LANGUAGE AND CONTENT IN LANGUAGE ARTS AND MATH

A Case Study

By

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Abstract

This thesis is a qualitative case study of a mathematics unit and a literature unit taught concurrently to a class of grades five and six students, the majority of who were English as a Second Language (ESL) students. The units were collaboratively planned with an ESL Resource Teacher. The study aims to illuminate the processes and products of student engagement with the two units. At the same time, it documents the teacher/researcher's process of reflection. The study makes reference to the teacher/researcher's growing understanding of the role that prior knowledge plays in the classroom. For the teacher/researcher, this study acted as a "voyage of discovery" as he made observations regarding the student's experiences and the role of prior knowledge. Students experienced considerable success with the literature unit, but had persistent difficulties with the mathematics unit. To investigate the reasons for this difference, concerning this difference in success, the researcher explored two matters of prior knowledge: prior classroom experience and the link between everyday language and technical language in student discourse. With respect to prior classroom experience, the students reported little prior teaching of relevant mathematical material whereas the literature material had regularly been taught. With respect to the link between everyday and technical language, the findings suggested that the students were able to draw on everyday language for describing persons in the literature unit, but were not able to draw on everyday language for describing patterns in the mathematics unit. More broadly, this suggests that students were able to draw on familiar social practices for describing persons but not for describing mathematical patterns. Implications are drawn for further research and for educational practice.
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CHAPTER ONE: The Problem

1.1 Background to the Study

Since 1986, the number of English as a Second Language (ESL) students within the public school system in many countries has been growing (Crandall, 1993). School boards have responded to the increasing pressures of this growth by increasing the numbers of ESL students in regular content classes. Collier (1987) and Cummins (1984) argued that it can take upwards of five to eight years for students to reach a level of competency in their new language and to be capable of fully coping with academic language demands found in regular content classes. Consequently, the ESL students require long-term language and content support.

Historically, ESL teachers were thought to be teaching only language and grammar, while enrolling teachers (classroom teachers who are responsible for a reporting on students) were responsible for content teaching. However, students cannot ethically be denied opportunities to develop cognitively. The presence of growing numbers of ESL students has created a new role for enrolling teachers in that they are now responsible for the ESL students’ language development as well as content language. The developing issues around the delivery of services for ESL students and the support of the enrolling teachers in the classroom involve a tremendous amount of resources. This involves a change in beliefs as well as teaching practices for the regular classroom teacher. In other words, there is a necessity to support enrolling teachers as they implement teaching and learning strategies to help meet the language and content needs of the ESL students. One form of this support is through specific curriculum adaptation (Early, 1989) in the regular classroom. As stated in
the *External Review of ESL Programs* (Ashworth, Cummins, and Handscomb, 1989) commissioned by the Vancouver School Board, it is necessary for all teachers to plan for the language and academic needs of ESL students. This requires a change in theory and practice for many ESL and content teachers.

1.2 ESL Pilot Project

The Vancouver School Board ESL Pilot Project was developed in 1989 in response to the increasing numbers of English as a Second Language (ESL) students in large urban school districts. The Vancouver School District had the largest ESL student enrollment in the province of British Columbia (VSB: Data Collections, 1999). According to the collection of data, approximately 53.5 percent of the student population speaks a primary language other than English at home (see Figure 1.0).

**Figure 1.0.**

*Graph of the number of ESL students attending Vancouver schools*

![Graph of the number of ESL students attending Vancouver schools](image)

Source: Adapted from the Vancouver School Board Information Systems Data Collections. 1999.

In September, 1987, six Vancouver elementary schools and four secondary schools
began a three-year-long project funded by the Ministry of Education Funds for Excellence. Led by Drs. B Mohan and M. Early (University of British Columbia) and Mr. H. Hooper of the Vancouver School Board (VSB), the participating schools received background information about the theories of Dr. Mohan on integrated language and content (ILC) instruction through a series of workshops. As a result of this project, teachers began to apply these theories to their classrooms and produce materials for student instruction.

Subsequently, the VSB began a two-year pilot project in September, 1989. The purpose of the pilot was to identify the optimal levels and context of support for students and teachers. The project was concerned with providing assistance in meeting the academic and social needs of ESL students at all levels of language, academic, social, and cultural acquisition. In addition, it involved the development and implementation of teaching and learning strategies for enrolling teachers.

1.3 The Present Study

The present study was a qualitative case study of a mathematics unit and a literature unit taught concurrently by the same teacher to a class of grade five and six students, the majority of whom were ESL learners. One unit was on patterns in mathematics, and one was from a novel-based reading program on the 1959 C.S. Lewis novel, *The Lion, The Witch and the Wardrobe*, which will be more briefly referred to as Narnia. In harmony with the ESL project, it was a study of integrated language and content learning and teaching, drawing on the Knowledge Framework (Mohan, 1986) theory developed in project workshops: Two different content areas, mathematics and literature, were taught to a class that contained both native English speakers and ESL learners. Mathematics and literature are two important
content areas in the elementary curriculum, and it is often popularly believed that they place different language demands on ESL learners, with mathematics being less demanding. As a qualitative study, it aimed to give a rich description of the processes and products of student engagement with the two units and to illuminate these processes and products. It was not a causal study of student achievement. One of the themes of the Knowledge Framework theory that is of particular interest to this study is the question of the role of prior knowledge in learning.

1.4 Patterns and Relations in Mathematics

Patterns and relations in mathematics has a special importance. A growing number of educators in the United States assert that patterns, relations, and functions have been underrated as a foundation for all aspects of applied mathematics and science skills. Steen (1980) indicated that historically, mathematics curriculum materials have tended to teach children arithmetic and students have therefore often spent time learning computational processes via a "drill and kill" format. Steen advocated using patterns as a key to uncovering the multitude of interconnections among mathematical constructs:

Mathematics is an exploratory science that seeks to understand every kind of pattern—patterns that occur in nature, patterns invented by human mind, and even patterns created by other patterns. To grow mathematically, children must be exposed to a rich variety of patterns appropriate to their lives through which they can see variety, regularity and interconnections. (p. 8)

The growing evolution regarding mathematical instruction has been aimed at developing young mathematicians who are confident in their approach to problem solving.
By providing students with opportunities to wrestle with mathematical principles and apply their understanding to problem-solving situations, it is hoped that students will be able to use numbers confidently to arrive at solutions to problems. Burns (1992b) believed that central to this notion is the recognition that patterns are a fundamental catalyst in number theory and mathematics in general:

The ability to recognize patterns is the key to this mathematical thinking.

Patterns are basic to the understanding of all concepts in math. Searching for patterns is essential in making generalizations, seeing relationships, understanding logic and order in mathematics. Functions evolve from the investigation of patterns and unify the various aspects of mathematics. Being able to understand functions, patterns and relations is among the most significant and useful ideas in mathematics. (p. 112)

Educators seemingly have identified the use of patterns in math as being a fundamental aspect of the mathematical process. Moreover, it would appear as though educators such as Burns believe in the potential for experiences using patterns to develop mathematical understanding in children as being very profound.

1.5 Prior Knowledge in Learning

The teacher/researcher’s understanding of the role that prior knowledge plays in the classroom initially emphasized the importance of prior learning gained from teaching in the school classroom but later expanded to include prior learning from engagement in a cultural community.

The question of the role of prior knowledge in learning is a familiar one. Farrell and
Farmer (1980) argued that understanding the significance that context and meaning have in the contextual understanding and development of children's learning may lead to understanding how children relate to, and assimilate with, the situation or problem being solved:

There is a growing body of research evidence which testifies that the degree of meaningfulness of newly learned materials correlates positively with both the remembering and the ability to use that material in applicable situations.

(p. 140)

However, it is worthwhile at this point to foreshadow some of the more specific connections between mathematics and the question of the role of prior knowledge in learning. Shoenfeld (1989) stated that being familiar with the context and operations improves the ability to reason and construct solutions to problems:

I believe at its core, mathematics can be and should be an act of making-sense, and moreover, that the facts and procedures students learn in mathematical instruction should be a means to that end, rather than an end in themselves. (p. 82)

This suggests that tasks in mathematical classrooms should be those that are culturally and contextually familiar. Shoenfeld (1989) continued:

In short, mathematicians spend most of their time making sense of things. Doing mathematics is sense-making and becoming a mathematician includes developing the mathematician's aesthetic, a predilection to analyze and understand, to perceive structure and structural relationships, to see how things fit together. Developing this aesthetic is a fundamental aspect of
learning to think mathematically.... To put it simply, you pick it up by internalizing it, that is, by living in a culture in which the appropriate values are reflected in the every day practices of the culture. (p. 87)

The issue of learning from the social practices of the surrounding culture is strikingly presented in Michael Cole's 1978 book titled, Cultural Psychology: A Once and Future Discipline. In the chapter Cognitive Development, Culture, and Schooling, Cole described the situation in Liberia where African students (from the Kpelle Tribe) were exposed to foreign mathematics content using Western textbooks. Over a period of several years, the Kpelle students experienced tremendous difficulty understanding the Western math. This eventually led several observers to question the cognitive abilities of the African students. However, Cole noted that if the Kpelle children were participating in mathematical tasks in market place transactions that were part of local cultural practices, they did extremely well.

Evidence of learning from the surrounding culture is reflected in the everyday language that students use. Researchers in the Systemic Functional Linguistics tradition, such as the linguist Jim Martin and the mathematics educator David Pimm, see the learning of mathematics and other subjects as an interplay between everyday knowledge and language and technical knowledge and language. This study will therefore give attention to the role of everyday knowledge and language as well as the technical knowledge and language which is often the centre of interest in research in curriculum.

1.6 Research Questions

What is the role of prior knowledge in the processes and products of student engagement in the math unit and the literature unit? Are there differences between the two
units in the role of prior knowledge? What is the role of prior knowledge gained from classroom teaching and learning? What is the role of prior knowledge gained from the participation in social practices in the community, as evidenced by the linkage between everyday language and technical language in student discourse?

1.7 Justification for a Case Study Approach

There are specific features of a case study approach which need to be considered when interpreting and applying the data from this study. This study focuses on a single successful school without examining the reasons why it is successful. The components that contributed to its success will be described briefly in chapter three and in more detail in other theses currently underway as part of the larger Social Sciences and Humanities Research Council of Canada (SSHRC) research project. Therefore, this study does not serve as a tool for developing a school culture regarding collaborative planning or curriculum design materials for novel-based reading programs or patterns and relations in mathematics. Additionally, this study is based on planning and teaching between a pair of teachers within two curriculum areas (Language Arts and Math). Consequently, it does not charge that the findings from it are universal nor definitive. This allows for a rich description of both the process and the product. It is hoped that this type of descriptive study will be informative for other's efforts in curriculum design; however, no claims will be made about direct applicability to other teachers or subject areas.
### 1.8 Glossary of the Terms

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<td><strong>Academic Language</strong></td>
<td>Language which is context-reduced and cognitively demanding. It is the type of discourse found in textbooks and is commonly used to explain concepts and debate ideas.</td>
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<tr>
<td><strong>Classroom/enrolling Teacher</strong></td>
<td>A teacher who enrolls a group of students in a regular classroom setting.</td>
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<tr>
<td><strong>Collaboration</strong></td>
<td>Planning between at least two parties as they work toward a common goal (e.g., lesson or unit planning).</td>
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<tr>
<td><strong>ESL Student</strong></td>
<td>Students who are learning English as a second or additional language.</td>
</tr>
<tr>
<td><strong>Integrated Language and content</strong></td>
<td>A method of instruction which combines both language and content goals within a curricular area.</td>
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<tr>
<td><strong>Knowledge Framework</strong></td>
<td>A guide to the structure of knowledge across the curriculum (Mohan, 1986). It is composed of six Knowledge Structures: Classification, Description, Principles, Sequence, Evaluation and Choice.</td>
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<tr>
<td><strong>Knowledge Structures</strong></td>
<td>Organize information, underlie discourse, are reflected in graphics, and are realized in lexico-grammar. They are often thought of as the six thinking skills that exist with in the Knowledge Framework.</td>
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<tr>
<td><strong>Key Visuals</strong></td>
<td>A visible framework commonly associated with graphics, charts, diagrams and pictures that represents information and/or discourse as it relates to content information.</td>
</tr>
<tr>
<td><strong>L1</strong></td>
<td>A person’s first language.</td>
</tr>
<tr>
<td><strong>L2</strong></td>
<td>A person’s second language other than their native language.</td>
</tr>
<tr>
<td><strong>Resource Teacher</strong></td>
<td>A teacher who plans with other staff to integrate language and content teaching by adapting curriculum and teaching and learning strategies.</td>
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<tr>
<td><strong>Pattern</strong></td>
<td>A repetitive factor that occurs in the ordering of objects (blocks, numbers, etc.) which result in a growing, shrinking, or repeating sequence of objects.</td>
</tr>
<tr>
<td><strong>Pattern Base</strong></td>
<td>The attribute (colour, size, number, shape, thickness) which the pattern is based on.</td>
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Pattern Rule

The governing factor (Principle) which makes the sequence of objects a pattern

Team Teaching

A situation whereby two or more teachers share the duties of instructing or teaching a lesson. Team teaching usually involves some form of joint facilitator and assistant roles.
CHAPTER TWO: A Review of Selected Literature

This chapter has five parts. The first and second parts (2.1 - 2.2) will review selected literature about patterns in mathematics. The third part (2.3) will review the Framework for Teaching and Learning (VSB, 1989) which was used as an approach in the classroom work studied in this thesis. The fourth section (2.4) of the paper details the roles of reflective response journals and their use in the study. The fifth part (2.5) will outline key research that applies to the research approach taken in this thesis, showing the relation between the register approach to the language of subject areas (such as mathematics) and the concept of knowledge structures which is central to the Framework for Teaching and Learning (VSB, 1989). The fifth part will thus explain the main relation between the earlier parts.

This review draws together research on the justification of teaching patterns and relations in mathematics, teaching and learning mathematics in context, the Knowledge Framework (Mohan, 1986) as a conceptual lens for viewing teaching and learning strategies for ILC instruction, and reflective response journal writing as a vehicle for student and teacher learning. The literature is arranged beginning with the value, significance, and rationale for teaching patterns and relations. It culminates in a review of the necessity for patterns and relations to be an integral part of the curriculum and the growing movement of educators in the United States who believe math patterns to be a foundation and cornerstone for all curriculum areas from Kindergarten to grade twelve. The literature outlines the value of language and content instruction using the Knowledge Framework (Mohan, 1986) and the Framework for Teaching and Learning (VSB, 1989) as the methodology for best meeting the needs of students. The literature concludes with an overview of reflective response journal writing and how learning logs have an underrated and important function in student learning.
2.1 All About Patterns

2.1.1 Introduction

Historically, the emphasis of the mathematics curriculum has been to teach children the computational skills necessary to perform grade appropriate operations and problem-solving functions. Students spent the majority of their time learning and practicing computational processes and drill-and-kill skill rehearsal. Burns (1992b) believed there has been a growing evolution regarding the instruction of mathematics. The evolution has been to develop young mathematicians rather than to produce computational experts:

Educators in the field of mathematics are re-thinking the “focus-points” in the curriculum and the methodologies behind them. Educators are trying to foster an enthusiasm among students to learn the value of mathematics.... In addition, educators are trying to nurture students’ confidence in their abilities to solve problems based on “real-life” situations. Moreover, there is a desire to foster skills in children that will allow them to communicate and reason mathematically in our society. (p. v)

Patterns are central to this notion in that they are believed to be the fundamental catalyst in number theory and mathematics in general. Burns (1992a) maintains that the new generation of students should be exposed to, and encouraged to participate in, exercises that are designed to foster a secure approach to problem solving. The focus is to provide students with opportunities to wrestle with mathematical principles and apply their understanding to problem-solving situations:

The ability to recognise patterns is the key to this mathematical thinking. Patterns are basic to the understanding of all concepts in math. Searching for patterns is essential in making generalisations, seeing relationships, understanding logic and order of
mathematics. Functions evolve from the investigation of patterns and unify the various aspects of mathematics. Being able to understand function, patterns and relations is among the most significant and useful ideas in mathematics. (p. 112)

2.1.2 The Significance and Connection with Patterns in Nature

Patterns exist in the world around us. By providing students with teaching and learning strategies to recognize patterns, and describe their relations mathematically, students will be better equipped to interact with and make sense of their world. Patterns can be thought of as the bricks or building blocks that go into constructing a house. In that they are the basis of mathematics.

Moreover, the visual and sequential nature of patterns can be observed in our everyday lives. Patterns occur in both the man-made and natural environments. Snowflakes, pine cones, telephone poles, sidewalks, cycles of plants, and ceiling tiles are just some examples in which patterns can be seen in both built and natural environments. Concrete bricks and blocks that form building walls can create specific spatial orientations, or patterns. The colour arrangements of shop awnings on streets can create and enhance the formations of patterns. Patterns can be determined by the orientation of tiles and bricks, units of measure, colour combinations, and by the way they fit together. Different shapes offer different possible designs, and these designs are repeated to cover areas such as walls, floors, and patios. Patterns can even be prevalent in household items such as blankets, quilts, china patterns, and even surface in residential architecture.

Patterns exist in all aspects of our world. Leaves, flowers, plants, land animals, and tropical fish have colour and texture patterns. Schoolyards often have planted tree patterns (e.g., big tree, little tree, big tree, little tree). Fabric may have distinct patterns (e.g., plaid
shirts). Sidewalks, walls, ceiling tiles, and fencing often serve as examples for repetitive patterning. Moreover, patterns can exist in poetry, art, music and nature. Even our own daily cycle should convince us of the crucial role patterns play in our lives (i.e., we wake up, shower, eat breakfast, go to work, come home, eat dinner, and go to bed). We all have a natural tendency to order our lives and thinking based on patterns. We are so inclined to shape our lives by patterns that interruptions cause us discomfort and concern. Many of us are creatures of habit having, for example, favourite coffee haunts, morning jogs after work, familiar routines, and even parking stalls to name a few. As lifelong learners, we should know the mathematics of patterns and appreciate their intrinsic and extrinsic value.

Burns (1992b) maintained that activities with patterns enable children to investigate many mathematical ideas. For example, our metric number system is an incredibly sophisticated pattern, or set of patterns, which groups numbers into ones, tens, tens of tens, ten of tens of tens, and so on. In the metric system, there is a constant pattern and relationship between the components (e.g., millimetres, centimetres, decimetres, metres, and so on). Further patterns can easily be seen in multiplication tables. Counting in groups (5, 10, 15, 20...) is referred to as interval counting or skip counting. When these sequences are mapped on a ten-by-ten number grid, the patterns become visual as well as numerical. Various patterns begin to emerge for numerous counting frames (e.g., 2, 4, 6, 8...). It is therefore crucial, as Burns (1992b) noted, to bring these patterns to the minds of children:

As patterns, relations and functions are now part of the mathematics curriculum, young children are beginning to identify and extend repeating rhythmical patterns, verbal patterns, and visual patterns. Observing and constructing patterns among various objects by sorting and classifying them, identifying similarities and
differences, and manipulating them, is developing the students’ problem-solving abilities. Finding numerical patterns on a 100's chart and counting by twos or threes helps students to develop an understanding of functions and multiples. (p. 5)

2.1.3 The Rationale of Patterns in the Curriculum

There has been a growing movement from educators that patterns in mathematics are of significant importance. Under-utilized and generally over-looked by many educators, patterns and relations in mathematics are recognized as bringing order, cohesion, and predictability to seemingly unorganized situations such as data in word problems or number sequences. Patterns have often been ignored and disregarded by educators as being too “primaryish” (Burns and Humphries, 1990, p.41;). However, many educators insist that patterns, relations, and functions are powerful problem-solving tools that can simplify unmanageable tasks. Their use as a strategy for solving problems can provide students with opportunities for making connections they might not normally make; in other words, students can see spatial objects or number sequences that act as objects for cognition without which cognitive connections might not be made.

Many of the benefits arising out of the research on patterns stem from the fact that patterns occur in all subject areas of the curriculum. In fact, patterns not only appear in all curricular areas, they appear to extend throughout all grade levels, from Kindergarten to grade twelve. Consequently, children who have had opportunities to work with patterns as they appear throughout the K-12 curriculum may be able to recognize patterns and functional relationships, a skill which enables them to simplify otherwise unmanageable tasks and to make generalizations about data. Children who have played with, manipulated, and worked with patterns seem to have a keen ability to interpret charts and key visuals (Mohan, 1986).
Moreover, they seem to have a greater understanding of the attributes and relationships of numbers and may be more likely to understand mathematics as it appears in later grades (e.g., fractions, algebra, geometry, statistics and calculus). As Steen (1980) stated:

Mathematics is an exploratory science that seeks to understand every kind of pattern—patterns that occur in nature, patterns invented by human mind, and even patterns created by other patterns. To grow mathematically, children must be exposed to a rich variety of patterns appropriate to their own lives through which they can see variety, regularity and interconnections. (p. 8)

It is a widely held belief among educators that constructing meaning for oneself fosters ownership and understanding of an issue. Providing children with opportunities to control their learning through the implementation of pattern-building activities may encourage their mathematical enquiry. Once the concepts of patterns and relations are understood, children can begin to use them during problem-solving activities; in other words, they can seek out patterns from their own experiences and use this background knowledge to construct meaning when problem-solving. Seeking out patterns and underlying principles in problem-solving activities can help the student make sense of mathematics. Consequently, the identification and use of patterns is a fundamental aspect of the mathematics process.

The National Council of Teachers of Mathematics, (1993), or NCTM, indicated that the act of children participating in pattern searching assists in building understanding and mathematical relevance:

Patterns should be part of every mathematics course at all grade levels. The study of patterns provides both motivation and relevance to the elementary school child’s involvement with mathematics. (p. 1)
The NCTM (1989) maintained that mathematics is a science and that the study of patterns is central to understanding mathematics. Further, they maintained that only when students gain this understanding of mathematics through the priority given to the study of patterns can students fully develop and understand mathematical relationships between variables:

Relating patterns in numbers, geometry, and measurement helps them to understand connections among mathematical topics. Such connections foster the kind of mathematics thinking that serves as a foundation for the more abstract ideas studied in later grades. (p. 60)

2.1.4 Patterns in the Curriculum

An integral part of the study of patterns is for students to be able to explore, analyze, and apply mathematics in both mathematical and real-world contexts. Developing a spatial awareness and familiarity with number sequences may help students recognize and apply inductive and deductive reasoning skills in an effort to speculate, solve, and make mathematical arguments. As students’ critical thinking skills develop, their problem-solving abilities become more sophisticated. They identify and represent numerical relationships in tables, charts, and graphs. For example, they may create a graph that represents the time verses distance relationship of data for a trip, and then display the data on a graph. Situational problem-solving and real-world examples provide students with opportunities to see the relevance of these concepts. From baby formulas to chemical formulas, mathematics and algebra offer a succinct way to define real-world situations. Kieren and Steffe (1989) reiterated Freudenthal’s (1983) earlier argument that the use of patterns, relations and functions provides children opportunities
to construct meaning. Providing students with opportunities to manipulate and
graphically display data develops their spatial awareness. Furthermore, it provides
students with practise at grouping, arranging, classifying, and sequencing data and
manipulatives. Bedford (1984) stated:

Orderly thinking involves the organization and classification of information, use of
tables, and the capacity to work through a sequential process without leaping out of
order. As problems become more complex, the orderly thinker can deal with parts of
the problem in detail before putting them together for a final solution.... We can
develop this skill by constantly looking for patterns. (p. 1)

Further to this, Burns (1992b) argued that constantly looking for patterns develops
specific critical thinking skills that facilitate decision-making, data collection, and
organisational skills later in life:

Looking for patterns trains the mind to search out and discover the similarities that
bind seemingly unrelated information together in a whole. A child who expects
things to “make sense” looks for the sense in things and from this sense develops
understanding. A child who does not see patterns often does not expect things to
make sense and sees all events as discrete, separate and unrelated.... If children do
not use looking for patterns as a basic approach to understanding, learning
mathematics is much more difficult than it need be. Patterns make it possible to
predict what is supposed to happen in mathematics. (p. 112)

2.1.5 Early Development and Patterns

During their first years in school, children learn about patterns in general. In the
primary grades, students begin to work with an array of patterns in a variety of mediums.
Children may start to explore patterns through their bodies (actions), with objects (manipulatives) and words (singing and music). It is not uncommon to see younger students identify, translate, and extend repeating rhythmic, verbal, and visual patterns. The NCTM (1993) believed that these sensory experiences lay the groundwork for developing the concept of pattern. Throughout this process children also learn a great deal of mathematics. Furthermore, children may indicate that they recognize patterns and relationships among objects when they sort and classify them by identifying similarities and differences. Once children are classifying objects according to a variety of characteristics, they are ready to explore the concept of pattern. Some children may make a list of animals and the corresponding total number of legs, or fellow students and the number of shoes, as they begin developing their own understanding of patterns, functions, and multiples. The NCTM stated:

There are certain key tasks involved in the study of patterns at each grade level. Students are asked to recognize and extend a pattern; to create a pattern or supply some missing part; and to analyze and describe the pattern. Younger children use concrete objects, sounds, and physical movement to create a pattern. They learn to transfer a pattern from one medium to another. As children begin to develop algebraic concepts they learn to create numerical tables corresponding to patterns made with objects or pictures. They begin to generalize the pattern—first with a verbal description, later with a variable. They create mathematical expressions that are rules for the pattern. (p. 1)

Initially, the pattern itself should be the focus of the experience. Children should have opportunities to use objects and manipulatives to construct personally and physically their own sequences. As they become familiar with tasks, they can practice recording their
patterns. An understanding of pattern grows out of repeated experiences with making patterns in a variety of contexts. The purpose of the activities is to give a concrete form to mathematical ideas, to focus children's action on these ideas, and through the child's creativity, provide an avenue for thinking about them. In these first years of school, children may learn about various types of patterns by making them with pattern strips, attribute blocks, beads, and manipulatives. Visual and tactile experiences, along with exploring ways of representing what is made, lead to develop an understanding of patterns and relations. Making these connections to mathematics is essential. Through creating patterns, and by exploring ways of representing them, children develop an understanding of patterns for use in the more abstract mathematical situations encountered as they progress through school. They also learn about size, shape, position, and number. As children make and continue to make patterns, there will be indications throughout this process which convey to the teacher a child's growing understanding and use of them. The teacher will need to constantly adjust the learning situations to meet the changing perceptions of the learner. Cruikshank and Sheffield (1988) stated that it is expected that by the end of their early primary years, students will be able to identify, create, and compare patterns that arise from their daily experiences:

Children should be physically involved in mathematics. Materials such as stacking blocks, pattern blocks, coloured cubes, attribute blocks, puzzles, Cuisenaire rods, geoboards, sand, clay, water, various containers, computers and appropriate software, and calculator should be available in school.... Children use these materials for counting, developing patterns, creating, observing, constructing, discussing and comparing. From the manipulations and observations come the abstractions of quantitative ideas and the communication of these ideas in pictorial and, later,
symbolic form. (p. 1)

Transforming patterns from one form to another, manipulating repeating, alternating, shrinking and growing patterns is a high level thinking skill that the NCTM (1993) believed would encourage creativity and challenge students to understand changing situations:

