student journal with Karen. The entries for two days in November, 1984 were noted. The journal was not turned in again after that time.

This cautionary introduction to Karen is not intended to imply that no relevant, valid data were obtained. However, as with the other participants' data acquired through research with Karen are used only to the extent that they have been determined as valid. The amount of such data in her case is limited, and for that reason, are used sparingly.

Karen's behaviour in the classroom followed much the same pattern as exhibited in the interviews. She showed limited patience and some unwillingness to continue to attend the main Mathematics activity in the class if she felt she understood the material.

Karen claimed her self-assessment of GOOD was made on the basis of her marks. As is indicated in Table 1, Karen was academically successful in Mathematics and in most subjects. Since, as she confirmed, she was generally able to quite quickly grasp the material she was being taught, it is perhaps not too surprising that Karen should tire of reviewing topics she felt she understood.

Mathematics was a subject she claimed to like. That liking, however, seemed primarily to be because she did well in the subject rather than as a result of any general substantial interest in it for its own sake. She did state in Interview 2 that she found Mathematics to be "more interesting than Social [Studies] and Science," and there were some topics in Mathematics, such as set theory, metric measurement, and grade eight motion geometry which she considered to be "fun" topics in which to do exercises.

R: . . . [when] Math is next. Any particular feelings?

K: [. . .] . . . I don't know. Like sometimes we have a test and Math is next, "Oh, oh boo." But if it's something like just sitting in the class and having him correct and then give me homework, it's just, "So who cares."

R: "So who cares." Umm, do you like Math?

K: Uh-huh. [Yes]

R: How does Math compare with the rest of the subjects you have?

K: I do best in Math.

R: You do best in Math. Do you like Math best?

K: Oh, it's just easier.

R: What subject would you like best?

K: What subject do I like best?

R: Yeah.

K: Math. [Very slight laugh]

R: Ah, and the reason you like that best? Because it's/

K: It's easiest for me.

R: . . . What does it mean when you say, "It's easiest"?

K: I understand it better than I understand, ah, the rebellion of Upper and Lower Canada [she was studying Canadian history in Social Studies at the time] and fog formation [the current Science topic].

R: Okay. . . . Do you think you can tell me what . . . you're trying to say when you say you "understand it"?

K: Well, like, he puts work in front of us, I know how to do it, like I can do it right away, but sometimes in Social [Studies] or Science I have to look for it.
(Int. 2)

As was posited to be the case with Ted, she may have been juggling relatively small "degrees" of interest in Mathematics. Even though she did well in most subjects there was some preference for Mathematics because it was the one in which she found she was most quickly able to learn what was being taught, and to complete the work that was asked of her.

Karen's marks compared quite favourably with those of EXCELLENT students Donna, Ted, and Peter. It might therefore be asked why she did not also claim to be EXCELLENT. The answer to this is not particularly clear; when the question of how she decided she was GOOD was raised, Karen stated that it was because of her marks. She appeared unwilling to discuss the matter beyond that point (Val./Int. 6). It can be said, however, that Karen did not seem to exhibit the same level of long-term preference for Mathematics as Donna and Ted. She claimed there were occasions in her schooling past during which Mathematics was not the subject in which she received her best marks (Int. 4).

Pamela

Pamela enjoyed the social aspects of school. She usually came to school early to meet with her friends, to "mess around," as she put it. She attempted to take advantage of the extracurricular activities the school offered - "trying out" for school sports teams, for example - but she was often not particularly successful. Despite these disappointments, she did make other attempts to get involved in school events such as inter-class "house league" activities.

Pamela was a "trier" at extracurricular school events, and the same could be said for her school subject academic effort. Success in the form of good marks did not come easily for her. As indicated in Table 1, her recollected grade seven final marks were not particularly high. She said she found the transition from elementary school to junior high school somewhat difficult.

> . . . Well, I guess in grade six it was a sort of a goof-off year for us. And so when we got to grade seven it was just, "Boom, you've got to concentrate now." Like, grade seven was sort of hard, and you're trying to piece everything together, trying to hit it off good with the teachers and friends, and you sort of want to stay with the in-group, but then you've got to listen to the teacher so you can pass your grades. And so, it was sort of a battle.
>
> (Val./Int. 7)

In grade seven Mathematics, in contrast to grade eight, she found "things sort of seemed to be moving really fast" (Int. 2). One of her problems was communicating with the grade seven Mathematics teacher:

> I got confused quite often last year and I got scared and I didn't feel like going up to the teacher [who was not Mr. V.] and asking what was happening. When he tried to explain it to me, I just sort of left him alone at that, and tried to work it out myself, but it didn't work.
>
> (Int. 2)

Many of the problematic aspects of changing from elementary school to junior high school had been substantially reduced by the time she had reached grade eight, and she felt she could occasionally talk to Mr. V. Nevertheless, the theme of "being confused" present in her comments above still characterized much of her academic effort. Statements in her student journal and in the interviews were frequently punctuated by claims of being somewhat uncertain and confused whenever specific topics in Mathematics - and in other subjects - were discussed. Claims of finding a topic "easy" or understandable were often presented in juxtaposition to expressions of confusion, or as signalling emergence from confusion. The following illustrative comments are from her journal.

> I had a little trubble [sic] but I managed. (Nov. 26, 1984)
>
> In the beginning of class I was really confused but I sort of understand now. I'm not to [sic] clear on it. (Nov. 28, 1984)
>
> It was pretty easy and I was not that confused. The new information we got confused me a little but I'm doing all right! (Dec. 4, 1984)
>
> I understand it. I was not confused at all. (Dec. 17, 1984)
>
> It was pretty easy, but I sometimes got confused, (Jan. 14, 1985)

Pamela lacked that confidence in her ability to quickly understand what was being taught that characterized all of the other students thus far discussed. While she claimed to be generally able to overcome her confusion, it was usually only after attentively listening to Mr. V.'s explanations and trying to solve the problems on her own that she was able to do so.

R: . . . the principal thing I was trying to get at here is that it struck me that you <u>often</u> felt kind of

> uncertain . . . you didn't have a lot of confidence about the Math. I mean, you could work your way through it, and you could get it, but it took working at.
>
> Pa: Umm, yeah, that's[. . .]the way it always is [*], whatever I do.
>
> (Val./Int. 7)

The decision as to how to rate herself was itself made with some uncertainty. This acknowledged confusion and lack of self-assurance in her Mathematics abilities served in part as a basis for her decision that "I guess it's probably between FAIR and GOOD."

In order to achieve some success in Mathematics, Pamela had to apply herself quite intently to the Mathematics activities at hand. She was a quiet and attentive student in class; very seldom was she noted as talking to another student, looking around the room, or doodling. Unlike some of the other students, Pamela usually was explicitly personally appreciative of Mr. V.'s frequent thorough reviews and explanations of the problems. They helped her to better understand and reduce the confusion.

As was indicated in an earlier excerpt, like all the other students, striving for good marks was important to her. "I need a good mark in Math. I put pressure on myself" (Int. 4). The previous year, in difficult, transitional grade seven, it was at "the bottom of the list [of subjects]." In November, 1984, in grade eight, she announced that she was "above average." The fact that, according to her own reckoning, she was above the class average by only one percentage point did not deter her from making the claim.

The research relationship developed quite well with Pamela. Although at times she found it difficult to know how to respond to the questions, she did always attempt a response. Often these indicated a substantial thoughtfulness. Her journal entries were also among the most elaborated and reflective of the students (see Appendix G(iv) for a sample).

Carol

As indicated in the introduction to the students earlier in this chapter, Carol's academic history was significantly different from the seven other participants. She had difficulty achieving academically. The previous year she had done very poorly in Mathematics.

Carol did not participate in any extracurricular activities on a regular basis. Outside of school she regularly worked in a retail store. This involved handling money, and figured in her discussions of experiencing mathematics outside of the school environment.

Carol was usually quite eager to discuss Mathematics-related activities. She was not reticent about engaging in discussion in the interviews, and her responses were among the most elaborated in the study.

The understandings that Carol had of mathematics seemed to hinge quite tightly and vividly upon her experiences in particular Mathematics classrooms. This was somewhat the case with all the participants, but it was stongest with Carol. For example, unlike Verna, who claimed that attending all the different elementary schools had not affected her views on mathematics [which is not to say that they did not, in truth, affect her understanding of mathematics], Carol's varied experiences in different Mathematics classrooms with different Mathematics teachers did explicitly figure prominently in most discussions. Particularly evident were contrasts between her current grade eight experiences and previous Mathematics classroom experiences.

A common theme throughout was that she considered Mr. V. difficult to understand. She perceived him to be quite strict and firm in his demands on the students in terms of understanding the material and in terms of what she saw as "his ways" to "do" the Mathematics. She saw his rules as being the difficult ways, and quite different from methods to which she had previously been introduced for doing the Mathematics work.

Carol claimed she did not like most geometry topics. She stated that she preferred topics of Mathematics that dealt strictly with numbers, for example "fractions and decimals." With these topics she felt the "rules" of

Mathematics she knew for solving such problems superceded any of those of the teacher which might be different. There was only a very limited number of ways of solving such problems which by now she felt she knew quite well. There was less confusion associated with fraction and decimal problems, and less possibility of becoming confused.

Carol's behaviour in class indicated that she sought recognition. There was evidence of boredom at times, yet also of a desire to succeed, and to be seen as being successful. While she stated that she was quite concerned about giving wrong answers in class, that did not prevent her from trying to demonstrate that she knew the material by answering teacher questions. She would frequently be among those who raised their hand to answer one of Mr. V.'s questions. Sometimes it was done with evident eagerness. If she was asked to answer, and her answer was correct, there would occasionally be visible evidence that she was pleased that she was right and that she had had the opportunity to demonstrate that she knew the answer.

Carol initially considered herself to be doing reasonably well (see Table 1). She rated herself as GOOD in Mathematics because she felt that she was achieving a mark that was well above the passing grade of fifty percent. Three months later, after having continuously studied various aspects of geometry, she considered herself to be POOR. This she based directly upon her marks - "I'm at for now" - which resulted from her lack of understanding of the subject matter.

This self-assessment was made during Interview 7. At that time the class was engaged in geometry constructions, and the negative attitude toward the topic was still very much in evidence. Carol felt she had to "worry about compasses and stuff [*], and getting it perfect" (Int. 7).

Sixteen days later, during Validation/Interview 8, the topic of study in Mathematics class had now become rational numbers. Because she felt she knew this material Carol assessed herself once again, and on the basis of anticipated success, she proclaimed that she was now "passing Math" and that she would "probably get sixty on [her] next report card in Math."

Carol's current grade eight Mathematics experiences, as suggested by the above self-assessment description, tended to vary with the different interviews. Her attitudes towards the subject varied, sometimes to the point of being, at one level at least, substantially at variance with earlier views. This necessitated further attempts at clarifying these matters, and searching for a deeper level or context within which to situate her comments.

Summary

This chapter has presented a number of biographical features of each of the grade eight participants, along with a description of their general attitudes toward Mathematics. It has described and interpreted the assessment rating that each student made of his or her own perceived Mathematics abilities.

It has provided a brief description and analysis of what the researcher perceived his relationship to be with each student participant. There was substantial variation among the eight students in this regard. With Karen in particular the problematic relationship limited the extent of the valid data available for inclusion in the thesis.

It can be seen from the profiles that while there was a wide range of achievement levels represented by these students, many of them were at least reasonably sucessful in terms of achievement in Mathematics. A number of the students identified Mathematics as one of the subjects - and in some cases, as the subject - in which they obtained their highest marks. All of these people, including Carol, were students for whom receiving good marks was explicitly important.

Beyond the similarities in achievement levels among several of the participants, however, the individuality of each student is strongly evident. An examination of such aspects as (i) the level of interest in the subject of Mathematics, (ii) the students' confirmed and professed achievement levels, and (iii) the students' perceptions of their own ability in Mathematics reveals that these factors were present in quite varying combinations among the students.

It was quite clear that marks alone was not a complete basis for judging either a student's interest in the subject or for interpreting how each assessed her or his own Mathematics abilities. The students who appeared to exhibit the least interest in the school subject of Mathematics, for example, were those who were most successful - Peter and Karen - and Carol, who had the most difficulty with Mathematics. One of the students who was most enthusiastic about the subject, Donna, was in fact often only moderately successful in terms of achieving high marks.

Perceptions of "doing well" in Mathematics were very much personally defined. Refraining from imposing external definitions on the four self-assessment categories of POOR, FAIR, GOOD, and EXCELLENT produced results which point to quite differing views of what it means to be a FAIR student in Mathematics, an EXCELLENT student in Mathematics, and so on. The individual interpretations were striking in terms of the variation among the participants. The differences between Donna, Verna, Karen, Ted, and Peter, for example, were quite prominent.

This chapter has provided some insightful descriptions and interpretations of some of the ways in which each of the study participants understand their relationship to Mathematics. It stands on its own as a signifier of the strong individuality of young adolescent grade eight students. The chapter also prepares the ground for following the students through a descriptive interpretation in Chapters 5 and 6 of their mathematics-related experiences in differing contexts, their conceptual characterizations of mathematics itself drawn from their experiences with the subject, and their understandings of the value of its study.

Chapter 5: THE SPATIOTEMPORAL SITUATIONS OF MATHEMATICS EXPERIENCE

Introduction

A principal aim of the research was to explore with the students their perceived mathematics-related experiences in various in-school and out-of-school contexts. One major aspect of this exploration was to identify the situational contexts themselves, at least in broad category groupings.

Analysis of interview and student journal data revealed that the nature of students' mathematics-related experiences varied significantly depending upon the physical and social contexts of the experiences. The results of the study led to deciding that an appropriate division was that between those quite specific places in which Mathematics was formally taught and studied, and those places in which mathematics was less formally, less focally, attended to. By this is meant, on the one hand, the Mathematics classroom and its homework extension, and on the other hand, essentially all other locations, including other classrooms and out-of-school, non-Mathematics situations. The decreasing specificity with which these four groupings identify the contexts appropriately reflects the decreasing prominence of the mathematical character or content of the activities in these contexts.

Using "spatiotemporal context" was seen, then, to be one appropriate means of organizing the description and interpretation of the students' mathematics-related experiences.

Of course, all experiences of mathematics in any one of the groups were not the same. For example, as might be expected, the Mathematics classroom was by far the most prominent of the various spatiotemporal contexts. In the classroom the types of experiences were quite varied, not only from student to student but for each student. It is not possible to describe every experience, nor even every type of Mathematics classroom experience. Rather, it is those types of experiences which were given emphasis by the students, such as those which they perceived as "fun," "boring," and "in-between" that are described. These types of experiences are discussed here because environmental or social aspects peculiar to the classroom were important elements of these situations. In other words, the meanings of mathematics are derived not only from the Mathematics topics but from the nature of the actions of the teachers, other students, and themselves in the process of being taught and learning about these topics.

The meanings of mathematics very much included what it meant to "<u>do</u>" mathematics. The contexts of these "doing mathematics" experiences were important. To expressly acknowledge involvement with mathematics is to say that in these situations mathematics gains an explicit, immediate meaningfulness. A need or a place for mathematics has been perceived, and the individual has become openly, actively involved with some aspect believed to be within the realm of mathematics. To say that in other situations mathematics is not even contemplated is to say that it is perceived as not having a meaningful place in these situations. This meaninglessness can only be articulated later, as the everyday life situations are reflected upon.

Between these two poles of experiences - the explicitly mathematically engaged and the definitely mathematically non-engaged - there may be occasions such as those to which Luijpen and Koren (1969) refer. These are those occasions which, during the action itself, there is a pre-reflective consciousness of some activity in which mathematics is involved, but the mathematics of which is not recognized as such because this "mathematics-ness" is not thematic. This middle "grey area" also is a focus of the following discussion to the extent that such occasions can be brought to reflective consciousness and discussed and interpreted.

There was a distinct difference between mathematics-related activities in the Mathematics class (and homework location) and mathematics-related activities in other situations. These latter experiences were perceived as occurring much less frequently, and were much shorter in duration, in contexts other than the Mathematics classroom. Accordingly, there is a shift through this chapter from a focus on exploring the experiences within the spatiotemporal context (as in the Mathematics classroom) to an emphasis on an exploration of the contexts themselves (as was largely the case in the out-of-the Mathematics class/homework occasions). That is, in the latter case, attention is particularly devoted to identifying the situations or types of situations in which students considered that they had engaged in some way in mathematical activity, and the mathematics of the situations.

Interpretation is then provided of students' understandings of their generally infrequent and brief mathematics-related out-of-class experiences. The claims by the students that they had very few mathematics-related experiences in away-from-the-Mathematics classroom everyday situations appeared to be grounded in a firm belief that this was indeed the case. However, examination of the interview and journal data indicated that methodology may also have had some effect on the students' reporting, particularly on the frequency of the occasions perceived to involve mathematics. Because of this, the chapter includes a brief discussion of the possible impact of the research methods on the claims.

The Mathematics Classroom

The General Experience

For all the students, the Mathematics class was clearly the predominant place of mathematical activity. This is not a surprising result. Almost by definition the students understood mathematics as being that which had been or was being taught in Mathematics class. While such acknowledgement was implicit throughout the study, it surfaced explicitly in such remarks as those made by Verna when she was asked what she considered as mathematics:

> I dunno. Just what you do in Math. Just math!
> (Verna, Int. 5)

Not only has the school defined what mathematics is, it has, particularly strongly for some, defined how mathematics is to be "done." Further, the latter defining influenced the former, that is, <u>how</u> mathematics was understood to be properly <u>done</u> influenced understandings of what mathematics <u>is</u>. The strength of this defining and influence appears in Carol's contrasting "doing" mathematical activity at work with that done in school.

> . . . But I don't find it as math, I just find it as a part of work. But in Math class, you have to sit in a desk, you have to sit there with books open and a pencil in your hand, and you have to look at the chalkboard, and he's sitting there explaining it to you. Whereas at work you just do what you think. . .
> (Carol, Int. 5)

Mathematics classroom experiences were regarded by most as generally rather routine. There were periods which all found boring, and there were experiences which most but not all considered to be "fun." These experiences varied with the different students. Often however, the Mathematics classroom experience, looked at generally, was considered to be

> all the <u>same</u>, really. Like, it isn't really <u>boring</u>, but it's just not exciting. . . . It's nothing new . . . it's just kind of in-between.
>
> (Anne, Int. 3)

Views such as this appear to have arisen principally for two reasons. The first of these had to do with the structure of the Mathematics class period. For example, the routine of the present class was relatively standardized. The second had to do with the long-standing perception that the content of Mathematics as a subject generally changed only slowly and systematically over the grades. There were few occurrences of significant, rapid change, and generally speaking, the present grade eight classroom experience confirmed that view.

While this understanding of Mathematics as a slowly changing subject which typically had been routinized in its instruction was the dominant view, it was not the only view the students had of Mathematics.

Junior high school did represent a notable change from elementary school Mathematics for many of the eight students, including Anne who was quoted above. There was some limited relationship between the occasions when statements regarding this perceived difference were made, and the occurrence of changes in the geometry topics being taught. This relationship was only partial, and often the significant elementary school - junior high school Mathematics change was credited with having taken place in grade seven and not grade eight. (Discussion of the nature of school Mathematics itself is provided in greater detail in Chapter 6.)

Experiences in the current grade eight class also varied. As mathematics enthusiast Donna stated:

> . . . I never know what's going to go on in Math. It could be boring, it could be dull, like, it could be exciting. I could learn something, I could not learn something. . . . It just depends what we're learning I guess.
>
> (Donna, Int. 2)

The first part of the Mathematics period was usually devoted initially to homework review, followed by instruction on the current topic. Assigned Mathematics homework was an almost daily occurrence for the students in Mr. V.'s class. When there was time during the latter part of the period to begin work on the assignment, there was frequently a significant amount of activity; the students were busy working on problems, with some discussion among neighbours, usually about the problems. Some students found this atmosphere to be distracting, contending there was a rushed quality to the activity. The nature of the Mathematics textbook problems - frequently short in length, numerous, and often having a definite answer - contributed to this feeling. Pamela, the student who often found Mathematics confusing, stated that she felt there was a "competitive" atmosphere in the classroom at these times. She attempted to avoid getting caught up in it, preferring to try to work more slowly, and with little discussion with those around her. She believed that if she was to be successful in answering the questions, she would have to shut out much of what going on around her and direct as much of her attention as possible to the Mathematical tasks at hand. Still, she thought that it was good to have time during the class period to work on the problems because if she got "really stuck" she could go to the teacher, who she believed was likely to be more helpful than her family.

The distracting nature of this part of the period was not interpreted as a particularly negative experience by all of the eight students. For example, Verna and Ted worked at answering the questions, yet professed a preference for doing them at home, thus leaving these class times for more social activities. They felt they had some trouble concentrating in class, not principally because of noise, but simply because their friends were there. As Verna said, "I'd rather talk" (Int. 3).

Observations confirmed that Ted did indeed talk. Verna on the the other hand was seen to be less given to talking. She appeared to devote greater time to the assigned work, and less to what was happening around her. With Ted, there appeared almost a need to talk. He was firm in his conviction that teacher intervention was pointless.

> You can't just tell them [students] to stop talking, because they'll just keep going. Like, no teacher's gonna stop you talking, ever.
>
> (Ted, Int. 5)

Verna, the girl who enjoyed going to school and to her subject classes, would perhaps rather have talked. When those opportunities arose however, she may have instead heeded the same schooling advisory as Pamela, one which was quite different from that of Ted:

> . . . because we're not supposed to talk.
>
> (Pamela, Val./Int. 7)

Carol, the student who generally had considerable difficulty with Mathematics, seemed to find herself caught in the dilemma of often liking to do the Mathematics questions with her friends in the classroom, yet finding her ability to concentrate sometimes seriously threatened by that very sociality. This led her to claim at one time (Interview 7) that she preferred to do this work at home. This occurred particularly when she was having difficulty: The quiet and the assistance of her family, she claimed, was preferable. Still she seemed quick to point out the "fun" times for her during these periods in Mathematics class because these were times when she had few problems.

Anne and Donna enjoyed the opportunity to work on the Mathematics problems <u>and</u> to be able to talk with their friends - to seek help from a neighbour, or to help a neighbour - to the extent that Mr. V. permitted such talking. As Anne explained in describing why she preferred these "second part" times to "first part" lecture and homework review times:

> 'Cause, it's easier to ask questions to kids than it is to teachers. Like all the teachers go, "Oh, don't talk to your friends; if you have a question come and ask me." It's harder to explain to a teacher than it is to a kid, and right away, the kid's having the same problem, so they already understand what you're talking about, and you try figuring it out together instead of going up to the teacher and, "Well, you weren't listening," or anything. So, it's more[. . .]it's/you actually learn more in the second part.
> (Anne, Int. 5)

Karen and Peter went about answering the questions with relative ease. At times, they engaged in some discussion regarding a question, perhaps comparing an answer, or helping a neighbour. Typically they perceived this period of time and the activities as simply a taken-for-granted "given;" it was accepted as simply part of the Mathematics class.