Working with patterns is an exciting and motivating experience for children and a significant form of problem-solving. Understanding and using patterns relationships lead students toward algebraic thinking. Recording and analyzing data to discover patterns build students' confidence in their ability to do mathematics independently, without the need for constant confirmation from the teacher. At each repetition of a sample pattern, children are validating, for themselves, the pattern that they have discovered. (p. 22)

Patterns and relations should not be thought of as a topic unto itself. It should not be taught in isolation. It should be taught as a process to help frame children's experiences and guide them increasingly towards more sophisticated mathematical thought. The NCTM (1993) was of the opinion that while students are making patterns, they are interacting with and learning about the concepts, skills, and procedures of mathematics such as place value, numeration, number theory, addition, subtraction, multiplication and division:

Pattern is a unifying theme that weaves mathematical topics together. The study of patterns supports children in learning to see relationships, to find connections and to make generalizations and predictions. Understanding patterns nurtures the kind of mathematical thinking that helps children become problem-solvers and abstract thinkers. (p. 2)

Ultimately, the NCTM (1993) believed the goal is to empower students so that they
feel comfortable with their prior experiences and background knowledge as to manipulate and apply pattern principles to problem solving:

The study of patterns affords students an opportunity to make conjectures about relationships. Through multiple experiences students learn that it is important to investigate a pattern in an organized and systematic way. By continuing to provide a broad variety of opportunities to explore and use patterns, we help students move from a basic recognition of patterns to a more sophisticated use of patterns as problem solving. In other words, we move from teaching and learning about patterns, to teaching with patterns. (p. 30)

### 2.2 Patterns and Contextual Learning in Mathematics

It seems obvious that for mathematics to have any meaning or significance for the student, it must somehow relate to the student’s life or have some kind of meaning for the student. Burns (1992b) argued that mathematics should be presented in problem situations that are familiar to the students. She argued that students need to see the purpose, or have it pointed out to them, in order for them to draw connections to background knowledge or prior knowledge. In addition, the students need to be included in the process of constructing meaning and recognising the current and future applications of their work:

Knowing mathematics means being able to use it in purposeful ways. To learn mathematics, students must be engaged in exploring, conjecturing, and thinking rather than only in rote learning of rules and procedures. Mathematics learning is not a spectator sport. When students construct personal knowledge derived from meaningful experiences, they are much more likely to retain and use what they have
learned. This fact underlined teachers’ new role in providing experiences that help students make sense of mathematics, to view and use it as a tool for reasoning and problem-solving. (p. 3)

The NCTM document, *Standards: Curriculum and evaluation for school mathematics* (1989, p. 32), argued that mathematical experiences and ideas that are linked with and connected to everyday experiences both in and out of school facilitate children’s awareness to the usefulness of mathematics. In addition, Burns (1989a) stated:

Mathematics instruction... should prepare students for expanded and deeper study in high school through exploration of the interconnections among mathematical ideas.... This integration of meaning is an overarching goal of all the standards. It allows students to see how one mathematical idea can help them understand others, and it illustrates the subject’s usefulness in solving problems, describing and modeling real-world phenomena, and communicating complex thoughts and information in a concise and precise manner. Different representations of problems serve as different lenses through which students interpret the problems and solutions. If students are to become mathematically powerful, they must be flexible enough to approach situations in a variety of ways and recognize the relationships among different points of view. (p. 84)

Developing an understanding for mathematics is accomplished through having students participate in recognising the significance of what they are doing. This process is able to not only improve comprehension through context, but as Van Reeuwik (1992) argued, it can also lead to an increased aptitude towards studying math:

After some weeks, they see the value of this new way of learning mathematics, and
they get involved and like it. When one can apply mathematics in real-life situations, it becomes much more motivating to study mathematics. (p. 518)

Further to this, most students' learning experiences with math tend to fall into the historically troubling category of barely tolerable. Brutlag and Maples (1992) believed that bringing students into the process and involving them in discovering the context surrounding the material being taught can translate into positive results in the classroom, not to mention life-long learning:

Traditional mathematics curriculum is described as a long dimly lit journey through a mountain of meaningless manipulations, with the reward of power and understanding available only to those who complete the journey. Students need more that the light at the end of the tunnel to guide them along their journey. Connections (meaning and context) do more that illuminate the tunnel; connections constitute paths for students and teachers; thinking to break out of the tunnel so that we can see for ourselves the beauty and power within our vast mathematical landscape. (p. 234)

Cruikshank and Sheffield (1988) believed that most educators are increasingly on-side with contextual learning and the significance to plays in retention, cognition, and academic growth and development. They argue that teaching with meaning or understanding tends to be richer and longer lasting than other teaching.

Just as Coles (1978) described the outcomes of his research on contextual learning involving the Kleppe children from Africa, Steffe (1989) reported Menninger (1969) discussion of how the Abiphones (a tribe of south American Indians) had their own mathematical reality in that they were able to perform complex calculations that were culturally, contextually, and situationally specific and demanding:
The Abiphones would indicate the size of a herd of horses by stating how much space the horses occupied when standing next to one another. Moreover, if so much as a single dog was missing from the huge pack, they would call the dogs together. They could tell without counting that one dog was missing and called then together to find which one. (p. 120)

Although Western mathematics was for the most part irrelevant to the Abiphones, they were quite capable of doing mathematical tasks that related to their schema. The connections and relationships between mathematics and culture, context and prior experience, is crucial to success. As mathematics is the study of relationships between numbers, data and units linking this to real-life experiences is significant. Moreover, Cruikshank and Sheffield (1988) argued that it is only natural that upon studying relationships that one would see connections, patterns relationships, and functions between numbers:

As children quantify their world, they become aware of arithmetical, spatial, logical, and collective relationships through their active participation with their natural environment.... Some relations are obvious... and it becomes necessary for teachers to provide experiences to link the more subtle relationships. Eventually mathematics makes sense, because learners understand how most of what they have been learning is connected. (p. 2)

The Massachusetts Department of Education indicated in a 1996 draft curriculum document that mathematics is the science of patterns and relationships. It went on to indicate that in order for children to develop mathematically, they need to be exposed to a variety of patterns appropriate to their own lives. Cruikshank and Sheffield (1988) argued that through this exposure children would begin to see variety, regularity, and interconnections between
life and mathematics. Consequently, they would begin to understand patterns. For example, patterns that occur in nature, patterns invented by humans, and even patterns created by other patterns.

The inter-relatedness of mathematics with subjects such as art, language, literature, social studies, and science illustrates the close ties of all bodies of knowledge. As mathematics is embedded in other subjects, so are other subjects embedded in mathematics. The educational process should bring many connected experiences to children in a lifelike environment. That children see connections is crucial. (p. 3)

In the context of a pattern-based curriculum the dilemma between a back-to-basics curriculum and or a problem-solving curriculum are nullified. Both these educational philosophies can work in the context of a pattern-based curriculum. Designing a patterns and relations curriculum that places appropriate emphasis on basic skills, competencies, problem solving, and higher order thinking skills can integrate both methodologies. Further, a pattern-based curriculum naturally incorporates massive drill and practice into the problem-solving process, while simultaneously challenging the students to use higher order thinking skills. The NCTM (1993) standards document maintained that pattern-seeking activities provide more basic skills practice than we would ever dare to impose in a pure drill approach and does so without numbing student interest:

Finding a pattern is a powerful problem-solving strategy. Recognizing and describing numerical patterns are foundational to the concept of function. Patterns should be part of every mathematics course at all grade levels. The study of patterns provides both motivation and relevance to the elementary school child's involvement with mathematics. (p. 1)
But the basics of solid pedagogical teaching of mathematics should not be forgotten. Brutlag and Maples (1992) argued that teachers must use examples that have significant contextual meaning for the students. This is crucial in inspiring the level of interest for the student:

Further, it connects or anchors mathematical ideas (i.e., students can forget rules or computational processes, but if the structure is linked to a memory, then there is a foundation for reconstruction at a later date).... Secondly, new concepts in mathematics should be presented using concrete tasks and manipulatives. Next, teachers should represent mathematical relationships using several mathematical tools (i.e., make the task visual in nature, concrete, linked to common experiences, use manipulatives).... Finally, teachers should have students reflect back on their mathematical experiences by writing in journals, logs, pair and share collaborative groupings, and working on projects. (pp. 231-233)

2.3 The Framework For Teaching and Learning

2.3.1 Introduction

According to the September 1993 British Columbia Ministry of Education Form 1701, the Vancouver School District has the largest ESL student enrollment in the Province of British Columbia. Vancouver School Board (VSB) statistics indicated that 55.3 percent of the student population speaks a language other than English at home. This ratio of native to non-native English speaking students in the Vancouver Public school system has been increasing at such a rate that classroom teachers are not able to effectively teach content
information to their students. Even though some of the ESL students are immigrants and refugees, there is a population of native-born Canadian students who are illiterate in English because they speak their cultural language at home within their community.

ESL students are faced with many changes, demands, and difficulties when trying to handle the academic expectations of content classes. They are continually faced with the struggle of having to keep up with regular content being presented in mainstream classrooms. In conjunction, teachers with large numbers of ESL students in their classrooms have not been able to provide quality instruction and education for all students.

Research in language acquisition has demonstrated that it takes anywhere from five to seven years, apart from specialized ESL classroom instruction, to achieve any degree of language proficiency necessary to succeed academically (Wong-Fillmore, 1989; Cummins, 1981 and 1984). ESL students acquire basic interpersonal communication skills of BICS (Cummins, 1981) in the playground at school. However, Cummins (1981) argued that five to seven years are necessary in order to gain what he called cognitive academic language proficiency, or CALP, which enables students to digest academic discourse:

It takes at least five years, on the average, for immigrant children who arrive in the host country after the age of six to approach grade norms in a second language (CALP). (p. 48)

Considering the time periods necessary to acquire various degrees of second language proficiency and the growing population of ESL students being mainstreamed into content classes, a need was recognized for developing effective strategies that enable the teaching and learning of language and content in a mainstream classroom environment. In addition, it was recognized that enrolling teachers must have opportunities to work with ESL specialists
to facilitate and adapt to the integration of ESL students and teaching and learning of content material.

Consequently, the Framework for Teaching and Learning (VSB, 1989) approach to language and content instruction was adopted based on the works of Early, Hooper, and Mohan, 1988. The Vancouver School Board ESL Trainers Manual (1989) states:

It is inefficient and ill-advised to teach language as a thing in itself separate from the school curriculum or conversely to submerge students in the language demands of school without structured support; ESL students require planned help with their real needs in coping with the language demands in the school context. (p. KF 8)

2.3.2 The Framework for Teaching and Learning

In response to the growing need for ESL students to develop their English language proficiency and achievement, the Vancouver School Board, in 1989, embarked upon an educational initiative based on the Knowledge Framework (Mohan, 1986) called The Framework for Teaching and Learning (see Figure 2.0). The focus of this initiative was to investigate and explore various means by which ESL students develop social and academic language proficiency. The Framework for Teaching and Learning (VSB, 1989) was comprised of, The Knowledge Framework (Mohan, 1986), The Task Design For Teaching and Learning (VSB, 1989) and the use of key visuals. In other words, the Knowledge Framework (Mohan, 1986), Task Design for Teaching and Learning (VSB, 1989) and key visuals make up the Framework for Teaching and Learning by the sum of their parts.
The Knowledge Framework (Mohan, 1986) acts as an organizational tool for the teaching and learning of content information and for language and thinking skills. Key visuals can act as graphic organizers or diagrams that convey content information in a visual or spatial nature in an effort to bridge the gap between language and content.

The Task Design For Teaching and Learning (see Figure 2.1) helps to organize the transfer of background or prior knowledge by connecting modes of learning into reconstructed knowledge in various presentation mediums.
The Framework for Teaching and Learning utilizes many of the pedagogical methods that are synonymous with effective educational practice. Moreover, Mohan (1986) believed that one of the advantages of using this approach is that it can be extended and adapted.
through the K-12 school curriculum:

The fact that it can be used at all grade levels across the curriculum, uses graphics that organize tasks to foster academic achievement and supports a content-based approach to providing meaningful language and content instruction. In addition, this approach gives students opportunities to take ownership of powerful tools and strategies that can provide them with a deeper understanding of content information, language and thinking skills as they relate to each of the six “Knowledge Structures” and across the curriculum. (p. 46)

The main attribute of this approach is that it allows for language and content to be taught simultaneously, thus effectively eliminating situations where ESL denied students opportunities to maintain academic proficiency by being held back in language classrooms. With the language and content approach, second language learners can keep up with academic, age and grade level content (Cummins, 1984). Language is learned through content information, without delaying the academic progress of the student. In other words, instructional objectives of the Framework for Teaching and Learning (VSB, 1989) and the Knowledge Framework (Mohan, 1986) are based on language acquisition through content learning.

One of the most positive aspects of this approach is that it facilitates students bringing their own wealth of personal experience and education into the classroom. By accessing and building upon students' background knowledge, the content information may have more contextual meaning and significance to the students. Certainly it would be more interesting and relevant to the students. In addition, dealing with content information that the student can relate to may increase the number of meaningful opportunities for language and
discourse to be learned. Furthermore, by framing activities in a meaningful context, the linguistic anxiety often experienced by students may decrease. Consequently, students may be able to focus on the content, language, and thinking skills associated with the lesson. Therefore, there are possible benefits for a variety of students. It can have a positive influence on second language learners, first language learners and students who experience learning difficulties.

The use of key visuals helps to present content information to all students in an organized, neutral, visual nature. The key visuals act as powerful tools that promote the students’ understanding of the relationships between ideas. The simplified, linguistically undemanding way in which information is presented facilitates faster, more effective learning of language acquisition (Mohan, 1986; Early, Thew, and Wakefield, 1986). This approach brings awareness to the organization, content, language, and cognitive skills being emphasized, resulting in a better balanced, well-rounded, and higher level of academic curriculum being developed. Finally, this approach encourages students to work in small groups or with and partners. Therefore, the students take more ownership and accountability. Moreover, the approach is resource-based.

2.3.3 The Knowledge Framework

The Knowledge Framework acts as a conceptual lens that facilitates the interrelationship of language, content, and cognition. In developing the ideals behind knowledge structures, Mohan based his work on the research of Malinowski (1935) and Abelson & Black (1986). Mohan argued that knowledge structures could represent ways in which people organize and give structure to their experiences (see Figure 2.2).
As part of the Knowledge Framework, Mohan identified six predominant knowledge structures: classification, principles, evaluation, description, sequence and choice (see Figure 2.2). The Knowledge Framework (1986) is a well-defined instrument which teachers and students can use at all grade levels and across all subject areas. It is an approach that uses graphics and organizes tasks to foster increased academic achievement. Tasks involving language, thinking skills and/or key visuals can be designed within the context of some of the six knowledge structures of the Knowledge Framework (1986) in mind for a systematic link between language and content.

**Figure 2.2**

**Chart of the Knowledge Framework**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Principle</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific/practical knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Sequence</td>
<td>Choice</td>
</tr>
</tbody>
</table>


Each of the six knowledge structures lend themselves to a particular set of thinking skills, key visuals and associated discourse. Figure 2.3 illustrates some of the thinking skills typically associated with each of the six knowledge structures.
Figure 2.3

Chart of the Knowledge Framework and its knowledge structures

<table>
<thead>
<tr>
<th>Classification</th>
<th>Principles</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorting Arranging</td>
<td>Explanation</td>
<td>Evaluation</td>
</tr>
<tr>
<td>Contrast Predicting</td>
<td>Theory</td>
<td>Judgement</td>
</tr>
<tr>
<td>Grouping</td>
<td>Rule</td>
<td>Criticism</td>
</tr>
<tr>
<td>Description</td>
<td>Principle</td>
<td>Justification</td>
</tr>
<tr>
<td>Comparison</td>
<td>Hypothesis</td>
<td></td>
</tr>
<tr>
<td>Contrast Quantification</td>
<td>Process</td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Sequence</td>
<td>Personal opinion</td>
</tr>
<tr>
<td></td>
<td>Chronological order</td>
<td>Refutation</td>
</tr>
<tr>
<td></td>
<td>Cycle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Process</td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Sequence</td>
<td>Choice</td>
</tr>
</tbody>
</table>


Early (1989) and Early, Thew and Wakefield (1986) described key visuals that apply specifically to each of the six boxes. Carrell (1985) highlighted the benefits of using graphics that relate to the different knowledge structures to facilitate reading. Early (1990), Early, Mohan and Hooper (1989), and Tang (1989) found that implicit instruction of knowledge structures and their accompanying graphics assisted students' comprehension and production of academic language. Mohan (1991) cited the importance of key visuals as they relate to the six knowledge structures.

2.3.4 Key Visuals

Key visuals are diagrams, pictures, charts, or graphic displays of information. At a deeper level, they represent the cognitive structure of the interrelationships of ideas. Moreover, key visuals can convey main ideas, thinking skills, and associated language for students. As a result of the way key visuals display and model information, they are able to assist in lowering the language barrier and make visible the knowledge structures which
underlie the content, increase language acquisition and facilitate quicker recall for short term memory (see Figure 2.4). In other words, they are a "visible framework of the shape of the content" (Mohan, 1986, p. 23)

**Figure 2.4**

**Chart of the Knowledge Framework**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Principles</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Webs</td>
<td>Diagrams</td>
<td>Rating charts</td>
</tr>
<tr>
<td>Tree diagrams</td>
<td>Graphs</td>
<td>Grids</td>
</tr>
<tr>
<td>Tables</td>
<td>Tables</td>
<td>Marks books</td>
</tr>
<tr>
<td>Graphs</td>
<td>Cycles</td>
<td></td>
</tr>
<tr>
<td>Databases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tables</td>
<td>Tables with numbered steps</td>
<td>Decision trees</td>
</tr>
<tr>
<td>Diagrams</td>
<td>Flow charts</td>
<td>Flow charts</td>
</tr>
<tr>
<td>Pictures</td>
<td>Cycles</td>
<td></td>
</tr>
<tr>
<td>Plans/drawings</td>
<td>Timelines</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Action strips</td>
<td></td>
</tr>
</tbody>
</table>

**Description**

**Sequence**

**Choice**


Key visuals can assist students in the organization of content and make visible the cognitive structures which underlie the content (Mohan, 1986; Early et al., 1986). Carrell (1985) highlighted the benefits of using graphics to facilitate reading. Early (1990), Early et al., Mohan, and Hooper (1989), and Tang (1989) found that implicit instruction of knowledge structures and their accompanying graphics assisted students’ comprehension and production of academic language. Mohan (1986) cited the importance of key visuals in integrated language and content instruction (ILC) by reporting that:

Knowledge structure graphics can become the visible language, a common currency and a bridge between the language teacher and content teacher, a visible basis for integration and co-operation. (p. 137)
In addition, key visuals package, display, represent, depict and translate the shape of content information without involving dense language involved. Key visuals are also convenient to use to develop and enhance presentations and organizational structures. Furthermore, key visuals present information directly and in a relatively neutral way. They clarify communication and, in so doing, promote the understanding of content. Often when ESL or English-speaking students experience difficulty comprehending content or the relationship between ideas, content teachers try to help them by restating or paraphrasing information. Key visuals such as diagrams, maps, flowcharts, graphs, and time-lines, which show the relationships between pieces of information in a language reduced form, are essential elements in the concurrent teaching of language, content, and thinking skills (ESL Resource Book, 1980. Vol. 1). Key visuals may assist students in activating their background knowledge in the understanding of new material. Therefore, the use of key visuals helps to assist content teachers in simultaneously aiding both the ESL and English-speaking students with background information. Their use is unlimited as children exposed to key visuals often take ownership in the ability to create and visually display information in a thoughtful manner.

2.4 Researching the Registers of Subject Areas

How is the language of school subject areas (e.g. mathematics and literature) to be studied? A widely influential approach has been that of the linguist Michael Halliday. In what follows, this paper will draw on a review of that approach and its relation to the concept of knowledge structures using examples from mathematics education wherever possible. The
paper will thus cover the main relation between the work on patterns reviewed in the first parts of this chapter (Section 2.1 and 2.2) and the Knowledge Framework (Mohan, 1986) reviewed in the second part (Section 2.3). To research the language of patterns in the classroom is to study school mathematics as a register; developments in the study of register now include the Knowledge Structures of classification and description, which are part of the Knowledge Framework. There is a difference, however, between the role of Knowledge Structures in the second part of this chapter and the role of Knowledge Structures in the third part. In the second part, this paper looks at the Knowledge Framework (Mohan, 199986) and its knowledge structures as an approach to instruction; in the third part, the paper uses knowledge structures as an approach to research.

The following extended quotation from Mohan (ms.) reviews recent thinking in the Hallidayan tradition which applies to the language of school subject areas and to the concepts of register, genre, and knowledge structures (e.g., classification and description). It provides a brief overview of the research rationale that supports the language data analysis of this thesis.

The Knowledge Framework (Mohan, 1986) provides a perspective on teaching and learning of content information, and language and thinking skills. It is coordinated with the Task Design For Teaching and Learning, which offers a view of the transfer of background (prior) knowledge into reconstructed knowledge via learning processes. Central issues therefore are questions of prior knowledge and knowledge reconstruction, particularly in relation to knowledge structures.
The question of the link between prior knowledge and new knowledge has been discussed in a variety of forms. Britton provides an influential statement:

Surely it is the links between 'commonsense' and 'theoretical' concepts, the links between 'ordinary language' and 'theoretical language' that make learning possible - whether in school or out - and it is the ability to move back and forth across that continuum that characterises thinking at any mature stage.

Here prior knowledge and new knowledge are discussed in terms of commonsense and theoretical language and concepts.

In what follows I will mention briefly how this issue has been seen in the anthropological tradition by Michael Cole and Shirley Brice-Heath, and at greater length, how it has been seen in the tradition of systemic functional linguistics. I will suggest that it is helpful to draw on both traditions, keeping in view both social practices and also the language that is associated with them.

To summarize my argument briefly in advance: An anthropological tradition sees this issue as a relation between social practices in the community and practices in school, and tends to find the link unsuccessful. A functional linguistic tradition sees the issue as a relation between everyday language and the technical language of subject area disciplines, and tends to assume that the two are linked readily, if not always successfully. Indeed, it has been claimed that classroom discourse may contain a mixture of everyday language and technical language. I will suggest that a way to research this
claim is to look at the language of descriptions in classroom discourse and see how students are describing the things they are learning about, and whether they are using everyday or technical language. Since technical language is typically learned in school, I will also suggest that examining descriptions in classroom discourse offers potential evidence to illuminate the relations between social practices in the community and practices in school. In the discussion below, we will focus particularly on mathematics education but use it to illustrate more general ideas.

Let us begin with the anthropological tradition. For Cole and Heath, the relation is between social practices in the local community involving knowledge and language and practices in the school, and it is a link which fails. Michael Cole's work on the learning of mathematics in Liberia (Cole 1996) found that Kpelle children were able to operate very successfully with mathematical concepts in transactions in the marketplace, but experienced difficulty with mathematics as it was taught in school classrooms. He engaged in a project to investigate indigenous mathematical knowledge and practices in the hope that a curriculum could be designed that built upon local knowledge. Heath (1983) studied the different language uses and literacy events that occur in home and school contexts. Investigating literacy practices in three different communities, she found that the communities socialized their children into distinct literacy practices, but children were unable to use those literacy skills that were expected and practiced in school contexts. The work of Cole and Heath raises the question: What social practices in the local
community correspond to the practices expected in the school context? It
suggests that this correspondence is problematic, and that there may be
considerable difficulties in the links between commonsense and theoretical
concepts, the links between ordinary language and theoretical language that
make learning possible.

We now turn to the tradition of systemic functional linguistics. In his 1987
book *Speaking Mathematically: Communication in Mathematics Classrooms*,
David Pimm (1987) provides a clear and readable introduction to the school
teaching of mathematics, using M.A.K. Halliday's perspective on
mathematics as a language. For Pimm, learning mathematics involves a
transition between everyday language and the technical language of
mathematics (the mathematics register):

Most mathematics classes in Britain take place in a mixture of
what has been called “ordinary English” and “mathematical
English” (Kane et al. 1974), where the latter refers to the use of
the English language for mathematical purposes. Many
confusions occur as a result of differing linguistic
interpretations, where the teacher, for instance, might be
employing terms from what has been loosely called a
“mathematical dialect”, with the pupils interpreting everything
they hear as ordinary English, thus trying to use non-
mathematical meanings in a mathematical context. (p. 75)
Here Pimm makes the important claim that mathematical classroom discourse will be a mixture of everyday and technical language. Concerning the technical language of mathematics as a register, Pimm explains:

The notion of register has been widely employed by the linguist Halliday, although the particular linguistic features he stresses as central to the notion of register have altered with time. His initial description was in terms of variation in lexical items and grammar. However, he later emphasized variation in actual meanings rather than solely surface variation.

We can refer to a mathematics register in the sense of the meanings that belong to the language of mathematics (the mathematical use of natural language, that is, not mathematics itself), and that a language must express if it is used for mathematical purposes. We should not think of a mathematical register as simply a process of adding new words. (Halliday 1975:65)

Thus it is not just the use of technical terms, which can sound like jargon to the non-speaker, but also certain phrases and even characteristic ways of arguing that constitute a register. Part of learning mathematics is learning to speak like a mathematician, that is, acquiring control over the mathematics register.

(D. Pimm 1987:76)

With respect to the mixture of the technical language of mathematical English and everyday English, Pimm (1987) gives a number of examples of which I will select three. These examples are chosen to illustrate technical/mathematical and ordinary English as they apply to the language of
description of geometrical figures:

When examples of figures are drawn to illustrate or merely invoke a concept, the orientation is seldom randomized, and many pupils seem to include the particular orientation in their concept. Skemp (1986) provides a nice example of a pupil having difficulty even constructing a square on the hypotenuse of a right-angled triangle in standard position, as the pupil's notion of square seemed to include that of the sides having to be "square" to the page. (p. 76)

Another example is the word right as in the phrase "right-angled triangle". Apparently, interpreting the word in the familiar sense of right contrasting with left, a pupil described a triangle as a "left-angled triangle" when a 90 degree triangle was oriented with its smallest angle on the left hand side of the page, by contrast with a "right-angled triangle" when it was oriented with its smallest angle on the right hand side of the page. The pupil was:

(... apparent unaware of the use of the word right to refer to a particular type of angle... The Greek origin of the term, rooted in their perception of the angle as being proper or fitting (i.e., balanced and symmetric), is not an obvious one. (D. Pimm 1987:87).

Pimm gives a similar example with the term diagonal. Pimm presented a student with some polygons and asked her how many diagonals they had. She said that a square could have no diagonals or four diagonals, depending on
which way you placed it, and drew pictures to illustrate her point. Pimm comments:

On the basis of the above I feel confident in asserting that Jill’s interpretation of the term diagonal differs markedly from mine. Her notion seems to be something like sloping side of a figure relative to the natural orientation of the page. In moving from ordinary English to mathematical English the term diagonal has undergone a syntactic category shift. In the former context of use, its function is adjectival, contrasting with vertical and horizontal. The referent for the mathematical sense of diagonal was missing from all of Jill’s pictures. Pupils are taught to “see” diagonals even when they are not drawn in and to speak of them as attributes of, for example, a square, even when they form no part of the definition of a square. This absence may account for Jill looking for (and finding) a referent for the word diagonal, one which was present in the picture itself, and one which agreed with the everyday meaning of the word diagonal. In the absence of the mathematical meaning, the everyday meaning has been used to make sense of the task. (D. Pimm 1987:85-86)

These three examples thus illustrate the mixture of everyday and technical language in the mathematical description of figures and objects. Adjectives and nouns like square, right, and diagonal are all used to describe geometric
figures. They have technical mathematical meanings that are different from
their everyday uses to describe objects and their orientation.

J.R. Martin (Halliday & Martin, 1993: Ch. 9), in a book co-written with
Halliday, further clarifies the role of meaning in registers such as the
mathematical register, offering a discussion of the role of the discourse of
classification in constructing meaning and academic knowledge and, to put it
in our terms, providing a language of description for the objects that the
register talks about. A section entitled “Science and common sense” explains
how science classifications construct alternative interpretations (in our terms,
alternative descriptions) of the everyday world, in the following way:
Scientists think about the world very differently from other people. At times
they are very critical of common sense understandings. The common sense
view (i.e., the common sense classification of the solar system) depends on
careful observation with the naked eye. Science augments this with
observatories, radio telescopes, space ships, studies of meteorites (meteors
which make it to the ground) and other types of information gathered in
various ways and accordingly produces a different picture. Rather than saying
that science is right and common sense wrong (or vice versa when religious
beliefs are introduced as evidence), it is more important to understand
common sense and science as different pictures of reality, based on different
organizing criteria. The function of science then is to construct an alternative
interpretation of our world to that provided by common sense. In our culture
that is its job.
Martin continues:

This has important implications for teaching practice. It means that common sense knowledge can be a very useful starting point for learning science, since it organizes the world in ways that can be clearly related to scientific understandings. At the same time it is clear that common sense understandings differ from scientific ones and that schools have a crucial responsibility to induct students into the alternative scientific worldviews. Classification is a fundamental part of every science. One important function of science textbooks is to introduce novices to this form of organization as it has been projected onto reality as a result of centuries of research. The following text is designed to socialize high-school students into one aspect of chemistry—mixtures. An analysis follows of a textbook passage classifying mixtures into solutions, suspensions, and colloids, using these words as technical terms.

(Martin 1993: 168-170)

To sum up the picture so far, registers such as the technical languages of mathematics or of science are not mere jargon but are frameworks of meaning which project worldviews. The role of education (e.g., in mathematics or science) is to socialize students into these frameworks of meaning. Within these frameworks, classifications serve to create, order and describe the objects with which a branch of mathematics or science deals, whether these
are classifications and descriptions of geometric figures or classifications and descriptions of mixtures. Classification discourses in genres convey these scientific and mathematical classifications and descriptions to students. But students already hold common sense, everyday classifications that relate to these objects. In educational interactions, students may apply everyday meanings to make sense of a task if they do not know technical meanings. To understand what is happening in these interactions, we need to follow the interplay between everyday language and technical language when students make sense of their tasks.

How can we find evidence for the question: “What everyday and technical meanings and wordings are being used in classroom discourse?” One way is to trace the descriptions that students use. The classifications of a subject area enable a learner to describe the items of that area; to learn about the definitions of types of mixtures is to become able to label a mixture as a solution, suspension, or a colloid. This implication can also be drawn from the examples from Pimm, which reveal how the language of description provides evidence for the classifications that students are applying. When Jill said that a square could have no diagonals or four diagonals, depending on which way you placed it, Pimm was alerted to a difference from the mathematical meaning of diagonal. In practice, if not in theory, Pimm was tracing Jill’s descriptions of polygons for everyday and technical meanings. Here is a general research procedure for tracing the descriptions that students use:
In classroom discourse (e.g., student talk or writing), find descriptions of geometrical figures or similar "objects of discussion". These descriptions will often be referring to expressions in the nominal group which contain adjectives (e.g., right-angled) or nouns (e.g., square) which codify the description into a word.

Categorize the descriptions into everyday and technical. Descriptions which are technical will typically draw on the explicit classifications and interlocking definitions that form part of the subject discipline. Descriptions which are everyday do not necessarily have explicit classifications associated with them. However, they typically reflect implicit classifications (for example, Pimm suggests that Jill’s use of diagonal contrasts with vertical and horizontal).

Since technical language is typically learned in school, I suggest that examining descriptions in classroom discourse offers potential evidence to illuminate the relations between social practices in the community and practices in school. Moreover, we should not assume that everyday language is a given: The anthropological tradition would imply that the familiar everyday practices of the community construct everyday language. This becomes an important issue because of the difference between the anthropological and functional linguistic traditions on this matter. Pimm and Martin tend to assume that the students are able to make sense of their tasks in everyday language; that students fairly automatically have access to a familiar ordinary language way of talking about the classroom tasks; that the students
can effortlessly draw on their prior knowledge and experience developed informally in family and community to talk fluently and meaningfully about classroom tasks. But Michael Cole’s research on mathematics learning in Liberia brings this assumption into question because it raises the problem of connection between mathematics in the classroom and mathematical expertise in the community. Halliday and Martin’s work has resulted in a greater awareness that mathematical and scientific language in the classroom embodies frameworks of meaning like classifications and is situated in contexts of use in the social practices and activities of communities of mathematical and scientific inquirers. Cole’s work implies that an equal awareness should be extended to mathematical language in the community, to recognize that it may similarly embody frameworks of meaning and be situated in contexts of use. (Mohan, ms.)

We can now summarize the implications of the above work of Mohan (ms.) for this thesis. The link between prior knowledge and new knowledge is an important issue both within the Knowledge Framework approach and more generally in the anthropological and functional linguistic traditions. It can be explored by tracing the link between everyday language and technical language in classroom discourse and examining the language students use to describe what they are learning about. In this thesis classroom discourse will be interpreted broadly, so that reflective journals will be seen as a part of classroom discourse and a natural extension of it. This exploration can follow the research procedure outlined by Mohan. The anthropological view of the everyday versus technical question as a relation between social practices in the community and practices in school should be kept in view,
since it is an important reminder that both technical and everyday language embody
descriptive and classificatory frameworks of meaning and are situated in contexts of use in
the social practices and activities of communities.

2.5 Conclusion

This chapter has reviewed selected literature about patterns in mathematics. It has reviewed the Framework for Teaching and Learning (VSB, 1989), which is based on knowledge structures and which was used as an approach in the classroom work studied in this thesis. It has detailed the roles of reflective response journals and their use in the study. Finally, it has introduced the research approach taken in this thesis, showing the relation between the “register” approach to the language of subject areas (such as mathematics) and the knowledge structures of classification and description. An important theme in the research approach will be the relationship between prior knowledge and new knowledge. This will be a theme at the macrolevel of qualitative research, and at the microlevel it will be explored as it is reflected in the relationship between everyday and technical language in discourse.
CHAPTER THREE: Methodologies and Procedures

3.1 Introduction

This chapter will discuss the qualitative research methodology used in this thesis. It will give a detailed description of various aspects of the research, including the site, the subjects, and the teaching and learning processes. As it does so, it will give some indication of the different kinds of data that will be drawn upon in the research analysis.

There are two main types of methods implemented to conduct research, quantitative and qualitative. Each method has a distinct set of criteria for collecting and analyzing data. The quantitative method is more scientifically oriented with measurable data playing a major role. This measurable data is gathered using a variety of instruments, including statistics and standardized tests.

Qualitative research methods involve the researcher examining the process and context of activity, rather than statistically analyzing certain variables. Information can be gathered using a variety of mediums including observation notes, tapes, journals, and video footage. It is important to choose the appropriate method to match the nature of the question, problem, or situation being explored.

This study was exploratory in nature. It took the form of teacher action research and sought to increase our understanding of the relevant issues rather than to establish cause-and-effect relationships. The study explored a number of tasks as they related to comparing student work in two curricular areas: mathematics and language arts. It described the role of the researcher and the methods of case selection, data collection, and analysis. As stated in chapter one, the purpose of this study was to describe ILC content and instruction as it relates
to two units of different contextual understanding on behalf of the students.

### 3.2 Site or Social Network Selected

The selection of the research site was not an issue in this study. This research project fell under the umbrella of the funds administered through the 1987 Ministry of Education funded 1987 Funds for Excellence program. In that proposal, the project describes the purposeful selection of this site because of its characterization by both school and district staff as a highly successful school. Early (1991) determined through a series of interviews that the site was not only successful, but also an excellent environment for the implementation of change as described in Chapter two. In fact, several research projects have been successfully undertaken at this site as part of the original research grant from the Social Sciences and Humanities Research Council of Canada (SSHRC). This study is considered to fall under the umbrella of the parameters of the proposal and grant.

One elementary school in particular appeared to have considerable success with ILC instruction and collaborative planning. Further research has been undertaken at this site as part of the research grant from SSHRC. The elementary school where this study was located was one of the six selected for a pilot project that took place in the urban district to which the school belongs.

The 1993 Special Alternative Instructional Program (VSB, 1994) booklet described many of the families of students attending the school when this study was conducted having a variety of educational experiences. Also, their socio-economic backgrounds were diverse, with most families being comprised of two income earners-- many in blue-collar jobs. Some parents were illiterate in English, while others are illiterate in both English and their first
language (L1). Some parents held degrees from universities in their home countries, but because these degrees were not always recognized in Canada, many were forced into low paying jobs. Only a few parents are practicing professionals. The book stated:

The school is in a relatively stable neighbourhood, with most families remaining in this catchment area for extended periods of time. The student transfer rate and single parent populations are less than 10%. However, recently there has been an increase in family break-ups in a variety of cultural backgrounds. Ramifications over child custody are a recent phenomenon. A few families have entered Canada as refugees. (p. 3)

The surrounding neighbourhood was comprised of a wide variety of socio-economic and educational backgrounds. Students came from a range of home environments ranging from poor or lower class where their parents were receiving welfare assistance to middle class families who were occasionally able to take vacations, lived mortgaged homes, and owned popular cars.

There was a student population of about five hundred with over thirty-one full time equivalent (FTE) teaching positions. The student population ranged between kindergarten and grade seven with twenty home languages and twenty-nine countries of birth (including Canada) represented. In the class where the present study was conducted, were eight countries of origin represented (see Figure 3.0) with fourteen languages represented. The amount of experience with English ranged from one to seven years.
In an effort to meet the needs of the students at the school, the administration made a variety of services available for classroom teachers in an effort to improve the literacy of students at the school. Classroom teachers were encouraged to sign up for collaborate consultation time with a variety of specialists who could consult, plan lesson and units, team-teach or assist in the instruction and development of students in the class (see Figure 3.1).
The school population was relatively stable in that most families lived in the neighbourhood for extended periods of time. The transfer rate was 10 percent. According to the September 1993 Vancouver School Board British Columbia Ministry of Education Form 1701 Data Collections, 76.8 percent of the student population attending the school was classified as ESL. This was higher than the district average of 53.5 percent ESL.

Prior to the Vancouver School Board ESL Pilot Project, the delivery of services available for ESL students included a District Intermediate Reception Class (DIRC) for students in grades four to seven. In addition, there was a Special Needs program for students at the beginning level of L2 acquisition which consisted of a pull-out program for grades one to seven mainstreamed ESL students (VSB, 1980). With the implementation of the ESL Pilot Project, the level of services changed by increasing the amount and variety of resource persons available for teachers and students to access.
The school-based steering committee (see Figure 3.2) felt that there was a necessity to keep the existing DIRC at the school for two main reasons: There was extra funding and staffing allowances associated with this, and it kept resource teachers accessible to the enrolling teachers. Also, the Special Needs pull-out program was kept in tact as a means of meeting the needs of students facing learning difficulties. The Primary Reception class, for beginning level ESL students in grades one to three was kept functioning as a means for providing primary ESL students a transition room before either mainstreaming into the intermediate grades or moving on to the district ESL class, also located at the school. A support teacher, who serviced grades one to three students in the regular classes, a pull-out program, and team teaching program, was kept as a valuable resource person for the primary teaching staff. In addition, a resource teacher was there to help children who were in the regular classroom, but required extra assistance. Finally, there was a resource teacher who provided collaborative planning, development of materials, and on-site professional development.

As the most successful school in the district’s ESL pilot program, the site was designated as a ESL demonstration site and thus became the flagship for the district.
regarding the implementation of the Knowledge Framework (Mohan, 1986), the Framework for Teaching and Learning (VSB, 1989), and the collaborative consultation process.

Consequently, these factors, combined with the findings of previous studies (Dempsey, 1994, Hurren, 1994 and Grant, 1995) indicated that this site was an excellent choice for studying successful staffing, collaborative planning, team teaching, implementation of change, ESL methodology ILC and an overall complete learning environment.

3.3 Role of the Researcher

The writer had a dual role of researcher and teacher. In quantitative research, the researcher is meant to collect data through objective measures. In qualitative research, however, the researcher usually maintains distance from the subjects, while subjective data is viewed and collected with a critical perspective. In action research, there is the potential for the researcher role to conflict with the teacher role, and possibly influence the subjects’ responses. This should be kept in mind when interpreting the findings of this research study.

Although the role of participant/observer may not be desirable, there are some important concepts to note that can justify it in this study. Firstly, although the researcher was also the enrolling teacher, he was aware of his role and tried to remain unbiased throughout the study. Secondly, as the school platoons classes (classes move throughout the day to see subject specialists), there was an element of consistency that was achieved by having the same teacher for both units of study in this research project. In addition, the staff at the site participated regularly and frequently in the collaborative consultation process and team teaching. Both these teaching strategies emphasized two or more persons teaching, leading, facilitating, and participating in the class. Thus, there would be natural blocks of
time were the researcher could do observations and journal entries.

Thus, as the role of the researcher was obviously important to the study, the platooning, team teaching and collaborative planning process models will assist in alleviating some of the reader's reservations about the researcher as an active player in the study.

3.4 Purposeful Sampling Strategies

Purposeful sampling strategies are easier to describe after the researcher has "mapped the field". As the site had been involved in the district's innovative ESL Pilot Project for five years and had been designated an ESL Demonstration Site, a lot of information-rich social context was easily documented. In terms of gathering data regarding the subjects in this study, multiple methods were used. The participants used reflective response journals as a medium to communicate their feelings and thoughts regarding the unit with the teacher. Participants were also involved in surveys, testing, written task work, audio-taped interactions, and interactions with the teacher. In addition, the participants reflected in their journals at the end of the major section of the unit. Particularly, this study employed ethnographic modes of research and data collection. Participants were involved with the observations, journals, audio interactions, written task work, and interaction with the teacher and given opportunities to reflect and maintain a reflective response journal in the study.

3.5 Selection of the Subjects

The sampling was by case type and employed a concept or theory-based sampling technique in which a new theory or concept is implemented and observed. In other words, the site
provided the study with information-rich persons and situations to experience, observe, and document. The students who took part in this study were ten or eleven years old. Although the class consisted of both grade five and six students, the teacher taught the same material to both grade levels and treated the class as one unit for all of the curriculum material. He taught content information selected from the Ministry of Education’s Language Arts Instruction Resource Packages (IRPs) and would often used the following six levels of protocol to justify teaching the same material to both grades:

a) The teacher never carried over students from year-to-year.

b) The teacher always alternated major themes (e.g., science and living resources versus anatomy and human sciences) so that those themes were never re-taught to a new group of students.

c) The teacher often taught to the class as a whole and then outlined extension material for the grade six students to complete.

d) The teacher frequently expected more detail, effort, time, and pride to be reflected in the grade six students’ work.

e) The teacher often stated that he expected the grade six students to elaborate or provide more details.

f) The teacher frequently extended the grade six students’ work to include more questions or longer assignments.

However, because the two units were special in that no students had participated in either unit for a number of years, the teacher taught the two units and their assignments simultaneously to both groups.

There was no random selection of subjects. In addition, there was no random
assignment. The students are members of an intact class. The sample size of twenty-eight students was addressed by the research problem and determined by the composition of the learning environment, the collective agreement between the union and Board of Trustees allowed for a maximum of twenty-eight students in a split grade class.

3.6 Background Information

3.6.1 Background Information on Mathematics

Students had completed four chapters from their math textbook prior to commencing the unit on patterns. They had finished units on place value, addition of whole numbers, subtraction of whole numbers and multiplication of whole numbers. In addition, the children had completed a unit on problem-solving, a word problem unit focusing on learning the strategies and process underlying solving problems.

The major objectives of the problem-solving unit were to focus on the process of solving problems and the application of strategies for solving problems. This was significant for the patterns unit because of the corresponding sequencing skills associated with solving problems and patterning. The teacher felt that a sequential process would assist students in understanding the similarities of solving word and pattern problems (see Figure 3.3).
Figure 3.3

Procedure taught by the teacher for the Problem Solving Process

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Read the question</td>
<td>Students read the question. This is a first read where they get a chance to get an overall picture of the problem and perhaps the question being asked.</td>
</tr>
<tr>
<td>2</td>
<td>Re-read the question</td>
<td>Students re-read the question with the specific task of determining what the question really is.... Also, they look for facts, patterns or clues.</td>
</tr>
<tr>
<td>3</td>
<td>Re-read the question</td>
<td>Students re-read the question to determine relevant facts and necessary information.</td>
</tr>
<tr>
<td>4</td>
<td>Decide on a process</td>
<td>Students read the question deciding on what computational process may solve the problem.</td>
</tr>
<tr>
<td>5</td>
<td>Strategy</td>
<td>Students pick a strategy to use as they tackle the problem.</td>
</tr>
</tbody>
</table>

In an effort to train students how to work through or apply problem-solving strategies, the students were given a decoding strategy for understanding the actual problem. Subsequently, students were trained to work through a problem-solving process using a road map or checklist to train them to look back and re-read problems. In addition, it was a ploy to get students to try to understand problems by repetition. This step-by-step procedure was designed to provide students with a framework for successful comprehension of word problems and to train them to re-read a question several times in an effort to fully develop an understanding of the question.

Figure 3.4 illustrates how the teacher tried carefully to guide the children through the necessary process of reading and re-reading word problems. In addition, it points out to students that they need to:

1) read and re-read a problem several times,
2) understand the real question being asked of them,
3) determine relevant and irrelevant facts, and
4) develop a strategy to attack the problem.

The second objective in the problem-solving unit was to expose the children to ten problem-solving strategies (see Figure 3.4).

**Figure 3.4**

Table of problem solving strategies taught to the class

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Acting</td>
<td>Students act out the problem.</td>
</tr>
<tr>
<td>2 Drawing</td>
<td>Students try drawing on a piece of paper.</td>
</tr>
<tr>
<td>3 Formulas</td>
<td>Students try to apply a formula to the problem.</td>
</tr>
<tr>
<td>4 Guess and test</td>
<td>Students pick and try numbers in a sequence.</td>
</tr>
<tr>
<td>5 Have I seen this before?</td>
<td>There are only about a dozen different problems, chances are students have solved a very similar problem.</td>
</tr>
<tr>
<td>6 Look for a pattern students</td>
<td>Students look for similarities.</td>
</tr>
<tr>
<td>7 Use manipulatives</td>
<td>Students use blocks or manipulatives to try to concretely work through the problem.</td>
</tr>
<tr>
<td>8 Back to front</td>
<td>Students start from the end and work backwards.</td>
</tr>
<tr>
<td>9 Solve a similar or simpler problem</td>
<td>Many problems replicate other word problems students use.</td>
</tr>
<tr>
<td>10 Make a model</td>
<td>Students using manipulatives to solve the problem.</td>
</tr>
</tbody>
</table>


These strategies were standard methods of solution that could be applied to generic word problems. Each of the eight strategies were made into cut-outs and displayed on a poster occupying a complete four-by eight-foot bulletin board in the classroom which allowed students easy access for reference.

The combination of using the problem-solving procedures and strategies was an effort to provide children with tools to use in their attempts to problem solve. The teacher hoped that, students would be able to read and re-read the question a couple of times to realize what was expected of them, and how to go about solving the problems.
The teacher observed many students reading a problem and then trying to solve it. As a means of curtailing this habit, the teacher provided students with a checklist to follow that specified to students to revisit a question several times. Furthermore, the teacher hoped that the problem solving procedures and strategies would be transferred by the students to the Patterns and math unit in mathematics.

3.6.2 Background Information on Language Arts

Prior to beginning the unit on The Lion, The Witch and The Wardrobe, the student read The Mouse and the Motor Cycle and Ralph S. Mouse by Beverly Cleary. These beginning novels introduced students to:

a) chapter books (books consisting of greater cognitive demands and more sections),

b) story structure—developing a story (introduction, setting, characters, mission and, conclusion).

c) theme—overriding statement or belief that resonates throughout the story,

d) plot outline—introduction, crisis and conflict, climax, resolution, and conclusion, and

e) characterization—developing characters (traits, persona, reader interest).

In addition, this format served as a staging ground for the introduction of key visuals. Many of the students were familiar with the Knowledge Framework (i.e., they had been with teachers in the primary grades that used Knowledge Framework activities, graphics and strategies).

Even though many students had been at the school for over five years, the teachers felt that it was necessary to start off the school year with some light storybooks and then move towards the more academic novels. More importantly, this provided the enrolling teacher with an opportunity to train the students on the usefulness and function of key visuals
that would be applied throughout the curriculum as the year progressed. Furthermore, through plot summary and characterization, the teacher was able to familiarize the students with their various forms of genre and the way target language can be incorporated into graphics.

Other components of the language arts involved having students participate in numerous mini-poetry activities, personal journals, spelling programs, and a writing skills booklet program (grammar) as well as a handwriting program. In addition, students worked once a week in the library on a multicultural fairytale unit that was being team-taught with the teacher-librarian.

3.7 Collaborative Unit Planning

3.7.1 Collaboration: The Collaborative Planning Team

The two units, taught in this study, Narnia (*The Lion, The Witch and The Wardrobe*) and patterns (*Patterns & Relations in Mathematics*), were developed by the ESL resource teacher and classroom teacher. Each teacher brought specific strengths to the collaborative consultation process. They were both experts in their fields. The ESL resource teacher brought many teaching and learning strategies to the collaborative planning sessions. She was one of the leading resource persons in the district and was recognized as an expert and leading authority among teachers on practical, successful and effective teaching and learning strategies. Moreover, as she was completing her graduate degree in language education, her pedagogical principles were founded and supported by leading research in language and content ESL instruction. In addition, she was a seasoned teacher with much practical and
front line teaching experience. These attributes lent much experience, credibility, and knowledge to her suggestions in the collaborative planning process.

The classroom teacher also had much to contribute to the collaborative planning process. He had been a teacher for ten years. In addition, he was familiar with the Ministry of Education’s Language Arts Instructional Resource Package (IRPs), the Prescribed Learning Outcomes (PLOs) and the widely held expectations for the grade level. To this end, he had in-the-trenches experience working with large numbers of ESL students in a classroom situation and he knew his students well. Furthermore, he had prior theoretical experience in ESL teaching and learning strategies as both a co-researcher in a graduate research study and as a staff participant in a dozen workshops on ESL methodology.

3.7.2 Collaboration: Considerations for Both Units

The collaborative planning sessions were not a regularly scheduled event. However, both teachers were committed to the ideals of the collaborative consultation process as described by LeGere (1991). He believed that critical-thinking skills best develop in an atmosphere of dialogue, interchange and problem-solving. Additionally, he felt that successful teaching recognizes that the development of understanding gained through the collaboration process. LeGere maintains that, “Many educators believe that collaboration is not merely an adjunct to lecturing but a vehicle for the learning process itself”. (p. 166)

The classroom teachers would usually sign up for about two forty-minute periods per week. During this time the teachers would discuss the goals, objectives, and desired outcomes that the classroom teacher had. They would then look at the IRPs and compare and contrast how the PLOs in the IRP relate to the learning outcomes in the unit. The planning of the units consisted of two focal areas (see Figure 3.5).
Figure 3.5

Unit and individual planning factors to be considered

Unit planning

What do we want the students to learn? Major topics?

What tasks support selected topics?

Individual planning

What is the content to be learned in this task? What are the language requirements needed for the task?

What strategies will be used to incorporate language and content goals?

The first area was the actual unit planning. Here, the teachers were interested in determining what the major topics of the units should be keeping in mind that themes, genres, content information, and cognitive demands vary, not only between subjects, but also among curricula. Associated with this process was the quest for designing appropriate tasks that would best facilitate and support the selected topics and tasks in terms of content and language demands.

The second area of focus was on individual planning. Here the collaborative planning team was concerned with the content to be learned for each task and its associated language demands. Also, the teachers were concerned about the strategies chosen to meet the language and content outcomes.
3.7.3 Collaboration: A Knowledge Framework Approach to Both Units

A great deal of planning, discussion, and debate went into the sequencing, developing, and context of all the tasks for both units. The tasks were carefully organized and developed using the Knowledge Framework as an organizational tool and conceptual lens (see Figure 3.6).

Figure 3.6

Chart of the Knowledge Framework

<table>
<thead>
<tr>
<th>Classification</th>
<th>Principles</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sorting</td>
<td>Explanations</td>
<td>Evaluation</td>
</tr>
<tr>
<td>Arranging</td>
<td>Theories</td>
<td>Judgement</td>
</tr>
<tr>
<td>Contrasting</td>
<td>Rules</td>
<td>Criticism</td>
</tr>
<tr>
<td>Predicting</td>
<td>Principles</td>
<td>Justification</td>
</tr>
<tr>
<td>Grouping</td>
<td>Hypotheses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Conclusions</td>
<td></td>
</tr>
<tr>
<td>Specific/practical knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Sequence</td>
<td>Personal opinion</td>
</tr>
<tr>
<td>Comparison</td>
<td>Chronological order</td>
<td>Refutation</td>
</tr>
<tr>
<td>Contrast</td>
<td>Cycles</td>
<td></td>
</tr>
<tr>
<td>Quantification</td>
<td>Processes</td>
<td></td>
</tr>
</tbody>
</table>


A tremendous amount of consideration was given to students' perceived prior experience and background knowledge for each task. Moreover, the resource teacher and classroom teacher were extremely cognizant of the fact that students' prior experiences might vary. They were aware that in some cases, the children may not have been taught math patterns for upwards of four years. Much time and effort throughout the planning and teaching phases of the units was spent on ensuring that if students were not familiar with the material, they would be able to identify with the tasks. Therefore the tasks were carefully developed to be sequential, developmental, and to relate to practical issues in the children's environment.
Using the Knowledge Framework basically provided his students with a framework for organizing, structuring, and depicting information and knowledge. This was needed to illustrate to the students that they actually had experiences they could draw upon to assist in the completion of tasks. Students would be able to bring their own wealth of personal experience and education into the classroom. By accessing and building upon students' background knowledge, the content information being covered would have more contextual meaning and significance for them.

3.7.4 Collaboration: The Use of Key Visuals

An important element in this process was the use of key visuals (charts, pictures, diagrams, and visual organizers) to organize and display content information in an effort to bridge the gap between language and content demands. The reduced amount of discourse would allow students to readily sift through language that would ordinarily cause some first and second language learners great difficulty.