For all these eight young people, doing Mathematics was a relatively individualistic act, regardless of how they interpreted the social environment of the Mathematics classroom while they were doing it. There was some point at which the individual alone had to attend to the Mathematical matter at hand.

Being Bored, Having "Fun"

Experiences of boredom in Mathematics class arose for various reasons. These centred around reasons having to do with (1) the topic: (a) it was considered intrinsically uninteresting, or (b) it was a topic which no longer held any novelty for the student, and (2) teacher practices, such as Mr. V.'s detailed explanations. These were periods when attention to the main Mathematics activities waned. The frequency and the occasions of boredom varied among the students.

There were also class academic activities which the students - different students at different times - found somewhat interesting, even "fun." "Fun" was a term which was used by these junior high school students to characterize a wide range of activities that were enjoyable in some way. "Fun" academic experiences were not unique to the Mathematics classroom, but they did occur in this class. The Mathematics context is examined here for their meanings. "Fun" is included in this section on the classroom experiences of mathematics because in the context of doing mathematics, "fun" was very much a classroom phenomenon. It is also discussed here because it appeared as a form of school academic experience that was important for many of the students. These were occasions which they highlighted.

With one exception, Peter, all of the students spoke of occasionally having "fun" doing Mathematics. "Fun" was not the same as "funny." "Fun" Mathematics experiences were not particularly humourous experiences. Rather, these were occasions when the students claimed to enjoy their Mathematics activities.

Three elements were discernible as common and basic to all of the "fun" occasions. "Fun" was a subjective labelling of the experiences. It was in the descriptive elaboration of these experiences that the three elements were discernible. The discernment of experiences as "fun" on the basis of researcher observations was largely unsuccessful.

The first of these elements, one which is foundational but not sufficient, had to do with how well the individual understood the topic in a second order way. This understanding did not need to be total, but it had to be sufficiently strong that any confusion and uncertainty were quite minor. The student's approach to the problem at hand had to be grounded in a feeling of relative confidence that he or she was capable of solving it. In other words, the problem had to be perceived as being easy. As Donna noted:

> I guess it's when it doesn't take a lot of thinking to do, it just sort of comes to you. It might take some other people a lot of thinking but . . . there seems no other way to do it for you. Like, it just has to be.
> (Donna, Int. 2)

"Fun" Mathematics was not Mathematics which challenged the student by being difficult. With this latter Mathematics,

> you have to get serious. You can't joke around. You have to sort of concentrate.
> (Pamela, Int. 5)

A substantial amount of Mathematics, for example much of that having to do with the basic operations of addition, subtraction, multiplication and division learned in elementary school, could be considered as Mathematics which all of the students felt quite confident in doing. But most of the participants no longer interpreted doing the elementary "basics" as "fun." Some easy Mathematics had become simply repetitive and trivial in their view. Thus this first element is not sufficient; a second element related to topic has to be introduced.

The second element discernible in these "fun" experiences had to do with the interest the student had in the topic. The topic was always one which was in some way intrinsically interesting to the student: The individual liked to work on problems involving this subject. In most cases - but importantly, not all - this meant that the topic was one which had been largely introduced in junior high school. That is, it was a relatively new topic which was still somewhat novel. Donna, for example, indicated she much preferred measuring with a protractor to measuring with a straight-edge ruler. Both were activities done at her desk, and both involved the use of tools. Protractor use was more recent than ruler use.

Most of the students had a small number of Mathematics topics which they felt were their favourites. For example, Verna particularly enjoyed condition solving, Donna's favourite topic was order of operations problems, Karen said she found parts of grade eight motion geometry "fun" to do, and Ted said he liked "drawing shapes" and "working with tools" in geometry. Thus, while the Mathematical character of the experiences was important, the topics themselves frequently varied from student to student.

These "fun" activities of doing Mathematics had to be activities which personally engaged the individual, such as performing calculations or constructing geometrical figures. Mathematics class activities such as copying or writing definitions, while important to attend to for reasons of success in achievement, were not activities in which the individual experienced this relationship with mathematics.

Thirdly, and for some, most importantly, this activity had to be undertaken in the company of friends with whom the person could discuss the results of his or her efforts. Attempting to solve the problem was understood to be a relatively individualistic act. Jointly solving a problem was felt to be less desirable than solving it by oneself. However, solving the problem in the company of friends provided opportunities to confirm results, to seek help, or to offer help. A "fun" time was a time of peer interaction. Thus in almost all cases these experiences occurred during what has been referred to as the "second part" of the Mathematics class period.

In this regard it is interesting to note that Anne, who was so conscious of her position relative to the "ninety honours" students, particularly sought out those around her whom she considered were good Mathematics students, such as Ted and Peter, to compare results. Donna on the other hand was generally more anxious to finish in order that she might help her friend.

All three of these aspects had to be present in order for a Mathematics class experience to be "fun," however, the existential importance of each did vary somewhat from student to student. To Carol, who found Mathematics quite confusing and difficult, and to a lesser extent Pamela, the first aspect was more explicitly critical than the third. Carol was significantly lacking confidence in her Mathematics abilities. Thus her preference was for topics such as fractions and decimals which she had studied for some time and about which she had developed some confidence. She claimed to find some geometry-related activities such as perimeter and area "fun" also. This was again because she had greater confidence in doing topics that involved extensive calculations. In her case, the mutually supportive relationship between elements one and two of "fun" experiences seemed quite strong.

> I like fractions and decimals. . . . They're fun to do, like you don't have to worry about compasses and stuff, and getting it perfect, where here [with fractions and decimals] you just do it the way you know. . . . there's about one or two ways to do it.

(Carol, Int. 7)

The first element, although still necessary, was less focal with students who were more successful and who had a greater confidence in their ability to understand and "do" most of the Mathematics they had been taught. These students claimed to find much of Mathematics reasonably "easy." Students such as Anne felt the third element, the social aspect of the "fun" experience, was the most important of the three.

> 'Cause, like, it's not really Math, the Math problems that are exciting, or fun, it's being able to do them with someone else [but each doing their own] . . . or talk to someone else at the same time, and help each other out. That's fun.
>
> (Anne, Val./Int. 6)

Anne claimed to be quite sensitive to the "mood" of the teacher and especially the friends who sat near her. According to her, "mood" had a significant bearing upon whether she experienced these activities as "fun."

For both Karen and Ted the second of the three elements, topic interest, appeared to be the major aspect. The two had confidence in their ability with all Mathematics topics. Some discussion with neighbours was a general occurrence during the "second part" portions of the class period. But references to "fun" were always made in connection with certain topics.

The relative importance of the three elements was not necessarily fixed with each student. For example, it was clearly the nature of "order of operations" and the experience of engaging in problems related to it that led Donna to describe it as her favourite topic. However, while she found measuring and drawing lines at her desk with her ruler uninteresting, the experiences of measuring the room or some other object with a group of friends were also those she recalled with considerable fondness.

Notwithstanding the variation in the apparent importance of the three elements among the different students, there is a hierarchical nature to these aspects of "fun." The first element in particular is foundational. It was the explicit or implicit ground of all "fun" Mathematics experiences. It is less clear that without some interest in the topic there is no possibility of Mathematics experiences being perceived as "fun" (Anne's situation, for example, raises some questions). If such should be the case, however, these would seem not to be "fun" <u>Mathematics</u> experiences; they would be "fun" in spite of the Mathematics.

Peter never used the word "fun" to describe any of his experiences in Mathematics class. In Validation/Interview 6 he was told that others had described some of their experiences as "fun," and he was asked if such had ever been the case for him. His response was "No." He did say that he did not "mind taking Math."

Peter certainly had no difficulty quickly grasping topics as they were introduced. While he was not an overly talkative student, he certainly discussed the problems with his neighbours on occasion. Elements one and three do not figure strongly in reasons why his experiences were never "fun."

An important reason why Peter did not consider any of his Mathematics experiences to be "fun" was that the second of the three elements, topic interest, was lacking. As noted in his profile, there was very little Mathematics that he considered to be interesting. What constituted an interesting topic for him was one that was not overly "hard" but which did present some challenge. In Peter's view, all of the Mathematics he had been taught very quickly became easy to do, even, apparently, trivial.

The Homework Location

On the basis of the student descriptions, the homework location exhibited characteristics both like and unlike the classroom. It was an extension of the classroom in that the current Mathematics was what was dealt with at this home location. On the other hand the dynamics of doing Mathematics at home were configured differently than those of the classroom acts.

At school, events were largely controlled by the teacher, and assignment work time was a time of some rushing and/or of some socializing, depending upon the individual's perspective. At the homework place, the control lay with the student. Many did acknowledge spending only a short time, often considerably less than thirty minutes on their Mathematics homework, as well as a desire "to get it over with." Still the environment was theirs to control, and the pace and the time spent was theirs to set. For many, doing homework was a solitary act. Doing homework - at home - was at least some of the time the best part of Mathematics for Ted and Carol. Verna claimed to prefer doing homework at home rather than at school. Those who found concentrating difficult in class could do so at home. For example, there was a period of time early in the study when a considerable number of geometry-related definitions were being presented in class. Several of the eight students claimed that home provided the environment for the more thoughtful reading and application of the definitions to the assigned problems. Yet help from family members was there, for some at least, if they felt they needed it. Here too, the confident, self-proclaimed EXCELLENT students Donna and Ted could occasionally indulge themselves in trying to solve the problems found in their older sister's and brother's Mathematics textbooks. Some made the decision to work ahead, knowing that Mr. V. would soon assign those problems as homework also. The common claim was that then "I won't have to do that page next day" (Ted, Int. 3). Still, the decision was theirs to make in the homework environment.

Thus, the Mathematics classroom was a place of being taught new Mathematics and a place of Mathematical review. It was a place of formality and structure. It was fundamentally a social place, however. Because of this, it was a place of occasional distraction for some; some struggled to shut it out, while some of the others contributed to it.

In contrast, the homework location had the characteristics of a haven for some, a place where the studying student could reduce the distractions and take more time if he or she desired. It was also a place for sometimes undertaking Mathematics activity not explicitly assigned by the teacher.

The somewhat detached attitude of Peter and Karen toward the work was again evident. For them, there was no preferred place and time. Discussion of the homework place was of an indifferent nature.

Beyond The Mathematics Classroom And Its Homework Extension

The Mathematics class and the homework place dominated the experiences of mathematics for all these students. They were, however, not the only daily situations in which the young person found him- or herself doing mathematics.

The discussion of mathematics experiences outside of the Mathematics classroom and homework location is divided into two sections, experiences in other school classes, and in out-of-school daily living contexts. The division follows the format of the student journal. In both contexts, however, the experiences tended to be similar: very limited in number, and brief in duration.

As was described i[illegible]3, there were no criteria provided to the students [illegible] them in their judgment of whether they had "done" [illegible]tics or not. The decision was theirs alone to make. It should also be noted that there was no attempt to sensitize the students to the extensiveness of mathematics use in daily life outside of school by discussing various possible situations in which mathematics could be involved. Finally it should be made clear that the journal questions asked the students to discuss their own daily "doing" or "using" mathematics. That is, the students were not asked in the "daily questions" of the journal to generalize about the extent of mathematics-based activity in society.

The mathematics-involving experiences in both these categories were cited very infrequently by many of the students. The question of why this was so is also pursued in this portion of this chapter.

The discussions of mathematics in outside-of-Mathematics class (and homework) situations had their genesis in the student journal questions. They began as discussions of current experiences, but they were not limited to these journal occasions. Students expressed general views on the extent and nature of outside-of-Mathematics class mathematics-related experiences as well.

Mathematics In The Other School Classes

One of the questions in the student journal asked the students, on a daily basis, to identify occasions when they recalled having engaged in mathematical activity in school classes other than Mathematics class. Doing one's Mathematics homework in these other classes was not considered an example. All except Peter did write of doing some mathematics in these places. This issue was also discussed during the interviews. All of the students claimed that they did very little mathematics in any of these courses. During the interviews Peter occasionally spoke of very infrequently making use of mathematics in Science, but, because he questioned whether the basic operations were truly mathematics, even at these times there was doubt as to the mathematicalness of what he had done.

Science was the most commonly identified subject in which some mathematics was used, although that claim was by no means frequent. Only two of the students cited a class other than Science - on one occasion in one case and twice in the other - in which some Mathematics was perceived as being used in some way integral to the course itself. The only other situation in which mathematics was claimed to have been used was in the calculation of an examination percentage mark.

Mathematics experiences in the other school classes, then, were limited to brief, infrequent occasions in which some topic or aspect of mathematics was perceived to be of utilitarian relevance to the situation.

Mathematics Outside Of The School And Homework Situations

A second question in the student journal asked the student to recall if he or she had done any mathematics outside of the school environment. Like the results that obtained when "mathematics in other classes" was considered, many of the eight perceived themselves as doing very little mathematics outside of school and homework. Some indicated that they never did any mathematics in their "outside" living. All of the students were expressly questioned in an interview as to how they went about answering the "mathematics out of school" journal question. At this time everyone stated that they had been in situations in which they had done some adding and subtracting, but in general, these occasions were perceived as having occurred very infrequently.

This understanding of mathematics as something that was made use of very infrequently outside of school was not fully accepted by all the students. The polarity of views is perhaps best shown in the positions of the two boys, Peter and Ted. In his journal, Peter, who was the student who most frequently made entries, was adamant in his claim that he did no mathematics outside the Mathematics classroom and homework. At the first interview session following the handing out of the journal, his response to the general question of how he had "made out with it" was:

> Like math is rarely ever used . . . except in Math class, right, and then maybe once or twice in Science, right[. . . .]but not much you know.
>
> (Peter, Int. 2)

And then again in the next interview:

Pe: Other than homework . . . there's nothing at all.

R: For the Math class.

Pe: Yeah. Or anything else. Other than the homework.

Pe: You know, like we don't have Math on Thursdays:

Pe: . . . you can actually forget all about math.

R: What do you mean? I don't quite follow you.

Pe: Like, O.K., on a Thursday, like you never even have to use math, right.

R: O.K.

Pe: Like, if you didn't know anything about math, it wouldn't really make a difference, you know, you rarely ever have to do math or anything other than in class or when you do homework.

(Int. 3)

Peter did believe that such basic matters as addition and subtraction were occasionally used in outside-of-school situations. He was reluctant, however, to claim that these things he did outside of Mathematics class and its homework extension were actually "mathematical." While his life-style may have indeed been such that he did not do much mathematics it is also clear from the discussions that the question of what was truly deserving of the labels "mathematics" and "mathematical activity" was very prominent in Peter's d[illegible] to answer the journal's questions.

Ted's view most opposed Peter's in terms of claiming to have done mathematics in other than the Mathematics classroom/homework situations. His single journal entry renders that source of very limited value, yet even in that one entry he claimed to have done "mathematics outside," having gone to the store to make a small purchase. Early in the discussions (Interview 2), Ted readily claimed to have used the basic mathematics operations outside "a lot." Later (Validation/Interview 6), while he felt that he did not "use numbers . . . really much," he still believed he used them every day. Ted had no limiting criteria of the mathematical "importance" or "complexity" of the occasion, and he was able to claim identifying the mathematical in even very short, simple events. He had no difficulty identifying these "occasions" in shopping and in sports, both of which he frequently participated in. Even the simple act of adding while keeping score in a game qualified as an activity in which some mathematics was definitely involved. For Ted, there were few perceptual barriers to the naming of mathematics.

Verna claimed no outside mathematics in her journal, while Donna, Karen, and Pamela claimed limited use of mathematics. These were rather miscellaneous events: determining the length of time it took an air mail letter to reach a friend (this rather novel situation was the only one cited by Donna), counting pennies, and calculating interest. Verna was very much like Peter, steadfast through discussion that "I never do anything [mathematical] outside" (Int. 5). Discussion on the matter revealed Karen more closely adopted the position of Ted in quite assuredly claiming instances such as shopping to be events which involved mathematical activity. Donna and Pamela saw themselves as using mathematics only on a very limited basis beyond the Mathematics classroom and the homework environment. Speculating on why there should be so few occasions for doing mathematics outside of Mathematics class, Pamela's journal response to the written question "What reasons can you see for there never being any math to do (outside of Math for school courses)?" was "Maybe because there really is no cause to use math in any other subject." While she misinterpreted the question, her point was still made. On the other hand, some uncertainty remained for her: She later appended "I don't know!!! (just a guess)" to her first comment (journal entry date December 17, 1984).

The elements of frequency or prolongedness of the m[illegible]cs-related activity were evident in the cases of the [illegible]t two students, Anne and Carol. Anne, who each week trained as a swimmer, often noted the outside-of-school activities of "counting laps" as she [illegible] and calculating the distance she had swam as activit[illegible] that involved mathematics. These were, however, the only such mathematics-related activities she noted. Carol, who worked after school several days each week, frequently cited "making change" as being an activity in which she used mathematics.

While such frequency or prolongedness may not always, or even often, be sufficient for the recognition of having done mathematics outside of school, following the thought of Luijpen and Koren (1969), the redundancy perhaps does help to make the mathematics of the activity thematic, that is, consciously recognized. Having been frequently present to the counting or the calculating, when asked if they had engaged in such activity, it may have been easier to acknowledge the mathematics of these acts. These locations - the pool and the work place - became physical places in which sufficiently sustained mathematical activity took place that it could be recalled as such at a later time. The suggestion follows from this that experiences which were neither prolonged in duration nor frequent in occurrence may have been completely overlooked, and thus not reported. The recognition of these situations as involving mathematics is of course predicated upon some underlying acceptance that simple counting and the basic activities of adding, subtracting, multiplying, and dividing are indeed mathematics.

Further Discussion On The Search For Mathematics-Related Situations

Basic elements of the configuration of the mathematics experiences changed greatly as the shift from Mathematics classroom to out-of-school situations took place. Certainly the duration and the frequency of the daily situational occurrences changed. The nature and aims of the experiences also changed.

The Mathematics classes were extended periods of mathematics-related activities that took place four times each school week. The students were required to be there. The activities were by definition mathematics-related: the period itself was identified as Mathematics, as were the many activities that took place in the class during this time. The question was not left to the student to decide whether what he or she was doing was mathematics. It simply was mathematics.

These points may appear as rather obvious but they warrant stating because they illustrate a fundamental influence on the nature of the research in this matter of contextual experiences. The taken-for-grantedness of the Mathematics class as being a context in which mathematics activity took place by definition meant that, as soon as this point was quickly established, the nature of the many various experiences themselves could be discussed. Somewhat the same could be said of the homework place. However, as soon as the contexts shifted from those directly related to studying Mathematics to other contexts, the tasks for the students changed.. There was now much less taken-for-grantedness about claiming situations as involving mathematics. Each student had to attempt to recall her or his daily activities, and at the same time attempt to assess these activities for their possible mathematicalness. This implies that the students had then to draw upon their respective "stocks of knowledge" for what constituted something being mathematics.

It was noted above that Carol wrote in her journal that "making change" was an activity in which she used mathematics, and that this signified some acceptance of the activity as mathematics-related. The strength of her belief that it was truly mathematics she was doing was not at all clear however. Discussions with her and with some other students indicated that once they were away from the classroom their strong classroom understanding of what mathematics is and what it meant to "do" mathematics was diffused by the external contextual factors and led to uncertainty whether they had really done mathematics.

A substantial influence on the reporting of having done, or not done, some mathematics in some activity outside the classroom was the perception of what truly could be defined or accepted by the individual grade eight student as being mathematics, particularly in a context apart from the Mathematics classroom. Student understandings of what mathematics is are explored in Chapter 6.

A second possible influence, that of the frequency of occurrence or prolongedness (brevity) of the activity, was posited earlier.

In accepting that, as many of the students claimed, there may simply not have been many mathematics-related occasions for them to report, no claim is made that the students exhaustively documented all such occasions. The two influences given above appear to account for some possible decisions not to report, or oversights in reporting in the journal, should there have been some. However, an examination of the interview and student journal data also suggests that some of the explanation for the very limited number of journal citations of "other classes" and "outside of school" experiences rests with the journal methodology of self-reporting itself. These are briefly listed here.

(1) Faulty recall may have been one factor. For example, on a limited number of journal entry dates,

discrepancies between "Yes" and "No" claims by students in the same Science class on the same date were evident. There could well have been other reasons for the differences, however if the length of time spent in reflecting on the day's events was short and the depth of that reflection was limited, this may have resulted in overlooking some mathematical events that occurred during the day.

(2) The students may have found themselves answering not, "Was that mathematics?" but rather, "Was that enough mathematics to report?", or perhaps more specifically, "Was that enough mathematics for Mr. Franks for me to report?" No qualifications were placed on what they could name as being mathematics: If they believed they had done some mathematics, they were to report it. The decision was explicitly made entirely the student's. Suggestions of this possibility of qualified reporting occurred when students stated in the interviews that the occasion was "not important enough" or "complicated enough," as Carol, Anne and Peter did. For example, Anne stated that "figuring out how many lines I wrote" - an example of counting - was "not very important," and thus she did not report it (Int. 5). Counting "laps" in the swimming pool apparently was sufficiently important (Val./Int. 6).

On the other hand, this matter of "being enough" or "important" may also be related to the understanding of what mathematics actually <u>is</u> for each of them.

(3) A third reason is suggested by review of the journal entries. It is possible that, especially for those who made more frequent entries in the journal, once a pattern had been established, that pattern might have dominated their reporting decision throughout. That is, if at some point the student made a decision as to what was "mathematics in another class" or "outside of school," that decision might have led to overlooking other cases of having done mathematics in some other situation. An example might be that of a student such as Peter who early in the study decided that mathematics was not used outside of Mathematics class, and therefore very little thought may have been given to these journal questions thereafter. While there is no definite evidence that this "pattern effect" was present, the repetitive nature of the manner in which these questions were answered by some of the students suggests that it cannot be completely ruled out. It must be quickly added, however, that the students' conviction in their belief that they did no mathematics was usually quite strong, even in the face of interview questioning.

It should also be added that while there may have been some situations that were not recorded for one of the three reasons given above, it seems almost a certainty that these would have been few in number, and, for the most part, very brief in duration.

Discussion And Summary

This chapter has revealed, perhaps not unexpectedly, the dominant place of the Mathematics classroom among the possible contexts for experiencing mathematics.

Within the classroom there is a structure to Mathematics activities that is not found anywhere else that such activities are undertaken. Here, day by day, the teacher largely controls what the topics will be and how they will be presented and directs the actions of the students in learning the presented topics. The strutturedness and external control of mathematics activities becomes increasingly reduced as the student moves from the Mathematics classroom to other academic situations (other classrooms and the homework location), and then to other, interpretive, Broudy-like (1972), completely non-academic situations.