The use of key visuals was particularly evident in the Narnia unit. The teachers used them in all of the Tasks. Moreover, they allowed for the teacher to infuse specific language and discourse into particular assignments. The use of key visuals was aimed at helping teachers to present content information to all students in an organized, neutral, visual nature. This would help make students aware of the organization of content, language, and cognitive skills being emphasized. Most of the tasks in the Patterns unit included some sort of pictorial representation of the problem or task (e.g., questions usually included some sort of diagram to assist students in solving the problem). The simplified, linguistically undemanding way in which information was presented could facilitate faster, more effective learning of language acquisition (Mohan, 1986; Early et al., 1986). From the teacher's perspective, the result
would be a better balanced, well-rounded, and higher level of academic curriculum being
developed. In other words, the key visuals were designed to act as tools to promote students’
understanding of the material, problems, and the relationships between ideas.

As a result of the way key visuals display and model information, they were a
convenient tool to develop and enhance presentations and organizational structures. The
direct and neutral nature of key visuals aided in the promotion and understanding of content.
Moreover, the teacher often commented that they reduced the amount of teacher-talk as they
enabled the clear and succinct expression of ideas. Using key visuals in the Patterns unit was
difficult. Although many of the chosen tasks had diagrams and charts associated with them,
not all of the questions associated with each task could have their own individual key visual.
Consequently, it became evident early in the unit that the success of the children in tackling
some of the tasks may be at risk.

The teachers had years of practical experience working with ESL students in a
classroom and centres situation. They believed that using key visuals in conjunction with the
Knowledge Framework (Mohan, 1986) would assist the students in understanding content
information, desired language and associated thinking skills. Using key visuals was an
integral part of their program and it was a significant part of the children’s learning. This
was made evident by the fact that students started to develop and create their own key
visuals. As students took the initiative and began creating their own key visuals (and proudly
showing them off to teachers), the teacher knew that they had begun to internalize the
benefits of using key visuals to manage language and content material. Their ability and
willingness to make their own key visuals illustrated a deep understanding of the process.
3.8 The Patterns Unit

3.8.1 The Patterns Unit: Looking at the Instructional Resource Packages (IRPs)

In an effort to understand patterns, the resource teacher and classroom teacher had to refer to the British Columbia Ministry of Education's Instructional Resource Package (IRP) for Mathematics. Although the teachers had prior experience teaching mathematics, neither of them were familiar with patterns as a major theme in the curriculum. Further, neither teacher could remember seeing patterns as a unit, chapter, or as an area of emphasis throughout any mathematics textbook curriculum.

Appendix A illustrates how the teachers compared and contrasted IRP statements versus how math patterns manifested itself at the worksite from Kindergarten to grade five. Appendix A is divided into 5 columns. For each grade level, there are four other columns. Two columns outline the PLOs for the grade level and the Suggested Instructional Strategy (SISs). The third column outlines the existence of math patterns in the grade textbook used at the site, while the fourth column details what was taking place at the site for each grade level based on informal discussions with teachers of the corresponding grades.

3.8.2 The Patterns Unit: Designing the Tasks using the IRPs

The teachers were not familiar with the PLOs for math patterns in IRPs. They had little experience teaching mathematics other than from a textbook. Significantly, they were doubtful that the students would be able to construct, extend, and summarize patterns using charts, rules, and mental math to any level of proficiency as required by the IRPs (see Appendix A).

Based on the IRPs (see Appendix A), the teachers designed an advance organizer (see
Appendix B) to prepare students for the upcoming material to be covered. Appendix B illustrates the direction of the patterns in the math unit. The teachers wanted to convey to the students that there was going to be a sequential process of moving through the Prescribed Learning Outcomes (PLOs). The advance organizer helped to represent significant upcoming themes throughout the unit and their supporting tasks, which allowed children to draw upon their own prior experience and knowledge throughout the progression of the tasks.

Furthermore, in an effort to layout the mandated curriculum and develop a needs assessment, the teachers constructed a chart to compare and contrast the IRPs with the current practice at the site (see Appendix A). In other words, the teachers felt that since they had never heard of patterns in math the children probably had not either since kindergarten.

### 3.8.3 The Patterns Unit: Using The Knowledge Framework

The teachers used Mohan’s Knowledge Framework (see Figure 3.7) as a conceptual lens for the task design. The majority of tasks fell within the lower level thinking skill structures of the Framework because many of the tasks revolved around introductory activities which did not demand higher level thinking skills (e.g., evaluation, sequencing and choice). Interestingly, many of the tasks fell within the knowledge structure of principles due to the this-is-how-it-works nature of the tasks.
As the Knowledge Framework suggests, many of the tasks fall within the knowledge structures of classification, description and principles. This is both reasonable and realistic as much of the work associated with identifying and working with math patterns at the grade five level involves classifying types of patterns based on colour, attribute, size, and number. Additionally, being able to describe, emulate, copy, predict, and extend the next part of a pattern is important to demonstrate an understanding of the segments of the pattern. Finally, being able to demonstrate an understanding of why, how, and what constitutes a pattern.
which is important for applications in real life.

3.8.4 The Patterns Unit: Developing a Draft Progression of Tasks

Based on informal discussions with teachers at the research site, it appeared that math patterns were not something that was generally taught in grades other than kindergarten. Subsequently, the resource teacher and classroom teacher suspected that it was necessary to begin developing the math patterns unit using materials from the primary grade levels. Since the teachers questioned when the students may have actually been taught patterns in math as part of the curriculum, they felt that it was necessary to use primary materials as a foundation for building background knowledge and prior experience. The resource teacher and the classroom teacher collaboratively planned and developed a scope-and-sequence document entitled the Draft Progression of Tasks that would become the fabric of the patterns unit (see Appendix C).

3.8.5 The Patterns Unit: A Closer Look at the Draft Progression of Tasks

The Draft Progression of Tasks outline (Appendix C) was a thorough plan for the implementation of the unit. There were testing and evaluation procedures (Tasks 1, 13, 16, 20, and 23) designed into the unit as a means for providing the teachers with feedback as to student achievement. Additionally, there were opportunities for journal writing (Tasks 2, 5, 14, 17, 21, and 24). The learning log activities were designed to be an evaluative tool for the teacher in that they provided feedback and data regarding student’s perceptions of the unit. Coincidentally, it also had tremendous benefits for the students in terms of reflection and internalizing concepts. Additionally, there were a variety of teaching strategies planned ranging from directed teaching to collaborative and co-operative group work, to
individualized learning. The breakdown of the unit showed that it was well balanced and sensitive to the variety of diverse student learning styles (see Figure 3.8).

Figure 3.8

Pie graph illustrating the percentage of the teaching of the tasks

3.8.6 The Patterns Unit: A Closer Look at the Knowledge Framework of Tasks

As Figure 3.8 outlines, the teachers originally planned for teaching time to be evenly split between problem-solving (23 percent), journal writing (23 percent) and collaborative partner work (23 percent), with direct teaching (12 percent) and co-operative group work (15 percent) following behind. In conjunction with the Draft Progression of Tasks, the teachers were cognizant of the tasks and how they fit into each box of the Knowledge Framework. In an effort to determine the composition of tasks and which cognitive structure they were focused on, the teachers used Mohan’s Knowledge Framework chart (see Figure 3.9) as a
As the completed Knowledge Framework suggests, many of the tasks fall within the knowledge structures of classification, description and principles. This is both reasonable and realistic as much of the work associated with identifying and working with math patterns at the grade five level involves classifying types of patterns based on colour, attribute, size, and number. Additionally, being able to describe, emulate, copy, predict, and extend the next part of a pattern is important to demonstrate and understanding of the segments of the pattern. Finally, being able to demonstrate an understanding of why, how, and what makes a
pattern, a skill which is important for applications in real life.

3.8.7 The Patterns Unit: Undertaking Changes to the Unit

From the beginning of the patterns unit, the teachers knew that the unit would be challenging and difficult for the students. They were cognizant of the fact that they may be required to modify the Draft Progression of Tasks in an effort to meet the needs of the students and ensure best practice by checking that the material was appropriate for the children. Not surprisingly, it became clear to both the classroom teacher and the resource teacher that the students were struggling with the material being covered, and it was evident that remediation and direct teaching were necessary to meet the needs of many of the students in the class. Subsequently, the Draft Progression of Tasks had to be adapted and changed to ensure student success.

Appendix D represents the Actual Progression of Tasks as they occurred in the math patterns unit. It evolved over the course of the unit, growing from 24 to 31 tasks. Additionally, many of the original tasks had to be expanded upon or taught using a direct teaching approach where there was explicit instructions and less room for interpretation. There were also some additional lessons in the Actual Progression of Tasks (e.g., Tasks 9, 10, 12, 23, 24, 25, 39, and 31). Specifically, Tasks 9 and 10 were lessons on teaching children how to describe a pattern. This was necessary because students appeared to be having trouble with the language of patterns and interpreting a pattern. In other words, children were understandably having some trouble deciding what was and wasn't a pattern. However, they appeared to be struggling with being able to describe what it was they saw or made. The teachers interpreted this as meaning that the students didn’t have the discourse specific to patterning. Also, students were not adept at being able to describe what it was
they saw.

The most significant additional tasks into the Actual Progression of Tasks occurred with Tasks 23, 24, and 25. Here, the teacher made a significant change to the unit's direction by adding three tasks and a specially designed template for solving pattern problems. The template basically provided students with a key for unlocking the mystery of solving pattern problems. The template key visual consisted of:

a) the problem itself, in sentence form,

b) a key visual (picture) of the problem,

c) a comparing and contrasting table for interpreting the problem,

d) a sequencing table for examining trials or sets of numbers in the problem,

e) a space for being able to describe the pattern in word form,

f) a section for describing what the pattern is based on (e.g., attributes),

g) a section for examining the rule of the pattern, and

h) space to solve the problem.

The development of a template provided students with a map for successfully solving pattern problems (see Appendix E). As students were experiencing mixed success on problem-solving tests, the template was designed to re-shape how students were attacking pattern problem solving. It was hoped that by providing students with a template, which would act as a remedial tool that framed the pattern problem, they might be more successful in learning the process, procedure, and strategies of tackling pattern problems.

The addition of the template as a remedial tool was the most critical moment in the unit. It was the tool the teachers had been seeking to provide students with a mechanism for framing pattern questions and developing experience with successfully solving pattern
problems. Moreover, as it truly was a key visual, and its graphic, visual nature made the context of pattern problem solving evident to most of the students (see Appendix E).

Another major evolution to take place throughout the unit was the decision to use a survey (Task 30 & 31) rather than a journal entry. The teachers decided to administer an extensive survey that summarized the children's experiences with math patterns instead of simply using journal entries. They felt that it was more final and brought some closure to the unit.

As a result of the reorganization of the unit, the distribution of tasks changed significantly (see Figure 3.10).

**Figure 3.10**

*Graph of the actual dispersion of tasks within the patterns unit*

Because students were struggling with tasks in the unit, the teachers dropped the amount of brainstorming work from four to zero percent of the unit's task composition.
Journal writing also took a hit (dropping 23 to 20 percent), as it was proving difficult for the children to interpret ideals and tasks they knew little about. Problem-solving also dropped from 23 to 20 percent as fewer tests were considered for the children since their performance was marginal in the early stages of the unit. The teacher’s rationale for this was that as the students were doing poorly on tests and there was no reason to overwhelm them with major amounts of formal test writing.

Unquestionably, the most significant modifications in the unit occurred to the amounts of direct teaching and co-operative learning involved. The amount of direct teaching required in the unit increased from 12 to 20 percent. This increase was understandable due to the necessary directions, explanations, guidance, and overall hand-holding the students required throughout the first half of the unit. The teacher felt more at ease controlling the rate, flow, and dissemination of information once it was confirmed that the children truly needed the assistance and instruction of the teacher. Conversely, the amount of collaborative working time dropped from 23 to 5 percent of the unit’s tasks. It would appear that as the teacher was spending considerable amounts of time working with the class, the opportunities for collaborative work fell by the wayside.

3.8.8 The Patterns Unit: Testing as Part of the Process

As the Draft Progression of Tasks (Appendix C) indicates, there were originally five problem solving tasks scheduled throughout the patterns in math unit. The first test was originally developed to act as a pre-test. The subsequent tests were designed to provide feedback to the teacher regarding the student’s progress throughout the unit. The questions for each of the problem-solving tests were taken from grade five resource booklets.

The results of Problem-Solving Test 1A (see Figure 3.11) were the first concrete
indicators to alert the teacher to the fact that the children were going to have trouble with the unit.

**Figure 3.11**

**Graph of student scores for Problem Solving Test 1A**

Although the marks tended to cluster between 17 and 31, ten students (35.7 percent of the class) failed the test. Moreover, not one student achieved over 79 percent. Upon closer inspection, it was evident to the teacher that many of the students struggled through much of the test (see Figure 3.12).
From Figure 3.12, it would appear as though questions 1 and 2 were easy for the children to answer. All students were able to provide correct responses and attain full marks. However, in question 3, eight students achieved full marks, and 28.5 percent of the class received a mark of zero for their efforts. The significant results occur in questions 4a, 4b, 4c, 5a, 5b, and 5c. Between 37 percent and 100 percent of the class received a mark of zero on the questions. This was concerning for the classroom and resource teachers. They were concerned that the test was too difficult, or at the very least, poorly designed. However, as they had used questions from grade-appropriate resource books, and as the IRPs indicated that students at even the grade four level should be able to successfully complete similar questions, and continued with the unit. The results were interesting for the teachers and they mused over why the children did poorly on specific questions. They quickly formed the opinion that the students had no prior experience or knowledge of these kinds of pattern problems. Furthermore, they felt that based on student journal entries (Tasks 2, 5, and 13), their only experience with problems of this nature last occurred in the early primary grades. Student responses in their reflective journals indicated that they found patterns, relations and functions to be difficult and that they only had limited experiences in primary grades working

### Chart of the level of success for questions on the Problem Solving Test 1A

<table>
<thead>
<tr>
<th>Question</th>
<th>10 marks</th>
<th>9 marks</th>
<th>8 marks</th>
<th>7 marks</th>
<th>6 marks</th>
<th>5 marks</th>
<th>4 marks</th>
<th>3 marks</th>
<th>2 marks</th>
<th>1 marks</th>
<th>0 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>2</td>
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</tbody>
</table>

From Figure 3.12, it would appear as though questions 1 and 2 were easy for the children to answer. All students were able to provide correct responses and attain full marks. However, in question 3, eight students achieved full marks, and 28.5 percent of the class received a mark of zero for their efforts. The significant results occur in questions 4a, 4b, 4c, 5a, 5b, and 5c. Between 37 percent and 100 percent of the class received a mark of zero on the questions. This was concerning for the classroom and resource teachers. They were concerned that the test was too difficult, or at the very least, poorly designed. However, as they had used questions from grade-appropriate resource books, and as the IRPs indicated that students at even the grade four level should be able to successfully complete similar questions, and continued with the unit. The results were interesting for the teachers and they mused over why the children did poorly on specific questions. They quickly formed the opinion that the students had no prior experience or knowledge of these kinds of pattern problems. Furthermore, they felt that based on student journal entries (Tasks 2, 5, and 13), their only experience with problems of this nature last occurred in the early primary grades. Student responses in their reflective journals indicated that they found patterns, relations and functions to be difficult and that they only had limited experiences in primary grades working
The students were visibly shocked by the questions from Problem Solving Test 1A (see Appendix F). They approached the teacher and asked permission to rewrite the test. The teacher indicated that a rewrite of the test would be appropriate as a means for increasing their grades, practicing test writing, and gaining experience in working with pattern problems, and reasonable based on the poor results of Problem Solving Test 1A. The teacher felt that a rewrite was just one of the adaptations he may have to make throughout the unit as a means of assisting the children in understanding the content.

The teacher decided to let the children rewrite the pre-test as Task 12 (Problem Solving Test 1B). The results were not that much different from Task 1 (see Figure 3.13). Even though the teacher had reviewed Problem Solving Test 1A in class, and test familiarity should have been a factor, many of the students still struggled with the test.

**Figure 3.13**

*Graph of student scores for Problem Solving Test 1B*
The number of students passing increased from 64 to 92 percent. However, 71 percent of the class scored between 74 and 79 percent on the test. Although the teachers were pleased that the students passed, they were troubled by the bottleneck of students trapped in the high 70 percent range.

In an effort to adapt the classroom circumstances to meet the needs of the children, the teacher began extending the testing periods. This was done to relieve students from test anxiety and provide them with more time to understand and think through given problems. This practice was culminated by a testing period extending over several days (Tasks 26, 27, 28, and 29) for approximately one hour per session. Students were given modified time allotments and brief instructions regarding interpreting certain questions on the test. The teacher rationalized this as being a necessary modification to the children's program in order to ensure reasonable student success. At one point the teacher stated that, “Just like we'd be expected to modify an SLD [special learning disability] kid's program or a LD [learning disabled] student's testing environment, so too is this.... All I've done is taken it [the modification] and applied the modifications to all the students.”

The final test was broken down into smaller remedial activity tests that were administered over the course of four math periods. Each test followed a similar format. For example, when using word problems, students would have graphic and visual cues, brainstorming space, computation areas, and sequencing grids to try and solve the pattern problems. The questions were selected based on their sequential nature and associated graphics.

The primary purpose of Final Tests 1 to 4 were to provide a battery of visual and graphic pattern problems to determine how successful students could be at understanding
patterns, rules, and attributes. The teacher admitted that Final Tests 1 to 4 were easier than originally planned. In his journal, he reported that in the design of these tests he was, once again, forced to re-think his expectations for the student performance and required PLOs. Well aware that students had not participated in pattern and relation activities for an extended period of time, he took to creating a series of tests that followed the same format as the remedial activities (Tasks 3, 24 and 25). As Appendix G illustrates, most of the tests indicate a relatively high degree of student success, the notable exception being Test 2B

3.8.9 The Patterns Unit: The Teaching Process

The teacher used a straightforward process for teaching mathematics (see Figure 3.14). It was basically comprised of three phases. The teacher was concerned about continually monitoring or checking the progress of students. In an effort in ensure best practice and the individual success of the students, the teacher used the following process for most of the lessons in the patterns unit. This teaching process was comprised of three phases, as shown in Figure 3.14.
Figure 3.14

The teaching process for the math patterns unit

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introducing</strong></td>
</tr>
<tr>
<td>The goal is for students to be able to demonstrate an understanding of the problem. They should be able to see how they can arrive at some possible solutions and methods of recording data. Present or review concepts. Pose a problem or part of a problem for students to try. Demonstrate solutions. Discuss to make sure students understand what they are to do.</td>
</tr>
<tr>
<td><strong>Exploring</strong></td>
</tr>
<tr>
<td>Students begin to digest the problem either on their own or cooperatively. The teacher may offer help or provide examples. Observe the interaction, listening for ideas, strategies and work procedures to use in later discussions with the groups. Offer assistance when needed.</td>
</tr>
<tr>
<td><strong>Summarising</strong></td>
</tr>
<tr>
<td>Groups have an opportunity to share their experiences (e.g., organisation, strategies used, problems that occurred, adjustments to make the next time). Have groups report their progress, both group procedures and strategies used. Generalise from the solutions.</td>
</tr>
</tbody>
</table>

As with the Narnia unit, the teacher was consistent in introducing the content, language, and cognitive objectives of the task. He would state what they were going to be learning. He would pose concepts and problems, and model or demonstrate a solution to a question. In the second phase students were given opportunities to digest the problems. As well, the teacher was able to circulate throughout the room and offer assistance and extension suggestions where appropriate. The teacher was cognizant of the scaffolding process and used his experience and insight to judge how much help he would offer individual groups of students. The third and final phase of the teaching process involved summarizing the lesson content, process, language (discourse), and thinking skills.
3.9 The Narnia Unit

3.9.1 The Narnia Unit: Collaboration and the Design of the Unit

The Narnia unit was originally developed with the assistance and guidance of the district’s ESL resource teacher as part of a graduate research project on the collaborative consultation process. It took into consideration the British Columbia Ministry of Education’s IRPs and PLOs for Language Arts, while at the same time, the teachers recognized their professional autonomy and thus were well aware of the flexibility they had in interpreting the kinds of task they could choose to meet the PLOs. Parts of the unit were modified over time to successfully implement language and content information and adapt the material to meet the needs of the children. Part of the adaptation included re-working sections of the unit with the school-based ESL resource teacher. This was extremely beneficial to the study as she was familiar with the students in the class and had participated in numerous team-teaching ventures with the classroom teacher. The students were given a key visual, or advance organizer, that outlined the anticipated direction and major themes in the up-coming unit (see Figure 3.15).
The tasks were sequentially developed and took into account recent work on plot outline and the five-part writing exercises students had been exposed to. As the entire staff had been involved with the Knowledge Framework (Mohan, 1986) since the first year of the pilot project the students were familiar with its manifestations. Students had previously received lessons on the Knowledge Framework as part of the curriculum and had dividers in their binders containing a section for a key visual dictionary and a thinking skills section, complete with discourse. Information was presented to the students as curriculum material. Its relation to the key visual and/or thinking skills sections of the binder is mentioned as an aside. This way the content is relevant, meaningful, and has context for the students. At the same time, the students are being exposed to content, language, thinking skills, and strategies.
An exact list of tasks was given to students in an effort to familiarize them with the coming unit (see Figure 3.16).

**Figure 3.16**

*Chart of the advanced organizer for the Narnia unit*

<table>
<thead>
<tr>
<th>Style</th>
<th>Task</th>
<th>Task Name</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration</td>
<td>1</td>
<td>Sort &amp; Defend</td>
<td>Vocabulary builder, background knowledge tester</td>
</tr>
<tr>
<td>Collaboration</td>
<td>2</td>
<td>Mr. Tumnus Key Visual</td>
<td>Introduction of key visuals and collaborative consultation process</td>
</tr>
<tr>
<td>Collaboration</td>
<td>3</td>
<td>Mr. Tumnus Writing</td>
<td>Picking from the key visual and applying it to the structured writing</td>
</tr>
<tr>
<td>Self</td>
<td>4</td>
<td>Edmund Key Visual</td>
<td>Using key visuals on their own, building independence</td>
</tr>
<tr>
<td>Self</td>
<td>5</td>
<td>Edmund Writing</td>
<td>Picking from the key visual and applying it to the structured writing</td>
</tr>
<tr>
<td>Partner</td>
<td>6</td>
<td>Lucy Writing</td>
<td>Writing without a teacher-prepared key visual</td>
</tr>
<tr>
<td>Collaboration</td>
<td>7</td>
<td>Character Development (Lucy versus Edmund)</td>
<td>Tackling the good versus evil. Characterisation</td>
</tr>
<tr>
<td>Self</td>
<td>8</td>
<td>Lucy/ Edmund Writing</td>
<td>Using the key visual and writing from it</td>
</tr>
<tr>
<td>Self</td>
<td>9</td>
<td>Beaver Choice Key Visual</td>
<td>Decision making skills/ CAPP/ consequences</td>
</tr>
<tr>
<td>Self/ share</td>
<td>10</td>
<td>Beaver Choice Writing</td>
<td>Writing from the graphic</td>
</tr>
<tr>
<td>Collaboration</td>
<td>11</td>
<td>Relationships Key Visual</td>
<td>Characterisation</td>
</tr>
<tr>
<td>Collab</td>
<td>12</td>
<td>Relationships Writing/ Detail Relationships</td>
<td>Structured writing</td>
</tr>
<tr>
<td>Self</td>
<td>13</td>
<td>Jadis/ Aslan Writing</td>
<td>Summary of the unit</td>
</tr>
</tbody>
</table>

Much consideration was given to the approach, content, language demands, sequence of the tasks, types and grouping of activities, materials, strategies for feedback, and the roles of the teacher and students.

Figure 3.17 illustrates how the tasks fit into the Knowledge Framework. Importantly, many of the tasks focus on description, evaluation, and choice.
### Figure 3.17

**Narnia tasks in the Knowledge Framework**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Principles</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sort &amp; Defend (T1)</td>
<td>Character Development (T7)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Lucy versus Edmund)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Detail Relationships (T12)</td>
<td></td>
</tr>
<tr>
<td>Specific/practical knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Tumnus KV (T2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Tumnus Writing (T3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edmund KV (T4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edmund Writing (T5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lucy Writing (T6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lucy-Edmund Writing (T8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relationships KV (T11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relationship Writing (T12)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jadis-Aslan (T13)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source: Adapted from the works of Mohan, B. A. (1986). <em>Language and Content</em>. Reading, Massachusetts: Addison-Wesley p. 29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 3.9.2 The Narnia Unit: The Teaching Process

The enrolling teacher was a master teacher who had trained more than half a dozen graduating student teachers from the University of British Columbia. He was determined to provide students with opportunities to access background knowledge and prior experiences as they relate to school curricula. Moreover, he always tried to draw students' attention to the content, language, and thinking skills associated with all tasks. Further, he frequently used advance organizers and key visuals as a means for connecting content, language, and thinking skills for children.

The teacher followed a commonly used methodology of teaching that was designed to increase student understanding by making lessons manageable, consistent, and predictable as well as isolating content, language, and associated thinking skills (see Figure 3.18).
### Chart of the teaching process for the Narnia unit

<table>
<thead>
<tr>
<th>STEP</th>
<th>TASK DESCRIPTION</th>
</tr>
</thead>
</table>
| 1     | ADVANCE ORGANISER OF THE TASK  
(Students get a preview of the activity ahead.) |
| 2     | MODELING THE TASK  
(Teacher models expectations and samples of work.  
In addition, he involves the class in designing criteria for evaluation.) |
| 3     | CONTENT INFORMATION  
(Teacher teaches the lesson. He outlines expected content and language demands.) |
| 4     | RECORDING THE DATA  
(Students record notes on a key visual, paying close attention to content and discourse.) |
| 5     | THE ASSIGNMENT  
(Students begin the writing task.) |
| 6     | PRESENTATION  
(Students present their work through a display or read-aloud.) |

The teacher was very much convinced that students need to know what they are going to be doing, then after they do it, they need to know what they have done. This process served several purposes. Firstly, informing students of the upcoming tasks gave them some context and allowed them to think back to any prior experiences that may relate to it. Secondly, the process gave students an opportunity to prepare themselves for the task at hand. Also, it gave all students an opportunity to check where they were in the lesson, and ensure that they were on task. Finally, it was a good classroom management technique for controlling the flow and continuity of lessons as well as checking for student cognition. Specifically, he used the process outlined in Figure 3.19 for Language Arts.
Figure 3.19
Chart of the process of introducing a task

<table>
<thead>
<tr>
<th>Statement of the task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher instructions for:</td>
</tr>
<tr>
<td>Content</td>
</tr>
<tr>
<td>Language</td>
</tr>
<tr>
<td>Thinking Skills</td>
</tr>
<tr>
<td>Examples</td>
</tr>
<tr>
<td>Task clarification</td>
</tr>
<tr>
<td>Student work</td>
</tr>
<tr>
<td>Monitor and adjust for:</td>
</tr>
<tr>
<td>Content</td>
</tr>
<tr>
<td>Language</td>
</tr>
<tr>
<td>Teacher feedback</td>
</tr>
<tr>
<td>positive/ negative</td>
</tr>
</tbody>
</table>

Note that the teacher states the task for the students. In other words, he says, "this is what you’re going to do". He then follows this by giving content, language, and thinking skill instructions by displaying samples or modeling the process. This supports the children by providing a clear visual picture of what the desired output or completed task is to look like. There is also a phase stating Task Clarification. This is when the teacher asks the class, “Are there any questions or concerns before we begin? Does anybody not understand the expectations?” This is an important moment as it allows students an opportunity to state any problems, questions, or concern regarding the task. The teacher did this for all his assignments in all subject areas throughout the day, and consequently, the children were very familiar with it. It was not uncommon for the teacher to do a quick check about five minutes
into the student work phase in order to check that all students had begun the task successfully.

Additionally, all of the activity and task work was collected and marked by the teacher every 2\textsuperscript{nd} period. The marking reflected the criteria and main objective for each task. The students were very familiar with this style of evaluation as the teacher had a number of classroom procedures and routines in place since the beginning of the school year.

### 3.10 Scaffolding with the Students

The teacher used a scaffolding process throughout both units (see Figure 3.20).

**Figure 3.20**

**Teacher scaffolding for tasks in both units**

![Teacher scaffolding diagram](image)


In the context of this study, scaffolding refers to the pedagogical relationship between the student and the teacher. Specifically, it revolves around the child in the performance of a
task and the gradual withdrawal of the teacher's assistance as competency increases. The classroom and resource teacher specifically planned sequential tasks, developing them in such a way that the students can be successful participants from the beginning of the unit. As the student's competency grows, the activity changes so that there is always something new to be learned until the student can take over the teacher's role. The teacher originally provided explanations coupled with modeling. Then he gradually withdrew to a coaching role, providing corrective feedback and encouragement. Although there was a varied rate at which this transfer occurred, the teacher was cognizant of the fact that the children must be challenged at their level of competence.

3.11 Data Collection

3.11.1 Data Collection: Various Means to Collect Data

The researcher was a participant/observer in this study. As outlined in section 3.2 the researcher was aware of his role in the study and advises that it be taken into consideration when interpreting the findings of this study. These findings complement several other graduate research studies that were conducted at the site (Dempsey, 1994, Hurren, 1994 and Grant, 1995). This study used multiple data collection methods to enable corroboration of data. Moreover, the study sought to increase our understanding of relevant issues surrounding contextual learning rather than simply exploring a cause-and-effect relationship. It attempted to use non-inferring data collection strategies to examine language and content teaching and learning.

Data were collected both formally and informally through a variety of means. Most of these have been mentioned in passing throughout this chapter. In this section and the
sections that follow, the paper will mention some of the data sources in more detail.

3.11.2 Data Collection: Field Diary

The researcher kept a field diary in which observations, impressions and reflections could be recorded on a daily basis. All entries were recorded as close to the actual lesson as possible, however many entries were left until the evening or weekend due to the teaching load and demands of the role of teacher at the school. The field diary became an important source of data and became a running account of the progression of the units.

3.11.3 Data Collection: Student Work Samples

The researcher also collected student work samples regularly. For the Narnia unit, this entailed collecting, marking, and commenting on the key visual and writing sample for each task. In terms of the Patterns unit, the teacher collected the students' work and put it into individual task folders to review several times per week. The students then received relatively instant feedback on their tasks and activities.

3.11.4 Data Collection: Testing

Only the Patterns unit had formal testing. The final marks for the Narnia unit were recorded on a cumulative basis. More weight went towards the final writing assignments as they were obviously more demanding and difficult in terms of understanding theme, characters, and the inter-relationships between characters. Also, the required language elements expected in the later writing samples were more demanding than in the earlier sections of the Narnia unit. In the Patterns unit, there were several tests throughout the unit including a unit final exam. Student achievement in terms of math marks was not the teacher's main objective; the teacher was looking for the students' abilities to use language as
a means for talking about and describing patterns. Further, the teacher was interested in the formal (school) and informal (outside of school) settings and the impact they may be having on the language which students used to discuss characters and patterns.

3.11.5 Data Collection: Using Reflective Response Journals

Using reflective response journals (Tasks 2, 5, 13, 19, 30, and 31) was an integral part of the Patterns unit. These journals were used as a creative tool to assist students in reflecting, rehashing, and articulating content information covered in the classroom. Furthermore, the teacher believed that using reflective response journals throughout the unit would provide him with some insight as to what information students understood. Consequently, students were asked to complete specific journal entries ranging from brainstorming and discussion starters to summarizing tasks and activities in an effort to outline a process or provide an explanation of their perception of the material. It was hoped that by using journals as a medium for reflection, the students might develop a greater understanding of the content information being covered.

The function of the reflective response journals or learning logs was to serve as a means for recording students' thoughts. The teacher's intentions were to strategically place journal tasks throughout the unit in order to provide students with opportunities to reflect and allow for a forum to respond to material and/or activities. Moreover, the teacher felt that having students complete journal entries would push students to think through topics and consequently become cognizant of their learning.

3.11.6 Data Collection: Reflective Journal Writing as Part of the Process

The teachers were of the opinion that reflective response journals were a reliable tool
to assist students in reflecting, rehashing, and articulating content information covered in the classroom. Additionally, LeGere (1991) believed that reflective journals would provide them with insight and feedback regarding how well students were grasping specific content information covered in class:

Comparisons of classes with and without writing components confirm that students who, “write to learn” actually do learn and retain concepts better than students who do not write as part of their course work. Appropriate writing exercises give students access to their own thinking processes and serve as a powerful aid to learning. Psychological theory suggests that verbalizing at the appropriate time also improves the ability to recall and organize information and that writing encourages greater precision that speaking. As with collaborative experiences, writing assignments are designed to involve students in the learning process and give opportunities for critical thinking. (p. 168)

McIntosh (1991) maintained that while reflective response journals can be used in all areas of the curriculum and at various strategic points throughout a unit, they can superficially outline a process, provide explanations, and review an observation. They were instrumental in the patterns unit by providing immediate feedback to the teacher. However, the teachers who are the most difficult to convince of the worth of writing as a normal part of their curriculum are the mathematics teachers. The idea is so foreign to the majority of mathematics teachers at every level that even the mere suggestion is often met with derisive looks, rolled eyes, and shaking head. (p. 423)

Consequently, students were asked to complete specific journal entries ranging from brainstorming and discussion starters to summarizing tasks and activities. The teacher hoped
that by involving students in the reflective response journal process, the students' learning might move from being receptive and passive to being active and productive. It was hoped that by integrating material and thoughts about a task to the students' personal frame of reference, they might develop a greater understanding of the content information being covered; a goal put forth by the Vancouver School Board:

Encouraging students to recall and reflect personalizes the process and may lead to a greater understanding (i.e., using their own words and ideas to express concepts may make information meaningful). (VSB Workshop, 1992)

The teacher was of the opinion that journal writing was a multifaceted approach to teaching that could be used at almost any point in the lesson for a variety of purposes. His intention was to strategically place journal tasks throughout the unit to provide students with opportunities to facilitate reflecting and allow for a forum to respond to material and/or activities and to correspond with students in a safe environment. Moreover, journal writing provided the teacher with another form of feedback as to student insight and understanding of patterns in math. The NCTM states:

Using writing in a content area has earned the support of many educators...writing in a content area can cause students to analyze, compare facts, and synthesize relevant material. Writing about a topic requires students to think about the topic, focus on and internalize important concepts, and make those concepts to some degree their own. (p. 516)

Learning logs have several advantages. Firstly, mathematical concepts when put in a written form have several advantages over discussion and verbal dialogue. Secondly, he believes that journals and learning logs foster simultaneous student participation. In addition, they
encourage children to be more precise because they need to put their thoughts clearly forward in writing rather than blurting it out in class. Finally, McIntosh (1991) believed that learning logs make student work available to further, extended examination by the teacher at later dates, notably dates closer to a reporting period:

Writing is not a sure-fire way to help students understand or like math, but it does open lines of communication and helps to build a sense of community and trust so that students can take risks. It also gives students another way to look at math problems. Mathematics is, after all, communication, but communication in math involves compact, unambiguous symbolism that to many students is cold and rigid. Writing, on the other hand, is a less structured way of expressing ideas. (p. 430)

The teacher was of the opinion that journals could be used in all curricular activities. Moreover, it could push students to think through topics and subsequently become accountable for their learning. He was of the opinion that journal tasks could help to provide samples of student writing that could go towards the report card. McIntosh (1991) contended that:

The benefits of writing in the mathematics classroom are numerous. Writing is an active process that promotes students' procedural and conceptual understanding of mathematics. Students often find out what they think when they write... and clarify their thinking about, mathematical ideas and relationships.... It can also serve as an informal assessment of understanding... It establishes an open channel of communication between teacher and students that promotes good rapport and positive classroom environment. (p. 354)
The journals were not used for any therapeutic means or sharing games. The teachers were very much advocates of developing communicative competency and critical thinking skills in students and believed that journal writing was a non-threatening environment to pursue this endeavour. McIntosh (1991) believed that the function of the reflective response journals or learning logs was to serve as a means for recording student's thoughts:

The remarkable thing is that most of the students repeat on a test a definition such as “An event is a set of outcomes”. Yet, when asked to explain how these two concepts are related or to write a sentence containing both words, students almost never write the definition or any mathematically correct statement. What student Learning Logs may perceivably lack... in precision is made up for in the likelihood that by using their own words, the definition has more meaning and is therefore more likely to be understood-- not merely memorised.... Misconceptions that may otherwise go unnoticed become apparent, thereby helping teachers identify areas that need re-teaching. (p. 424)

3.11.7 Data Collection: Analysis of Descriptive Language

The students' written work will be given a detailed analysis. Details of the rationale behind this was given in the chapter that reviewed the research literature, but at this stage certain general points can be made. It was noted that the children’s written work in the Patterns unit was directed towards the description of mathematical patterns, and that the children's written work in the Narnia unit was directed towards the description of characters in the novel. This suggested that a comparison could be made of the language of description in each case as a way of illuminating the students' work in each unit. In addition, since description was one of the knowledge structures used in the Knowledge Framework, an
analysis of the language of description provided a way of looking in detail at one of the knowledge structures which formed a basis for the design of both units.

This paper will now summarize the use that it will make of the various kinds of data. The account of the Patterns and Narnia units will operate at a macrolevel and a microlevel. At a macrolevel the paper will provide a detailed narrative of the progress of the two units. This will draw on most of the kinds of data mentioned above and weave them together. From this macrolevel narrative the paper will identify certain questions which will be pursued further. Then it will move into a microlevel analysis, which addresses those questions by providing a close analysis of the discourse of description in the Patterns and Narnia.

3.12 Conclusion

This chapter outlined the methodology and procedures used throughout the Narnia and Patterns units. It has reviewed the site selection, the role of the researcher, purposeful sampling strategies, and the selection of the subjects. Additionally, it reviewed some of the prior units and activities the children had been taught in an effort to provide some context and paint a picture to illustrate where the children were in their schooling regarding prior knowledge and experience with this material. The chapter discussed some of the nuances of the collaborative consultation process. This included the roles of the teachers and some of the factors they took into consideration. It highlighted how they planned the major topics for the unit, developed the strategies for working towards the unit goals and objectives, designed tasks that are useful and interesting for the students, and then ensured that the tasks allowed them to access the language and content demands of the unit. It looked at both the Patterns.
and Narnia units through the conceptual lens of the Knowledge Framework in developing appropriate tasks to meet the PLOs of the IRPs using key visuals. The chapter mentioned the teacher’s willingness to make adaptations and changes to the unit in an effort to meet the needs of his students. Finally, the chapter outlined some of the purposeful data collecting activities used, such as strategically placed student reflective response journals, a major student survey at the conclusion of the unit, testing throughout the unit, teacher journal, the collection of student writing samples, and informal student interviews.
CHAPTER FOUR: Discussion of the Results and Findings

This chapter will examine the data of the Narnia and Patterns units and will mainly consider two matters of prior knowledge: prior classroom experience and the link between everyday language and technical language in student discourse. It is divided into three parts. Part A will consider the schoolwork data from the Narnia and Patterns units and their relative degrees of success. Part B will consider the Patterns unit in more detail and discuss the role of prior classroom experience. Finally, Part C will consider the Narnia unit in more detail and compare both units with respect to quality of descriptions and the link between everyday language and technical language in student discourse.

4.1 Part A: Overview of the Results from the Narnia and Patterns Units

This section considers the schoolwork data from the Narnia and Patterns units.

4.1.1 The Narnia Unit

From the beginning of each unit, there was a marked difference in the level of achievement of students between the Narnia and Patterns units. In terms of the Narnia unit, approximately 19 out of 29 students (65.5 percent) achieved 80 percent or higher for their overall term average mark. Only three out of 29 students (10.3 percent) scored less than 50 percent for the unit. The teacher believed that much of the students’ work was well done, and their writing samples were clear, succinct, and indicative of grade-appropriate writing. The students appeared to understand readily how to describe characters—certainly they were opinionated about their favourite and least favourite ones. A possible explanation for this success at character description may be the students’ prior experiences with adjectives,
descriptors, and the mechanisms of character description taught in earlier grades. Further to this, a significant amount of language around the classification and description of characters takes place throughout the early elementary school years. Therefore, it is plausible that the students had a certain familiarity with the everyday language of ranking and evaluating characters and personalities. Thus, the level of success and proficiency in the Narnia unit may be attributed to prior school experiences and some familiarity with community practices such as talking about people.

4.1.2 The Patterns Unit

In comparison to the Narnia unit, it would appear from the results of the Patterns unit that many children experienced difficulties answering questions regarding patterns, relations, and functions. Apart from the beginning activities in which the teacher was trying to build context and background knowledge by doing simple pattern tasks using manipulatives or pattern strip activities the students' achievement suggested that many students found the Patterns unit to be complex and challenging. Only one student scored 80 percent or higher for the unit. When the level of achievement over 80 percent from the Patterns unit is compared to the level of achievement from the Narnia unit (3.4 versus 65.5 percent respectively), it appears that the students found the Patterns unit to be more difficult, and perhaps many of the concepts were not clearly understood.

In the Patterns unit, 13.8 percent of the students scored less than 50 percent. This was slightly higher than the 10.3 percent in the Narnia unit. There appears to be two significant findings that arose out of the data. Firstly, there was a surprisingly high percentage of students (65.5 percent) scoring above 80 percent for the Narnia unit. Secondly, there was a
significant difference in the levels of achievement between the two units. For example, the class average in the Narnia unit tended to be around 87.7 percent for most of the tasks, whereas in the Patterns unit it fell to about 65.5 percent.

This was a puzzling set of findings to the researcher because the Narnia and Patterns units had been developed under similar circumstances. The scores indicated that students experienced some difficulties understanding and interpreting the questions in the Patterns unit. Additionally, the teacher believed that a large number of students were unfamiliar with the language and contextual nature of patterns, relations, and functions. Many students did not appear to be aware of the existence of a vast array of patterns such as growing, shrinking, repeating, and alternating patterns based on numbers or attributes). This was troubling for the teacher because the Ministry of Education’s IRP for Mathematics indicated that this should be common knowledge among students at the grade five level. Thus, the student context regarding school experiences with patterns, or their familiarity with the content material, may have been somewhat deficient. Further to this, the teacher found that he continually had to describe, elaborate, simplify, equate, and define terms, discourse, and situations as they related to patterns, relations, and functions. This ongoing dialogue between the teacher and the students often left the impression that the students were not experienced at discussing patterns as they exist in math or in everyday life.

This discrepancy between the scores in each unit is illustrated in Figure 4.0.
The graph in Figure 4.0 outlines the difference in the levels of student achievement between the Narnia and Patterns units. In addition to the relatively large difference in the level of achievement between these units, the teacher noticed a difference in the students' level of confidence and success with which they tackled the tasks between the two units. This will form the basis of Parts B and C of this chapter.

4.2 Part B: The Patterns Unit and the Curriculum

This section of the paper will consider the role of prior experience in the school curriculum as it may have impacted on the students' achievement in the Patterns unit. Throughout the course of the unit, there were a number of incidents during which the teacher felt that the students were experiencing difficulties due to a lack of familiarity with the material. An example of this occurred early in the Patterns unit and was observed in the student journals for Task 2. Many of the students indicated how surprised they were at the
difficulty of the Patterns activities. Several students wrote that some of the pattern questions were hard and that they were not sure what to do because they had never seen the question before. A number of students wrote journal entries that indicated that they were struggling with this type of patterning. Student 3 wrote that patterns were, ... "hard and easy, that depends on the pattern..." Student 10 stated, "I know what a pattern is, I just can’t explain it." Other students such as Student 17 reported that “It is easy to do a pattern, but it is hard to explain a pattern”. Finally, Student 19 summed up many of the entries by saying “... you may not know it, but there could be a pattern right under your nose.” An important surprise for the teacher was that the students indicated that they had not actually worked through problems like this before, and therefore they were not too sure how to go about answering some of the questions. The students appeared not only apprehensive about answering pattern questions, but they used very basic discourse and simple adjectives to describe patterns (see Figure 4.1).

**Figure 4.1**

*Bar graph classifying student responses to describing patterns*
Figure 4.1 graphs the frequency and type of descriptors used to classify patterns by the students. Interestingly, Figure 4.1 illustrates that 22 students (75.8 percent) recognise that the nature of patterns is that there is a repeating element about them. Unfortunately, less than half the class (44.9 percent) included any mention of attributes (e.g., colour, size, and shape). Further, only 27.6 percent of the students commented that patterns can be seen in numbers. Even the Math IRP (1995) for grade two specifically states that students should know that:

... repeating and growing patterns leads to their being able to associate and record numbers for patterns.... It is expected that children will investigate, establish and communicate rules for numerical and non-numerical patterns. (Appendix A)

Thus, it seems as though the curricular knowledge expected for even grade two students was not something many of the students participating in the Patterns unit were familiar with.

The teacher was pleased to see that three students (10.3 percent) mentioned the existence of patterns in real life; however, the reality of the situation was that the teacher recognized that this demonstrated an element of naivété and inexperience with patterns as a mathematical concept. He believed that the children were being sincere and answering the questions to the best of their abilities, but according to the widely held expectations in the Mathematics IRP (1995), the children should have been able to:

... describe, extend, create, analyse and predict patterns knowledgeably... Students will construct, extend, and summarise patterns using rules, charts, mental mathematics and calculators... Describe how a pattern grows using everyday language orally and in writing. (Appendix A)
Therefore, the teacher was hoping for more comprehensive descriptions that
demonstrated some familiarity with increasing, decreasing, and repeating patterns of multiple
attributes and rules. It should be noted, however, that the students’ inexperience with
patterns did not come as a complete surprise to the teacher. In fact the teacher designed the
journals as a means for making sure all the students were rowing in the same direction at the
same time. The early journal entries served as a way for the teacher to re-group the students
as a class and make sure that they were all on-side regarding the concepts covered in class.

Thus, it quickly became apparent that one possible explanation for the students being
too indecisive and uncertain about their answers and responses was that many students did
not appear to have been involved with Pattern units for the past two to six years. In an effort
to determine the children’s prior experiences, Task 30 and 31 involved survey questions
regarding the children’s past experiences with math patterns (see Figure 4.2).

Figure 4.2

Bar graph of student responses recalling the last grade they worked with patterns

Figure 4.2 is a graph of student responses recalling the last grade they remember
working with patterns. It illustrates that approximately 25 students (71.43 percent) recalled
that the last time they worked with math patterns was prior to grade three. From Figure 4.2 it is clear that the last time many of the students said they worked with Patterns was back in Kindergarten to grade two. This graph paints a picture of a group of children who have a limited amount of background knowledge regarding this specific topic. In fact, almost 72 percent of the class indicated they had not worked with patterns since grade two, or earlier. This lack of exposure to patterns, relations, and functions in school life may be the reason for their marginal performance. Consequently, the teachers felt comfortable with their earlier conjectures that one possible reason for some of the children experiencing difficulties interpreting and answering particular questions may be reflected in the children’s limited prior knowledge and curricular exposure to patterns, relations, and functions.

It is obvious that the students found the material in this unit to be challenging. Although students had covered materials in units on place value and decimal notation, addition, subtraction, multiplication and division of whole numbers, number theory, metric measurement and problem-solving, nowhere in the curricular materials were there any overt or explicit references to patterns, relations or functions.

Another example that illustrates the unfamiliarity with curricular material is Problem Solving Tests 1A and 1B (See Appendix F). The material and questions for this test were compiled from grade-appropriate math material notably grades three to five (grades 3 to 5).

Although the test was collated and designed using grade appropriate material, no students received higher than 79 percent for Problem Solving Test 1A and they later rewrote the test as Test 1B. Figure 4.3 illustrates student achievement on Problem Solving Test 1A.
Figure 4.3 illustrates that there were no marks lower than 17 out of (39.5 percent). Consequently, nine out of 27 students (31 percent) received less than 50 percent on the test. Most students were clustered between the 24/43 to 30/43 range (55% to 69.7 percent). Thus, the overall achievement for this test was average to mediocre. Figure 4.4 illustrates the breakdown of achievement for Problem Solving Test 1A.

Figure 4.4

Chart summary of the distribution of marks for Problem Solving Test 1A

<table>
<thead>
<tr>
<th>Marks/Question</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
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<td>13</td>
<td>1</td>
<td>2</td>
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<td></td>
</tr>
<tr>
<td>4a</td>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>0</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4b</td>
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<td></td>
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<td>8</td>
<td>0</td>
<td>13</td>
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<td></td>
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<tr>
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<td>0</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5b</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5c</td>
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<td>0</td>
<td>28</td>
<td></td>
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</tbody>
</table>
In particular, Figure 4.4 indicates that there are several questions where all students in the class received zero marks. In fact, 8 students (28.5 percent) received zero marks on question 3, 16 students (51 percent) received zero for question 4a, 10 students (35.7 percent) received no marks for question 4b, 13 students (46.4 percent) received no marks on 4c, and all students (100%) received zero for questions 5a, 5b, and 5c.

The teachers were obviously concerned about the scores, distribution of marks and the apparent gaps in student understanding of particular questions. Although both the resource teacher and the classroom teacher in hindsight conceded that questions 5a, 5b and 5c were in hindsight probably too difficult for the students, their interest was drawn to the poor results of questions 3, 4a, 4b and 4c, as the material came from grade five resource books.

The questions that caused problems for many students may be indicative of the students' lack of familiarity with that particular type of question. As the questions were all based on grade-appropriate material and yet, many of the student responses consisted of blank responses, the teachers questioned the familiarity students may or may not have had with the questions. For example, question 3 was an addition triangle (see appendix F). Its rule is based on always being the sum of the lower boxes. However, many students could not attempt, complete, or answer the question correctly. Upon discussing this with the class, many students indicated that there were no signs indicating what to do and that they had not seen a question like this in any other math class. They complained that they did not know which direction the triangle went or which function they should apply to solve the problem. Student 1, a fourth year ESL student didn't attempt the question, Student 3, a straight A student, left it blank, and Student 5 thought it was a multiplication problem.
The students themselves were able to state as early as Journal 2 that their background knowledge was weak. Several students commented that although they thought patterns were easy, they were difficult to explain. Student 17 wrote in his journal, “It’s easy to do a pattern but hard to explain.” The resource teacher and the classroom teacher felt that these difficulties in explaining patterns might have been because patterns are not defined frequently in the curriculum. This led students such as Student 15 to write, “I don’t know how to do a line (a pattern strip). I really get mixed up on that...”

Students appeared to have found the task of writing about patterns uncomfortable and difficult. Their inability to use the language of describing, classifying, or explaining patterns reaffirmed the fact that they had had little experience describing, extending, or discussing patterns. The epitome of this was when student 10 wrote, “I know what a pattern is, I just can’t explain it”. This recurring theme of unfamiliarity with questions throughout the Patterns unit gave the teacher reason to hypothesize that there was a common thread of lack of prior knowledge and experience with school-based materials.

In an effort to accommodate the wishes of the students and to provide them with an opportunity for increasing their grades, the teacher let the children rewrite the test. Rather than just rewrite the next day, the teacher slotted in a rewrite as Task 12 in the unit. As the original Problems Solving Test 1A was Task 1 in the unit, eleven tasks were completed before the students actually re-wrote the test as Task 12 Problem Solving Test 1B (see Figure 4.5).
A significant amount of background-knowledge building activities was conducted prior to re-writing the test as Problem Solving Test 1B. Students had opportunities to complete two journal entries, receive direct instruction on patterns as they occur in nature, the environment, and around the school, discuss patterns as numbers, and practice making and describing patterns for other children in the class.

Figure 4.5 also suggests that the students did not have the experience, knowledge or context to successfully answer the questions upon rewriting the test. Their marks showed less than significant improvements between the original and the rewrite. Although 71.43 percent of the students scored between 74 to 79 percent, only one student scored higher than 81 percent. The students still appeared to be unable to interpret or answer the questions on the tests. As the test had been reviewed with the students, and they had their original Problem Solving Test 1A to refer to for studying, the teacher was concerned about the students’ proficiency at solving pattern problems. Furthermore, by the time students wrote Problem Solving Test 1B, they had completed Tasks 2 to 10 which were designed to build
Figure 4.6 illustrates the distribution of marks for Problem Solving Test 1B. It demonstrates that students did well on questions 1, 2 and 3. However, it outlines that a number of students still had difficulties answering questions 4a, 5a, 5b, and 5c. Although the thought of abandoning the unit was discussed, the classroom teacher and resource teacher made a conscious decision to continue with the unit in an effort to see how students managed with the materials dealing with number patterns, problems, and computations. Further, they wrestled with the ethical decision of exposing the children to the type of mathematics which they were supposed to have learned previously and be still learning, or quitting and then just being part of the problem in that the children again suffer.

Problem Solving Test 2 (See Appendix H) was designed from grade five mathematics resources and based on the following considerations:

1. Students should be able to identify a sequence of numbers (e.g., linear form).
2. Students should have some form of diagram (key visual) in order to reduce the risk of language interfering with their ability to solve the problem. Plus, the
teachers felt that the key visual may resemble familiar pattern blocks that the students may have worked with in earlier grades.

3. Problems had to incorporate word problems as a means of outlining real-life experiences or situations.

Questions 1 to 5 were sequential numerical pattern problems; questions 6 to 10 were diagram pattern questions that examined students' spatial perceptions (question 9 and 10 even illustrated the solutions to the problem). The results of this testing appeared to indicate a mediocre success rate (see Figure 4.7). After 18 tasks and activities, numerous reflective response journals, and hours of direct instruction coupled with peer response sharing, approximately 12 students (43.8 percent) scored above 50 percent. Nobody in the class scored above 78 percent.

Figure 4.7

**Graph of student achievement for Problem Solving Test 2**

As 17 students (60.7 percent) failed Problem Solving Test 2, the classroom teacher and the resource teacher were beginning to think that the time had come to throw in the
towel. Figure 4.8 graphically shows how the students did not fully understand the concepts being covered in class. This was the most discouraging part of the unit for both the resource teacher and the classroom teacher:

An intensive remediation program is necessary if we're to provide the students with the foundations for solving patterns... these kids just don't have it, nor get it... because they've never been given it. (Teacher’s Journal)

**Figure 4.8**

**Chart summary the distribution of marks for Problem Solving Test 2**

<table>
<thead>
<tr>
<th>Question/ Marks</th>
<th>2 marks</th>
<th>1 mark</th>
<th>0 marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>15</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>12</td>
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</tr>
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<td>0</td>
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<tr>
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</tr>
<tr>
<td>10</td>
<td>26</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 4.8 reflects an overview of student achievement for Problem Solving Test 2 and the distribution of marks which tend to reflect a familiar pattern regarding student achievement. There appears to be a large number (50 percent) of partial marks being awarded per question. Unfortunately, the result is that a large number of students appear to receive only minimal marks for the first six questions of the test. Additionally, they appear to have not understood question 7 (25 students, (93 percent) received zeros marks for that question). On the positive side, all students in the class received 100 percent and full mark values for both questions 9 and 10.
At this point in the unit, the teacher realized that what made these questions different from the first eight was that these two questions used key visuals or diagrams as a means for conveying and illustrating the patterned partial solution to the word problem. The students did well with the visual, so the teacher set out to redesign part of the unit so that it took advantage of working with visual organizers and the Knowledge Framework (Mohan, 1986), in which key visuals assist in easily representing content information in a text-reduced manner. The teacher was excited about trying to develop a generic template that would assist children by visually and spatially representing the context of a Patterns unit question.