In the Mathematics classroom students had many types of experiences. Significant among these were the "boring" and the "fun." It is interesting that at the junior high school level students still refer to some of their academic experiences as "fun." These were experiences which were engaging, which involved the individual. Reflection upon their "fun-ness" centred on how the student felt personally, positively engaged. These experiences engaged the student more completely than did uninteresting or boring activities. They engaged the student differently than did difficult topics. The labelling of these experiences as "fun" was always initiated by the student. It was an emotional response to the experience; "fun" was a response that implied a closeness to the experience itself. There was a spontaneity to such descriptions.

It was possible to discern three characteristics in the "fun" Mathematics experiences, although these varied in their relative significance among the study participants. Most commonly, however, Mathematics classroom work and study was experienced as "in-between," neither exciting nor boring.

The homework location was the only place outside of the Mathematics class that extensive mathematics was also undertaken. For several of the students this place was quite well defined. While the experiences in this context were those that had to do almost completely with school Mathematics, the students characterized this situation in considerably different terms than they did the Mathematics classroom.

Mathematics activities in the classroom and the homework location had as their aim the learning and practicing of Mathematics. Once outside these spatiotemporal contexts, most students had considerable difficulty identifying many mathematics-related situations. The experiences typically became brief in duration and infrequent in number. The students interpreted these as occasions the aims of which, while mathematics had functional relevance, were ultimately non-mathematical.

Aside from there truly being few occasions in which the students used mathematics, understandings of what constituted mathematics also influenced their perceiving mathematics experiences outside of the Mathematics classroom. Those such as Ted and Karen for whom there were fewer contextual influences on their perceptions of what [illegible]tituted mathematics seemed to have greater ease in [illegible]ing outside-of-Mathematics class mathematics [illegible]ences. It is difficult to say whether their [illegible]etations of their experiences implied they were more [illegible]n their observations and firm in their convictions [illegible]hat mathematics is, or simply less discriminating. It remains, however, that while for all students mathematics seems to have a quite limited place outside of the Mathematics classroom/homework location contexts, there were variations among the group in terms of the extent of their naming of these experiences.

The students' understandings of the character of mathematics itself, and its value, both very closely related to the naming of the spatiotemporal situations of mathematics, are explored in the next chapter. This present chapter has served to prepare the ground for Chapter 6.

Chapter 6: MATHEMATICS: ITS CHARACTERIZATION AND ITS VALUE

Introduction

In terms of the student/mathematics relationship, Chapter 4 gave prominence to the "student." Chapter 5 began a shift in the portrayal of the relationship, with increasing emphasis given to "mathematics," although the "student" remained strong. In this chapter the shift in emphasis continues. While the students are always visible, and while it is their experiences that are drawn upon, the focus is now more definitely on "mathematics": what it "is," and what the value of its study is.

The first part of the chapter describes how the students characterized or depicted mathematics itself. The notion of "characterization of mathematics itself" is also referred to here as the students' "conceptualization of mathematics." In a sense it is a question of seeking out how each student subjectively defined "mathematics," but "definition" is too formal and narrow in its connotation.

Seeking this characterization took various forms. A general naming of mathematics arose through a more direct questioning of what mathematics is for each of the participants. For many students the examination with them of how they made decisions regarding their journal entries revealed this general characterization. In Ted's case, following up on his early (Interview 2) statement that he "used numbers a lot" revealed his basic claim of what mathematics is. With Peter, a discussion about the relationship of mathematics and computers led to an understanding of what mathematics conceptually meant to him. This general characterization of mathematics is presented first.

Each school subject was considered by the students to be very different in content from the other subjects, and Mathematics was no exception. There was no connection between Mathematics and other subjects except as suggested in the previous chapter. That is, students sought connections between Mathematics and the other subjects only by looking for its applications.

A second understanding of what mathematics is that gave specific, in-depth consideration to school Mathematics was also sought. This was done by asking the students about their elementary school Mathematics experiences and their perceptions of possible changes in Mathematics over the years of their schooling from the early elementary grades to grade eight in junior high school. That is, elementary school/junior high school Mathematics relationships were discussed. The intention of this discussion was not to produce a list of topics that the students could recall from their Mathematics study. Topics of study did, however, figure strongly in shaping the students' understandings of what is Mathematics and what is not Mathematics.

As was noted in Chapter 5, situational contexts also influenced the individual student's attempts to conceptually delineate mathematics. The nature of the influence of the daily physical and social contexts is discussed in the third section of the exploration of the "characterization of mathematics itself" in this chapter.

The perceptions of what mathematics is were seldom thoroughly definitive. The historical and spatiotemporal influences were often subtle, even occasionally seemingly contradictory. At times these contradictions could not be completely resolved.

The second portion of this chapter is a description and interpretation of what the participants understood to be the value of mathematics and its study. These understandings were disclosed first by seeking out what perceptions the students had of the usefulness of mathematics in their daily lives. This followed directly from discussions with them about related questions in their journals.

It was shown in Chapter 5 that all of the students used or "did" mathematics very infrequently outside of the Mathematics classroom. This understanding by the students led to interview discussions moving from the personal use of mathematics to the more general question of what each considered the value of mathematics and its study to be. Interpretations of these latter discussions are presented here.

In Chapter 4 the interest each student had in Mathematics was portrayed. Discussion with students about the value of studying mathematics indicated that for many of these eight young people, there appeared to be a relationship between interest in Mathematics and the concern each had for the subject's utilitarian relevance. This relationship is examined in this portion of Chapter 6. ("Interest" is used here to mean the appeal the study of the subject has for its own sake. Other aspects of "interest" in mathematics, such as practical interest, are subsumed under the "value" of mathematics.)

As in previous chapters, students' quotations are extensive in order that the language of these young adolescents may be examined. The uncertainty, the subtlety, and occasionally, the certain firmness of the students' understandings of mathematics are revealed in this way.

Mathematics: Understandings Of What It "*Is*"

The General Characterization Of Mathematics

In perhaps a somewhat uncharitable naming of mathematics, it was Ted's contention in one instance that it is "just a big bunch of numbers and stuff" (Val./Int. 6). However, less much of the apparent negativity present in his representation, that description was very much the common one for them all.

The general characterization of mathematics was that of "working with numbers" (for example, Peter, Int. 4). That concept was central to the notion of what mathematics is. Both aspects of the phrase - "numbers" and "working with" - had significance. This was evident in the following remark by Pamela:

> . . . Well, math is sort of like calculations. Not just numbers, but calculations, and[. . .]
> (Int. 5)

and in the equally certain, but less polemic comments by Ted in the exchange below:

R: . . . So it seems to me that for you, you're doing math when you're using number in some way.

T: Uh-huh.

R: [reading] "Counting, adding, subtracting and so forth. Identifying something by number." So I guess my bottom line question - if there's number involved somehow, then that's math -/

T: Yeah.

R: /-somehow that's math. Even if it's only to say, "There's one clock on the wall." That's math. Or "He's player number thirty-three." Is that math? 'Cause there's number there.

T: No, that's not math.

R: No?

T: That's just looking at numbers.

R: O.K.

T: If you're adding two numbers, if there's two numbers that you've got to put together and do something with, that's math.

(Val./Int. 6)

Well into the research period, a period during which the students had been continuously studying various aspects of geometry, "calculating numbers" was the standard by which they identified that which was mathematical. The geometry was acknowledged to be mathematics, but it seldom was <u>named</u> in any characterization of what mathematics is. For example, during the validation/interview, Pamela did allow that what is mathematics had broadened and was

> . . . not only numbers and calculations, it's sort of, now with the constructions, making things with something to do with math.

But even in these circumstances she sought the reassurance of "number" and "calculation."

R: . . . There has been some [geometry sections], like areas and perimeters, if you would call that calculating, but some of the first things, with relationships and definitions[. . .]and then with this current stuff, <u>constructions</u>, so[. . .]things like that kind of[. . .]

Pa: Well, it's calculations or[. . .],

R: But are they still math?

Pa: Yeah.

R: O.K. [. . .] Why is it math? I guess it's math because they[. . . . . .]

Pa: I dunno, umm[. . .]it's, see, the geometry set is related to finding the length, and length is just a part of calculation and stuff[. . .]/

R: O.K.

Pa: /and numbers and that sort of (helps?)?

(Val./~~Int~~. 7)

In seeking the mathematicalness of those topics within geometry which appeared to involve little calculation, such as constructions, she sought out just that aspect. So integral was the concept of "using numbers" to the personal defining of what mathematics is that when it was very difficult to locate the calculative in the topic, it began to be perceived as less mathematical. At one point Pamela compared a section of geometry which made extensive use of the definitions of geometric figures, such as various types of angles and triangles, and geometric relationships, such as congruency, to a later section involving the calculation of the area and perimeter of various plane figures. She declared the latter to be "more mathematical" because "you have to work it out more, like with numbers and stuff" (Pamela, Int. 5).

Two aspects of the nature of mathematics for Pamela and the others are revealed in this analysis. First, more generally, mathematics is a "doing," that is, it is action oriented. Secondly, the doing is "calculating." Thus, the more there is a doing, and the more that doing is an explicit calculating, the more mathematical the activity tended to become.

Understanding mathematics As School Mathematics

It has been shown that mathematics generally was characterized as "working with numbers." Elementary school

Mathematics was characterized more specifically as "adding, subtracting, multiplying, dividing" - "just basic" (Verna, Int. 5; Carol, Int. 7; Pamela, Val./Int. 7). For some, the elementary school seemed a distant past. There was often difficulty in recalling what had been done in studying Mathematics in the various elementary grades. Beyond the strong naming of elementary Mathematics as "adding, subtracting, and things like that" (Donna, Int. 5), the mathematics-related activities of the past elementary Mathematics classes often lost definition, commonly to be subsumed under phrases such as the above "things like that" or more simply "stuff." Anne could remember very little earlier than grade five. Some could readily recall highlights, points in time when perhaps a new Mathematics topic was introduced. Verna recalled beginning multiplication in grade three (Pamela thought it was in grade four). Enthusiastic Donna recounted how her grade three teacher permitted her to work on order of operations problems because "I always got my Math done so fast" (Int. 5).

Already implicit in its general characterization, from the grade eight perspective, the elementary Mathematics period was seen as a time of slow development, with a great deal of repetition.

The following comments illustrate this point.

Anne:

R: Why is it better in junior high?

A: Different things.

R: Different things?

A: 'Cause we been just doing the same thing over for six years, just using bigger numbers each year.

(Int. 5)

Donna:

R: . . . do you see any difference [in Mathematics study] as the years go by?[. . .]

D: Not really.

R: Not really?

D: Not really. Maybe one point/

R: What do you mean, one point?

D: /every year.

R: Oh, you mean . . . add some one little thing each year?

D: Yeah. Yeah.

R: What do you think about that? Why do you think they do that?

D: Guess so that you can have a lot of ways of doing one question. And have the fastest way - pick out the fastest way.

(Int. 3)

The activities of the Mathematics classes past and present greatly defined "mathematics," yet elementary Mathematics was held in varied relationship to junior high school Mathematics. The quotes of Anne and Donna point to the two major perspectives on this relationship. Some such as Donna above interpreted the changes as smoothly progressive. That is, her portrayal of "one point each year" extended into junior high school. Others such as Anne perceived a greater disjunction between elementary and junior high school Mathematics. All did see the basic elementary Mathematics as foundational to their junior high school studies. Pamela, struggling somewhat, found the words that perhaps more than most reached to the core of the question of elementary school Mathematics for these young people, and what junior high school Mathematics now represented.

R: What about some of the Math you learned in elementary school . . .?

Pa: I dunno. That's sort of/ That was[. . .] Through elementary everything was sort of built up and so it's now one thing.

R: O.K. What do you mean now?

Pa: Well, it's sort of[. . .]it's all together, it's not[. . .] I dunno how to explain it, umm/

R: It's been set around the[. . .]the different/

Pa: Everything I learned in elementary is now really understood, and I've moved on to more difficult things. (Val./Int. 7)

The understanding of elementary school Mathematics as ground upon which the "more difficult" junior high school Mathematics was developed was present in her remarks, as well as was the undifferentiated nature of that understanding. Elementary Mathematics was "all together," it was "one thing." This was consistent with her earlier description of elementary Mathematics as "just basic."

Others in addition to Donna held to the progressive view of elementary to junior high school Mathematics study. It was put by Karen in characteristically succinct fashion.

> We did almost everything we did here, but at a lower level.
>
> (Karen, Int. 4)

Peter, perhaps the most analytical of the eight young people in the study, discussed the study of elementary and junior high school Mathematics in greater depth.

R: . . . When you get the point of the thing [newly introduced topic], . . . how do you feel about that in relation to what you already know about math? . . .

Pe: Well, it seems like everything's . . . like, a lot of times, that things are based on things that you learned last year at approximately the same time of year, right.

R: Uh-huh. [drawn]

Pe: But then, but when you travel between unit to unit, like, it's totally different, right.

R: You mean . . . what they cover within a unit is different from[. . .]

Pe: [in background] Yeah. Yeah. Yeah.
But, like, the first thing you learn in grade seven is usually the first thing you learn in grade eight, you know, and it's not relatively totally new, like if you started learning it in grade three, right, you'll learn it at the same time in grade four - all the way up, until, like, maybe they'll drop it after awhile.

R: O.K. What do you think about that?

Pe: [. . .]Well[. . .]I guess that's the most orderly fashion . . .

(Int. 2)

The issue was again dealt with in the final meeting.

R: . . .[reading] "You see the way Math has been taught over the past few years to you as quite orderly. The topics follow in the same order - generally - from one year to the next." Now, I asked the question, "Is it primarily just expanding, just adding new ways to do something from one year to the next?" . . .

Pe: Well, it depends. Like, sometimes in elementary, in grade three we'd learn how to do multiplication, right, and grade four, about the same time of the year, we'd learn to multiply with bigger numbers, right/

R: Right.

Pe: /and then it'd just build up. But then there's some points, like, this year in grade eight, like, we're doing construction right now, right, like there's no unit, nothing even close to that, last year at this time.

R: O.K.

Pe: Or any time last year. So sometimes new things do come.

(Val./Int. 6)

Donna, Karen, and Ted also did acknowledge the occasional completely new topic, such as geometry constructions. In most cases it was a matter of building upon what had they had been taught before. The perception of the slow developmental nature of their school Mathematics study throughout their schooling was strong and they saw little of a substantial disjunction between elementary school and junior high school Mathematics. It was a case of

Mathematics, and thus of mathematics, gradually becoming more diverse and perhaps more difficult.

Not all students felt this way. The Mathematics of junior high school, to the mid-point of grade eight at least, was leading some of these young people to more strongly interpret this period of schooling as a time for reconceptualizing what mathematics is.

The transformation in Pamela's understanding of the character of mathematics as a consequence of her junior high school studies was not an easy one. A broadening view was taking place, but as seen above, notions of the more mathematical as strongly involving the calculative continued to dominate her perceptions of mathematics.

For Verna the move to studying junior high school Mathematics was necessitating an explicit reappraisal of the notion of mathematics. The "all one thing," the "basics" of elementary school, were still integral to an understanding of what constituted mathematics, but the present situation of doing of "a lot more," studying, as she described them, "condition solving, geometry, constructions, fractions, rational numbers, decimals" (Val./Int. 6) was leading her to substantially broaden her understanding of what mathematics is. With uncertainty, she recalled that the study of some of these topics had begun in elementary school. From her current grade eight vantage point, the identification of the first six grades with the basic operations of adding, subtracting, multiplying, and dividing greatly overshadowed these other, introductory, topics. Just the converse was apparently occurring in junior high according to Verna's perception of her Mathematics education thus far; the wide variety of activities was overshadowing the basic operations. It was not that these were not being performed, but rather, they were seldom the focus of study. Junior high school Mathematics, particularly in her current grade eight year, stood out for her as "quite a bit harder," more "complicated."

As noted earlier, Anne, like Verna, perceived a substantial change moving from the elementary to the junior high school levels. The difference, the break from just "adding and subtracting and multiplying and dividing" with progressively "bigger numbers" was a welcomed step for her, even though it meant being confronted, at times, with Mathematics which was difficult and "way more challenging" (Int. 4).

The shift to the different and the more complicated, which was generally to Anne's liking, was not without paradox. Aspects of this recent Mathematics were less mathematical than those in elementary school. The "basics" of the earlier grades were definitely mathematics.

A: I call them almost more "math" than what we're doing now, I guess.

R: Oh, is that right?

A: 'Cause it's like the basics, and you were learning how to add one plus one, and you got into bigger additions, subtraction, big multiplication, like four numbers, and that, and bigger division. And then we moved on to fractions, and I call that stuff more useful. So if something's useful, then I call/

R: /So that's more useful.

A: Yeah. 'Cause you're gonna add a lot more than you're gonna construct an angle or something.

R: O.K.

A: So I call that more "math" than what we're doing now. I don't think that's right, but that's[. . .]
(Val./Int. 6)

Despite recognizing the possibility that her interpretation was probably "not right" according to some uncertain mathematical "standard," she had made a personal qualitative decision that, according to her own criteria - an intuited sense of "degrees of usefulness" - the basics were more mathematical than geometric constructions. Thus, for slightly different reasons, Anne, like Pamela, had not yet completely come to terms with the broadening occurring in junior high school Mathematics.

For some of the students then, there were explicitly acknowledged degrees of "mathematicalness" within the realm of that which was recognized as Mathematics. For Pamela, it was the calculativeness of the task and the extent of the "doing" in the immediate Mathematics project that helped to deepen the sense of being mathematical. On the other hand, the foundational and functional nature of elementary Mathematics helped instill a sense of its greater mathematicalness in Anne. She, like the others, had studied and practiced the "basics" extensively over a period of years. She had made use of her knowledge of them in situations outside of the Mathematics classroom. They had developed a meaningfulness for her that marked them as more mathematical than this new activity of constructing figures on paper which, while admittedly interesting, was of no apparent use to her, a thirteen year-old in grade eight.

Peter, the boy who saw in his Mathematics of the last seven and one-half years an orderly development, nevertheless also understood the Mathematics of the elementary and junior high school levels as being very dissimilar (Val./Int. 6). He did concede that because it was taught at one time under the name "Mathematics," that which he had studied in the elementary classroom was, in "a literal sense," "math." But in terms of that which for him truly was mathematics, the "basics," particularly the simpler aspects - simple addition, subtraction and so on - were "not really math." They were foundational, one "needed to know the stuff," however, they were "just getting you ready for Math." They were preparatory to the real Mathematics he was being taught in junior high school. Gauged on the basis of one and one half years of study in Mathematics at the junior high school level, such early activities lacked the depth and the conceptual complexity for Peter to truly consider them as mathematics. They were not what he would ever study in a Mathematics class again. As with Pamela, they represented a mathematics ~~of~~ a time past. Unlike Pamela's view of them, for Peter the "basics," while being worthy of knowing because of their grounding character, were not fully deserving of the name "mathematics." Thus Peter's notions of what mathematics is stand in sharp contrast to those of students such as Ted and Karen, for whom even the Mathematics of the earliest grades still was unquestioningly mathematics.

Peter's claims of what constituted mathematics appear to be contrary to his general characterization of mathematics as "working with numbers" (Int. 4). Some of this contradiction was removed when he made it clear that he did not consider very simple calculations to be mathematics in anything other than a literal sense.

Carol also perceived a substantial change in the move to junior high school Mathematics. As she recalled rather emphatically,

> I thought I was gonna die when I saw the [grade 7] Math book!
>
> (Carol, Int. 5)

The perspectives of Peter and Pamela can also be identified in Carol's understanding of what was within the realm of mathematics.

Elements of the influence of both historical context and the daily physical and social contexts are present in

Carol's perceptions. It became necessary to distinguish between the operations of addition and subtraction, for example, and the human, existential dimensions of "doing Mathematics." Simple operations remained as mathematics in a literal sense. This belief guided her in her decision to enter activities involving them in her journal, and she explicitly identified them as such in discussion. Yet, overlaying this inclusion were contextual issues which further shaped her perceptions of the mathematical. For example:

> . . . [they are] not [math] for what we do in Math class now, but when I was in grade one and two, I'd find it as math. But not now, no. It's just something that comes. Nothing important. [*]
>
> (Carol, Int. 5)

As she explained in Interview 7, adding and subtracting <u>were</u> mathematics in grade one and two "because we were just starting to learn about it." The more current Mathematics of the classroom tended to be perceived by Carol as more mathematical. Presently, even though these basic operations were used outside and inside the grade eight Mathematics classroom, they were no longer the focus of study. At an operational level, this simple mathematics had become "all one thing" for Carol also, and had reached such a degree of taken-for-grantedness that it was now perceived as less mathematics than that more recently being studied. Glimpses of a historicality are thus present in Carol's conceptualizing of mathematics. As will be more clearly disclosed in the following section, the daily physical and social contexts in which she found herself doing mathematics also figured strongly in her notions of what is mathematics.

The Influence Of Daily Physical And Social Contexts On Characterizations Of Mathematics

It has been previously described that some students, such as Karen and Ted, readily acknowledged even the simplest, short-in-duration activities as being mathematical regardless of where they occurred. For others, however, consideration of physical and social contexts did bring about a questioning of the very mathematicalness of the activity. The Mathematics learned in the classroom, even the very basic Mathematics, was still considered as being mathematics when it was done in the classroom, or as homework. Only Peter, and to a lesser extent Carol, seriously questioned such labelling. Outside of the Mathematics classroom, only very basic simple mathematics was generally acknowledged as being done. In these external contexts the strength of the resolve in maintaining the status of these basic mathematics activities as definitely mathematical was reduced, particularly for some. These "basic" activities were acknowledged by all to be useful, even critical to everyday living. Yet their mathematicalness was questioned.

Since Peter had questioned the validity of identifying much of that taught in elementary school as "mathematics," it was entirely consistent that he should disavow the labelling of those same activities undertaken in other physical and social contexts as being truly of a mathematical nature.

Verna and Carol also expressed doubt about conceptualizing these actions as involving the mathematical when undertaken in contexts other than the classroom. Their views bore similarities to Peter's reasoning, and to each other, while still showing differences in stance. These differences were admittedly subtle.

Verna in particular strongly identified mathematics with the Mathematics classroom. As referred to in an earlier section, when questioned at one time on what was mathematics for her, her initial response was:

> I dunno. Just what you do in Math. Just math!
> (Int. 5)

Earlier too, reference was made to her adamancy that she did not "do" any mathematics in a non-homework context outside of school. For Verna, "either you did or you didn't" (Int. 5), and she was quite certain that she did not. That was visible in the following exchange:

R: . . . O.K., we said earlier, I think, that, well, basically everything that you've done in school, . . . the calculations, the adding - that's math/

V: Uh-huh.