Meanwhile, Problem Solving Test 3 was designed as a continuation of Test 2 (See Appendix I). Its purpose was to present real-life situations in the form of pattern word problems. The test involved larger numbers (e.g., 50 laps or 400 metres) but all questions were from grade five curriculum resource material. The teacher included key visuals, charts and diagrams, as a means of visually conveying information to the students. Unfortunately, these efforts did not result in improved student performance (see Figure 4.9).
Figure 4.9 illustrates that 16 students (57.14 percent) scored below 50 percent on the test. Concurrently, students worked through a number of tasks that made up the fabric of the unit. Each task was deliberately developed, sequenced, and planned to act as part-of-a-whole. The teachers anticipated that these pieces (tasks) would create a larger picture of patterns in mathematics as they were combined and worked through.

As the students were exposed to different tasks and activities throughout the first half of the unit, their background knowledge was slowly developing to a point were they were able to provide some insightful comments about patterns in mathematics. It was at this point that an underlying perception by the classroom teacher and the resource teacher evolved. There appeared to be a large gap between the Provincial Ministry of Education IRPs and the abilities of the students. Further, the textbooks and mathematical material being used at the school barely touched on the Prescribed Learning Outcomes (PLOs) that were expected from
the Ministry of Education. In other words, somewhere between making pattern strips and playing with beads in kindergarten and the expectation to be able to use \( x+1-4 \) as a formula in a word problem in grade five, the students’ educational opportunities were apparently being restricted. The teacher hypothesised three possible explanations for this.

Firstly, he was of the opinion that patterns, relations, and functions were not being taught in grades two, three, four and five to any useful extent. The cooperating teachers acknowledged that there may only be periodic exercises, tasks, and activities that require math pattern strategies. Unofficially, however, a number of primary teachers indicated that they did not expressly work with patterns, and nor were they an integral component to their teaching.

Secondly, the teacher felt that there was a definite lack of mathematics materials, manipulatives, and resources at the school. The staff had identified professional development growth options in literacy and mathematics as essential areas. Consequently, the staff participated in a one day math strategies workshop at a local elementary school. However, ideas, strategies, materials, and resources acquired at the workshops were only recently being implemented in the school and only with some staff members. Consequently, many of the students appear to be behind or not able to meet the PLOs of the Ministry of Education’s IRPs.

Finally, the teacher felt that there was a gap even in the pedagogy of teaching concepts of math patterns at all grade levels throughout the school. Upon informal questioning, various teachers admitted that they did not teach patterns as a unit, and nor did they base criteria for reporting on patterns in math. Some teachers included patterns in kindergarten, others did not. This seemed to be consistent throughout all grade levels, were
becoming readily apparent from the onset of the unit. The students' understanding of math patterns possibly included some form of exposure in either kindergarten or grade one. There appears to be a number of years during which they did not work with math patterns. Even for students who generally performed to a high level of achievement, some of the pattern material appeared to be challenging and difficult for them (see Figure 4.10). This might be an indication that some of the PLOs are too cognitively demanding for particular grade levels.

**Figure 4.10**

**Graph of student responses to the difficulties working with patterns (Journal 4)**

Perhaps the most revealing information from Journal 4 entry came by way of the "your thoughts" section. Many of the students wrote insightful entries which revealed that they were engaged in the unit but experiencing problems. In this particular example, Student 27 indicated that she “...never knew there were patterns till grade 6.” This statement tends to be at the root of what the teacher saw time and again throughout the unit.

Other students such as Student 6, Student 9 and Student 16 alluded to the difficulty of
finding a pattern. Student 6 wrote, "I believe that is hard to find a pattern because it is camouflaged or it is right under your nose and you don't even know it... If the pattern is overlapping or crowded it is difficult to find a pattern. You can't easily find a pattern that is the colour". Student 9 was more direct with her comments. She stated:

First, some pattern problems are hard.... Hard pattern problems are tricky; meaning hard to figure our or it tricks you.... Well, it hard when a pattern problem starts too tricky from the beginning, then its very hard to figure out. Also, a pattern is hard to find when the first number is odd and even the second number is odd and so on... However, if the pattern problem doubles itself, it might look kind of like an easy pattern and if a pattern is easy from the beginning you'll go, "Hey I already know the rule".

What Student 9 was perhaps saying was that it is easier to solve patterns if the student can identify the pattern early in the pattern. The longer the identification time, the greater the difficulty in spotting the pattern. Student 16, an A student, was most indignant that something as simple as math patterns was causing so such thought-provoking work:

... a pattern hard to find is there is sometimes a very easy pattern right after that, there is a hard one and that makes you think a lot more. Patterns are also hard to find because they involve different types of math equations. Another thing that makes a pattern hard to find is if you don't put your mind to it, you are automatically making it hard on your own.

Several students made reference to the fact that they had not done work like this before. Perhaps the most telling comment came from a third year ESL student. Student 5 wrote, "I think a pattern is hard to find because if you had never learned about patterns
before. It's hard to see a pattern when your teacher asks you to see if there is a pattern on paper. What would you say? So, you should learn about patterns."

There seems to be overwhelming possibilities regarding the students' abilities to digest the language associated with interpreting, describing, and communicating mathematically. Based on the struggles students had with beginner-level categories that they must classify patterns under, it appeared that their mechanism for interpreting and describing patterns was weak. Upon trying to complete the activities in a task, the student's abilities to communicate mathematically appeared to differ from the widely held expectations of the Ministry of Education's IRPs. Further, as their reflective journals tended to carry overtones of their marginal performance, it should be noted that students appeared to have not participated in nor worked on questions similar to those in the Patterns unit since grades one or two. This prolonged gap or period of inactivity may have had an influence on the students' inability to manage, manipulate, extend, infer, and describe patterns, relations, and functions.

Consequently, the language and prior knowledge they used was limited and underdeveloped. The children's ability to interpret questions, problem-solve, and express answers was hampered. Students did not appear to have extensive school experiences regarding the language, genre, or context used to discuss, evaluate, and describe patterns, and they were rarely able to effectively articulate their opinions about patterns. The students were trying their best. Moreover, their collaborative planning efforts were constructive. However, this researcher believes the students were working to the level they had previously experienced. It seemed that only with the introduction late in the unit of a key visual template which gave structure, organization and shape to pattern problem solving did the
students achieve higher scores. The teacher moved the class towards working with a visual template which was designed to assist students with strategically working through pattern problems. The British Columbia Ministry of Education's IRPs stated that children had to be able to recognize and create patterns since grade four. Students were to have begun identifying and explaining the relations between patterns and systematically investigating a variety of patterns using grids. The teacher saw no evidence that this had previously occurred.

4.2.1 The Template: Remedial Activity Tasks

Interestingly, once a key visual template was introduced to the students (Tasks 23, 24 and 25), their marks improved noticeably (see Appendix E) for most of the activities. The template was divided into several sections:

a) The Objects—was a pictorial representation of the pattern problem

b) The Problem-- the pattern was presented in a word problem format

c) Finding the Solution-- was a working area were students could brainstorm, scribble, look for similarities and differences, and compare and contrast parts, facts, and details of the problem

d) A table-- was a section to record terms and trials of repeating, growing and shrinking patterns questions.

e) Is there a pattern? Describe it!-- was a section where students were required to use English language as a means for communicating and describing the pattern.

f) What is the pattern based on?-- was a section where students were required to isolate the attribute of the pattern

g) What is the rule-- was a where students were required to isolate and identify the rule of
4.2.2 The Unit Final Tests

It would appear as though there were enough subtle differences that students were not able to transfer the same results to subsequent questions (see Appendix G). An example of the seemingly subtle differences was that Test 2A gave students both the input and the output number. On the other hand, Test 2B gave between 0 and 2 input and output numbers. As a result, it would appear as though students were required to rely more on the visual graphic that accompanied the question and predict not only the operator, but also the resulting number.

The second difference relates to the concepts of the visual and spatial representation of the two tests. As discussed, Test 2A required students to find only the operation and operator (rule). On the other hand, Test 2B gave only the input number with the occasional output number. The most notable difference was that Test 2B required students to utilise the accompanying key visual and subsequently predict the output number. Moreover, Test 2B required not only the output number, but also the operator (rule).

It appears as though students had difficulty with Test 2A and 2B. The cooperating teachers hypothesized that this might have been the result of students grappling with key visuals. Although students were familiar with key visuals in Language Arts, they were seemingly not comfortable with their presence in mathematics. So much of their school curriculum tends to focus on computational skills versus application to problem-solving and trouble-shooting that there may have been little room for visuals in math. Thus, the teacher
was led to believe that the students were okay with the Language Arts key visuals, but math key visuals gave some problems.

It would appear that more testing should have taken place to determine how well students understood pattern problems. Based on the context of this study, it appears as though the children, although trying their best, were unable to interpret and answer questions that involved patterns in number and word problems. Future research should include examining the stages of pattern teaching throughout the elementary school curriculum, notably how patterns are being taught and what the content and context is that is being introduced to students.

We have looked at patterns and considered our first interpretation that the students had been provided with little prior experience with patterns in the school curriculum. This provides some account of the difficulty that the students had with the Patterns unit.

4.3 Part C: Narnia and Language

Part C will consider the Narnia unit in detail and then compare both units with respect to the quality of descriptions and the link between everyday language and technical language in student discourse. It is worthwhile to remember that the two matters relating to prior knowledge that are being pursued through this study are not alternatives to one another, but rather potentially complementary. For example, it is possible that students lacked prior experience in working with and talking about patterns both in the school and in the community. However, it appears to this researcher as though the students' difficulties with patterns appear to go beyond the general lack of school experience. Instruction alone did not seem to be a complete remedy, as evidenced by their marginal success throughout the
Patterns unit. They seemed to be having persistent difficulties with the unit even when they were getting instruction. On the other hand, the classroom teacher and the ESL resource teacher anticipated that the students were not going to have difficulties with the Narnia unit. Moreover, they were of the opinion, based on their practical experience, that the students would understand the tasks and would be capable of completing them successfully for several reasons. Firstly, the students at the grade five and six level would have already completed a couple of years in a classroom that had been focussing on discourse and vocabulary for character description. Secondly, rather than working with patterns, the work associated with the Narnia unit lent itself to evaluating characters and judging their qualities and attributes, which seemed to be a more natural procedure. In other words, the social language that we use daily lends itself to ranking and judging character traits (see Figure 4.11).

**Figure 4.11**

*Distribution of student scores for Tasks 3, 5 and 6*

![Figure 4.11](image)

Figure 4.12 illustrates that for Tasks 3, 4, and 5 of the Narnia unit, the students had an average score of 90 percent. Many of the students worked through the tasks with ease and
comfort. One of the first tasks where this was evident was Task 1 Sort and Defend. This was a task that was designed to provide some insight regarding vocabulary, as a resource for the children. In this task, students were divided into groups, given envelopes containing the same words chosen from the novel, and told to sort, arrange, or classify the words in any way that made sense to them. Upon sorting and agreeing on the categories, the words were glued to a cardboard poster for display and presentation purposes. Members of the group then toured the room looking at other groups’ work. One member from each group was designated to stay behind and defend, justify, or explain the groups’ classification scheme.

The intent of this task went far beyond having children sort and classify words. One of the goals was to provide students with a preview of the language that they could expect to see throughout the novel. A subsequent goal was to determine whether or not students were familiar with words that were associated with the prevalent theme of the novel, such as good versus evil. Many of the words were similar within all groups (see Figure 4.12)

Figure 4.12

Chart of Task 1 Sort and Defend classification schemes used by student groups

<table>
<thead>
<tr>
<th>Term</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
<th>Group 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bad</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Cold</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Frozen Water</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Landscape</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Narnia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Natural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Personality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Places</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scenery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Stones</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>War</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Weather</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

All groups were able to construct an interesting array of categories that reflected the
similarities and differences of the arranged words, as Figure 4.12 demonstrates. Further, based on their interpretations and classification schemes, students recognized a need for categories dealing with things that are cold and places.

It may be that the students in this class were able to work through the discourse and make sense of it based on their prior experiences of describing people and not simply on their school experiences with the study of novels. It is possible, based on the children’s social experiences with description and the use of adjectives to describe everything from television heroes to sports stars, that they were able to complete this task relatively easily. Their everyday language seemingly included the necessary vocabulary to understand and work with the discourse. It seems to the researcher that students were continually engaged in the social practice of defining, judging, evaluating, choosing, and describing peers, adults, friendships, relationships, and fictitious characters in television shows and novels. From an early age, students are not only being conditioned to be able to scrutinize and evaluate people, but also to being able express their views and opinions, and critically reflect on what people—friends, relatives, strangers, bosses, teachers and peers—mean to them.

The fact that the children were able to collaborate and arrange words so that they reflected the major themes of the story was an indication that they collaboratively shared a functional understanding of discourse and vocabulary as it related to the novel. Their ability to express the desired answer was important because it demonstrated an understanding of the language skills necessary for effectively utilizing descriptors of objects, events, and characters that appeared throughout the novel. Although this was the second novel study the class had participated in, the teacher was impressed with the abilities of the small group members to discuss the meaning of the words and themes. The skills associated with this
task appeared to utilize the everyday language that children and adults continually participate in throughout their lives.

**4.3.1 Using Key Visuals with Tasks 2 and 3: "Mr. Tumnus"**

Support for the suggestion that students are familiar with character descriptions of people is found in their descriptions of one of the characters, Mr. Tumnus, in Task 2 and 3 of the unit. A key visual was used as a means to promote greater understanding for the character. The graphic represented the cognitive structure of the interrelationship of actions, feelings, physical characteristics, and opinions of Mr. Tumnus. By encouraging students to think of descriptors relating to several specific personality traits, the resource teacher and classroom teacher hoped that the students would write paragraphs which would be more descriptive, comprehensive, and detailed than if they had just sat down and started writing. The key visual displayed and modeled the essential information and discourse. In other words, it helped to shape the content of the students' work. Once students had descriptors for a number of personality traits, they were given the assignment to use the language of opinion to write a five part essay describing Mr. Tumnus (see Figure 4.13).
Based on the frequency of adjectives selected to describe Mr. Tumnus, Figure 4.13 indicates that the majority of children perceived him to be friendly, gentleman-like, and polite. Moreover, they have determined that he felt bad, guilty, and sad that he tried to trick Lucy into being captured by Queen Jadis. Further to this, the students described him as being different from humans in that he was hairy, weird, and tidy. Also, the majority of students noticed that he spoke with an English accent and was always polite. As a whole, the chart indicates that students had a rich understanding and vocabulary to describe Mr. Tumnus.

By providing students with a framework for accessing key descriptors of Mr. Tumnus and by brainstorming the language for writing opinions, which was provided on a word bank sheet, students could then pick and choose between any descriptor or opinion phrase and insert it into their writing. The process allowed students an opportunity to select and infuse specific language and discourse into their paragraphs. The teacher hoped that by using the key visual, students were able to structure and organize their work, communicate in a clear,
effective, and efficient manner, and alleviate the anxiety of trying to pull words out-the-air to construct a coherent paragraph. Student 1, an ESL student wrote a character description of Mr. Tumnus in Figure 4.14. Although it is short, it contains precise information that makes the writing detailed, complete, and accurate.

Figure 4.14

Writing sample from Task 3 of the Narnia unit

| In the novel, The lion, The Witch and the Wardrobe we are introduced to Mr. Tumnus the faun. |
| From my point of view, I think that Mr. Tumnus is kind, honest and hairy. |
| Mr. Tumnus is kind because he invited Lucy to his cave to have cake, tea, sardines ect. |
| Mr. Tumnus is honest because he never lies. |
| Mr. Tumnus is hairy because he has many hair in his legs, tail, head, chest and he also has a beard. |
| This chapter ended that Edmund went into wardrobe. |

Although there are some minor grammatical errors and his concluding paragraph is weak, Student 1 used descriptors, the language of opinion, and provided the reader with evidence to support his point of view. His writing reflects a genre of opinion language (e.g., From my point of view, I think...). Moreover, he provided a thesis statement supported by three statements of detail. This is particularly surprising when one considers that according to the Gates-McGinity Testing, Student 1 scored two grade levels below the norm (i.e., he was equal to gr. 3 students for both vocabulary and reading comprehension.

Figure 4.15 represents another writing sample from student 27, another ESL student. She used several opinion language phrases to outline her point of view on Mr. Tumnus. Note that each sentence has the language of opinion, an adjective, and a supporting reason.
In the novel, The Lion, The Witch and the Wardrobe, we were introduced to a Faun name Mr. Tumnus. From my point of view, Mr. Tumnus is tidy, thoughtful and noble.

In My opinion, that Mr. Tumnus is tidy because he keeps his house clean and he is organized.

I believe that Mr. Tumnus is thoughtful because he asked Lucy to come to his house.

It seems to me that Mr. Tumnus is noble because he put the umbrella over to Lucy when she didn't ask him to (he covered Lucy in with the umbrella to protect her from the lightly falling snow).

To end with Mr. Tumnus is a tidy thoughtful and noble faun.

_ = language of opinion
Bold = language of giving details

This writing sample illustrates how effectively ESL students can use the discourse of description to describe Mr. Tumnus. Their familiarity with describing people is revealed by the fact that all students were able to choose discourse which appropriately described the characteristics and traits of Mr. Tumnus. Moreover, the teacher judged that the children were able to write effective descriptions as evidenced by their 87 percent average for the unit (see Figures 4.0).

A further example of interpreting the question using a key visual and providing a good answer in the form of a writing sample is from another ESL student, student 7. In Figure 4.16 the student assesses the character based on how the character acts, what they feel, what they look like, and what they say.
From the key visual illustrated in Figure 4.16, Student 7 used the specified language of opinion writing requested by the teacher for this task and infused the key discourse that he developed in the key visual into his writing sample (see Figure 4.17).
In our novel, *The Lion, The Witch and the Wardrobe*, we were introduced to a kid named Edmund. *In my opinion, I think* he is **bad**, **neat** and a **liar**.

**First,** I'd say that Edmund is **bad** *because* when Lucy said there was a town in the wardrobe and the others found that there weren't any town, then Edmund used words that made Lucy cry.

**Next,** *I think* that Edmund is **neat** *because* every day he wears a suit and his hair is tidy.

**Last,** I'd say that Edmund is a **liar** *because* when he found the town that Lucy was talking about he told the others that he didn’t.

**In conclusion,** *I think* Edmund will get better.

---

He developed a coherent and appropriate writing sample even though his Gates-McGinity testing placed him at a grade three to four level for both vocabulary and reading comprehension.

Although the work represented in Figure 4.18 is arguably simplistic, for a student new to Canada as recently as two years prior with marginal English language abilities and scoring at a grade three to four level, he had managed to pull together a structurally correct writing sample. Moreover, he included the language of sequencing and description. Furthermore, he included opinion language and the language of giving details.

Based on the wealth of adjectives illustrated in Figure 4.13, it appears as though the students had very good vocabulary for describing Mr. Tumnus, Edmund, events, and objects. The discourse which the students used to describe characters was intriguing:

“... is honest because he never lies.”
"... is tidy because he keeps his house clean and he is organised."

"... is noble because his put the umbrella over to Lucy when she didn't ask him to (he covered Lucy in with the umbrella to protect her from the lightly falling snow)."

"... Edmund used words that made Lucy cry."

4.3.2 Description of Persons and Key Visuals: Task 7 "Character Analysis"

Task 7 required students to evaluate, rank, and describe Lucy and Edmund. The children were given opportunities to select from two columns of adjectives and then rank how much each of these attributes Lucy or Edmund possessed by positioning a dot on a sliding scale line (see Figure 4.18).

Figure 4.18

Narnia character development key visual for Task 7 and 8
The process was repeated four times throughout the novel to see how the characters changed. By ranking characters four times, it was hoped that a pattern would emerge as to whether or not characters were always good, evil, or whether they changed throughout the novel. It also gave students an opportunity to practice evaluating characters and to watch how a character’s actions and deeds make up the fabric of his or her character.

The children were proficient at analyzing characters. They were definite and purposeful in their evaluation. Moreover, there was no real hesitation on their behalf to judge the characters. This may be the result of their own experiences with interpersonal relations and the evaluation of persons in their lives. Of particular interest to the teachers was the fact that 95.45 percent of the students constantly ranked Lucy and Edmund at opposite ends of the character scale (see Figure 4.18). This may be a reflection of how well and in agreement their evaluative skills are, or it may be more of a reflection of the obvious nature of the characters.

**Figure 4.19**

*Graph representing how the students felt about Lucy and Edmund*

![Graph](image)
Figure 4.19 illustrates the ratio to which students ranked the characters Edmund and Lucy. Ninety-five percent of the students were in agreement that Lucy was righteous and Edmund was evil. It also set the tone for a series of writing samples that reflected the students’ abilities to critique and analyse characters and their traits. Students were required to utilize their ranking of characters into a detailed five-part writing sample, comparing and contrasting Lucy and Edmund (see Figure 4.20).

**Figure 4.20**

**Student writing sample from Task 8 (student 5)**

In the novel, “The Lion, The Witch and the Wardrobe”, we were introduced to Lucy and Edmund. In my opinion, Lucy is loyal, kind and honest. Yet, Edmund is disloyal, unkind and dishonest.

I think Lucy is loyal. For example, she was loyal to her ideas and she believes in what she thinks. On the other hand, Edmund is disloyal because he agreed to the White Witch that he will take his brother and sisters to her.

I feel that Lucy is kind. Like she didn’t yell at Mr. Tumnus. Instead she talked nicely. But Edmund is unkind because he teases Lucy about the wardrobe.

I believe that Lucy is also honest. As proof she never lied to Peter, Susan and Edmund. However, Edmund is not honest. For instance he lied to Peter, Susan about Narnia.

In conclusion, Edmund and Lucy have different personalities. Edmund is disloyal, unkind and dishonest. Lucy is the opposite. She’s loyal, kind and honest.

**Bold** = giving details  
**_** = language of opinion  
**italics** = language of comparing and contrasting

Figure 4.20 illustrates that the structured writing samples are beginning to become linguistically and cognitively demanding based on the language and content requirements. Students used the language of comparing and contrasting (e.g., however, but, on the other
hand), opinion (e.g., I think, I feel, I believe, It seems to me), and giving details (e.g.,
because, as seen by, for example). Moreover, they had to substantiate and support their
claims with examples drawn from the novel. The result was a writing sample that illustrates
that students were able to use a variety of selected discourse to effectively convey and
express their opinions about characters.

Considering that these students were grade five ESL students their writing was
thought to be excellent according to the cooperating teachers. The cooperating teachers gave
much of the credit to the use of key visuals and the Knowledge Framework (Mohan, 1986) as
organizing structures underlying the unit. Further, they thought this use was invaluable in
assisting children to focus on the discourse of their choice. They felt that perhaps the most
significant aspect emerging from the Narnia tasks was the degree to which the children were
familiar with the practice of describing and judging people. The teachers were surprised by
the accurate and creative contexts in which children were able to describe the characters.
Consequently, the teachers reasoned that the prior experiences and background knowledge of
the children probably allowed them to effectively formulate ideas and draw upon social
experiences to critique characters.

4.3.3 Comparing Writing Samples from the Narnia and Patterns units

The students appear to have done well throughout the Narnia unit. Even though the
September 1996 British Columbia Ministry of Education Form 1701 Data Collections may
have classified many of the children as being ESL students, the quality of their work
throughout the unit was excellent. The degree to which assignments were completed and the
quality of discourse used reflects the grammar one might expect from some high school
students. Furthermore, the grades achieved reflect a moderate to high average level of achievement that was indicative of the students' performance.

Some of the success students experienced may be attributed to the language and content pedagogical approach of the teacher. The use of the Framework for Teaching and Learning (VSB, 1989) may have helped students develop language proficiency. The teacher used the Knowledge Framework (Mohan, 1986) as a conceptual lens for organizing information. This in the context of this study, seemingly provided students with a framework for organizing, structuring, depicting, and reconstructing knowledge. This was useful in illustrating to the students that they had experiences they could draw upon to assist in the completion of tasks. By accessing and building upon students' background knowledge, the content information covered may have had more contextual meaning and significance to the students. Additionally, the mechanical writing structure demanded by the teacher may have provided a template for success as it mapped the students' work on paper.

The Patterns unit consisted of many similar approaches, methodologies, and teachable moments that were consistent with the Narnia unit. The teacher taught both units to the same group of children. In addition, the two units were taught simultaneously throughout the school term. Yet the degree to which the units were successful varied. The Narnia unit had a higher level of achievement than the Patterns unit.

Figure 4.20 represents a writing sample which is comprised of a nice flow, continuity, structure and quality of writing representative of most of the writing throughout the Language Arts unit, Figure 4.21 seemingly struggles to convey its message. Although it communicates thoughts regarding the task, and includes the language of opinion and giving details, it does not possess the quality of writing that was prevalent throughout the Narnia
unit.

Figure 4.21 illustrates Student 5’s attempt at writing about math patterns.

**Figure 4.21**

**Sample journal assignment 1 by student 5 from task 2**

<table>
<thead>
<tr>
<th>What is a Pattern?</th>
</tr>
</thead>
<tbody>
<tr>
<td>I believe that a pattern is something that repeats itself in a order. It can be used in real life and school. It can be hard or easy. That depends on the pattern. I think patterns are usually used in school for example problem solving. I forgot to say that is can be fun too.</td>
</tr>
</tbody>
</table>

From Figure 4.21, the writing sample appears to be less comprehensive and at a basic level. Although the student used some opinion language, the structure and sequence of thoughts appears to have vanished.

Based on the marks for the unit and the noticeable difference in student performance, the teacher was convinced that the level of writing in the Narnia unit often reflected a comprehensive, thorough, and well-planned approach. In addition to infusing specific language, using technical writing skills, and including appropriate information from the novel, students had to provide an example from the story to support their point of view. The teacher believed that many students were able to produce a grade appropriate end-product which effectively conveyed and expressed the student’s opinion about characters. Figure 4.22 demonstrates that students used a variety of discourse devices, which were skillfully presented and woven into the mechanics of their writing.
In the novel The Lion, the Witch and the Wardrobe we were introduced to Edmund, Peter, and Queen Jadis. These paragraphs compare the relationship between Edmund and Peter, Peter and Edmund, Edmund and Queen Jadis and Queen Jadis and Edmund.

In my opinion Edmund feels that Peter is bossy, mean and a goodie good. Yet, Peter thinks that Edmund is selfish, a liar and unbrotherly. Edmund think that Peter is bossy because he gives suggestions to him. On the other hand Peter thinks Edmund is selfish. For example didn’t consider why the White Witch would be so nice. Edmund strongly feels that Peter is mean. As proof, Peter always yells at him. However, Peter feels that Edmund is a liar. For instance, he lied to Peter and Susan about Narnia. Edmund also believe that Peter is much of a goodie good. To illustrate he always does the right thing, but Peter believes that Edmund is unbrotherly. Generally speaking he made fun of Lucy everyday.

I am of the opinion that Edmund believes Queen Jadis is evil, magical and frightful. On the other hand Queen Jadis feels that Edmund is greedy, foolish and powerless. Edmund feels that Queen Jadis is evil because she was so mean at first and she has evil eyes. Yet, Jadis believes he is greedy. As proof he wanted more and more Turkish Delight. Edmund strongly thinks that Queen Jadis is magical. For one thing she can create a tent with one swing of her wand. However Queen Jadis thinks he is foolish. To illustrate he was tricked so easily by sweets. In Edmund’s opinion Queen Jadis is also frightful. For example she is so pale white, but Queen Jadis believe he is powerless because she can kill him with a swing of her hand.

In conclusion, Edmund thinks Peter is bossy, mean and a goodie good. But peter think that Edmund is selfish, a liar and unbrotherly. That proves Edmund and Peter has a horrible relationship. Edmund believes queen Jadis is evil, magical and frightful yet Queen Jadis believes he is greedy, foolish and powerless. I think this relationship is only a big lie. I feel that they are using each other to get what they want.

Figure 4.22 illustrates a fairly complex performance in descriptive writing. Not only is the student using a introductory paragraph supported by two paragraphs of details and a concluding paragraph, he is comparing and contrasting the relationships of three characters. Furthermore, he has incorporated several elements of description, including the language of opinion, giving details, and specific adjectives that describe personality traits.
In comparison, the grades from the Patterns unit were significantly lower. Many questions were incomplete, not correct, or left blank. The teacher was disappointed with the students’ lack of success and felt that there may have been a combination of explanations for the students not doing well. Furthermore, the writing samples were not sophisticated (see Figure 4.23).

**Figure 4.23**

**Descriptive writing samples from the Patterns unit**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The pattern is that its always doubling</td>
</tr>
<tr>
<td>2</td>
<td>Yes it does. It goes up by 2</td>
</tr>
<tr>
<td>3</td>
<td>If there it does in order it will turn out 2 4 6 8 and on.</td>
</tr>
<tr>
<td>4</td>
<td>the pattern is timesed by 2 and it is even numbers.</td>
</tr>
</tbody>
</table>

Figure 4.23 is a compilation of written statements from the Task 23 Remedial Activity 1A and 1B that tend to be representative of how the students described patterns. It represents some simplistic expressions regarding the description of a doubling pattern. The process of writing about math was foreign to the students, and their written responses were weak, underdeveloped, and lacking in structure and detail. Additionally, the teachers felt that the students’ lack of exposure to patterns in math made the testing of results and students abilities to complete tasks suspect. Additionally, they were convinced that students had not done any material on patterns since grades one and two, as the students themselves had expressed.

The teacher wrote:

In all the years of teaching, this teacher had not witnessed journals of such a primary nature. The students, although in grade 5, were writing as best they could on a subject that I suspect they haven’t really studied since Kindergarten. This teacher
suspects that the information they recited was based strictly on their “primary grade level” experience. In other words, the students were giving information they knew to be true from prior experience, experiences that were based on Kindergarten to grade one learning outcomes. (Teacher Journal; Review of Journal 1)

A further complication was the fact that much of the primary PLOs around patterns and relations involve basic attributes such as patterns of colour, size, shape, and number. Compared to the selected grade-five-appropriate material on Tests 1A and 1B, the material for the unit was totally number driven and even alluded to basic algebraic function. Consequently, the teacher believed that the material involved an enormous increase in cognitively demanding knowledge regarding number patterns. As students had not worked with patterns since the early primary grades, the teacher believed that there was a gap in the developmental learning curve involving the transition from primary pattern strips to intermediate number theory.

By Task 3, the teacher felt that many students appeared to have difficulty understanding how to answer the questions, and this was quite troubling as he had previously taught the children a unit on problem solving. Upon analysis, the reflective response journals indicated a surprise at how difficult math patterns were for the students. Students wrote that some of the pattern questions were “hard” and that they were, “not sure what to do”.

4.3.4 Key Visuals and the Template

One major factor that appears to have had an influence on the level and degree of success of the students was the use of key visuals. The use of key visuals assisted students in working with discourse and content information because they offered something that could
be used as a graphic organizer in which content information in an organized visual of spatial nature. Moreover, by removing the dense language associated with paragraphs, the key visuals were able to package, display, and represent the shape of content information.

Throughout the Narnia unit, students used Key visuals as tools to assist them in understanding the inter-relationship between ideas. Consequently, they were able to develop in the direction of a balanced and well-rounded level of academic writing. In addition, several students started to develop their own key visuals in other subject areas. As students began taking the initiative to create their own key visuals (and proudly show them off to the teacher), their ability and willingness to make their own key visuals illustrated a deeper understanding of the process.

Throughout this process, there was a significant difference in the level of achievement in the Patterns unit. The students’ level of achievement appeared to be below average until the infusion of a key visual template, which was designed to provide students with a sequential and conceptual framework to work through pattern-problem situations.

It was only with the introduction of a graphic template in the Patterns unit that grades and student achievement increased. The teacher believed it was a significant moment in the unit. Interestingly, once a template was introduced (Task 23, 24 and 25) to the students, their marks noticeably improved. The template appeared to give some sort of structure to the students for the pattern-solving process. It seemed to have acted as a framework that organized, sequenced, and gave students a particular way of mapping solutions to problems.

In the context of this study, the key visuals use in the Narnia unit, appear to have acted as tools that promoted the student’s understanding of the relationships between ideas. Also, key visuals brought an awareness to the organization, content, language, and cognitive
skills being emphasized.

By comparison, the grades from the Patterns unit were significantly lower. Many students appeared to have tremendous difficulty understanding how to answer questions. Even when graphics, pictures, and diagrams were associated with particular questions, students had trouble interpreting the key visual and the question. It appeared that in the context of this study, children were not familiar with relevant math language and diagrams. Once they were taught to use a math key visual, they performed better.

The resource teacher and the classroom teacher agreed that there was a difference between units in the familiarity of using Key visuals to complete tasks. The students were comfortable with the Key visuals used in the Narnia unit. However, the teachers mistakenly assumed that the pattern diagrams accompanying many of the pattern problems were sufficient enough to act as key visuals in the Patterns unit. This was a miscalculation or oversight, as many of the students misunderstood, and were not able to answer the questions. Figure 4.24 illustrates the difference between the Math and Narnia units regarding being able to interpret the questions and express the answer.
Table outlining the teacher’s hypothesis of student achievement

<table>
<thead>
<tr>
<th>Interpreting the Question</th>
<th>Math</th>
<th>vs</th>
<th>Narnia</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Students experienced major difficulties understanding questions. They had the necessary language to be able to interpret and understand what was required of them (not until the introduction of a key visual Template did their work improve)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Students used key visuals from the onset, which resulted in an organized, successful approach to writing and working with language and content material.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Because of students’ familiarity with social practices and the description of people, peers, relations, objects and events, they naturally did well and were able to effectively describe characters and their traits.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expressing the Answer</th>
<th>Math</th>
<th>vs</th>
<th>Narnia</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Initially students didn’t have anything to use and consequently had major difficulties in understanding questions and expressing desired learning outcomes. Once they started to use the template, there was an underlying structure and framework to follow.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• The use of graphics assisted students in organizing their work and formulating a measured response in their writing.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.24 also illustrates that there was a difference in the abilities of the students to use descriptive language for the patterns and Narnia Units. The social language students used to describe a person, object, or event was far more refined than the language they used for describing patterns.

4.3.5 The Language of Description

One way to summarize the comparison of writing in the Narnia and the Patterns units is that students were at ease when describing people, but they experienced difficulties when
describing patterns. It is therefore worthwhile to look more closely at the language of describing people that the students used in the Narnia unit and the language of description of patterns that they used in the Patterns unit.

We looked at the language of description using the research procedure described in Mohan (ms.) and discussed in Chapter 2. We first identified clauses that describe a person in the Narnia data or describe a pattern in the Patterns data. Specifically, with the Narnia data, we selected only those clauses which described a person from a moral point of view since the novel study had approached characters from the standpoint of whether they were good or bad. We divided these clauses further into those that describe using an adjective (e.g. X is greedy) and those that use a descriptive phrase (e.g. X goes on forever). Adjectives relatively salient in this data and were of particular interest because they had the potential to reflect organized taxonomies or classifications of what was described (see Halliday 1993, p. 73). We recorded the occurrence of an adjective or descriptive phrase only once, regardless of the number of times it occurred, since we were interested only in the types of adjectives and descriptive phrases and not in their frequency of occurrence. Thus three occurrences of X is greedy would count only as one.
Figure 4.25

Adjectives and descriptive phrases used in the Patterns and Narnia units

<table>
<thead>
<tr>
<th>Patterns Unit</th>
<th>Narnia Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GROUP A</strong></td>
<td><strong>BAD</strong></td>
</tr>
<tr>
<td>Directional</td>
<td>Bad</td>
</tr>
<tr>
<td>Increasing</td>
<td>Guilty</td>
</tr>
<tr>
<td>Decreasing</td>
<td>Sad</td>
</tr>
<tr>
<td>Ordered</td>
<td>Dishonest</td>
</tr>
<tr>
<td></td>
<td>Untrustworthy</td>
</tr>
<tr>
<td></td>
<td>Spiteful</td>
</tr>
<tr>
<td><strong>GROUP B</strong></td>
<td><strong>Selfish</strong></td>
</tr>
<tr>
<td>Repeats</td>
<td>Jealous</td>
</tr>
<tr>
<td>Goes on and on</td>
<td>Mean</td>
</tr>
<tr>
<td>Keeps going on</td>
<td>Nasty</td>
</tr>
<tr>
<td>Goes on forever</td>
<td>Greedy</td>
</tr>
<tr>
<td>Over and over</td>
<td>Grouchy</td>
</tr>
<tr>
<td>Gets longer</td>
<td>Stern</td>
</tr>
<tr>
<td>Goes on and then back again</td>
<td>Sneaky</td>
</tr>
<tr>
<td>Keeps coming back</td>
<td>Curious</td>
</tr>
<tr>
<td>Can be added and subtracted</td>
<td></td>
</tr>
<tr>
<td>Its like roses-- layers and layers</td>
<td></td>
</tr>
<tr>
<td><strong>GROUP C</strong></td>
<td></td>
</tr>
<tr>
<td>Colours</td>
<td></td>
</tr>
<tr>
<td>Numbers</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td></td>
</tr>
<tr>
<td>Shapes</td>
<td></td>
</tr>
<tr>
<td>Objects</td>
<td></td>
</tr>
<tr>
<td>Dishes, clothes, blankets</td>
<td></td>
</tr>
<tr>
<td>Buildings, schools, homes</td>
<td></td>
</tr>
<tr>
<td>Nature, parks</td>
<td></td>
</tr>
<tr>
<td>Different pictures</td>
<td></td>
</tr>
<tr>
<td>Real life</td>
<td></td>
</tr>
<tr>
<td>Art</td>
<td></td>
</tr>
<tr>
<td>Problem solving</td>
<td></td>
</tr>
<tr>
<td>The way you arrange it</td>
<td></td>
</tr>
<tr>
<td><strong>GROUP D</strong></td>
<td></td>
</tr>
<tr>
<td>Hard</td>
<td></td>
</tr>
<tr>
<td>Easy</td>
<td></td>
</tr>
<tr>
<td>Fun</td>
<td></td>
</tr>
<tr>
<td>Neat</td>
<td></td>
</tr>
<tr>
<td>Difficult</td>
<td></td>
</tr>
<tr>
<td>Tricky</td>
<td></td>
</tr>
<tr>
<td>Camouflaged</td>
<td></td>
</tr>
<tr>
<td>Sometimes they're right under your nose</td>
<td></td>
</tr>
<tr>
<td>I just can't explain it</td>
<td></td>
</tr>
</tbody>
</table>
Figure 4.25 represents adjectives and descriptive phrases that were used by the students throughout the Narnia unit and throughout the Patterns unit. The Narnia unit adjectives were used in tasks and activities that required students to describe characters from the point of view of moral assessment. The Patterns unit section of the table pulls together adjectives or descriptive phrases used to describe patterns.

The Narnia side of Figure 4.25 can be discussed first. In the Narnia case there are only reported the adjectives, since students used them frequently. The Narnia unit adjectives, which were used in tasks and activities to describe characters, were developed by the students, and not generated by the teacher. It is worthwhile to note that the 37 descriptive adjectives on the Narnia table present a shared classification of Bad and Good aspects of persons. This classification included a number of finer contrasts, such as sad versus happy, untrustworthy versus trustworthy, spiteful versus forgiving, selfish versus caring, mean versus generous, and grouchy versus cheerful. In addition, within the Bad and Good groupings were further distinctions (e.g., happy versus joyful versus cheerful; caring versus thoughtful; dishonest versus untrustworthy; mean versus greedy; stern versus grouchy). In other words, there seems to be a shared language--a shared set of meanings with fine contrasts and distinctions conveniently codified in adjectives--for talking together about how people can be assessed. These meanings enable students to make specific moral distinctions about a character's behaviours and actions in ways that are appropriate to the assessment of characters in the novel or in the world at large.

All of these adjectives appear to be everyday language. None of them appear to be technical terms. All of these adjectives appear to be words that these students could have learned informally. None of them appear to be words that would only be accessible through
classroom instruction. It is quite possible, and indeed likely, that this shared language is
developed and maintained by student participation in community practices in family and peer
groups where people talk about and morally assess other people. Finally, since all of the
adjectives are everyday, there is no indication of the interplay between everyday and
technical language, the linkage between ordinary language and theoretical language, that was
though to make learning possible.

On the patterns side of Figure 4.25 there are few adjectives were used to describe
patterns— so descriptive phrases were reported as well. Let us first look at Group A. Group
A consists of four adjectives: directional, increasing, decreasing, and ordered. These are the
only adjectives used in the students’ work that actually described patterns (i.e., labeled them
in a way that could be used to differentiate between patterns by making mathematically
relevant distinctions between them). The adjectives comment on the pattern itself in ways
that are relevant to mathematical development. They provide the beginnings of something
like a classification of different kinds of patterns (as in increasing and decreasing), but they
do not offer much in the way of finer differences. Notice that there are only four of them, by
comparison with the thirty-seven present in the Narnia data.

Considered together, Group A appears to be relatively technical, compared to the
group of everyday adjectives from Narnia. As applied to patterns, they appear to be words
that would occur in classroom instruction, in the opinion of this researcher. They are more
likely to have been learned and used in school rather than in community practices. As
technical language, they contrast with Groups B, C, and D, which appear to be everyday
language.
Group B consists of phrases used to describe patterns, such as “Goes on and on.” This is a phrase created to describe a particular pattern. The student does not appear to be able to draw on an adjective to codify the pattern, to summarize its description in a distinct term that can play a role in a classification, and contrast with other terms. In addition, these phrases are vague and do not have distinct meanings from each other, so that they appear to mean much the same thing (Goes on forever, Over and over, Keeps going on). In other words, they do not in themselves distinguish one type of pattern from another.

Group C of the Patterns data is different from Group A. They are not descriptions of different types of patterns; they are mentions of what patterns are made of. Colours, numbers, sizes, shapes and objects, are items that form patterns or attributes of patterns. At the primary level, patterns are mainly formed by colours and/or shapes. Later, patterns are often formed by numbers. Finally, Group D of the Patterns data is different again. Adjectives such as hard, easy, fun, and difficult, say how the student reacts to the pattern; they give the subjective response to the pattern. Unlike the adjectives of Group A, they do not comment on the pattern itself in a mathematically relevant way.

In the Patterns data, is there any indication of the interplay between everyday and technical language that has been thought to be centrally important for learning? Certainly Group A of the Patterns data can be considered technical and Groups B, C, and D can be considered to be everyday. Is this evidence of interplay? The case would seem to depend on the relationship between Groups A and B, since these are the only two groups that describe patterns in a mathematically relevant way. On balance, it would seem that Group B is too vague to indicate that an everyday description and classification was being correlated with the sparse but more differentiated Group A. The evidence is lacking, therefore, for an
interplay between the everyday and the technical in the Patterns data. It seems more likely that the vagueness of Group B means that the learners are unable to access familiar everyday descriptions and classifications of patterns.

To summarize, in the Narnia unit the students used everyday language. Through the adjectives they used, they were able to draw on the rich resource of a shared classification scheme for evaluating good and bad qualities of a person; a classification which brought a number of finer distinctions. In other words, they used a common language, a shared set of meanings, for talking together about how people can be assessed morally, and for making specific detailed distinctions about their behaviour and actions. There is evidence of detailed classifications, even though the language would seem to be everyday rather than technical. It seems unlikely that this everyday language was learned in the classroom through schoolwork.

A sociocultural perspective on community practices and school practices might suggest that this is developed and maintained by the student's participation in community practices and family and group interactions, and at the same time supported and extended through school-based experiences. With respect to the question of the interplay of everyday and technical language, however, the evidence is absent. There is no evidence of a movement between the everyday and the technical. Narnia was the everyday without the technical.

In the Patterns unit a small amount of technical language was used. The adjectives *directional*, *increasing*, *decreasing*, and *ordered* seem to be technical rather than everyday. There was sparse evidence of a shared classification scheme for distinguishing between patterns. Students truly experienced difficulties finding words to describe patterns. They
were not able to demonstrate an ability to use a rich, underlying classification of patterns that could form the basis for further learning. There was little evidence of finely differentiated semantic structure to parallel the judgements about persons that were available in the Narnia data.

A sociocultural perspective might suggest that students were not able to draw on ways of talking and thinking about patterns that might be available as a resource in their community or in the school. From the point of view of the everyday versus technical language distinction, however, the evidence is absent. There is no indication of an everyday language which adjectives such as *directional* or *decreasing* might build on. Again, there is no evidence of a movement between the everyday and the technical. Patterns was the technical without the everyday.

Of course, this does not imply that a community way (or ways) of talking and thinking about patterns does not exist, but merely that the language evidence from this particular group of students would tend to indicate that it was not available to them. But it does raise a very important question: What are the everyday ways of talking and thinking about patterns that might be available to students? Outside of school, where do people talk about patterns and describe the similarities and differences between patterns? What social practices involve the discussion of patterns (knitting? painting? music?), and what language do people use to describe patterns?

### 4.4 Summary

Let us summarize the results of this chapter. The comparison of the Narnia unit and the Patterns unit showed that students had much more success with the Narnia unit than with
the Patterns unit, despite having the same teacher for each unit. We then considered if prior knowledge could provide some possible explanation of this difference in success. We explored two matters of prior knowledge: prior classroom experience and the link between everyday language and technical language in student discourse. Looking in more detail at patterns, we found that students reported that they were unfamiliar with the material and had not studied it for a number of years. By contrast, they had been made familiar over a number of years with novel studies such as the one on Narnia. Thus, part of the explanation of the difference could lie with a difference in prior teaching and learning: It appeared that the students lacked adequate prior exposure to the ideas developed in the Patterns unit. Yet this did not appear to be a complete explanation. For example, it did not account for the persistent difficulties that the students had with the Patterns material, difficulties which remained as the unit progressed.

Looking in more detail at the Narnia unit, it appeared that students were able to perform required tasks with relative ease, more than one might expect from their familiarity with school experiences of the study of literature. They made use of language which seemed to be based on their prior experiences of describing people and not simply on their school experiences with the study of novels. In other words, they seemed to be drawing on their familiarity with the social practice of describing people.

When their writing in the Narnia unit was compared with their writing in the Patterns unit, it was markedly superior: It seemed that their writing in the Narnia unit was above their grade level, but their writing in the Patterns unit was below their grade level. The students seemed to be at ease when describing people, but they experienced difficulties when describing patterns. This led us to look more closely at the language of description that the
students used in both units. In the Narnia unit the students were able to draw on a rich set of almost 40 adjectives which gave evidence to the notion of a shared and complex classification scheme for evaluating the good and bad qualities of a person. In the Patterns unit, where only four relevant adjectives were used, there was little evidence of a similar scheme for the description of mathematical patterns.

With respect to the contrast between everyday and technical language, the evidence suggested that the students were able to draw on everyday language for describing persons in the Narnia unit, but were not able to draw on everyday language for describing patterns in the Patterns unit. This evidence suggested that the students were able to draw on their familiarity with the social practice of describing persons, but not able to draw on familiarity with the social practice of describing patterns. There was no evidence in the Narnia unit or in the Patterns unit of the interaction and linkage between everyday and technical language that has been thought by some to be essential in learning.
CHAPTER 5: Conclusions and Recommendations for Further Research

5.1 Introduction

The chapter will first remind the reader of the general rationale for the study in the introduction, then summarize the results, discuss various provisos and qualifications, and finally move into recommendations for further research and practical educational implications.

Throughout the researcher’s eleven-year teaching career, he witnessed the emergence and growth of ESL issues in the classroom to epidemic proportions. Simultaneously, there was a growing movement from educators in the United States who were asserting that patterns, relations, and functions were being under-rated as the foundations for all aspects of applied mathematics and science skills. Central to this notion was the recognition that math patterns are a fundamental catalyst in number theory and mathematics in general, not to mention all other areas of the curriculum. Intrigued by the topic of patterns in mathematics, as a prescribed component in the Provincial Government’s Ministry of Education Instructional Resource Packages, the researcher decided to make observations surrounding his grade five and six class. He decided to observe the experiences of his class as they embarked upon a Patterns unit and, as a contrast, a Narnia unit. The researcher was influenced by his reading of *Cognitive Development, Culture, and Schooling* from Michael Cole’s book titled, *Cultural Psychology: A Once and Future Discipline*. This increased his awareness of the relation between schooling and the social practices of society. The immediate purpose of this study was to explore differences in student experiences in completing tasks related to the Patterns unit versus tasks associated with the Narnia unit.
Both units were collaboratively planned with school-based and district-based resource teachers. These content, subject, and teaching strategy experts brought the necessary format, educational justification, credibility, and experience to the planning and design of the units. More importantly, their expertise in teaching and learning strategies and their experience with curriculum design complemented the classroom teacher's teaching experience, context, relationship with the students and front-line experience in teaching students from a multitude of cultural backgrounds in an enrolling classroom situation.

5.2 Results

When the Narnia unit and the Patterns unit were compared, it appeared that students had much more success with the Narnia material than with the Patterns unit, despite having the same teacher for each unit. This thesis aimed to illuminate the processes and products of student engagement with the two units. At the same time, it documented the researcher's process of reflection and the teacher/researcher's growing understanding of the role that prior knowledge plays in the classroom. The paper then considered if the notion of prior knowledge and its relation to new knowledge could provide some illumination of this difference in success. Two matters of prior knowledge were considered: prior knowledge gained from classroom experience and the link between everyday language and technical language in student discourse.

With respect to prior knowledge gained from classroom teaching, the students reported that they lacked adequate prior exposure to the ideas developed in the Patterns material. However, they were familiar over a number of years with novel studies such as The
Lion, the Witch and the Wardrobe. This difference offered a possible reason for the difference in student success.

With respect to the link between everyday language and technical language in student discourse, the evidence suggested that the students were able to draw on everyday language for describing persons in the Narnia unit, but were not able to draw on everyday language for describing patterns in the Patterns unit. This difference offered a further possible reason for the difference in student success. This finding was based partly on a general comparison of student writing in the Narnia and Patterns units, but particularly on a comparison of the students' use of the language of description of persons and the language of description of mathematical patterns. There was a relatively rich language for the description of persons which evidenced a complex underlying classification scheme, but only a sparse language with little classification for the description of patterns.

Considering that this finding concerns social practices, we can suggest a parallel with Michael Cole's research (1979) which showed how Kpelle children in the mathematics classroom were unable to draw on their familiarity with their marketplace mathematical practices. It would seem that with the Narnia unit, the students in the present study were able to draw on their familiarity with the moral description of persons, but in the Patterns unit, like the Kpelle children, they were unable to draw on the familiar social practice of the description of patterns. This promotes the hypothesis that students may find it easier to relate the study of literature to their daily lives than to relate to the study of mathematics. One difference from Cole's study needs to be noted. Cole was able to document the existence of mathematical practices in the marketplace and wider community. We do not know whether there are practices for the description of mathematical patterns in the communities that our
students are members of. Research on this issue would seem to be an important priority, given the importance of the topic of patterns in elementary mathematical education.

Another parallel should be drawn with the work of Martin (Halliday & Martin, 1993) and others who have analyzed the language of school textbooks, seeing educational development in terms of Britton’s (1989) concept of the interplay of everyday language and the technical language of textbooks and other authoritative sources. Martin’s analysis shows how the language of textbooks constructs classifications of subject area knowledge which are conveyed to students in the process of apprenticing them to a subject discipline. As a first step to address the interplay of everyday and technical discourse, the everyday language that students bring to the classroom requires a similar analysis. Accordingly, using simple techniques, this study has examined the language students’ use when writing in the two subject areas of literature and mathematics. It has examined the description of persons and the description of patterns and touched on the classifications of subject area knowledge that are articulated by students. Future research on the interplay of everyday language and technical language, or more generally on the interplay between prior knowledge and knowledge to be learned, could well extend this line of investigation: investigate prior knowledge/everyday language in part through the analysis of student discourse for relevant descriptions and classifications; Investigate knowledge/technical language in part through the analysis of textbook and teacher discourse for relevant classifications and descriptions; investigate teacher-student dialogue for the interplay between these different groups of classifications and descriptions.

In a roundabout way, this brings us back to the two issues of prior knowledge that were considered in this study: prior knowledge gained from classroom teaching and the link
between everyday language and technical language in student discourse, which brings in the question of prior knowledge gained from social practices. It is an important contribution of anthropologists and cultural psychologists, such as Cole, to draw our attention to the significance of social practices and to increase our awareness of their role in education. For the purposes of this study, we have dealt with our two issues of prior knowledge somewhat separately, but future work along the lines of this study will clearly have to look at ways in which they interact or fail to interact.

The next section will begin to discuss various provisos and qualifications

5.3 The Role of the Researcher

In this particular study, the researcher played two roles. He was both the enrolling classroom teacher and the researcher for this study. In this participant-observer role, he was responsible for performing his duties as teacher in accordance with school board policy and Ministry of Education guidelines. However, he was cognizant of his research role and tried to maintain a normal operating classroom environment. Moreover, he tried to stay true to his usual beliefs, practices, and habits in an effort to ensure reliability and validity. An example of this was evident through the collaborative planning sessions he engaged in with the school-based resource teacher. These sessions of planning and debriefing were part of his regular and normal practices. Additionally, they acted as a check to ensure that he was grounded in the way he was going about the business of teaching to maintain a neutral and unbiased classroom environment. Moreover, he was aware that the observations in this study were limited to the context of this study.

The researcher recognizes that his role was only one form of researcher role and that
other roles for researchers have worthy attributes that limit observer/researcher effects. In an effort to replicate the findings of this study, it would be appropriate and judicious for future studies to include a multitude of researcher roles (observer, participant, and interviewer). Providing these studies were to involve lengthy periods in the field, extensive interviews with participants, and include corroborating data from a variety of sources, these varied researcher roles could provide a multiplicity of insight and wealth of understanding of contextual knowledge in curriculum subject areas.