R: /It hasn't been so much[. . .]deciding that something is no longer math, but it's been more or less . . . still thinking of the other things you learned before as math, but adding to it new ideas of what is also math.

V: Yeah.

R: O.K., but[. . . . . . .]You felt quite certain that you hadn't done anything [involving mathematics] outside[. . . .]

V: No, I never do anything outside [of Mathematics class].

R: O.K. I guess I was trying to think of, well, when you were thinking about that, were you thinking mainly in terms of, "Well, I didn't do any geometry today," or "I didn't do any condition solving today." . . .

V: Yeah.

R: . . . but maybe, would you have done some of the other things?

V: Umm, no.

R: Not even some of the more basic things.

V: No.

(Val./Int. 6)

It was the intent as much as possible to avoid directly proposing situations in which some mathematical activity may have been undertaken. A checklist of occasions when mathematics was used was not the purpose of the research. Rather, these occasions were to arise out of a thoughtful reflection upon what, for the individual young person, in some way constituted a mathematical situation. Nevertheless, there was concern that situations that were possibly important in terms of their significance for revealing how the student conceptualized mathematics were being overlooked at times. This was the case here with Verna, and finally, later in the same discussion, a more explicit question was broached.

R: . . . Do you go shopping?

V: Yeah.

R: Do you ever see yourself as using any kind of math at those times?

V: Well, adding in your head.

R: O.K.

V: Stuff like that.

R: But, even then, maybe not/

V: No, not really.

R: That, that sort of thing wouldn't have counted as far as/

V: Well/

R: /putting it down in a book [journal].

V: I dunno. I guess it could, but[. . .]

R: You're rather uncertain.

V: Yeah.

(Val./Int. 6)

Uncertainty definitely was present. The suggestion is there that she, like Peter, might have acknowledged "adding in your head" as constituting a mathematical act in a literal sense. But was it really mathematics? The possibility of it being mathematics but simply too "little," too simple and short to be worth entering in a journal was explicitly proposed. There was a grudging, uncertain acceptance of the proposal.

Verna's own final speculative response was more revealing.

> V: Umm, maybe it's because[. . .]it was done in my head and I didn't have to do it, but I did. [emphasis added]
>
> R: O.K. Rather than a piece of paper, and[. . .]
>
> V: Uh-huh.
>
> (Val./Int. 6)

It appeared that for Verna the domain of doing mathematics was essentially the domain of doing Mathematics; the former actions had become defined almost entirely in terms of the latter. There was an intuited sense, or belief, or recognition that the Mathematics class was by definition where mathematics was done and had always been done. The classroom was where Mathematics was learned and the tasks - constructing, calculating, defining and so on - were labelled as mathematics. The "doing" of Mathematics in the classroom was quite structured and formalized. The mathematical tasks were assigned by the teacher or the textbook; they were relatively clearly identified. The general procedure for doing mathematics was well defined - one sat at a desk and attended to the matters at hand with pencil and paper. The physical reality of doing mathematics had, for Verna, become equated with that of doing Mathematics. In addition, Mathematical activity in the classroom had as its aim doing the problems in order to learn the Mathematics. This formality, this structure and these aims dissolved in the more "natural" setting of shopping and in most other situations outside school studies, and along with them the appearance, the recognition, and the sense that what she was doing is mathematics, even though there was an acknowledgement of adding. The "literal" mathematics was not truly mathematics in these contexts.

This revealing of the domain of doing mathematics as coinciding with the domain of doing Mathematics was largely implicit in Verna's remarks. It was made quite explicit by Carol. In an earlier section, the presence of an historical aspect to what is truly mathematics was noted in her language. As aspects of Mathematics became well learned, taken-for-granted, and were no longer the focus of study in the Mathematics class, they seemed to become less mathematical than currently studied topics. Physical and social contexts were equally integral to Carol's perception of "doing mathematics."

R: . . .O.K., when we talked about what you thought of as being math. . . . When it was being taught to you in school at the time, then it's math. When you move away from it, or when it becomes[. . .]/

C: It's work.

R: /work. O.K., then it's not math?

C: No, it's just something I have to do, because it's work.

R: You mean like making change?

C: Yeah.

R: Making change basically is adding, and subtracting, and/

C: Yeah.

R: /that sort of thing.

C: And balancing. Balancing is a little harder. But not very much.

R: Do you see it as, umm . . . it's not math, but you're using it though. [Tone switches from questioning to statement, but one which seeks response.]

C: Yeah. But I don't find it as math, I just find it as a part of work. But in Math class, you have to sit there with books open and a pencil in your hand, and you have to look at the chalkboard, and he's sitting there explaining it to you. Whereas at work, you just do what you think, you know, "O.K., well, I was taught to do it this way and it's the only way you can do it." Whereas he throws a whole bunch of different rules at you to do it, you know. Whereas this way, there's only one way. It's not like math, it's just like work. (Int. 5)

Nevertheless, making change and balancing, tasks which involved working with numbers, were explicitly identified as activities in which mathematics was "done outside." They were in some sense mathematical for Carol.

In Interview 7, the possibility of there being "different kinds of math for different situations" was explored. She agreed with the following formulations of contextual influences on the conceptualizing of mathematics.

R: . . . making change. . . . Because you put it in the [journal] column "math outside," somehow you must have said, "Well, it's math because it's adding and subtracting," and yet, in other ways it wasn't math. [. . .] And I'm just trying to/. . . Is it because[. . .]/ -

C: I'm not in the classroom.

R: |/adding and subtracting/ Yeah. It's not in the classroom, it's not something new that you're being presented with, it's old stuff.

C: Uh-huh. [Matter-of-fact tone.]

R: . . . So there's a distinction. There's kind of different kinds of math. There's kinds of math - and in some ways really aren't math because you use them so much day-to-day in your work, and then there's other kinds of math that are kind of[. . .]more seen as math[. . .]because they're Math class kind of math.

- - - - -

R: . . . O.K., but then you said "Well, back in grade one and two though, that was math."

C: Yeah, because we're just starting to learn about it.

(Int. 7)

The basic operations of addition and subtraction were accepted as mathematics in the literal sense. However, historical and situational contexts combined here to substantially influence Carol's perceptions. Mathematics was becoming increasingly complicated for Carol. She saw it as infused with a number of rules that she claimed she found difficult to cope with and understand. There seemed to be an ever-broadening diversity of "ways" to do things which she found confusing. What was mathematics, or was mathematical, was becoming closely associated with this apparent cacophony of "ways" and rules. The taken-for-grantedness of basic adding and subtracting, in which there was "only one way" to solve the problem of determining the correct change - experienced as the freedom to do it <u>her</u> way in the work situation - lessened the perception of it being mathematical.

Summary And Reflections On The Characterizations Of Mathematics

In the general characterization of mathematics, students provided a phenomenological understanding of what mathematics is. Rather than speak of it in ways that would have depicted it as a body of knowledge remote from themselves, these young grade eight students epistemologically portrayed mathematics in terms that very much revealed what they interpreted to be the nature of their active engagement with the subject. The "I"/"mathematics" nexus was at the centre of the general naming of mathematics. "Working with numbers" followed entirely from "mathematics means I work with numbers." It represents the existential synthesis of their work to date with mathematics.

It is clear that elementary school Mathematics and much of junior high school Mathematics has been the genesis of the general characterization of mathematics. "Working with numbers" is perhaps not surprising in light of the nature of much of this Mathematics. However, some of the Mathematics the students were encountering in junior high school was not particularly number-oriented. There was an identifiable lag or inconsistency between their general naming and what they were allowing as mathematics in a taken-for-granted way on the basis of their understanding that school Mathematics defined mathematics. While some of the participants seemed to be in the process of reconceptualizing mathematics because of their junior high school Mathematics experiences, none of them seemed yet to have begun to reconceptualize their general naming of it. The existential nature of this naming seemed a deeper interpretation of their experiences with the subject than that determined through a consideration of what mathematics is on the basis of what they have studied as school Mathematics to the present.

What constituted the content of <u>m</u>athematics for these young people has been circumscribed by what has constituted <u>M</u>athematics for them. These commonly rooted understandings were, however, impinged upon by a number of factors which varied somewhat among the students. These discerned factors, often subtle and sometimes only implicitly present, were (a) the perceived usefulness of the mathematics, (b) the amount of calculation involved, (c) the complexity of the mathematics, (d) where the mathematics is done, and (e) how the mathematics is done. The latter two related particularly to the influence of physical and social context upon perceptions of what mathematics is. Thus, while school Mathematics had very strongly guided these young adolescents' notion of what mathematics is, there was not complete uniformity in their understanding.

The Perceived Value Of Mathematics

The usefulness of mathematics is partially based on the extent to which the student has found that what he or she has learned is of use in out-of-Mathematics class situations. But it also entails a projective or predictive element based upon past experiences, hypothesized future experiences, and a general underlying perspective of education, society, and one's place in society, for example, one's career. As with all humans, the young adolescent interprets his or her existential position through such a framework although, because the student is actively "emergent," this interpretive framework may be quite fragmented, changing and changeable, and incomplete.

In this section the meanings that mathematics has for these young people in terms of what they perceive as the field's value for them are presented.

The purposes of mathematics experiences inside and outside the Mathematics classroom were fundamentally different. Within the classroom these experiences were almost entirely devoted to the purpose of second order understanding of the Mathematics subject matter. On the other hand, mathematics always had a utilitarian function in contexts outside the Mathematics classroom and homework locations. That is, whenever it was referred to in these "outside" contexts, it was always for an aim other than the goal of Mathematics learning and practice. Mathematics was <u>used</u> in these external contexts.

A view of Mathematics held by some was that it had some importance, perhaps a greater importance than that which was learned in some other subject areas. As Peter cautiously indicated:

> Pe: . . . it seems that Math is a bit more important than some of the other subjects.
>
> \- - - - -
>
> Pe: Well, like, maybe later, you might need to know the stuff, right?
>
> \- - - - -
>
> Pe: Not many people will have to know what happened in Canada a few hundred years ago.
>
> (Int. 4)

Karen also expressed similar thoughts:

> 'Cause like in Social [Studies] we're learning all this about Canadian rebellion and all this. Well, like . . .

. we're not going to need it all that much when we get older, but they make us learn it now because[. . .]I don't know why, but they make us learn it now and it's just boring whereas math, like you have to know it when you get older for whatever you do.

(Karen, Int. 2)

The nature of this importance of mathematics was initially rather vaguely defined. These beliefs of the general importance of mathematics were usually strongly influenced by the perceived importance of basic mathematics. The continued conversation with Karen illustrates this point.

R: O.K. [. . .] Well, a little while ago you mentioned that things like parallelograms, you're not sure about.

K: I know but like, how to add and divide.

(Int. 2)

Peter also, when the matter was pursued, made it clear that he was referring to basic mathematics, and not to some of the more recent junior high school Mathematics (Ints. 3, 4).

All of the students believed that basic mathematics operations - adding, subtracting, dividing, and multiplying - involving the types of numbers they had encountered thus far in school were essential in day-to-day living. That is, this was an essential mathematics to the extent that each student may be said to have conceptualized these basic operations as mathematics. It was shown in Chapter 5 that many of the eight students felt that they seldom made use of any mathematics outside of the Mathematics classroom. Still, it was their position that this mathematics had been useful to them, and would continue to be needed throughout their lives.

The perceived usefulness of much of the more recent, advanced Mathematics they had been taught in junior high school, such as set theory, condition solving and geometry topics, was more problematic. All eight students agreed that much of this Mathematics was of very little value to them in their present daily lives outside the classroom. The geometry they were studying at the time of the field research seemed particularly subject to this perception. The following examples are illustrative of this general view.

Verna:

> . . . I don't see how it [geometry] will help me in the future.
>
> (Val./Int. 6)

Karen:

> I don't understand why we have to know the different parallelograms, . . . or different quadrilaterals and name it all.
>
> (Int. 2)

Anne:

> I don't understand how the Math we're doing right now [congruency of triangles] is going to help me later on.
>
> (Journal, Nov. 21, 1984)

To the extent that this more recent, abstract mathematics was believed to have relevance, it lay in the future. The value was purely career-related. This was the view held by all eight of these young people. This was, however, typically a very cautious, qualified perception on their part. The uncertainty of the future meaningfulness was reflected in the responses that several gave to the question of why they thought they were being required to learn this Mathematics. Donna, Verna, Pamela and Anne initially responded that they simply did not know. It was only following further reflection on the matter that they suggested various careers might require knowledge of this recent Mathematics.

Ted was the only student who differed somewhat in this regard. He seemed to believe or accept that many "jobs" would require the Mathematics knowledge and skills he was currently acquiring, even though they had very little current functional value to him.

R: . . . why do you think you have to learn math? What's its purpose? I mean, do you see much purpose in some of the Math you're learning now?

T: Actually, no.

R: No?

T: You're not going to be using geometry, or you're not going to be carrying around a little geometry set with you all the time, so I don't see how it can be used.

R: O.K., do you have any thoughts on why they ask you to take it?

T: Well, it's supposed to help you.

R: It's supposed to help you. In what ways is it supposed to?

T: Different jobs.

(Val./Int. 6)

In the above excerpt there is some equivocality about the value of the current Mathematics. In the preceding interview the certainty had been more in evidence. Not knowing what the future held for him, it appeared essentially as an article of faith in schooling that he would require the knowledge later.

T: . . . it'll [Mathematics] be important later.

- - - - - -

T: Like a lot of jobs require math skills.

- - - - -

T: . . . But things like circles, circumferences [current topic], I don't think I need now.

R: Right. But you might need later? Why do you think you're bothering to learn all this stuff now?

T: Well, we're gonna need it later. We're getting <u>taught</u> it. [Emphatic]

- - - - -

T: Like, they wouldn't teach us if we were never gonna use it.

(Int. 5)

In all cases the careers cited were specialized in nature. Careers such as physicist, mathematican, carpenter, mathematics teacher, engineer, and computer designer were tentatively offered as those in which one might use the abstract mathematics they were studying.

R: Do you see any value in any of this Math that you're doing in junior high?

A: If you want to be a carpenter [*], yeah. But, well, like some of it, like problem solving and that, I can understand that, 'cause like, you'll be using that. You'll be faced with that - grocery shopping or something - how much all this is gonna cost you, how much you'll have left, and all that stuff. But, unless

> I'm gonna build my own house, I don't think I'll be worried about area and perimeter [*].
> (Anne, Int. 5)

This brief interview excerpt also illustrates the form of the questioning regarding the value of mathematics. Initial questions on what the students understood to be the value of mathematics were always of a general nature, such as that above. Thus, the interpretation of this Mathematics as being only of future-oriented, career-related value originated with the students themselves. The students were also the source of all the careers named. No list of potential careers was requested. Those cited simply arose in the course of discussion.

Two points are revealed in Anne's remarks and indeed in most of the useful-in-careers statements made by these grade eight students. The first is an implicit claim that the Mathematics school knowledge was becoming increasingly specialized. Basic mathematics skills - adding, subtracting, multiplying, and dividing, and even some measuring - were general purpose skills. The second point is that these careers were often referred to in tones of voice and in terms of reference that suggested that these were careers that many of the students themselves believed they were not likely to pursue. Donna (Mathematics teacher) and Ted (extensive possibilities - ?) were the exceptions.

One rather positive perspective of the future value of mathematics was seen in Ted's remarks above. Carol held a view quite in opposition to this. The influence of the [illegible] current difficulties she was having with certain of the geometry topics was evident.

> C: . . . when we go to diagrams . . . . – boring! [*] Who cares! I'm never gonna use this.
>
> – – – – –
>
> C: . . . You know, like half the Math we do right now we aren't gonna use, like when we get to be in our twenties. Except for adding and subtracting and stuff, unless we're accountants or something. Like, I'm not gonna use it.
>
> – – – – –
>
> C: Well, when I go to university, I'm going for Drama teacher, I'm not going for Math teacher.
>
> (Int. 5)

It was quite evident that from the egocentric position of a thirteen or fourteen year-old in grade eight, very much the "emergent being," making functional sense out of much of the more abstract, recent Mathematics was a struggle. As has been indicated, all eight sought to give it some value by tentatively forecasting that the subject had some future career pay-off potential. This was extremely conjectural. Peter and Karen also searched for and offered reasons of more immediate import that had more to do with educational bureacracy than with educating the child.

According to Karen, Mr. V. was teaching this current Mathematics because he had to. The City School Board had "a program they make you do. I guess that was on it" (Int. 4). Why the topics were on the program she did not know.

Peter's analysis was more extensive. It is suggestive of the lengths to which some students go to try to make sense of what they are doing when they are taught material that seems to them to have very little intrinsic functional relevance. Peter had just explained that he saw nothing useful in some of the geometry he was currently being taught.

R: So, I guess there's this question: What do you see in your mind as the reasons for why we have to learn this, or, Why do they teach it?

Pe: Well, the way I thought was that you've gotta have twelve years of school, right?

- - - - -

Pe: And then, they've gotta teach Math in the beginning, you've gotta know that stuff [basics], right?

- - - - -

Pe: And then, they've just gotta keep teaching, so then[. . .]

R: So then it becomes, "Well, what do we teach?"

Pe: It seems more like that. . . . It doesn't seem that you have to really need to know the stuff past, let's say, grade seven or eight, right? Maybe even grade six. But then after that, they're just . . . saying that, "Well, you took it before so then we gotta keep consistency," or whatever.

R: O.K. But they could just drop it/

Pe: Yeah.

R: /and do other things.

Pe: Yeah. Things like that.

(Int. 5)

Peter did not believe there were no redeeming qualities to what he was presently being taught. This current material did have value inasmuch as it required a solid understanding of the basic mathematics in order to do well in it. Thus, the current Mathematics provided opportunities to check how well one understood the basics, and to improve where there were problems.

Peter's views of the usefulness of Mathematics were particularly interesting and somewhat puzzling in light of his professed interest in computers and his claim that he might pursue a computer-based career such as programmer. (Peter was not the student who suggested that one career which required a knowledge of mathematics was "computer designer.") The relationship between such a career and mathematics would seem to be reasonably close. Nevertheless, notwithstanding his skills of analysis, his claimed ability with computers, and his observed ability with Mathematics, Peter did see little relation between computers and mathematics. When it was proposed during Interview 4 that there might be a significant amount of mathematics that could be used in programming, he was quick to deny this. He believed instead that the mathematics involved, if there was any, was of a trivial nature.

Peter's understanding of the relationship between computer-based activities and mathematics activities is itself an interesting one, but it does help to explain why he saw so little specific future value in much of junior school Mathematics.

Summary And Reflections On The Value Of Mathematics

The meanings of mathematics which have been explored in this section have been related to value. For the students, the question of the value of mathematics study became the question of its functional or utilitarian value. For many, much of mathematics had few meanings in this regard. There was a disjunction, almost a contradiction between an underlying belief in the general importance of mathematics and the particular claims of its value in only specialized careers. Perhaps most of the students, like Ted, merely took it for granted that mathematics somehow held future value - unlike the Social Studies topic, which was clearly about the past. Very little conscious thought had been devoted to the matter. When explicitly confronted with the question of why mathematics was being taught, most could only fall back upon this underlying taken-for-granted acceptance.

Interestingly, perhaps the two students most aware of the functional meanings of mathematics were Carol and Peter. This is not to imply that they were more cognizant than the others of more extensive utilitarian values of mathematics in their present and future lives, for clearly such was not the case. Rather, they were among the most definitive in their judgements of such values.

Meanings arise out of past experiences, not those unknown still to come in the future. In this regard clearly there are different bases for the students' dichotomous views of basic and more recent, specialized mathematics. There is a long-term familiarity with the former. Given this extensive period of time, and the nature of the mathematics itself, within that time there have been opportunities for all the students to have experienced its use in existential situations. Conjecture about its future value is therefore rather solidly grounded in the past. On the other hand, the students have had relatively little time with this more recent mathematics. The "not-yet" nature of the young adolescent is evident in their appraisal: the opportunities for experiences of this mathematics have been limited. Thus perceptions of worth are almost by necessity of a much greater possibilistic nature based upon what has been passed onto them by others.

Existentially thus far the students' experiences have revealed to them that mathematics was not full of meaning in terms of functional relevance. As a phenomenon still considerably in the future for these early adolescents, the notion of career itself lacked substantial meaning. If most meanings of mathematics were derived on the basis of a discernment of the usefulness of mathematics in these students' lives, the subject would have quite limited standing. For some of the students, the meaningfulness was elevated because of their interest in the subject.

The Relationship Of The Perceived Value Of Mathematics And Interest In Its Study

There was a strong suggestion in the students' understandings of their Mathematics experiences that much of the interest they had in the subject was related to the social aspects of the classroom experience. However, with the exception of Peter, all of them claimed that there were aspects of Mathematics that they found interesting. Peter's most positive response was that he "did not mind taking Math."

Interest itself is relative. Recalling the profiles in Chapter 4, participants such as Verna and Donna found much of Mathematics interesting, but still preferred some topics to others. Some of the other students found Mathematics generally uninteresting, but claimed that certain topics, or activities related to certain topics, were interesting. Some claimed that Mathematics was more interesting than many of the other core subjects (Language Arts, Science, and Social Studies), but less than some of their optional courses. As noted in his profile, the depth of Ted's interest in Mathematics was difficult to ascertain, and was somewhat suspect. However, he did seem to have some interest in some specific topics. Even Carol professed to finding certain topics of interest for their own sake, as will be recalled from the analysis of "fun" experiences.

"Interest" bore a close although not altogether clear relationship to perceptions of the usefulness of mathematics.

It was noted in Chapter 5 that "fun" Mathematics experiences in the classroom typically involved topics the students found interesting for one reason or another. It was also discerned that "usefulness" was not a factor in these "fun" experiences. There was no consideration of "usefulness" in topics the students found interesting. As Anne noted:

> It [Mathematics] can be interesting, but not useful. And that's what it is most of the time, too.
> (Anne, Val./Int. 6)

It is possible that some topics somehow lent themselves to greater explicit questioning of their usefulness by some of the students. It was the case however, that whenever a student expressed a substantial interest in a topic, that is, when the student's experiences with that topic had been quite positive, perhaps even "fun," then the matter of "usefulness" was of no concern. While "usefulness" was not often raised, it was an issue only in the case of topics that lacked interest or were difficult and confusing to the person.

For Donna, there was no question at all. She simply enjoyed Mathematics. That much of it was perceived to lack usefulness was not problematic. It was not an issue for her.

The same was generally the case with Verna. On the other hand she was quick to question the "point" of geometry, a topic which she felt was only "O.K."

Carol, the student who had difficulty with Mathematics, and in particular with geometry, proclaimed "I'm never gonna use this stuff!" When the Mathematics was something she felt capable of doing, "usefulness" was not an issue.

Peter's claim of "no interest" was at least partly related to the ease with which he grasped all Mathematics. Instead, he was frequently inclined to respond to Mathematics in the more distanced, measured, evaluative manner of perceived "importance" and "usefulness." He may have been less given to explicitly assessing subjects and topics in such terms had he found at least some of them intrinsically interesting. For most of the eight students in the study this more often was the case.

The perceived usefulness of Mathematics topics was not a concern when they were considered as interesting to do for their own sake. A corollary of this was that any topic potentially was interesting. It was strictly personal choice.

Summary: Linking Chapters 5 And 6

In Chapters 5 and 6, the understandings this group of grade eight students had of mathematics have been described and interpreted from three major perspectives: understandings of what the subject "is," contextualized experiences of mathematics, and the value of its study. As has been acknowledged from the outset and which has been re-affirmed in this study, the Mathematics classroom has been and continues to be the fundamental place of mathematics. The topics to which the students have been exposed, the ways in which they have been exposed to them, and the ways in which they have engaged in Mathematics have produced the individual definitions of what mathematics is for the participants.

The students' phenomenological knowing of mathematics as "working with numbers," derived from their extensive experiencing of mathematics in this way, can be seen as fundamental in terms of the students' understanding of the subject's value meanings and its situational context meanings. Mathematics gains its immediate experiential value inasmuch as, and to the extent that there exist contexts outside of the locations where it is studied in which "working with numbers" takes place.

This connection between the three major aspects of Chapters 5 and 6 may be the strongest link between the three, but as has been shown, the variations in understandings of each of these thematic areas have been significant.

Chapter 7: DISCUSSION, RECOMMENDATIONS, AND REFLECTIONS

Discussion: Author Inferences

Views Of Mathematics

(I) The Taken-For-Grantedness Of Mathematics And Schooling

Schooling, and Mathematics as a subject to be taken in school, seemed largely taken-for-granted features of daily life for these young people. Given a choice, some of them said they would rather not have been there, it is true. But there was no serious challenging of having to attend Mathematics by most. Carol alone strongly questioned the necessity of Mathematics study at times, and this not consistently.

These were students for whom succeeding in school - getting good marks - was important. While the immediate and specific value of school and Mathematics may have been questioned by some, the success in achievement that most of them experienced, especially in Mathematics as their "best" subject, had a dampening or tempering effect upon such questioning. Much of the general "goodness" of Mathematics, for some students at least, resided in their understanding of the subject as positively contributing to their successful negotiation of school. Only the individual who had experienced very substantial, ongoing difficulties with Mathematics challenged its position as a compulsory subject.

(II) A Mundane Understanding of Mathematics as a Discipline

Characterizations of mathematics as "working with numbers," and much of school Mathematics - certainly elementary school Mathematics - as "just basics" indicate that many of the eight participants in this study generally had a relatively undifferentiated, even mundane understanding of what they have been doing in Mathematics for the past seven and one-half years. It is difficult to be too categorical in this claim because the students may understand the nature of mathematics more deeply than they were able to give voice to. It may be too, as at least some of the students indicated, that switching to the more "senior" junior high school structure, combined with reaching early adolescence, served to further reinforce the "just basic" character of much of elementary school in general, and elementary school Mathematics in particular. Still, the assertion of a largely undifferentiated understanding of mathematics as a discipline seems a reasonable one to make. The statement by Hoyles (1982) in her study of fourteen year-olds that mathematics was "something to be done, something to be mastered, something with an existence of its own" (p. 369) is an equally appropriate statement for many of the students in this present case.

Perhaps it is asking too much of thirteen year-old students to understand mathematics in more sophisticated, discriminating ways than they apparently do. After all, an examination of the elementary and grade seven Mathematics curriculum materials shows that the students are indeed asked to "work with numbers" in some way much of the time. Nevertheless, the undifferentiated character of the depiction of the discipline itself is reason for concern.

Much time and research is devoted to investigating how children learn mathematics in order that it may be taught better. This study suggests that the matter of the interpretations that children give to what they learn of mathematics also is an issue in need of addressing.

(III) The Classroom Is Mathematics for Some

For students such as Carol and Verna, the Mathematics classroom has come to define not only the content of mathematics but also how mathematics is to be done. Mathematics appears to have become almost completely to mean sitting in a desk engaged in solving problems by means of pencil and paper, very traditional ways of doing mathematics. This has led to difficulties in disconnecting mathematics from the Mathematics classroom, that is, in envisioning mathematics activities as taking place in any other environment but the classroom and the homework location - where mathematics is done in the same way.

Associating mathematics so completely with classroom structures may have also contributed to a restricted belief in the importance of studying the subject.

(IV) The Unseen Cultural Pervasiveness of Mathematics

Contemporary North American society is pervasively quantitative. Our daily lives tend to be chronologically structured, sectioned into more or less discrete time-based units of activity. Quantitative economic perspectives and activities underlie much of our daily life of producing and consuming. Many of our political, social, and legal institutions are threaded through in part by a quantitative ethos. Science and technology are both thoroughly rooted in the systematic, patterned character of mathematics. Mathematics provides a means of unifying experience and naming nature. We hold scientific knowledge up as objective, and thus more truthful knowledge than other, perhaps more subjective forms. We hold modern technology up as the exemplary fruit of scientific endeavour which has produced the standard of living and living conditions many of us in North America have come to take for granted. Indeed, much of the quantitative nature of society itself is taken-for-granted by most. Thus, while mathematics is significant at the deepest epistemological and ontological levels of contemporary "knowing" and "being," much is at best only tacitly acknowledged.

For the eight grade eight participants, there is only an inchoate understanding of the pervasive nature of the place of mathematics in their contemporary North American social lives. It begins to appear in the students' speculations that mathematics may be important for them to know in their careers, and in their claims that "the basics" are occasionally important in their daily life situations. Still, as was shown in Chapters 5 and 6, even these situations were perceived as rare for some. Furthermore, all these expressions of the place of mathematics are only of discrete moments in their lives that pass. As yet these young adolescents understand mathematics almost exclusively as a tool to be sometimes used and then to be put aside, or as one forty-five minute per day subject among several taught in school. Otherwise they understand mathematics to have little place or influence in their lives.

The Individuality Of The Students

Notwithstanding the statements made previously about the generally undifferentiated nature of students' conceptions of the character of mathematics and school Mathematics, it is imperative to recall that there were differences in the meanings of the subject for the students. In this study the individuality of each of the participants manifested itself in a number of ways. Variation, sometimes subtle, occasionally strong, was a hallmark of the discernible meanings of mathematics held by each of these young people. Chapter 4 revealed some particularly strong images of the different ways in which students understand and portray their personal relationship to Mathematics, and perhaps to other school subjects.

Educational Significance: Recommendations And Concerns

This study has particular value for Mathematics teachers, and for Mathematics teacher educators.

It is hoped that teachers, upon giving this thesis a close, thoughtful reading, will see in these eight grade eight students something of the students in their own classes. It is hoped that teachers will look at all the young students in their classrooms in ways which they had not considered before. It is hoped that this study will raise questions in the minds of teachers about the content and practice of school Mathematics generally.

In a study such as this there can be no definitive educational recommendations to be drawn from the research endeavour. Nevertheless, students' understandings of mathematics and its study which have been revealed here do suggest some specific responses from mathematics educators. With this in mind, some of the educational responses which the author feels are appropriate are presented here for consideration.

(a) This first educational response is as much a confirmation of a practice that teachers often follow, as did Mr. V., as it is a recommendation. Social interaction within the academic environment of the classroom is important for junior high school students. There needs to be regular opportunities in the context of the "second part" of the class period to discuss particular Mathematics problems with their peers. It is a time that is valued by many. Some students do find this period a little competitive, and prefer to work alone. This does not mean the elimination of this part of the class period, only its supervision.

(b) Teachers need to examine their own beliefs, attitudes and conceptions of mathematics. The literature has shown that there is a relationship between one's beliefs and conceptions, and how the person teaches mathematics. There is also evidence that teachers' attitudes and teaching styles affect students' conceptions and attitudes toward mathematics.

It has been shown here how students generally characterize what mathematics is: "working with numbers." It has also become evident from this study that grade eight students have a rather vague understanding of the value of mathematics. Beyond the "life skills" basic operations, the value of mathematics is particularly opaque to these young people. These were views that almost all of the students had acquired through the course of more than seven years of Mathematics schooling. In light of this, teachers need to ask if these are not similar to views of mathematics that they themselves hold. They need to ask themselves if this is how Mathematics to the grade eight level should be understood.

These are such limited views of the subject that the answer ought to be, "No." What might be done to help bring about a rectification of the matter?

It seems first of all that the understanding individuals have of the subject must be made public. For at least many if not all of the eight students in the study, it appears this research occasion was the first time they had attempted to give voice to what they understood the meanings of mathematics to be. Students and teachers need to hear themselves articulate what they believe mathematics is. There needs to be periodic discussion in the class that is first a sharing of these understandings, and subsequently is a clarifying and a deepening of the various dimensions of mathematics: concept development, structure, purpose or value, mathematics and society, and so on. It ought to get beyond superficial discussion centred around the question "Why do I have to learn this?" and the answer "It will help you think better."

(c) The third educational response is a reminder again of the need to honour the individuality of the student.

Perhaps the differences among the students are often not great, but if we wish to strive for a deepened understanding of mathematics by the students, then the individuality of each person and the distinctions which do exist among students must be acknowledged and highlighted. Even though Skemp (1971) states that mathematics can only be learned from other mathematicians, we need to appreciate the potential influence of the entire biography of each individual on their understandings of mathematics.

(d) Another response to the study focuses on the notion of homework. Teachers need to understand the various relationships of the homework place to the classroom that exist among the students. There may be a reluctance to do so on the grounds that this is a private place, and as long as the students get their homework done, then how they do it is a matter for the student and his or her parents to deal with. The academic educational process extends beyond the confines of the classroom however. The existence of homework and the place separate from the classroom in which it is done acknowledges this. The environment of the homework place is often quite different from that of the classroom, and while teachers may have a tacit understanding of these differences, they need to make this understanding explicit. Rather than consider the homework location as only a place where the classroom work gets completed, teachers need to consider the possibilities for how the differences in the two space-time contexts might be made use of in deepening the students' understandings of mathematics. In conjunction with classroom discussion about the nature of mathematics, activities which might take place effectively only out of the classroom could be explored.

(e) A particularly interesting aspect of the issue of how students come to judge themselves as FAIR, GOOD and so on is the apparent place of marks in this decision. For several of the students the marks each was receiving seemed to serve as the principal basis or ground upon which they arrived at their decision. For others, marks were as much or more a confirmation as they were the ground of the assessment. Confidence through success historically seemed also to serve as important ground for these particular young people.

Beliefs in one's ability that are not so closely dependent upon marks may be more enduring, less susceptible to variations in achievement as portrayed by test and assignment marks. Such beliefs may also lead a student to not strive for high grades quite so actively as a student who interprets his or her Mathematics "self" more completely on the basis of marks and at the same time wants to do well.

Teachers do need to be aware of the great potential for variation that exists among students in terms of their interpretations of abilities and marks, and that these may be at substantial variance with their own interpretations.

(f) A number of questions are posed here that speak to the issue of teaching and learning Mathematics, indeed, to the issue of what mathematics as Mathematics is. Does the very nature of mathematics demand the formalization that Verna in particular imputes to engaging in mathematics activities? Accepting Skemp (1971) as correct, that is, one cannot learn mathematics directly from one's environment, then at least while learning mathematics (as Mathematics), some formality seems necessary. Students need to be instructed in the contemporary content of mathematics. They need to be informed of procedures and strategies in order to succeed in problem solving. However, the question needs asking, has the classroom traditionally been too limited in its approaches to learning and "doing" mathematics? At what point does the acceptance of doing mathematics as the particular structuredness embedded in pencil-and-paper desk work become the legacy of the structures of schooling, and no longer intrinsic to mathematics cognitive activity itself? Notwithstanding Skemp's (1971) position, it might also be questioned whether the environment has been "shut out" too completely by the ways in which mathematics has been taught.

Perspectives of mathematics such as that held by Verna may be modified as the student proceeds through higher grade levels. Still, it would seem that ways of understanding mathematics and how it may be done need to be expanded beyond the traditional formality of the desk/pencil/paper structure in order to lessen the perception of the Mathematics classroom's complete ownership of the subject. The ubiquitous computer may be one medium for extending the student's understanding of the ways in which one can engage in mathematics activity.

Many of the above remarks have significance for teacher educators also. It would seem a valuable aspect of pre-service teacher education to raise these issues with Mathematics student teachers, and to have them begin to reflect upon their personal understandings of mathematics before they enter the classroom as teacher.

Interest And Value

Another matter that arises out of the study relates to the relative "fragility" of the aspects of (a) interest (as intrinsic appeal) in Mathematics and (b) perceptions of the general importance or value of mathematics.

It seems desirable that students find studying Mathematics interesting for its own sake. Two students, Donna and Verna, did enjoy Mathematics generally. However, both of them, and particularly Verna, could claim little major usefulness for the subject beyond a need for understanding the basic mathematics operations. Its future career usefulness was not strong. (It seems clear that

Donna's interest in Mathematics led her to say that she wanted to be a Mathematics teacher.)

On the other hand, Peter and Ted - particularly Peter - found little of continuing interest in Mathematics study. Nevertheless, both of them - in this case, particularly Ted - perceived Mathematics as important in the future for them, even when the specific nature of this importance was relatively undefinable.

Is interest in Mathematics study as enduring as perceptions of its general importance? The concern is that it may not be. Interest level is a more personal response to a more immediate situation. "Importance" implies understanding mathematics as a significant means to ends, no matter how unclearly defined either the "ends" themselves are, or the relation of Mathematics to those ends. Seen in this light, interest seems more vulnerable.

Clearly it would be preferable if students found Mathematics interesting to study and had a strong sense of its value for them. There is no complete polarization in the case of the four students cited above, but one or the other side of the relationship is given considerably more significance. In junior high school students have no choice but to take Mathematics. However, when a student reaches senior high school where Mathematics begins to become more optional, the question of wanting to continue study in Mathematics becomes more critical. Continuing interest in

Mathematics study or maintaining a belief that it is important will hopefully provide a sufficient basis for wanting to continue to study the subject. Having neither an interest in nor a belief in the importance of the subject may reasonably lead a student to seriously challenge the need to continue Mathematics study. Given the nature of "interest" and "importance," potentially a student such as Verna, who primarily finds Mathematics only of interest - and not of importance - may lose that interest more readily under later classroom conditions than a student such as Ted may come to reinterpret mathematics as having no importance.

This has been posed as concerned conjecture. It implies that Mathematics educators should continue to seek ways of sustaining interest and beliefs in the subject's potential importance or value for all students. Without in any way limiting the students about whom this concern is addressed, it also seems particularly important that students such as Donna and Verna, who enjoy Mathematics but who consider it to be of limited value, not lose that interest.

The Significance Of The Choice Of Grade Eight "Early Adolescents"

It was noted earlier in the thesis that the choice of early adolescent, grade eight students was deliberate. The literature suggests that young people of this age are potentially in a very personally changing time of life, although the character of this change may be quite variable among the students. It is difficult at this point in looking back upon the research and the results to be able to see in them any telling early adolescent characteristics. Nowhere in the thesis or the field research can it be pointed to and claimed that the particularly early adolescent-ness of the participants was significant at that point. This is not to say that the early adolescent or transescent time of life of these young people was categorically not of significance, perhaps of even major significance, to their understanding of mathematics, only that such could not be identified.

What the understanding of these young people as early adolescents or transescents has done, however, is strengthen the interpretation of them as emergent beings. Their position as grade eight students, and their emergent and "not-yet" character as children, were important. As grade eight students, they were situated in a school which was structured along subject lines, and they were situated in a Mathematics environment in which the Mathematics was becoming increasingly abstract. Yet, as early adolescent grade eight students, they were not far in time and grade level from a schooling environment in which both the structure and the Mathematics were, or tended to be, of a different nature. The relationships between elementary school and junior high school Mathematics could be explored to increase insights into the ways in which the students understood mathematics as Mathematics. The emergent, not-yet character of these children had an important place in their perceptions of the value of mathematics, as well, quite possibly, in their naming of mathematics as "working with numbers" and thus portraying mathematics through their own active, unseparated relation to the subject.

The Significance Of Inside/Outside-Of-Mathematics Classroom Experiences

A second claim was that in order to gain a more complete sense of what meanings mathematics had for these young students, it was necessary to explore with them what they believed were experiences of mathematics in any context they could name. In particular, it meant seeking their understandings of mathematics that derive from their mathematics-related experiences, to the extent that they had them, outside of the Mathematics classroom. It was shown that while for all students mathematics had a restricted relevance outside of the classroom, there were important variations. For a few, the ethos of the Mathematics classroom pervaded their understandings of what mathematics is to the point that it was very difficult for them to believe they truly did mathematics in any other place. Others had few barriers to what was mathematics and seemed to be able to identify mathematics-related situations with relatively little difficulty. And still another felt that he did no mathematics in out-of-school everyday life situations because the mathematics-like activity he did accede to infrequently engaging in was not truly mathematics in substance.

Experiences of school Mathematics had strongly influenced the meanings that mathematics had as to the subject's content and "doing." There is no doubt that this Mathematics had also deeply shaped the students' understandings of experiences in other contexts.

The meanings of mathematics discerned in these "other" contexts seemed largely to pertain to the value that was attributed to mathematics. Their limited frequency and their nature, focusing as they do on mathematics at the "basics" level, both speak to the discernible place of mathematics in the lives of the participants.

These two major situational contexts had, in significantly different ways, gone far in shaping the meanings that mathematics held for the students.

Personal Reflection

This thesis has been mine from the beginning, but before I close this last chapter, I want to clearly profess my ownership of it.

The basis for this research was conceived while sitting in two or three junior high school Mathematics classrooms as an observer watching young students work away at geometry and condition problems. (My own children were both in junior high school as well.) I asked myself at that time what sense these students were making of what they were doing. The tasks seemed so remote from what I imagined their activities to be in other parts of their daily life outside of school. The abstractness of mathematics activities when placed against these other activities, even in other school subjects, seemed so vivid and strong that I felt compelled to explore the question with them.

In preparing myself for this research I postulated a dialectical relationship between the in-Mathematics class and outside of school experiences of mathematics. By that I mean I thought I might find essentially polar opposites in the nature of these two broad categories of experiences, and that making sense of mathematics might entail the student actively working out the necessary tension in these two forms of experiencing mathematics. I envisioned the students attempting to make sense of the subject as a form of classroom mental activity, and as something which does or should have practical value in daily life outside the classroom. I envisioned each experience-type as not at all like the other, and yet both being necessary in order to gain the fullest understanding of mathematics. Very importantly, I knew that I would find the classroom "side" of the dialectic pair to be prominent, but I also thought that I might find a quite active process of the student trying to see where mathematics had its place in non-mathematics classroom contexts. Perhaps it was wrong to consider the possibility of this as a true dialectical relationship if I was willing from the beginning to accept that Mathematics classroom activity would strongly dominate the students' experiences with the subject.

What the study with these eight students has shown is that for at least most of these young people, the dialectic sense-making of mathematics exists at most in rudimentary form.

I think in the beginning I did not fully heed Skemp's (1971) statement. By its very nature mathematics has to be initially located in a place like the classroom if we do not want to leave mathematics learning completely to individual re-invention. Initially, mathematics as it is known today has to be taught. Thus, there can be no polar dialectically related moments of mathematics development in in-class and outside-of-class environments. A classroom-like environment is the genesis of mathematics, and the focal point of mathematics activity. From that focal point a widening presentation and consequent understanding of mathematics should develop. This means that the experiences of mathematics in contextual situations other than the classroom are rooted in, and grow out of, the experiences of the Mathematics classroom.

Nevertheless, the students have to confront this expanding interpretation of mathematics. They have to integrate their understandings of Mathematics as it develops in the class with their experiences with the subject, and the possibility of experiences with it, in other situations. This synthesis can produce significantly variable understandings. All we need to do is recall the views of Peter and Ted. They both held that mathematics study was important, yet their views of what mathematics is, and its day-to-day occurrence in their present lives differed relatively considerably.

I am no longer certain of even the possibility of a dialectical relationship in the inside/outside classroom context. Perhaps that representation in itself, while not a simple dichotomization of the experiences of mathematics, is too much of a reduction of the complex process of coming to fully understand the place of mathematics.

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APPENDIX A

REQUEST FOR PARENTAL/GUARDIAN PERMISSION:

RESEARCH PROJECT AT CITY JUNIOR HIGH

Request for Parental/Guardian Permission

To the parent(s)/guardian(s):

Your child has expressed an interest in taking part in a research project which I am beginning at City Junior High. My name is Doug Franks. I am a graduate student at the University of Alberta in the Department of Secondary Education. This project is part of my study and research toward obtaining a master's degree.

The study is aimed at gaining a deeper understanding of the meaning that mathematics has for junior high students. It will be conducted with some of the students in Mr. John V.'s grade 8 Mathematics class. (Mr. V. has granted me the necessary permission.)

To help in understanding how your child would be involved, I'll give you a brief outline of the procedure. Approximately twice a week I will be observing the students during Math class, and once each week I will hold short interviews with each of those who have agreed to participate. I will also be asking these students to keep a journal in which they briefly record the mathematical activities they engage in outside of Math class. The class observations and journals will assist in providing insight and a basis for the interviews. Finding times to conduct the interviews may result in the students missing a <u>small</u> amount of class time each week; this will only be with the teacher's permission. Your child's academic progress and achievement should not be affected by the research.

The interviews will be audio tape recorded in order that I may have an accurate record of what is said. However, I can assure you that anonymity will be maintained: whenever reference to students is made in any published report (such as my thesis), either no names or fictional names (bearing no resemblance to actual names) will be used. The tapes will not be made available to any other than myself. As well, in any published report neither the teacher nor the school will be identified. Lest these last few comments give rise to concern and perhaps misunderstanding as to the nature of the study, let me assure you that such practices are quite standard as a sign of respect for the individual's privacy and to help foster an atmosphere of trust. Please understand that this study is not conducted as an evaluation of students, teacher, or school.

I expect the study to last approximately two months, but this is quite tentative. Much depends upon working around school activities, short interviews may necessitate holding a few more of them than initially anticipated, etc. Involvement in the study is strictly voluntary, and (while I would hope that it does not occur,) students may withdraw at any time.

The principal report produced from the research will be my master's thesis. The university will receive copies of this. Results of the study will also go to program personnel in the City Public School System and to City Junior High as part of a general agreement between the university and the school system regarding research in City's public schools.

I mentioned above that participation was voluntary. While this is certainly so, agreeing to take part does place a commitment on your child that should be recognized. However, I believe the study can be beneficial to him or her. Through the course of the study, I fully expect that students will become more aware of the significance that mathematics has for them.

Thank you very much for your time and consideration. If you agree to your child's participation in the study, please sign the attached consent form and have her or him return it by ________________. My receipt of the form is necessary before we can begin.

Respectfully,

Doug Franks

Date: ________________

Please Note:

If you have any further questions, please feel free to contact me at (tel. no.) evenings, or Mr. John V. at City Junior High: (tel. no.)

CITY JUNIOR HIGH SCHOOL MATHEMATICS RESEARCH PROJECT

PARENTAL/GUARDIAN CONSENT FORM

I/we have read the summary of the research project to be conducted by Doug Franks and understand its general nature and intent. While I/we understand the general commitment that my/our child is making by agreeing to participate, I/we also understand that involvement is strictly voluntary and participants may withdraw at anytime. I/we further understand that researcher interviews with my/our child will be audio tape recorded as required for accuracy, but that anonymity as stated in the summary will be maintained and that my/our child's academic progress and achievement should not be impaired by the in-school research or subsequent published report(s).

I/we hereby grant permission for ______________________ to participate in the study on the basis of the above understandings.

Parent(s)/Guardian(s) Signature(s):

SIGNATURE: ______________________

SIGNATURE: ______________________

DATE: ______________________

APPENDIX B

STUDENT BACKGROUND SHEET

STUDENT BACKGROUND SHEET

(A) NAME:____________________________________. (B) AGE:______.

(C) SEX: F / M

(D) HOW MANY BROTHERS AND/OR SISTERS DO YOU HAVE?

(i) Brothers:_____. Older or younger than you?_______.

(ii) Sisters:_____. Older or younger than you?_______.

(E) SCHOOL HISTORY:

(i) Grade	School	Location
1		
2		
3		
4		
5		
6		
7		

(ii) Have you ever skipped a grade? _____. Grade?_____.

(iii) Have you ever failed a grade? _____. Grade?_____.

(iv) What was your final average mark last year? (As close as you can recall.) ____________.

(v) What was your final mark in math last year? (As close as you can recall.) ____________.

(vi) Approximately what is your mark in mathematics so far this year? (As near as you know.) ____________.

INITIAL PERSONAL VIEWS

(A) How good a student academically do you consider yourself to be overall? Underline one.

(Poor Fair Good Excellent)

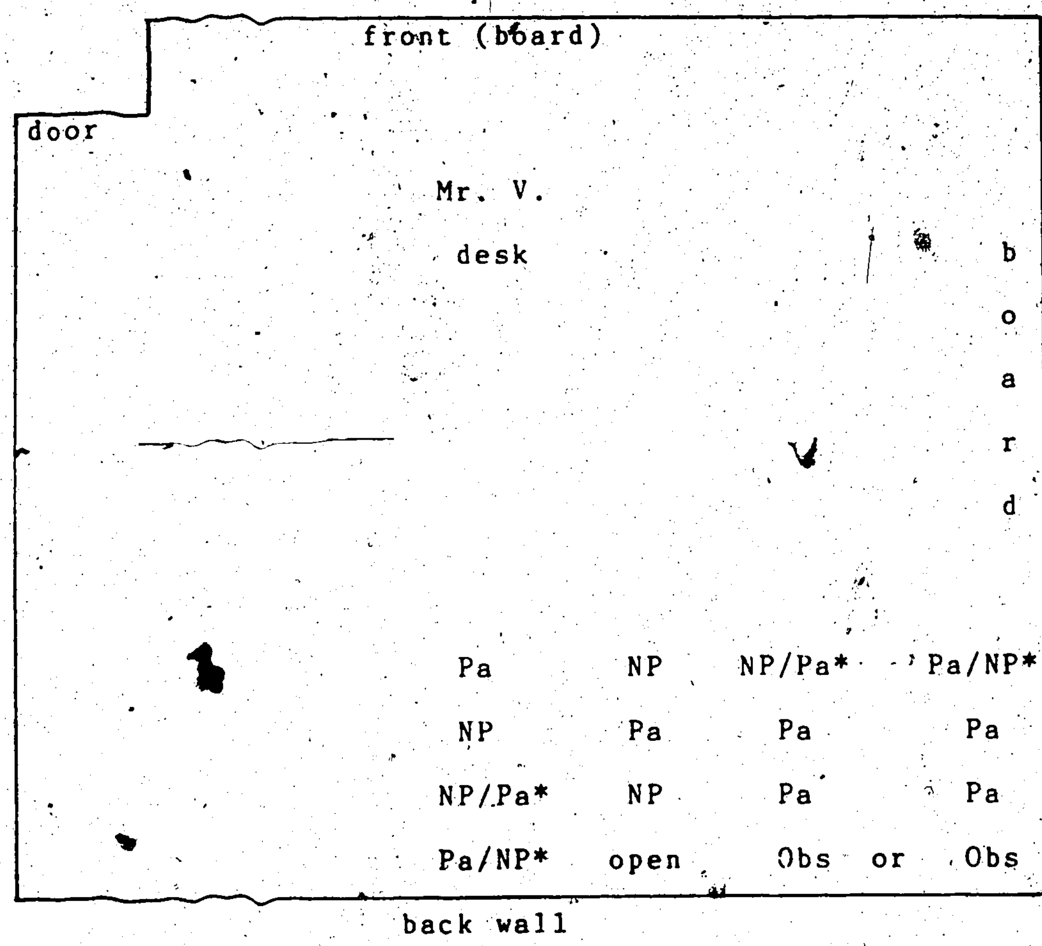
(B) How good a student in mathematics do you consider yourself to be? Underline one.

(Poor Fair Good Excellent)

APPENDIX C

SKETCH OF MATHEMATICS CLASSROOM SHOWING OBSERVATION POSITIONS AND STUDENT LOCATIONS

Sketch of Mathematics Classroom Showing Observation Positions and Student Locations



Pa: Student Research Participant
NP: Non-participating student
Obs - Researcher Observation Seat (both were open)
* - Seat after Christmas Break
Note - Six rows, five desks per row
- Almost all unmarked desks were occupied

APPENDIX [illegible]

WEEKLY SCHOOL AND RESEARCHER SCHEDULE SHOWING AVAILABLE INTERVIEW AND OBSERVATION TIMES

Weekly School and Researcher Schedule Showing Available Interview and Observation Times

TIME	MON.	TUES.	WED.	THUR.	FRI.
BEFORE	I?	I?	I?	I?	I?
PER. 1	********* ********* *********	********* ********* *********	I	I	********* ********* *********
PER. 2	********* ********* *********	********* ********* *********	I	I	I
PER. 3	********* ********* *********	I	********* ********* *********	********* ********* *********	I
PER. 4	I	********* ********* *********	I	********* ********* *********	********* ********* *********
NOON	I	XXXXXXXXX XXXXXXXXX XXXXXXXXX	I	XXXXXXXXX XXXXXXXXX XXXXXXXXX	I xxxxxxxxx XXXXXXXXX
PER. 5	MATH (ob)	XXXXXXXXX XXXXXXXXX XXXXXXXXX	********* ********* *********	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXMATHXXX XXXXXXXXX
PER. 6	********* ********* *********	XXXXXXXXX XXMATHXXX XXXXXXXXX	MATH (ob)	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX
AFTER	I?	XXXXXXXXX XXXXXXXXX XXXXXXXXX	I?	XXXXXXXXX XXXXXXXXX XXXXXXXXX	XXXXXXXXX XXXXXXXXX XXXXXXXXX

* - Unavailable Time: Student Core Subject
X - Unavailable Time: Researcher University Commitment

MATH - Mathematics Class
(ob) - Observable Class

I - Available Interview Time
I? - Possible Interview Time; Availability in Practical Terms Questionable

APPENDIX E

RECORD OF "INTENSIVE INTERVIEWS" SHOWING DATES AND FREQUENCIES

RECORD OF "INTENSIVE INTERVIEWS"

1984-1985

STUDENT	WEEK beginning Nov. 19	26	Dec. 3	10	17	24	31	Jan. 7	14	21	
Carol	1	2	3	s4		----------	----------		5	6	
Peter	1	2	s3		4	----------	----------		5		
Ted	1	m2	3	4		----------	----------		r	r	r
Karen	1	m 2	m 3	4		---------- Christmas break	----------		s	m	5
Pamela	1	2	3		4	----------	----------		5		6
Anne	1	2	3		4	----------	----------		5		
Verna	1	2	3		4	----------	----------		5		
Donna	1	2	3	s 4		----------	----------			s5	

r: Scheduled interview cancelled by researcher

s: Scheduled interview cancelled by student

m: Scheduled interview missed by student

RECORD OF "INTENSIVE INTERVIEWS"

1984-1985 (continued)

STUDENT	WEEK beginning Jan. 28	Feb. 4	11	18	25	Mar. 4	11	18
Carol				7			8	
Peter					6			
Ted		5				s 6		
Karen							r m6	
Pamela						7		
Anne					r6			
Verna						6		
Donna						s 6		

Mr. V.						1		

r: Scheduled interview cancelled by researcher

s: Scheduled interview cancelled by student

m: Scheduled interview missed by student

APPENDIX F

RECORD OF STUDENT JOURNAL ENTRIES

SHOWING DATES AND FREQUENCIES

RECORD OF STUDENT JOURNAL ENTRIES

Name	1984 November	1984 December	1985 January	1985 February
Ca[illegible]	19-24	3, 11-13	14	
Pe[illegible]	21-24, 27-30	3-7, 10-12, 14, 17	14-18, 21-25, 28-31	
Ted		4	[illegible]isplaced? Not [illegible]ed in.	
Karen	26, 27		[illegible]isplaced? Not [illegible]urned in.	
Pamela	21, 22, 25, 26, 28	4, 11, 17	14, 15, 24	3
Anne	20, 21, 25, 26, 29, 30	2, 10, [illegible], 14, 17, 18	14-16, 20, 25-29	1, 3, 5
Verna	20-22, 25, 27	17, 18.	14, nd, nd	
Donna	26-30	Lost, replaced in January		11-13, 15, 18-20

Dates represented as x - y imply "from x to y inclusively."

Journals were taken in by researcher late in December and held until second week of school in January.

Final collection of all Journals began in early February.

APPENDIX G

SEMI-STRUCTURED STUDENT JOURNAL FORMAT

SHOWING AN EXAMPLE OF EACH STUDENT'S* DAILY ENTRIES

(* Karen's and Ted's Journals Not Available)

G (i)

EXAMPLE OF ANNE'S DAILY JOURNAL ENTRIES

JOURNAL

DATE: Nov 30/84

DID YOU DO ANY *SCHOOL MATHEMATICS OUTSIDE OF CLASS TODAY - LIKE HOMEWORK? No

IF SO WHAT WAS IT ABOUT? WHAT DID YOU THINK OF IT? WHERE WERE YOU WHEN YOU DID IT?

DID YOU DO ANY MATHEMATICS IN ANY OTHER CLASSES TODAY? (BESIDES MATH CLASS)

IF SO CAN YOU BRIEFLY DESCRIBE IT?

Yes - I calculated my average in science and figured out R.H.

~~[illegible]~~

[illegible]

CAN YOU RECALL IF YOU USED ANY MATHEMATICS OUTSIDE OF SCHOOL TODAY?

Yes

IF SO, CAN YOU DESCRIBE WHAT IT WAS FOR, AND WHAT SORT OF THINGS YOU DID?

for swimming I had to calculate the metres I swam.

COMMENT ON ANYTHING YOU WANT - THIS STUDY WE'RE IN TOGETHER, SOMETHING YOU WROTE EARLIER, MATHEMATICS (WHAT IS IT LIKE DOING MATH) - JUST WHATEVER

In class we spent most of the time correcting h.w.
I felt really bored.

DF COMMENTS

G (ii)

EXAMPLE OF CAROL'S DAILY JOURNAL ENTRIES

JOURNAL

DATE: Dec 3

DID YOU DO ANY SCHOOL MATHEMATICS OUTSIDE OF CLASS TODAY - LIKE HOMEWORK? Yes

IF SO WHAT WAS IT ABOUT? WHAT DID YOU THINK OF IT? WHERE WERE YOU WHEN YOU DID IT?

it's about geometry and angles

DID YOU DO ANY MATHEMATICS IN ANY OTHER CLASSES TODAY? (BESIDES MATH CLASS) IF SO CAN YOU BRIEFLY DESCRIBE IT? NO

CAN YOU RECALL IF YOU USED ANY MATHEMATICS OUTSIDE OF SCHOOL TODAY?

yes at work

IF SO, CAN YOU DESCRIBE WHAT IT WAS FOR, AND WHAT SORT OF THINGS YOU DID?

I had to add and give out change. I find this sort of fun but math class a bit more confuseing.

COMMENT ON ANYTHING YOU WANT - THIS STUDY WE'RE IN TOGETHER, SOMETHING YOU WROTE EARLIER, MATHEMATICS (WHAT IS IT LIKE DOING MATH) - JUST WHATEVER

in math class we talked about geometry and angles and wrote down defininitions it was fun when we were working but when he sat up there and talked it was rather boring for a while

D.F. COMMENTS

G (iii)

EXAMPLE OF DONNA'S DAILY JOURNAL ENTRIES

JOURNAL

DATE: Feb 19

DID YOU DO ANY SCHOOL MATHEMATICS OUTSIDE OF CLASS TODAY - LIKE HOMEWORK?

yes (Just for Practice)

IF SO WHAT WAS IT ABOUT? WHAT DID YOU THINK OF IT? WHERE WERE YOU WHEN YOU DID IT?

constructions

I did it in my bedroom.

DID YOU DO ANY MATHEMATICS IN ANY OTHER CLASSES TODAY? (BESIDES MATH CLASS)

IF SO CAN YOU BRIEFLY DESCRIBE IT?

Sorry but I cant recall eny thing

CAN YOU RECALL IF YOU USED ANY MATHEMATICS OUTSIDE OF SCHOOL TODAY?

No.

IF SO, CAN YOU DESCRIBE WHAT IT WAS FOR, AND WHAT SORT OF THINGS YOU DID?

2

COMMENT ON ANYTHING YOU WANT - THIS STUDY, WE'RE IN TOGETHER, SOMETHING YOU WROTE EARLIER, MATHEMATICS (WHAT IS IT LIKE DOING MATH - JUST WHATEVER

No

THE DAYS MATH CLASS ACTIVITIES (BRIEFLY)

~~marked~~ marked homework
wernt asined enything

YOUR REACTIONS AND FEELINGS.

Happy no homework
but I dident do very good on the lastdays homework.

D.F. COMMENTS

3

G (iv)

EXAMPLE OF PAMELA'S DAILY JOURNAL ENTRIES

JOURNAL

DATE: Jan 24/85

DID YOU DO ANY SCHOOL MATHEMATICS OUTSIDE OF CLASS TODAY - LIKE HOMEWORK? yes! It was homework

1 IF SO WHAT WAS IT ABOUT? 2 WHAT DID YOU THINK OF IT? 3 WHERE WERE YOU WHEN YOU DID IT?

1. It was finding the area and perimeter of objects.

2. I thought it was o.k. pretty easy.

3. I did this work in the computer room

DID YOU DO ANY MATHEMATICS IN ANY OTHER CLASSES TODAY? (BESIDES MATH CLASS).

IF SO CAN YOU BRIEFLY DESCRIBE IT?

No! I did not do any mathematics in any other classes.

CAN YOU RECALL IF YOU USED MATHEMATICS OUTSIDE OF SCHOOL TODAY?

No! I did not use any other mathematics besides homework

IF SO, CAN YOU DESCRIBE WHAT IT WAS FOR, AND WHAT SORT OF THINGS YOU DID?

COMMENT ON ANYTHING YOU WANT – THIS STUDY WE'RE IN TOGETHER, SOMETHING YOU WROTE EARLIER, MATHEMATICS (WHAT IS IT LIKE DOING MATH – JUST WHATEVER

In-class activities We marked our homework Mr. V. spent a lot of time explaining things

Reactions, feelings Some of the things I had guffed up on the homework.

D.F. COMMENTS

G (v)

EXAMPLE OF PETER'S DAILY JOURNAL ENTRIES

JOURNALS

DATE: Wed. Jan. 16/85

DID YOU DO ANY SCHOOL MATHEMATICS OUTSIDE OF CLASS TODAY? LIKE HOMEWORK?

Homework

IF SO WHAT WAS IT ABOUT? WHAT DID YOU THINK OF IT? WHERE WERE YOU WHEN YOU DID IT?

~~pr[illegible]~~; ~~[illegible]~~

word ~~po~~ problems on parallelograms, not very hard

DID YOU DO ANY MATHEMATICS IN ANY OTHER CLASSES TODAY? (BESIDES MATH CLASS).

IF SO, CAN YOU BRIEFLY DESCRIBE IT?

1

CAN YOU RECALL IF YOU USED ANY MATHEMATICS OUTSIDE OF SCHOOL TODAY?

IF SO, CAN YOU DESCRIBE WHAT IT WAS FOR, AND WHAT SORT OF THINGS YOU DID?

2

COMMENT ON ANYTHING YOU WANT - THIS STUDY WE'RE IN TOGETHER, SOMETHING YOU WROTE EARLIER, MATHEMATICS (WHAT IS IT LIKE DOING MATH) - JUST WHATEVER

THE DAYS MATH CLASS ACTIVITIES (BRIEFLY)

finding Areas of squares given perimeter & vice versa, finding area/perimeter of rectangles given area/perimeter & altitude/base

YOUR REACTIONS AND FEELINGS

not difficult and a bit boring

DF COMMENTS

3

G (vi)

EXAMPLE OF VERNA'S DAILY JOURNAL ENTRIES

JOURNAL

DATE: Dec 18

DID YOU DO ANY SCHOOL MATHEM[illegible]
OUTSIDE OF CLASS – LIKE HOME WORK

Yes

IF SO WHAT WAS IT ABOUT? WHAT DID YOU THINK OF IT? WHERE WERE YOU WHEN YOU DID IT?

ACTITUDES, AREA
PERIMETER

DID YOU DO ANY MATHEMATICS IN ANY OTHER CLASSES TODAY? (BESIDES MATH CLASS)

IF SO CAN YOU BRIEFLY DESCRIBE IT?

CAN YOU RECALL IF YOU USED ANY MATHEMATICS OUTSIDE OF SCHOOL TODAY?

IF SO, CAN YOU DESCRIBE WHAT IT WAS FOR, AND WHAT SORT OF THINGS YOU DID?

COMMENT ON ANYTHING YOU WANT - THIS STUDY WE'RE IN TOGETHER, SOMETHING YOU WROTE EARLIER, MATHEMATICS (WHAT IS IT LIKE DOING MATH - JUST WHATEVER.

MeRRY
ChRistmas

THE DAYS MATH CLASS ACTIVITIES (BRIEFLY)

Marked homework
Definition

YOUR REACTIONS AND FEELINGS

I understand the definitions NOW

D.F. COMMENTS

APPENDIX H

CONVENTIONS FOLLOWED IN INTERVIEW TRANSCRIPTIONS

Conventions Followed in Interview Transcriptions

Character/Phrase	Description
R:	Researcher speaking.
/	Interruption of 'train of thought' or sentence. May be by speaker or second party.
|	Signifies both parties are speaking at the same time.
[(some text)]	Researcher comment or explanation.
"Uh-huh"	"Yes"
"Uh-uh"	"No"
[*]	Very brief titter. Like a single gasp of air. Usually indicative of some nervousness or embarrassment or feeling 'silly' about some remark just made. With some participants, occurred frequently.
[. . .], [. . . . . .], etc.	Short pause by speaker in his or her speech, or between speakers. Number of dots is not a count of seconds in speech pause, but does indicate increasing duration. [. . .] represents a pause of approximately 1 to 3 seconds, [. . . . . .] a pause of approximately 3 to 6 seconds, etc.
. . . or - - - - -	Some of original interview text omitted.

APPENDIX I

TEXT AND ANALYSIS OF "INTENSIVE INTERVIEW" #2

WITH DONNA HELD NOVEMBER 26, 1984

The following is an example of the first individual interview in which the student and the researcher began to extensively discuss mathematics. It is presented here for two reasons. First, to provide the reader with an overall sense of the type of interview conducted with the participants. It should be recognized, of course, that these varied somewhat from interview to interview and from student to student.

Secondly, following the transcription itself, a section by section analysis of the interview is provided. This analysis follows the coding and interpretive pattern initially undertaken. Thus, such things as the questions the interview raised and the lines of investigation it suggested are indicated.

This interview with Donna was the first Interview #2 held.

Text of "Intensive Interview" #2 with Donna, November 26, 1984

R: O.K. Donna, did you have something to tell me about your journal?

D: Well, on Friday, we had two typed pages of homework, and I did those in class so I didn't have any homework. And I didn't do really anything else, in any of the other classes or anything. And, besides adding shopping lists I didn't do [laughs] anything at home or anything like that. So I just[. . .]

R: O.K.,[. . .]. O.K., let me ask you, do you see a problem with keeping it up? What was the/ Why didn't you keep it up? Was it because you just forgot, or[. . .]

D: No, I didn't forget, it's just, ah, I'm so busy I just can't write in it.

R: Umm, no time.

D: Yeah.

R: How have you been - like, did you take it home with you or did you leave it here? What did you do?

D: I took it home.

R: Did you?

D: Yeah.

R: O.K. Ah, yeah, I'm sure that's going to be, you know, that's something we all have/ Yeah, we're all pretty busy, but again, if you can try and/

D: Yes.

R: /Even just a few minutes, you know, in the evening, before you go to bed, or something; just try and jot down some things, O.K.? Ah, what I would/ While we're on the journals, what I would also like to mention - maybe I could just see it for a second [takes journal]. This pretty well all deals with, you know, nothing to do with right inside the classroom. Did you do/

D: |Uh-huh.

Uh-huh.

R: /math outside? Did you do your homework outside? [Reading journal questions] Did you do something in |some other class? Or did you do some math somewhere |else?

D: |Uh-huh.

R: What I would also[. . .] Hope you don't think this is adding more - well, I guess in one way it is. What I would like you to do - again, if it's at all possible, try and[. . .]probably here in this[. . .] Well, either here or in this [pointing to pages 3 and 4 of journal] down here in this last page or the blank page. I would appreciate it if you could also comment on just some of the things that might have even happened in the Math class, O.K.?

D: Uh-huh.

R: Ah, in other words, maybe we can kind of downplay a little bit some of these other things, although just try and make a few points, but I'm also thinking that I would like you to add, if you can, a few comments on the Math class. Now, the reason I didn't kind of include it to begin with was that, "Well, . . . you know, you get four classes in a week and I'm going to be in here for two of them. So there's really no need for me to ask you to do more."/

D: Uhm. [yes]

R: /But there are a couple of classes that I don't sit in on, and with eight people, I'm finding it's difficult to . . . watch everybody and to kind of see what you're personally doing.

D: Uh-huh.

R: And so that I think it would be personally useful for me to have/to ask you if you wouldn't mind also adding some comments about Math in class. O.K.?

D: Uh-huh.

R: Now, you don't need to give a detailed description of the, "Well, you know, we went over pages so-and-so and so-and-so today and I did this" but I think what I would like more than anything from you is sort of a reaction, sort of your feelings about what you're doing, O.K.?

D: Like, if you learnt anything, and how/

R: Yeah, if you feel you learnt anything, and/

D: |Yeah, or if it was really just/

R: Yeah/

D: /um, running everything over again that you already knew.

R: That's right.

D: O.K., I got that.

R: O.K., you got that? So,[. . .] O.K., I won't take/ there's not much point in me taking your book in then.

D: Yeah. [laughs]

R: But I'll just make a note that you didn't have anything on it, but you just briefly told me on the tape.

D: Yeah.

R: O.K., I guess then you don't have any other questions about that.

D: No. [laughs]

- - - - [discussion on what group might do when study is completed]

R: . . . The other thing is, when we have our little discussions here, I would appreciate it if sort of the same thing goes as far as the journal, that you don't talk about what we talked about here, O.K. In other words/

D: Uh-huh.

R: /don't discuss, "Well, today we talked about this, and that,"/

D: Uh-huh, yeah.

R: /O.K., that's kind of again just between you and I. By the way, did you happen to talk to your parents about this [journal], or/

D: Ummm/

R: /or not at all. Just a curious question.

D: Talked about it a bit. Not much.

R: O.K. Any reactions from them?

D: No, they're kinda busy . . .

- - - - - [short discussion about tape noise]

R: . . . Now, first of all, when we're talking back and forth here, I want to really emphasize, you know, that there's no right answers, there's no wrong answers,/

D: Uh-huh.

R: /it's not a Math quiz or anything like that. And if you feel you're not sure what I want to/what I'm trying to ask, then, you know, ask again.

D: Uh-huh.

R: . . .That's quite all right. And if you want to take some time to think about what I'm asking, O.K., don't worry about the fact that the tape is going. Just, if you want to stop and take a couple of seconds to kind of - a few seconds - to think about what it is then that's fine too.

D: O.K.

R: And just relax the best you can.

D: |Uh-huh, yeah. [laughs a little]

R: O.K., let me start off with a - having said all that - let me start off with a sort of a[. . .]scene here. Just as happens every day, suppose the bell has just rung, and you've just finished so you get up from that class, and you realize that Math class is next. Right?

D: Uh-huh.

R: So you arrive here in the [Math] room, and you sit down and take your seat, and the teacher starts to talk, Mr. V. starts to talk. Now, so that's the scene.

D: Uh-huh.

R: What I would like to ask you is, O.K., can you recall/can you think about/how do you feel about being here, sitting down, getting ready to do Math. You know, what's your feeling?

D: Umm. ['nervous' laugh] I don't know, I'm not all there until [little laugh] he starts talking about something that I don't know.

R: O.K. —

D: Like, if he's just repeating what we've done the day before I'm not all there. I know exactly what we did the day before.

R: O.K., so you feel quite sure, do you, of what's gone on/

D: Yeah.

R: /in the past?

D: Yeah.

R: O.K. What other things sort of might be going through your mind then?

D: I dunno. [*] Well. You know G_ and I always talk. [laughs]

R: O.K., right.

D: . . . Whatever we, comes to mind we/

R: Right.

D: /just sort of talk about. But, otherwise, I know what he's talking about all the time. Like, I can do the things. Like if he asks me a question, I could probably be answering it even though I didn't hear it.

R: Is that right?

D: Yeah.

R: Even though you, ah/

D: /like just heard it in through the background of my conversation I could probably answer it.

R: So you feel quite sure of your mathematics then, do you?

D: Yeah, Math's my easiest subject, yeah.

R: O.K. When you say "easy," what do you mean by "easy"?

D: Like, I understand it. Like, I have no trouble at all by understanding it, like, in Social you have to really listen, except in Math you just have a one-time explanation and you've got it. Like, that's for me, like I've got it for life.

R: So you remember, then, some of the things that you were taught from before, do you?

D: Yeah, like I can remember last year really easy.

R: Where were you last year? You were here?

D: Yeah, except I was with Mr. O. And we just did fractions and decimals and we did just a really small amount of measuring, and we did whole numbers, and, umm, natural numbers. All that[. . .]

R: O.K. When you say it/ What kind of a feeling does that give you, to say that it feels easy, it's easy? How do you feel about that?

D: Umm, I don't have any trouble with, like I don't have to listen so hard because I don't get it,/

R: Right.

D: /so I can just, like, hear it, do it - all my work - and get it all correct. Like I usually have[. . .]the majority of my work correct/

R: Uh-huh.

D: /unless there's one section that I don't understand; then I ask him.

R: Right. [. . .] O.K., I guess[. . .]what I mean, the fact that you feel it's easy, when you say that it's easy, I guess that to you then means that you can do [illegible]

D: Yeah.

R: /and understand it. [. . .] . . . O.K., when we get back into coming into the classroom, then, how do you feel about, just in general, about the fact that the next class is Math?

D: I dunno, like, I never know what's going to go on in Math. It could be boring, it could be dull, like, it could be exciting. I could learn something, I could not learn something.

R: Right.

D: It just depends what we're learning I guess.

R: Right. When is it boring?

D: When we've done a unit for over a week [little laugh], and you're sitting there, "Yeah, we know this" and/

R: Right.

D: /and like every single person in that whole classroom's totally "Uh-huh, uh-huh." So [laughs a little throughout] it seems like Mr. V. doesn't get the hint "We know this." You know. That's pretty boring.

R: So [redacted] you understand it, it's getting to be a lot of repeats -/

D: Yeah.

R: /-that's when it gets boring.

D: Yeah.

R: O.K., is there anything right now sort of boring?

D: No, not really, 'cause like we're learning of different shapes and all that stuff, and like how to classify them. It's O.K. I don't think it's boring that much.

R: What does it mean, what do you mean, "O.K."?

D: Well[. . .]

R: How do you feel when you say it's "O.K."?

D: Umm[. . .] I guess it's just that I don't completely enjoy it, I don't love it. I just feel that it's, ah, up to my standard. It's all right, you know. I don't mind it. [*]

R: Is there anything about math, about doing it that really[. . .] When is it really interesting?

D: Umm, like when some of the questions are fun to do. They're not all[. . .] They're quite simple questions and they're really fun to do I guess, that's what[. . .]

R: . . .What do you mean? How would a question be "fun"? I don't quite understand how a question would be "fun"?

D: Well, it's, umm, I guess it's when it doesn't take a lot of thinking to do, it sort of just comes to you. It might take some other people a lot of thinking but, it's when a question is/there seems no other way to do it for you. Like, it just has to be.

R: Does it kind of come naturally?

D: Yeah, like there's one way to do it and that's it. And then some people think there's a lot of other ways to do it. They don't understand it. I always feel like, some questions are like that, and then others there's one way to do it and you can't get away with doing it another way, so you always get it correct.

R: Well, there are some things about math where there is only one way to do it that you see?

D: Yeah. Like, ah, operations. Like order of operations. There's only one way to do it and it's kind of fun to do it. But, like each step individually.

R: That's interesting. Now, is there any other cases where something would be fun?

D: Ah, I like the geometry set.

R: Do you?

D: Yeah, I like doing geometry.

R: What is it about geometry that[. . .]

D: I dunno. It's fun to draw shapes. [laughs]

R: Is it?

D: Yeah. Draw, like, the slides and the flips and all that.

R: When you do geometry, do you like the tools?

D: They're fun to use, but I don't have them. [laughs] That's the only problem.

R: Yeah, O.K. Again, when you say they're fun to use, what does that mean?

D: Umm[. . .]well[. . .]it's like, it's more exciting 'cause you don't just use your pencil and your eraser and your paper. You use more things to get an answer, really. I guess that was what I meant. [*]

R: Right, O.K. . . . O.K., when it's boring . . . is there a recent example of when something has been boring? You said it's not boring now?

D: Yeah.

R: Is there times now when it's boring?

D: I guess it's/ I think, like, multiplying, adding, subtracting, things like that, like decimals and fractions; I think that's sort of boring. We've done it almost all my life and it's just a total repeat. [*] I think that's probably one of the most boring things I've done. And measuring. Like, I mean, everybody knows how to measure things.

R: . . . When you say "measure," what kind of measurements are you measuring, are you talking about?

D: Like lines and[. . .]just[. . .]the real simple. It's like, lines and the fraction of the shape, and all that. It's real simple. So, it gets kind of dull after awhile.

R: How long have you been doing measuring? Do you remember?

D: Well, I did it in grade five and six[. . .] No; grade four, grade five, grade six, grade seven, and a bit in grade eight. So[. . .]it's kind of just really repeating. It's like Social where you study Canada all your life. [laughs] It gets really boring.

R: O.K., I hate to say this but twenty minutes has already gone by.

D: Oh.

R: It seems like we just got started . . . It is a good start, actually, and I'm going to listen to what you had to say, and I hope by next week you'll have a few things jotted down in your book.

D: Yeah.

R: Try and do what you can.

[Remainder of interview deals with Donna finding time to write in her journal, and with setting a time for the next interview.]

Analysis of Interview #2 with Donna

Lines 1 - 113: The Student Journal

Lines 1 - 28

Donna had been given her student journal the previous week. This first section of the discussion was in part a journal "progress report." The intent was to take in her journal at this time. As she had written nothing in it, this was not done.

There were clear indications that Donna may be a student who was going to have difficulties in keeping up the journal.

Lines 28 - 86

The journal initially did not ask the students to specifically comment on the events of the daily Mathematics class, and their reactions to what took place and what was studied. By the time of Interview 2, R. had recognized that this was an omission which needed to be corrected. At this point the journal was not taken in and physically modified. Donna was only asked to try to remember to provide the additional information. The journal was physically modified later.

The request for the additional information was made with a great amount of caution, so much so that it appears excessive. The reason for this caution was a definite concern that asking Donna (and the others) to do this additional writing, particularly as the research was just beginning, might lead her (and the others) to feel they were being asked to do too much, and thus decide to drop out of the study. There was a strong desire that the study begin as positively as possible. On the one hand, asking the students to take on more "work" might induce them to stop participating. On the other hand, their response to each class was definitely wanted. Whether the cautious approach was necessary, at least to the degree evident in the transcription, is an open question.

Lines 107 - 113

All of the students were asked not to discuss with the other participants either what they wrote in their journals (request made in Interview 1) or what was said in each interview. Students were told that they could generally describe to their parents what they were doing with their journals. They were asked not to enter into discussion with them regarding responses to particular questions, especially those that dealt with mathematics experiences out-of-class.

<u>Lines 114 - 131: The Nature of the Discussion</u>

The informal, "non-testing" atmosphere of the interviews was emphasized.

<u>Lines 132 - 323: The Mathematics Classroom Experience</u>

In this first interview in which mathematics was extensively discussed, the focus was on the classroom experience. It was felt that this was a strong, appropriate place to begin. Much of this interview was categorized under the general heading "Math class." Several aspects of it were further placed in subcategories of the "Mathematics class" experience.

The focus was on the classroom experience, but the research relationship and biography development were also implicit features of the meeting.

Lines 132 - 147

The "opening scenario" (as described in Chapter 3) was presented to Donna. In this interview, no other prepared questions were posed. The subsequent discussion was developed entirely upon the response she provided to the scenario question.

Lines 162 - 167

Donna's comments on talking to her friend were an acknowledgement of what the first classroom observations had indicated.

Lines 148 -- 212

The questions posed by R. (lines 145-147, 160-161) were designed to solicit evocative, emotional responses to beginning a Mathematics period. In this section her rather unequivocal views of Mathematics quickly became clear. The confident, almost casual approach to Mathematics that Donna took is clearly evident. Her confidence reached overstatement in lines 153-154, 167-171, and 184-186. In this first interview she herself began to position Mathematics relative to her other school subjects, and readily asserted that it was her easiest subject, much less difficult, for example, than Social Studies.

It was considered essential to attempt to gain greater insight into what students meant when they said that they found something "easy," "fun," and so on. One approach taken to gaining this insight was to directly pose the question, for example, "What do you mean by 'easy'?" (lines 180-181). Donna provided further material and confirmation in her later discussion of "fun," but direct questions such as this one (and there are other similar questions in the interview) were specifically asked in an attempt to have Donna (and the others) "stop-and-think." These direct questions were admittedly sometimes difficult to answer, although Donna did reasonably well in answering. These direct questions did, however, serve as one point of entry into taken-for-granted attitudes and understandings.

R.'s on-the-spot formulation (lines 209, 210, 212) of what Donna meant by finding Mathematics "easy" was, if anything, understatement. Donna's various statements indicate more than simply "you can do it . . . and understand it." There was much greater confidence evident in Donna's remarks than in R.'s summative comment.

The confidence she exuded in this section was consistent with her claim of being EXCELLENT on the Student Background sheet she completed at Interview 1. At this point, however, it was still not clear how, in light of her marks (see Table 1), she could consider herself so highly given the level of Mathematics mark she regularly received. There is no sense yet, for example, of her historical views of Mathematics. Had she always considered mathematics to be her easiest subject? This was an area which needed further investigation in later interviews. This confidence in her ability would also have to be checked again as the study progressed and as she continued to be introduced to grade eight Mathematics.

The question of the relationship between "easiest" and her liking for and interest in Mathematics generally was another area for future exploration that arose from this section.

Major portions of this discussion section were placed in a subcategory, "Math class - Math: easy."

Lines 212 - 323

In this section R. returned to directly pursue expressions of the Mathematics classroom experience. Donna's first statement (lines 216-219) provided a good introduction to the variety of experiences ("boring," "O.K.," and "fun") that she brought up in this section. This in itself was an important aspect: She did regard the Mathematics classroom experience as varied. Donna first used the terms "boring," "O.K.," and "fun" (and not R.). "Math class - Math: boring" and "Math class - Math: fun" were analysis categories.

Lines 222 - 241, 297 - 323

The questioning in all three cases sought an elaboration of what she meant when she used the terms. In lines 223-236 Donna provided one type of boring instance, that of remaining on a topic beyond the point at which she felt she she understood the topic. Later, in lines 297-323, she provided a second instance, an extension of the first, in which a topic she claimed she thoroughly understood was taken up in class year after year. Repetitious Mathematics appeared to be a major boredom inducing phenomenon. Was all such Mathematics boring? Some "fun" experiences also seemed to involve repetitious Mathematics.

Analysis of her comments also led to the question of why she thought the same or similar topics were taught year after year.

Lines 242 - 248

This is the first reference to a "standard." An initial inference from the expression "O.K." was that something which just met her standard was satisfactory, neither boring nor exciting. Still, it was not overly clear from this brief, incomplete discussion what she meant by "standard." It remained as a question to be taken up later.

Lines 249 - 296

The matter of Mathematics experiences of solving problems being "fun" was not entirely expected, and the discussion turned to an elaboration of what she meant by "simple," "really fun" questions.

Two aspects of "fun" Mathematics experiences were tentatively discernible in this first interview. One aspect of "fun" problems for Donna was the ease with which they could be solved. The confidence she had in her mathematics ability was again evident in this section. She had success while some others do not. They became confused while she was able to see the "way" through to the solution. A second aspect of "fun" Mathematics experiences was also discernible. "Fun" experiences seemed to be topic-dependent. She liked order of operations problems and geometry, but she found boring other activities which she felt she had done for some time - for years, in her estimation.

As this was the first Interview 2 held, no other students had as yet made reference to "fun." It was not known at this time whether this was an isolated occurrence. It was noted that "fun" Mathematics experiences would have to be discussed again to determine whether the two tentative aspects could be verified. There was also a question of how extensive "fun" experiences in Mathematics might be for Donna. This question may have to be considered in connection with her interest in and enjoyment of Mathematics generally.

After this interview, it was felt that the entire matter of better defining "boring," "O.K.," and "fun" occasions still needed further exploration. It was also recognized that this desire for a deeper understanding of these classroom experiences had to be tempered by the recognition that this was a relatively small area of focus in seeking what meanings Donna held of mathematics, and that because of time constraints the study must quickly move on to other areas as well.

This first intensive interview to focus on mathematics provided a good introduction to Donna's perceptions of Mathematics class activities and her Mathematics self-image. Although she showed signs of occasionally being nervous, and the questioning was tentative at times, the interview and the researcher-student relationship were considered to have gotten off to a reasonably good start. (Interview 3 did not go as well. Later interviews were better.)

An overall impression from the interview was that Donna seemed to be an energetic, cheerful individual willing to try to answer the questions as best she could.

APPENDIX J

INTERPRETATION NOTES AND TEXT OF VALIDATION/INTERVIEW #6

WITH VERNA, HELD FEBRUARY 28, 1985.

Interpretation Notes for Validation/Interview #6 with Verna, February 28, 1985

The final interview with each student was a thirty to forty-five minute question and interpretation validation procedure. It departed from the procedure followed in the previous, shorter interviews held with each student.

The following four pages are reduced reproductions of the interpretation/validation notes prepared for and used at Validation/Interview #6 with Verna. Verna and the researcher both had copies. They were slowly read aloud. Verna was encouraged to react in whatever way she felt appropriate as the reading progressed.

The text of the interview itself immediately follows these four pages of notes. It illustrates Verna's responses, and it shows where and how the discussion occasionally departed from the topics in the interpretation notes.

Verna — Feb. 28

You are quite definite and certain that math is your favourite subject at school.

But you like going to school, and generally like most subjects. You don't like to miss school. You like being with friends there, and you enjoy the extra things you can do at school - dance club, year book, house league, even trying to sell a cake.

I am going to offer my ideas about why you like math.

(1) you find that you are able to understand the concepts introduced and the 'how-to-do-it' methods quite easily;

(2) you like calculating - you get a definite answer - quickly;

(3) you like solving straight forward problem solving like condition solving, and problems that give a formula

- you are able to get an answer [you know positively what to do.]
- you know there is an answer, and only one answer.
- it doesn't take much time to get to the answer
- nevertheless it involves work; you don't know the answer beforehand
- there is a bit of a challenge involved with each problem - a "Can I do this one? Bet I can."

(4) You like to get good marks, they are important to you. In math you are able to get good marks

(5) there are lots of things to figure out - calculate, or draw - in math. But not every class in math is 'unboring'.

- You don't like taking definitions (i.e. copying definitions off the board) although you believe they are important for doing geometry.
- you are not fond of geometry, you question its usefulness
- you don't like word problems - they are often too hard and difficult. They are not straightforward.
  - but you can still do them.

Still, math is best in marks, and best in your liking it

- you don't like math - it's boring - if the teacher goes over/talks about subjects you already know. You are bored by such reviews

2.

-when you are bored (in class) your mind drifts to think of other things; you doodle. You often do not pay total attention to the teacher, but you do usually pay enough a tt'n that you know what's going on. When new material is being introduced you pay quite close attention—you want to try to understand it quite quickly and well.

How do you now feel about geometry?

You have said that you do not see much point in learning geometry (most of it). But you are also quite unsure of condition solving's point, but you still like them. In elementary school, you liked calculating. In fact you got better math marks then than you do now in Junior High.

However, you are still able to see the usefulness or uselessness in many of the things you study in math

My interpretation: —or usefulness
The usefulness of the math is not what is really important.
What is important is the straightforwardness of the problem. —the procedure is clear, you understand it
- You enjoy following the procedure, the steps
- there is a definite answer
- it does not take long to do them.

-you feel good getting the right answer

Primarily, math appeals to you for its own sake—you just like doing it—and much less to do with how useful/useless you believe something to be. It is a bit of a challenge that you know you are usually able to meet.

usefulness is not a great concern. Not something you think much about. The sense of accomplishment in solving the questions is more important. That's what is best about math

- I think you are a conscientious student
  - you care how well you do
  - you make a good effort to learn what the teacher is presenting.
  - You try to learn the material even if you think it useless, or not interesting.

3

You said one day that you prefer to do your math assignments at home rather than in class.
You said you could not concentrate in class. You'd rather talk
[doing your homework, you like to be alone, and have it quiet]
I find your not able to concentrate statement a little surprising. You seem to me to be someone who would go right to it; you would want to get it done. You'd like to do it then (in class) for the sake of accomplishing the task or job.

Question: Do you prefer to work alone?
or: Do you also like to discuss problems with friends; to see if you can work it out together?

Would you say (ever) that math class is fun?
I am not sure myself what you would think
[but I do not think so].

What do you think about going to all those different elem. schools?

Compared to junior high, you did better in math in elementary (marks), but you have said you still like math about the same.
You find the things you learn in junior high different from elementary.
You also find grade eight math harder than gr. 7 - its more complicated.
Question: In what ways do you think 8 is more complicated than 7 math?
Was gr. 7 math more complicated - harder - than gr. 6?

4.

Do you hope to take math right through high school?

We have talked about 'math outside' in the journal and that you felt you never did any 'math outside'

When we talked about what you consider as math, you had difficulty in describing it beyond "Just what you do in math. Just math." Later you did say "working with numbers"

You said basically either its math? or it isn't math? Is it this clear? What examples?

Q: Where does what you are doing in math class now fit?

Where does what you did in elementary fit?

Do you now consider what you did then as mathematics?

When you thought about that question in the journal, were you thinking primarily in terms of the math you've been learning this year?

Now that you are in Jr. High, has your idea of what mathematics is changed?

Did you feel that things like adding up change, figuring out your Christmas shopping etc, were
- not math?
- not important enough?

Would you still rate yourself the same as you did back in November? (Background Sheet)

Comment - sometimes felt I was pushing her into a position

Does she really agree?

Text of Validation/Interview Session #6 with Verna, February 2[illegible], 1985

R: You are quite definite and certain that Math is your favourite subject at school.

V: Yes.

R: O.K. That doesn't mean that you don't like everything else, but as far as your favourite goes, it/

V: Uh-huh.

R: /you are certain that Math is. But you do like going to school.

V: Yes.

R: O.K. You don't like to miss school.

V: No. [*]

R: O.K. That goes part and parcel with liking to go to school. You like meeting with friends here.

V: Yes.

R: You enjoy the extra things you can do at school, and you do quite a few extra things - the dance club, yearbook,/

V: Uh-huh. I/

R: /you get involved with house league.

V: Yeah. I quit yearbook.

R: Oh, did you?

V: Yeah.

R: Oh. Why did you quit yearbook?

V: Umm, well, it interfered with my other activities. Like with dance club, we were going to perform in a cheerleading thing. We had lots of practices on Wednesdays, and so I quit yearbook.

R: O.K. So, you didn't quit it because you got tired of it necessarily, but you quit it because you had other activities to go to as well.

V: Yeah.

R: Dance club activities?

V: Yeah.

R: You're really into dance,/

V: Yeah.

R: /aren't you. You dance in the evenings, and after school, and you - Umm!

V: Yeah. I've been dancing for nine years now.

R: You have?

V: Yeah.

R: Even things like, getting involved with bake sales, or selling cakes and that. Right?

V: Sometimes. [*]

R: O.K. Now, I'm going to try and offer some ideas about why you like Math. First of all, you find that you are able to understand the concepts introduced, and the procedures, that is, the way to do things, quite easily.

V: Uh-huh.

R: You pick up that quite easily./

V: Yes.

R: /Do you agree?

V: Yes.

R: O.K. You like to calculate.

V: Yes.

R: You like to figure it out.

V: Uh-huh.

R: And one of the things about it is that - the thing that appeals to you - is that there's a definite answer.

V: Uh-huh.

R: So, you like calculating, you like solving straight forward problems, like condition solving.

V: Yes.

R: And problems where you have a formula. [. . .] Ah, you can have a formula, and from that, you're able to - given the condition, or given the formula, you like those kind of things because you're able to get an answer fairly quickly, easily; you know that there is an answer, and you know that generally there's only one answer. [. . .] Doesn't take much time to get the answer! That's one of the nice things about those kinds of things is that they're not long.
Would you agree?

V: Uh-huh. O.K., but, that's maybe not why I like it because they're short.[*]/

R: O.K.

V: O.K.?

R: That just happens to be one of the features of/

V: Yeah. [giggle]

R: But not just because it's short.

V: Yeah.

R: O.K. Good. Glad you kind of/

V: [embarrassed laugh]

R: /check me up on these things. [. . .] But there is one feature/a feature about them, that is they do involve working out, having to figure something out. You don't know what the answer is beforehand, so it's part of the challenge in those kind of things[. . .]is in going through the steps to work out the answer. [. . . . . .] And you feel quite confident of the steps, of knowing what the steps are, the procedures that you follow. So it's always a kind of a[. . .]and each time you come to a new problem, it's always kind of a challenge to see, "Well, can I do this one? I got that one, now let me see if I can do this one."

V: Uh-huh. [quietly]

R: It gets kind of[. . .] Are you a little uncertain of what I'm trying to say, or, um/

V: Umm, no, I think I understand.

R: O.K. Do you agree with it?

V: Yeah.

R: O.K. These are kind of hard things to determine, and I know that it's very easy to put ideas in your mind. You say, "Well, that sounds reasonable, yeah, I like that one./"

V: [short laugh]

R: "I think, yeah, that's probably[. . .]." Whereas it may not be how you really feel about them. But I think part of the appeal to them is that even though they're fairly straight forward - 'cause you've said you don't really care that much for word problems where you have to kind of/

V: Uh-huh.

R: /figure out the condition, or set up the equation yourself. You got to kind of look through all the words to try and/

V: Uh-huh.

R: You like conditions.

V: Yeah.

R: Where it's "Bango! There!" But there's a challenge still, in working them through. It's kind of a bit of a competition between the problem and yourself.

V: [. . .] Uh-huh.

R: O.K.?

V: O.K.

R: You're not sure about that, you think/

V: No, no!/

R: /maybe I'm/

V: /I'm sure.

R: O.K.

V: O.K.[*]

R: Like, sort of thing, "Can I do this one? I bet I can do this one."

V: Uh-huh.

R: You like to get good marks, they're important to you. Getting good marks is an important aspect of[. . .]/

V: Yes.

R: /taking subjects. Some people don't care[. . .]but you care.

V: Yes.

R: And in Math, one of the things that appeals to you about Math, is that you get fairly good marks.

V: Uh-huh.

R: Do you agree?

V: Yes.

R: O.K. And, another thing about Math is that while you like calculating and solving things, there's a lot of that kind of thing to do in Math! It's not just a little bit every now and then, there's a lot of it to do. There's a lot to calculate, or to draw, or to figure, or to construct. Now, you may like some of those things better than others,/

V: Uh-huh. [quietly]

R: /but there is quite a few things to do, and I think I'll get, a little later on, I'll get to some of those things that you think are better than others. Won't touch on that now. Would you agree with what I[. . .]/

V: Yeah. [quite definite]

R: /or disagree, or feel you want to[. . .] "Umm, could be but[. . .]"

V: |I agree. |I agree.

R: [. . . . . .] O.K. Now: but not every class in Math is - now this is not a very good word in English, but I've used it - is "unboring."

V: [*]

R: In other words, some classes are kind of boring.

V: Yes.

R: For example, you don't like taking definitions. Would you agree?

V: Yes.

R: Copying definitions down off the board. Although you have said that, "Well, although you don't much care for them, they're important."

V: Yes.

R: To do geometry, they're important. If you want to be able to do the work[. . .]/

V: Um, maybe not just in geometry, but anything.

R: O.K., wherever there's definitions then.

V: Yeah. O.K., even though I don't want to do it, in the end they end up helping me.

R: O.K. Because a lot of the work is based on the knowledge of the definitions.

V: Uh-huh.

R: O.K. You're not fond of geometry. At least[. . .]. A while back you said/ To begin with, two or three months ago now, you said "I'm not sure I have the right attitude towards geometry. I don't really see its usefulness."

V: Uh-huh. I don't see how it will help me in the future.

R: O.K. Do you see how some of these other things will help you in the future?

V: Umm[. . .].

R: Or, do you have a feeling that they might?

V: Sometimes, yes[. . .]

R: [. . .] Now what kind of things[. . .] What are some of the things you did in elementary school? Are they[. . .]

V: I don't remember. [brief "embarrassed" laugh]

R: O.K. What basically did you do in elementary school?

V: Umm, adding, subtracting, multiplying, dividing.

R: [. . .] Do you call that "math"? Is that mathematics for you?

V: Yeah, I guess so.

R: O.K. But you're not sure? Does the idea of what's math change for you?

V: [. . .] Umm, I don't think it's changed, I think it's broadened. Like, umm[. . .]/

R: O.K.

V: Do you understand what I mean?

R: Yes. As you do more things, you add to your idea of what you consider math.

V: Yeah.

R: [. . .] Do some things seem more math, "mathy" if you want to call it that, than others?

V: Um, not really.

R: No? [. . .] O.K. So, but[. . .] O.K. I think you would consider the calculations kind of thing, the basic operations, that's math.

V: Uh-huh.

R: You would consider, well, certainly things like geometry is math?

V: Uh-huh.

R: Quite a bit different kind of math[. . .]

V: Yeah.

R: Is that what you mean, like, the kind of things that as you[. . .]go through junior high, and you learn more, it broadens[. . .]more, ah, well it's expanded from just arithmetic kinds of things[. . .]/

V: Uh-huh.

R: [. . .]to include set theory[. . .]/

V: Yeah.

R: /geometry, that sort of thing. O.K. So, you still feel kind of uncertain about the usefulness of geometry?

V: Uh-huh.

R: Do you like it though? You said you also weren't sure that you liked it. Do you[. . .]

V: Uh[. . .] It's O.K., I guess. [somewhat indecisive]

R: O.K. 'Cause I guess I was trying to think of it is it possible for you to[. . .]to see math, some things about math, as not useful, but nevertheless, still of interest.

V: Uh-huh. Um, well, I guess so. [somewhat indecisive] I don't mind geometry. I don't really like it.

R: O.K. [. . .] Something the same with word problems. You say they're often quite hard and difficult. They're not very straightforward. They're tricky.

V: Uh-huh.

R: But, you can still do them.

V: Most of the time.

R: Most of the time? O.K.[. . . .]
[. . .] Still, overall though, Math is best in marks, and best as far as you liking it.
Agree?

V: Uh-huh. Yes.

R: Both of those things? O.K.
Another area you don't like Math, or, when it's boring, is when the teacher[. . .]does a lot of talking about things that you already know.
Agree?

V: Yes. It's like review.

R: O.K. Review you find kind of boring?

V: Umm, sometimes, if I[. . .]if I know what he's reviewing, I understand it, then I find it boring.

R: O.K. Otherwise it's not.

V: Uh-huh.

R: You find it's useful because you want to know.

V: Yes.

R: O.K. In other words, you're interested enough in Math to
want to know how to do it. O.K.
When you're bored in class your mind tends to drift to
other things, think about other things.

V: [*]

R: You doodle.

V: Yeah. [quietly]

R: I noticed you like to doodle.

V: ["embarrassed" laugh]

R: Even so though, you often do not pay total attention to
the teacher, but you do usually pay enough attention that
you know what's going on.

V: [. . .] Yeah. [quietly]

R: Or do you[. . .] Would you like to/ Is that not[. . .]

V: Umm.

R: Do you feel that's unfair to you? You pay more attention
than that?

V: [short "embarrassed" laugh]

R: Or is it the other way?

V: No, I think what you said is right[. . .].

R: You agree?

V: Yes.

R: O.K. You're not totally devoted to exactly everything that the teacher's doing, but you're aware enough/

V: Umm. When he says[. . .] It's like I'm listening to him but I'm not watching what he's doing.

R: O.K.

V: When he says something I don't understand, I ask, and then, while he's giving the explanation, I give him my complete attention.

R: O.K. And when new material is being introduced, you try and pay close attention, because you want to try and/it's important to you to understand it, and try and understand it quickly and try and understand it quite well.

V: Uh-huh.

R: O.K. [. . . . . .] This is going to go back to some of the comments we referred to before a little bit, but you said you do not see much point in learning geometry, that is, most of it[. . .]that is, the usefulness of it.

V: Uh-huh.

R: And you kind of agreed with that just a few minutes ago, but when we talk about condition solving, which is one of the things that you really liked, you also seemed to be unsure of the point of condition solving.

V: Uh-huh.

R: But you still liked it.

V: [*]

R: You clung to that liking them. So, here was a situation where, even though it wasn't obvious to you, it's use[. . .]for example, you might find that adding and subtracting, having lived, is useful.

V: Uh-huh.

R: 'Cause you do that quite a bit.

V: Yeah.

R: Not only in Mathematics, but you do it outside in other situations. But with condition solving, well, that point is a little uncertain, but you like it.

R: You just like to do them. Now, in elementary school, you said that you liked calculating. O.K., well, that was the kind of thing you were doing. You weren't doing condition solving and you weren't doing a lot of geometry, you were doing calculation kind of things. And you said you <u>liked</u> that.

V: Yes.

R: You did comment that you even got better Math marks back in elementary than you do now in junior high. Is that true?

V: Well[. . .]/

R: Or, do you still agree?

V: /I brought my mark up this term, so I'm about the same.

R: Are you?

V: Yeah.

R: O.K. When you say "mark," what kind of a mark are you talking about?

V: Low eighties.

R: Very good. O.K. [. . .] O.K., I've tried to put together a little interpretation here, and you can[. . .] I said, the usefulness, or, on the other hand, the use<u>less</u>ness, the usefulness, or, on the other hand, the uselessness of the math is not what's really important for you. What's important is the straight forwardness of the problem, the procedure is clear, you understand it, you enjoy following the procedure, the steps that is, there's a definite answer. And then I said again, it does not take long to do them, but you said, "Well, that's not necessarily the case." [. . .] And you feel good when you get the right answer.

V: Uh-huh.

R: [. . .] Um, O.K. Any comments on those things? Particularly, for example, what's really important, or not really important, is whether it's useful or useless.

V: I don't think it really is important, or, not important. I don't know about geometry [*], I can't say.

R: O.K. Umm [. . . . . . .] And then I guess what I'm trying to decide is what is it about condition solving that appeals to you compared to some of the other things, so I just put down some ideas. You know, the condition is there, so that the problem that you're presented with is quite clear.

V: Uh-huh.

R: And then, you've learned quite quickly the procedure. Now, there's variations in the procedure, but basically the methods are kind of the same with condition solving, O.K.? In other words[. . .] And you understand, you feel <u>confident</u> about your understanding of how to solve conditions.
Agree?

V: Yeah.

R: O.K., you have some confidence there. And I said, you enjoy following a procedure. I'm not sure whether the enjoyment is so much following the procedure[. . .]/

V: I think it's more getting the right answer.

R: Getting the right answer. It's a looking back and saying, "Well, I did follow the right procedure."

V: Uh-huh.

R: It confirms your understanding of/

V: Well, you see the way I got the right answer is by following the procedure.

R: O.K.

V: So, maybe that's why the procedure is important.

R: O.K. [. . .] Do you look back at/ Do you ever just look at the condition and say, "Well, let me just try and guess it," [. . .] Or do you just go through step by step?

V: Um, if it's little numbers you can guess quite easily.

R: O.K. If it looks quite simple.

V: Yeah.

R: Yeah. Good. "Three plus X equals six," it's fairly clear what X is going to be.

V: Yeah.

R: Yeah, right. [. . .] Now, I made a comment here. For me it's fairly important. So I'm not sure how you'll agree with it. I'd like you to kind of think about it. Remember, we're not in much of a rush here, although we want get through before the end of the period. But I said: Primarily math appeals to you for its own sake, which again kind of goes back to the fact that it's not really whether it's useful, or useless, that's important. It's your interest in the mathematics itself. Basically, you just like doing it.

V: Yeah.

R: And it has much less to do with how useful or useless you believe it to be.

V: Uh-huh.

R: It's a bit of a challenge that you know you're usually able to meet.

V: Uh-huh.

R: O.K. You can usually do it. I've added some more comments. I guess they sort of say the same thing. Usefulness is not a great concern. It's not something you think much about.

V: Yes.

R: The sense of accomplishment in solving the question is what's more important.

V: Uh-huh.

R: That feeling of goodness. Even though you don't bubble over, and jump up and down every time you get the right answer/

V: [brief laugh]

R: /it's a good feeling.

V: Yeah.

R: Whereas, you can compare that - well, you like the other subjects, but you can/ Maybe you like the other subjects for their reasons[. . .]the other subjects are often kind of different. Do you see a big difference between Math and the other subjects?

V: Umm, every subject is different from the others.

R: Every subject is different from Math, or every other/

V: From every other subject.

R: From every other subject.

V: Yeah.

R: O.K. Big difference between Math and Science?

V: Uh, yeah. Right now we're doing learning about the weather, so, there's little connection between.

R: O.K. Now, I have some comments here. I think you're a conscientious student. You know what that means?

V: Yeah.

R: O.K. You care how well you do. You make a good effort to learn what the teacher is presenting.

V: Uh-huh.

R: Even if it's not terribly interesting you feel that it's important to try and learn it. Yeah: You try to learn the material even if you think that it's of questionable usefulness,/

V: Uh-huh.

R: /and you think it could be rather useless, or its not very interesting. In other words, you still try to learn the material.

V: Uh-huh.

R: You agree?

V: I agree.

R: You said one day that you prefer to do your Math assignments at home rather than in class. You still agree?

V: Yeah.

R: And the reasons you gave were that you couldn't concentrate in class. Now, we were talking here mainly about the last ten minutes, or five, or fifteen/

V: Yeah.

R: /where you can do your homework. In class you said "You'd rather talk."

V: Well, you see, we usually have Math last period of the day, and I'd really rather get out of the school and go home.

R: O.K. [. . . . .] I had some comments, but I think I'll leave them. Question: Do you prefer to work alone, or do you also like to discuss problems together with friends? Do you like to see if you can work it out together?

V: Um, I try to do it myself first, and if I can't do it, I ask my parents, and if they can't do it, I call a friend.

R: O.K. But you like to feel you can give it a good shot yourself. A good attempt to begin with. Would you say ever that Math is fun?

V: Yeah. [quite definite]

R: Would you?

V: Uh-huh.

R: In what ways is it fun?

V: Umm, I think all of school's fun.

R: Oh, do you?

V: Yeah. I really like school. I don't know why, I just [. . . .]

R: Is it/ Well[. . . . . . .] "All school is fun." Is it because of the chance to be with people?

V: Um, a chance to be with my friends, a chance to learn new things.

R: O.K. And you're fairly successful at learning new things, right. You're a person that does fairly well in school?

V: Um, I'd like to do better.

R: Right. But[. . .]I guess we'd all like/ or. I shouldn't say that. There are probably some who don't. [. . .] Compared to junior high, you did better in Math in elementary in marks - Oh, well you changed that now,/

V: Yeah.

R: /you said about the same now; you've done better. But you still like Math about the same.

V: Uh-huh.

R: O.K., and your interest in Math has always been there, and you haven't lost that interest in Math. It was kind of the favourite thing to do, and it still is/

V: Yeah.

R: /the favourite thing to do. You said, you find the things you learn in junior high different from elementary school.

V: Uh-huh. [touch of uncertainty]

R: Agreed?

V: Yeah.

R: You also said that you find grade eight harder than grade seven Math. You said it was more complicated.

V: Uh-huh. I think each grade gets harder.

R: O.K. Is there any point that you can recall where there was particularly big jumps between grades in terms of being a lot different, in terms of being lots of new things?

V: Umm.

R: What do you think about the change[. . .]?

V: Um, I think between grade two and three maybe. 'Cause two we just did adding and subtracting, and in grade three we learned all four.

R: O.K. Multiplying and dividing as well.

V: Yeah.

R: O.K. Now, going back to the comment you made about things being different between elementary and junior high, is it different mainly because of the way the school is organized, or is it a lot different in what you learn?

V: It's different in what you learn. Like, all through elementary all we learned was adding, subtracting, multiplying, dividing, and fractions in grade six. And now we learn condition solving, geometry, constructions, fractions, rational numbers, decimals. We learn [*] a lot more.

R: O.K. Was there a big change from grade six to grade seven?

V: Um, yeah, I guess so.

R: How would you compare the change between grade seven and grade eight? Is there a bigger change between this year and last year than/ or/

V: Um, there's a bigger change between grade six and seven than between seven and eight.

R: O.K. [. . . . . . .] Oh, yeah. You remember that sheet I gave you a way back when, where I asked you for some background information, at the very beginning?

V: Oh yeah.

R: One of the things that I noticed, and I never have asked you about, and I'd like to: You went to an awful lot of different elementary schools.

V: Yeah. [*]

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R: What do you think about going to all those different elementary schools? Did that have an effect on how you thought about school?

V: Um, no.

R: No?

V: No.

- - - - - - - - - - - - - - -

V: No, we've always lived in ____, but all over ____. . . .

R: O.K. So, but as far as affecting how you thought of school, or affecting your interest in mathematics in particular, it didn't change your ideas much?

V: No.

R: No? O.K. Do you hope to take Math right through high school?

V: Yep. [quite definite]

R: O.K., the last bit here. We have talked about "math outside" in the journal - you know, "Have you done any math"/

V: Uh-huh.

R: /"outside?" And you felt that you never did any/

V: No.

R: /math outside. When we talked about what you considered as math, which I guess was the last time, I felt that you had sort of particular difficulty, you had [V: embarrassed giggle] some difficulty in trying to describe it beyond, "Well, just what you do in Math. Just math."

V: Yeah. [nervous or embarrassed giggle or laugh]

R: And later on you did say, "Well, it involved working with numbers."

V: Uh-huh.

R: [. . .] Now that's/um[. . .] I guess where my question comes in is in, how do you/if[. . . . . . .] O.K., we said earlier, I think, that well basically everything that you've done in school, like, you said, the calculations, the adding - that's math./

V: Uh-huh. [quietly]

R: /It hasn't been so much[. . .]deciding that something is no longer math, but rather it's been more or less, sort of still thinking of the things you learned before as math, but adding to it new ideas of what also is math.

V: Yeah.

R: O.K., but[. . . . .] So when you/ You felt quite certain that you hadn't done anything outside[. . .].

V: No, I/ No, I never do anything outside.

R: O.K. I guess I was trying to think of well, when you were thinking about that, were you thinking mainly in terms of "Well, I didn't do any geometry today", or "I didn't do any condition solving today." Like, those kinds of things[. . .]are the things that you are trying to think of, "Did I do any of that?"/

V: Yeah.

R: /and well, "No, I didn't do any geometry outside of class today," but maybe, would you have done some of the other things?

V: Um, no.

R: Not even some of the more basic things.

V: No.

R: O.K. No, you know, I'm not challenging and saying you're wrong/

V: Yeah. [*]

R: /I just want to try and clarify here, O.K.

V: Um, the only thing I can think of is, when you get a test back, to figure out percentage or something like that.

R: Like in L.A., or French, or Math, or/

V: Yeah.

R: O.K. But as far as outside - I guess with dance, and with the other interests - you said you liked to watch quite a bit of TV as well.

V: Uh-huh.

R: [. . .] Ah, O.K. Do you still sort of feel that way, that/

V: Yeah.

R: O.K. Math is one of those things where even though it's a little hard to describe in words, it's still fairly clear/

V: Uh-huh.

R: /as to whether[. . .] O.K. [. . . . . . .] Let me see. [. . . . . . .] O.K., well, where do you think/ Do you go shopping?

V: Yeah.

R: O.K. Now, this is back before Christmas. You must have done some Christmas shopping and that sort of thing.

V: Uh-huh.

R: Do you see yourself as using any kind of math at those times?

V: Well, adding in your head[. . .]

R: O.K.

V: Stuff like that.

R: But, even then, maybe not/

V: No, not really. [*]

R: That, that sort of thing wouldn't have counted as far as/

V: Well/

R: /putting it down in a book.

V: /I dunno. I guess it could, but[. . .]

R: You're rather uncertain.

V: Yeah. [*]

R: O.K. Would you be uncertain mainly because it seems so[. . .]little, like such a small thing?

V: I guess so.

R: Not because it's not math,/

V: Yeah.

R: /but because it's so little.

V: I guess so. I[. . .]/

R: Or would you[. . .] Am I putting ideas in your head here, that you disagree with, really?

V: Umm, maybe it's because[. . .]it was done in my head and I didn't have to do it, but I did.

R: O.K. Rather than on a piece of paper, and[. . .].

V: Uh-huh.

R: O.K. That's a good point. One last question here. Now that you're in junior high, has your idea of what mathematics is changed? I guess we've already partly answered that.

V: Yeah.

R: It hasn't changed you in terms of thinking that it's no longer math, but it's added to[. . .]/ O.K. Do you remember[. . .] Well, back to that Background Sheet.

V: Uh-huh.

R: Do you also remember I asked for your opinion on where you put yourself[. . .]/

V: Yeah. [*]

R: /as[. . .]you know. Down here [on sheet]. O.K. now, this is at the beginning of November. I said "How good a student academically do you consider yourself to be?" and you said GOOD. And "How good a student in Math do you consider yourself to be?" This was based on what you thought about yourself back then at the beginning of November, and you said GOOD as well. Just a question. If I were to ask you that, as I would, right now, where would you put yourself?

V: Umm, GOOD.

R: Same place?

V: Yeah.

R: O.K. Actually I should give you a blank sheet, but what basis do you use to decide GOOD? Are you using your interest, or, you're able to do things, or your marks, or what kind of[. . .]/

V: I would say[. . .]seventy-five to eighty-five is GOOD.

R: And that's basically where you fall?

V: Yeah.

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Personal note after the interview: Sometimes I felt I was pushing her into a position. Does she really agree?