5.4 Reflective Journals

In hindsight, one of the areas in this study open to criticism is the reflective journal writing. Unfortunately, the teacher did not require students to complete reflective journal entries for both units. Only the Patterns unit involved reflective journal writing. Consequently, there were no regularly scheduled reflective student responses to the Narnia unit. As a result, some of the conclusions inferred regarding student perceptions of assorted tasks between the two units might be brought into question. On the other hand, it should be pointed out that students were much more ready and fluent in their reflections on the Narnia unit.

The teacher therefore relied on the reflective journal entries for the Patterns unit, but only on informal observations, levels of student achievement on tasks, and teacher instinct for interpreting observations in the Language Arts unit. In the context of this study, the informal observations were a credible method of making inferences regarding student demeanour, aptitude, and affective work habits during the completion of a task. In addition, the levels of achievement for each student were valuable gauges for interpreting student
aptitude towards a task in the context of this study. Finally, teacher instinct, although not scientific, provided some basis for interpreting how students were coping and managing a given task.

Another concern regarding journal writing was that some of the journal questions could have been designed better. Many of the questions were too open-ended (i.e., they asked how a student was feeling about... or what their thoughts were about...). Upon reflection, the resource teacher and classroom teacher felt that some of the journal questions could have been designed to elicit more focused and constructive responses.

**Figure 5.0**

**Sample Math Journal entry starter statements**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I understand everything until I get to the part...</td>
</tr>
<tr>
<td>2.</td>
<td>Another way I found to do this problem was...</td>
</tr>
<tr>
<td>3.</td>
<td>Today, something new I learned was...</td>
</tr>
<tr>
<td>4.</td>
<td>I would explain this problem to a different age group by...</td>
</tr>
<tr>
<td>5.</td>
<td>The tricky part of this problem is...</td>
</tr>
<tr>
<td>6.</td>
<td>The clue I look for is ...</td>
</tr>
<tr>
<td>7.</td>
<td>A different way to solve this problem is...</td>
</tr>
</tbody>
</table>

Although the journal responses for this unit were appropriate, informative, and provided significant insight as to how students were interpreting information, statements such as the ones in Figure 5.0 may be more suitable for eliciting more constructive and revealing information from the students. It is the opinion of this researcher that future research should include some of the above reflective response statements in an effort to maximize the quality of student feedback in the journal writing process.
5.5 Teacher Expertise

One potential concern regarding the findings of this study may center on the notion that the teacher was not a math specialist. Subsequently, the question of appropriateness of material covered throughout the Patterns unit may be suspect. Moreover, parts of tasks and task design may be open to criticism or subject to revision in the event of future studies.

Much of these concerns are arguably addressed by the fact that resource material was collected from grade appropriate materials and that the PLOs were taken directly from the Ministry of Education’s Mathematics IRPs. Further, the teacher’s prior experiences in teaching this grade is both an asset and strong factor for understanding best practice and normal student achievement. Moreover, the classroom teacher collaboratively planned the unit with a resource teacher, as outlined in Chapter three. As professional educators, they had an excellent working knowledge of the students, of British Columbia Ministry of Education’s IRPs and PLOs, and of the widely held expectations for the grade level.

5.6 Further research

One of the limitations of this particular study was that it only investigated one particular class at the grade five/six level. It would be interesting to see if similar results would be achieved if pattern tasks were conducted throughout a variety of grades. It is particularly essential to track the transition from primary grades to the intermediate grade levels in an effort to determine if there is a succinct development of the curriculum. Furthermore, this study provided a simple snapshot of a grade five/six class. There is room for future research to investigate a more longitudinal approach and follow groups of students through the elementary school grades as one sample population group. The outcomes could
provide researchers with insights regarding the development and acquisition of pattern solving skills.

Additionally, this study took place in an inner-city school where the socio-economic backgrounds of the students may arguably affect the results of the study. It would be prudent to conduct similar studies and research in a variety of areas throughout urban school districts to determine if there is any correlation between the results of the study and the socio-economic background of the students. In other words, the wealth of background knowledge and experiences commonly associated with socio-economic standing may influence the success rate of students.

Further, 75 percent of the student population in the school were classified as ESL students. Thus, future research should encompass several different schools of mixed population distributions in an effort to provide a broader sample population base. This would address the issue as to whether or not language proficiency was associated with math pattern proficiency.

An additional point is that the data, observations, documents, and results from this study may have some educational significance in the areas of accessing students' prior and background knowledge relative to their achievement. Moreover, there may be some implications from this study regarding how students utilize their previous experiences in learning new concepts. Understanding the significance that context and meaning have in the contextual understanding and development of children's learning may lead to understanding how children may relate to, and assimilate with, the situation or problem being solved.
5.7 Practical Educational Implications

There is a need to study the effectiveness of the British Columbia Ministry of Education’s Instructional Resource Packages (IRPs) as it relates to the study of mathematical patterns. As educators have been trying to implement IRPs for four years, there is a need to interview, discuss, and collaborate with teachers as to their thoughts, opinions, concerns, suggestions, and recommendations regarding the implementation, appropriateness of the curricular material, Prescribed Learning Outcomes (PLOs), and Suggested Assessment Strategies (SASs).

Specifically, there is a need to survey and gather data on the design of the British Columbia Ministry of Education’s Instructional Resource Packages (IRPs). It would be interesting to examine teacher’s thoughts regarding the appropriateness of the material as it is laid out throughout the grade levels and also the significance of the major themes across the curriculum and grade levels.

In addition, it would be interesting to gather some insight as to what difficulties teachers face in the implementation of the PLOs. Moreover, it would be valuable to develop an understanding as to what support structures are available for the classroom teacher in terms of professional development, in-service training, collaboration, and release time to become familiar with not only the curriculum, but the development of teaching and learning strategies in mathematics. Questions like who is supporting teachers and how much curricular material is really being taught would be interesting. Moreover, educators need the support of professional development growth options and in-service training. Students’ ideas and competencies develop over a long period of time. Teachers must have the financial and pedagogical support behind them in order to effectively begin to understand and develop a
working knowledge of curriculum, teaching and learning strategies, and instructional pedagogy as it relates to children’s mathematical growth and development.

There is also a need for the teacher’s knowledge base to be considered in this process. The process of reflection is a valuable tool for teachers to use as a means for asking relevant questions such as the following: How could I have taught this lesson more effectively so that student understanding was higher? What changes could I have made in order to raise the student’s level of consciousness to the problem of issue at hand? Rather than focus on student answers as being correct or incorrect, what linguistic, cultural, or sociological growth have the students experienced?

As researchers and educators we need to explore ways of making students more comfortable with learning mathematical concepts and educating others that mathematical patterns and relations are an underlying structure in many aspects and components of our curriculum, environment, educational institutions, and society.

Therefore, there must be some exploration and research into the integration of mathematics into other curricular areas. Although this researcher recognizes that some work has been done, there needs to be a movement adopted by the mathematics councils, foundations, associations and curriculum developers to encourage educators to look for ways to integrate mathematics across the curriculum. As mathematical concepts are rooted in situations and problems, as educators, we need to analyze, classify and relate these situations and procedures to real-life experiences in an effort to help students use strategies to deal with them.
BIBLIOGRAPHY


BIBLIOGRAPHY (continued)


BIBLIOGRAPHY (continued)


BIBLIOGRAPHY (continued)


## Appendix A Adapted BC Ministry of Education IRPs and a Site Description

<table>
<thead>
<tr>
<th>Prescribed Learning Outcome</th>
<th>Suggested Instructional Strategy</th>
<th>Existence in the Textbook</th>
<th>Instruction at the site</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Students at the Kindergarten level should be able to recognize relationships between varying patterns.</strong> Making the connection to math is essential. The study of patterns can facilitate student learning. The ability to see patterns can aid children in being more efficient problem solvers. As patterns occur in nature, math, the environment and the classroom, a familiarity with patterns and their functions can help aid the students in their learning. Moreover, it's important for children to link patterns to their regular activities in the classroom.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- It is expected student will identify, create + compare patterns that arise from their daily experiences.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Identify, reproduce, extend, create, compose a pattern using action, manipulative, diagrams + spoken terms.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Look around the room- describe any patterns. What actions might you use to act out a pattern?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- What counter, words, pictures ought you use to copy the pattern? Show it on paper.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- What do you think comes next?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Can you keep the pattern going?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- How can you make the same pattern using base 10 ones?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Make up actions to do with your patterns (e.g., stand, and sit,...)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- All of the K to 1 teachers appear to use many of the various coloured blocks, beads and counters as they teach counting, grouping and place value.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Only 2 of the 4 K teachers use attribute block sets.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Neither of the 2 gr. 1 teachers use attribute block sets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- All the teachers use “additional” instructional materials that are photocopies from remedial and enrichment exercise booklets.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Classrooms have various coloured blocks, beads and counters. There are a couple of attributes block sets in 3 of the 6 K to 1 classrooms. Many primary teachers teach from “Journeys” text</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Patterns concepts are taught in isolation in the K classrooms (colour, number, size + shape). “Patterns” are not taught in isolation in the gr. 1 classrooms.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 2 of the 4 K teachers teach Patterns by looking for examples that occur in the world around us. 2 of the 6 teachers teach activities that deal with “Patterns &amp; Relations” out of necessity rather than interest.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- There is an atmosphere of “stumbling” through Patterns in math tasks rather than investigating meaning and making connections to the “Real” world and exercises that extend thinking.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

K to 1
Appendix A (continued)

<table>
<thead>
<tr>
<th>Prescribed Learning Outcome</th>
<th>Suggested Instructional Strategy</th>
<th>Existence in the Textbook</th>
<th>Instruction at the site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through concrete experiences students develop habits of finding, inventing, and using patterns to solve problems. Becoming familiar with repeating and growing patterns leads to their being able to associate and record numbers for patterns. Students will develop strategies for analyzing and communicating patterns, which then can be connected to other areas such as graphing and data analysis.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| It is expected student will investigate, establish + communicate rules for numerical and non-numerical patterns that arise from daily mathematical experiences and use these rules to make predications. |

<table>
<thead>
<tr>
<th>2 - 3</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>identify, create + describe number + non-number patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td>translate patterns form on mode to another using manipulatives, diagrams, charts, calculators, spoken and written terms and symbols</td>
</tr>
<tr>
<td>explain the rule for a pattern and make a prediction based on patterns using models and objects</td>
</tr>
<tr>
<td>Students find patterns around the classroom. Create patterns with manipulatives + represent patterns in different ways (e.g., blocks, beads, sticks, pictures, actions, etc.)</td>
</tr>
<tr>
<td>Have students predict Patterns (See IRP p.38)</td>
</tr>
<tr>
<td>Calculator game 2: In pairs, take turns, subtract 1 digit numbers from 50 (any 1 digit number except 0) First player to zero wins.</td>
</tr>
<tr>
<td>Can you find the strategy?</td>
</tr>
<tr>
<td>Does it matter whom goes first?</td>
</tr>
<tr>
<td>How do the rules work?</td>
</tr>
<tr>
<td>If the rule changes and the first to reach zero looses, how might this change your strategy?</td>
</tr>
<tr>
<td>Can you keep the pattern going?</td>
</tr>
<tr>
<td>How can you make the same pattern using base 10 ones?</td>
</tr>
<tr>
<td>Make up actions to do with your patterns (e.g., stand, and sit....)</td>
</tr>
<tr>
<td>Primary teacher appear to use many of the coloured block, beads and counters as they teach counting, grouping and place value</td>
</tr>
<tr>
<td>Only 1 of the 4 grade 2 and 3 teachers use attribute block sets in the classroom</td>
</tr>
<tr>
<td>All the grade 2 + 3 teachers appear to use their manipulatives for computation + calculation processes, rather than “Patterns &amp; Relations”</td>
</tr>
<tr>
<td>All of the teachers use “Additional materials that are photocopies from remedial + enrichment exercise booklets</td>
</tr>
<tr>
<td>All classrooms have various coloured blocks, beads and counters. There are a couple of attributes block sets in 3 of the 6 K to 1 classrooms.</td>
</tr>
<tr>
<td>All of the gr. 2 – 3 teachers teach from “Journeys” booklets</td>
</tr>
<tr>
<td>Patterns &amp; Relations concepts are taught in isolation. They are only taught or experienced as they come up in the exercise booklets.</td>
</tr>
<tr>
<td>The gr. 2 – 3 teachers feel pressure to have children achieving levels of computational proficiency, not understanding “Patterns &amp; Relations”</td>
</tr>
</tbody>
</table>
Appendix A (continued)

<table>
<thead>
<tr>
<th>Prescribed Learning Outcome</th>
<th>Suggested Instructional Strategy</th>
<th>Existence in the Textbook</th>
<th>Instruction at the site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students' abilities to recognize and create patterns become more refined. Students become more able to use their knowledge of patterns to explain relationships. Key is the development of their ability to use patterns as a means to solve problems. Beginning systematically investigate a variety of patterns and apply recognition of patterns as a problem solving strategy.</td>
<td>Students find patterns around the classroom. Create patterns with manipulatives and represent patterns in different ways (e.g., blocks, beads, sticks, pictures, actions, etc.)</td>
<td>Students use Houghton-Mifflin series</td>
<td></td>
</tr>
<tr>
<td>Students will investigate, establish + communicate rules for + making predictions from numerical + non-numerical patterns.</td>
<td>Have students predict Patterns (See IRP p.38)</td>
<td>Both teachers like to do geometry and line art as part of their math program.</td>
<td></td>
</tr>
<tr>
<td>- Identify + explain mathematical relationships + patterns through the use of grids, tables, charts and calculators</td>
<td>Use 12x12 table. Look for different multiples + patterns. Work in groups. One multiple per group. Discuss: ✔ Are the tables similar? ✔ What differences do you see? ✔ With in one table can you explain why certain number are coloured? ✔ What do you think a table 13 to 17 would look like? Why? ✔ Geoboard diagram (see IRP p.58)</td>
<td>There was no emphasis on patterns, relations or functions as a combined subject or even as part of math. Upon reflection, the teacher acknowledged that they remember and could think of pattern examples. But, they never drew student’s attention to the patterning as they did not think it was important</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Students work directly or even as part of work, activities, tasks in this grade.</td>
<td>The teachers do not teach any “Patterns &amp; Relations” work, activities, tasks in this grade.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix A (continued)

<table>
<thead>
<tr>
<th>Prescribed Learning Outcome</th>
<th>Suggested Instructional Strategy</th>
<th>Existence in the Textbook</th>
<th>Instruction at the site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Here the emphasis shifts to general patterns, variable and functions. By investigating patterns, students develop their mathematical abilities and hone their ability to describe, extend, create, analyze + predict knowledgeably. Students need concrete pictorial experiences to make connections and to build relationships between the real world and the symbolic nature of numbers. There is a major shift in theory at this stage (i.e., students move from being able to recognize a pattern and then describe it, to being able to make a pattern from a description).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is expected that students will construct, extend + summarize patterns using rules, charts, mental mathematics + calculators</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Develop charts to record + reveal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Describe how a pattern grows using everyday language orally + in writing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Construct + expand patterns in 2 + 3 dimensions, concretely + pictorially</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Generate number patterns with in a problem-solving context</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Predict + justify pattern extensions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• In groups, use counters to develop concrete patterns for increasing a number, double, triple, etc. Record</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Use graph paper to design visual pattern flips + slides</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Melting ice in water experiment (see IRP p.78)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Students use Houghton-Mifflen series</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Additional handouts + worksheets were incorporated as supplementary work</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• “Patterns &amp; Relations” handouts were given to students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• There were no “concrete manipulatives, or resources. Teachers had to borrow or purchase materials for the units.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• “Patterns &amp; Relations” are taught in isolation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Students must complete a 12 week unit on “Patterns &amp; Relations”</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix B

Graphic of the “Patterns & Relations” Advance Organizer

Patterns
a) What are they?
b) Are they naturally occurring or man-made
c) What do they look like?

Patterns in the environment
a) All patterns have rules
b) They shrink, grow, repeat
c) Patterns are based on something
d) All patterns do something

Draw ~ What’s the pattern?
a) Build a Pattern
b) Draw a Pattern
c) What is the pattern rule?
d) What is it based on?

Pattern ~ draw it?
a) Replicate a Pattern
b) Draw it
c) What is the pattern rule?
d) What is it based on?

Work with patterns in numbers
a) Even odd numbers
b) Number problems
c) Number Charts
d) Problem solving
## Appendix C

### Draft Progression of Tasks for the “Patterns & Relations” in Mathematics Unit

<table>
<thead>
<tr>
<th>Style</th>
<th>Task</th>
<th>Task Name</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word Problem 1</td>
<td>1</td>
<td>Pattern Word Problems</td>
<td>Word problems form a grade 5 problem-solving booklet.</td>
</tr>
<tr>
<td>Journal 1</td>
<td>2</td>
<td>Journal 1 “What is a Pattern?”</td>
<td>Open journal question: description</td>
</tr>
<tr>
<td>Direct Teaching 3</td>
<td>3</td>
<td>Discussion “What is a pattern?”</td>
<td>Discussion of patterns that occur in the world, BS, classify, think of headings</td>
</tr>
<tr>
<td>Direct Teaching 4</td>
<td>4</td>
<td>Walk About</td>
<td>Walk about the school noting patterns (qualities, why, rules, etc) &amp; discuss</td>
</tr>
<tr>
<td></td>
<td></td>
<td>revisited?”</td>
<td>vs. man-made.</td>
</tr>
<tr>
<td>Direct Teaching 6</td>
<td>6</td>
<td>Peter’s Patterns</td>
<td>Real-life patterns.</td>
</tr>
<tr>
<td>Collaboration 7</td>
<td>7</td>
<td>Make a pattern (then draw it)</td>
<td>Are patterns shrinking, repeating or growing students 2-4-8 sharing of patterns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(describe the pattern)</td>
</tr>
<tr>
<td>Collaboration 8</td>
<td>8</td>
<td>Repeat</td>
<td>Explain rules (i.e., how and why patterns work)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaboration 9</td>
<td>9</td>
<td>Discussion &quot;What makes it a</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>pattern?&quot;.</td>
<td></td>
</tr>
<tr>
<td>Collaboration 10</td>
<td>10</td>
<td>&quot;Teacher give the pattern ~</td>
<td>Major theory change. Prior to this, the sequence was:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>students think of the rule&quot;</td>
<td>Here's the pattern ~ What's the rule? Now:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Series of 7: 2 demonstrations/</td>
<td>Here's the rule ~ What's the pattern</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 practice</td>
<td></td>
</tr>
<tr>
<td>Collaboration 11</td>
<td>11</td>
<td>Using the rule(s)</td>
<td>Can your partner get the rule through the pattern?</td>
</tr>
<tr>
<td>Collaboration 12</td>
<td>12</td>
<td>Write the rules of a pattern</td>
<td>Write a rule(s) for a pattern/ Trade cards with partner</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Build their pattern/ Discuss</td>
</tr>
<tr>
<td>Word Problem 13</td>
<td>13</td>
<td>Pattern Word Problems</td>
<td>Problem Solving Activities</td>
</tr>
<tr>
<td>Journal 14</td>
<td>14</td>
<td>Journal &quot;Making Patterns:</td>
<td>Open Journal Questions: Why do you do it this way? What rule would be helpful?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Why are they true?&quot;</td>
<td></td>
</tr>
<tr>
<td>Co-operative Learning 15</td>
<td>15</td>
<td>Grid Games</td>
<td>Moving from attribute block to numbers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 grid / 100 grid</td>
<td>2's, 3's, 5's, 9's even odd</td>
</tr>
<tr>
<td>Word Problem 16</td>
<td>16</td>
<td>Pattern Word Problems</td>
<td>Problem Solving Activities</td>
</tr>
<tr>
<td>Journal Task 17</td>
<td>17</td>
<td>Journal Entry</td>
<td></td>
</tr>
<tr>
<td>Co-operative Learning 18</td>
<td>18</td>
<td>Primes &amp; Composites</td>
<td>p. 2-6 Expositions</td>
</tr>
<tr>
<td>Co-operative Learning 19</td>
<td>19</td>
<td>Multiples</td>
<td>p. 6-9  p. 91-92 Making Patterns</td>
</tr>
<tr>
<td>Word Problem 20</td>
<td>20</td>
<td>Word Problems</td>
<td>Problem Solving Activities</td>
</tr>
<tr>
<td>Journal 21</td>
<td>21</td>
<td>Journal Entry</td>
<td></td>
</tr>
<tr>
<td>Co-operative Learning 22</td>
<td>22</td>
<td>3D Patterns with numbers</td>
<td>Sequencing, growing patterns, etc. looking at different numbers</td>
</tr>
<tr>
<td>Word Problem 23</td>
<td>23</td>
<td>Pattern Word Problems</td>
<td>Problem Solving Activities</td>
</tr>
<tr>
<td>Journal 24</td>
<td>24</td>
<td>Reflective Journal</td>
<td>Cumulative Journal Entry</td>
</tr>
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</table>
## Appendix D
### Chart of the Actual Progression of Tasks for the Patterns in Mathematics unit

<table>
<thead>
<tr>
<th>Style</th>
<th>Task</th>
<th>Task Name</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1A</td>
<td>1</td>
<td>Test 1A Pattern Problem-Solving</td>
<td>Grade 5 Pattern Problem-Solving activities.</td>
</tr>
<tr>
<td>Journal 1</td>
<td>2</td>
<td>Journal 1 &quot;What is a Pattern?&quot;</td>
<td>Describe a pattern</td>
</tr>
<tr>
<td>Direct Teach</td>
<td>3</td>
<td>Discussion “What is a pattern?”</td>
<td>Discussion of patterns (in the world) (BS, classify, think of headings)</td>
</tr>
<tr>
<td>Direct Teach</td>
<td>4</td>
<td>Walk About Record &amp; draw patterns</td>
<td>Noting patterns (qualities, rules, etc) &amp; discuss.</td>
</tr>
<tr>
<td>Journal 2</td>
<td>5</td>
<td>Journal 2 &quot;What is a Pattern?&quot;</td>
<td>“Are patterns intentional?” C/C patterns nature vs. man-made.</td>
</tr>
<tr>
<td>Direct Teach</td>
<td>6</td>
<td>Peter’s Patterns</td>
<td>Interpret Real life patterns</td>
</tr>
<tr>
<td>Collaboration</td>
<td>7</td>
<td>Make a pattern (then draw it)</td>
<td>Using attribute blocks</td>
</tr>
<tr>
<td>Collaboration</td>
<td>8</td>
<td>Teacher give the pattern (drawn)</td>
<td>Students must identify the rule</td>
</tr>
<tr>
<td>Infused</td>
<td>Direct Teach</td>
<td>9</td>
<td>Following Directions</td>
</tr>
<tr>
<td>Infused</td>
<td>Direct Teach</td>
<td>10</td>
<td>Following Directions</td>
</tr>
<tr>
<td>Collaboration</td>
<td>11</td>
<td>Students make a pattern</td>
<td>Explain rules (i.e., how patterns work)</td>
</tr>
<tr>
<td>Infused</td>
<td>Test 1B</td>
<td>12</td>
<td>Test 1B P Pattern Problem-Solving</td>
</tr>
<tr>
<td>Journal 3</td>
<td>13</td>
<td>Journal 3 “Patterns enlightened”</td>
<td>Questions about patterns, rules, what make a pattern true?</td>
</tr>
<tr>
<td>Coop. Learning</td>
<td>14</td>
<td>Grid Games 10 grid / 100 grid</td>
<td>Moving from attribute block to numbers 2's, 3's, 5's, 9's evens odds</td>
</tr>
<tr>
<td>Coop. Learning</td>
<td>15</td>
<td>Grid Games 10 grid / 100 grid</td>
<td>As Above</td>
</tr>
<tr>
<td>Coop. Learning</td>
<td>16</td>
<td>Grid Games 100 grid</td>
<td>As Above</td>
</tr>
<tr>
<td>Coop. Learning</td>
<td>17</td>
<td>Grid Games 10 grid / 100 grid</td>
<td>As Above</td>
</tr>
<tr>
<td>Test 2</td>
<td>18</td>
<td>Test 2 Pattern Problem-Solving</td>
<td>As Above</td>
</tr>
<tr>
<td>Journal 4</td>
<td>19</td>
<td>Journal 4 “Making Patterns”</td>
<td></td>
</tr>
<tr>
<td>Coop. Learning</td>
<td>20</td>
<td>Primes &amp; Composites</td>
<td>Using 100s chart</td>
</tr>
<tr>
<td>Test 3</td>
<td>21</td>
<td>Test 3 Pattern Problem-Solving</td>
<td>Problem Solving Activities</td>
</tr>
<tr>
<td>Journal 5</td>
<td>22</td>
<td>Journal 5 “What makes a pattern hard to find?”</td>
<td>Description of a process</td>
</tr>
<tr>
<td>Infused</td>
<td>Direct Teach</td>
<td>23</td>
<td>Template- Remedial Tasks</td>
</tr>
<tr>
<td>Infused</td>
<td>Direct Teach</td>
<td>24</td>
<td>Template- Remedial Tasks</td>
</tr>
<tr>
<td>Infused</td>
<td>Coop. Learning</td>
<td>25</td>
<td>Template Remedial Tasks</td>
</tr>
<tr>
<td>Infused</td>
<td>Individual</td>
<td>26</td>
<td>Final Test 1 Test 1 to 4</td>
</tr>
<tr>
<td>Infused</td>
<td>Individual</td>
<td>27</td>
<td>Final Test 2 Test 1 to 4</td>
</tr>
<tr>
<td>Infused</td>
<td>Individual</td>
<td>28</td>
<td>Final Test 3 Test 1 to 4</td>
</tr>
<tr>
<td>Infused</td>
<td>Individual</td>
<td>29</td>
<td>Final Test 4 Test 1 to 4</td>
</tr>
<tr>
<td>Infused</td>
<td>Journal 6</td>
<td>30</td>
<td>Journal 6 “Student Survey”</td>
</tr>
<tr>
<td>Infused</td>
<td>Journal 6</td>
<td>31</td>
<td>Journal 6 “Student Survey”</td>
</tr>
</tbody>
</table>
Appendix E

Key Visual Template for the Patterns Unit

Patterns & Relations Template

The Object: | The Problem:
---|---

Finding a solution: Are there any similarities & differences?
Your ideas: | Similarities | Differences
---|---|---

Table

What comes next?

Is there a pattern? Describe it to me!

What is the pattern based on? (colour, size, shape, number) | What is the rule?
Appendix F

Problem Solving Test 1A and 1B

1. Mr. Chan was putting up wallpaper in the spare bedroom. He used 2 sheets of wall paper every 3 metres of wall. How many sheets of wallpaper did Mr. Chan use after 24 metres of wall?

<table>
<thead>
<tr>
<th>Metres of wall</th>
<th>3</th>
<th>6</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheets of wallpaper</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

2. Phuong had a nasty cold. She took six spoonfuls of cough syrup each day for 5 days. How many spoonfuls had she taken after 5 days?

<table>
<thead>
<tr>
<th>Days</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spoonfuls</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

3. Complete the patterns

\[
\begin{array}{cccc}
16 & & & 48 \\
6 & 10 & & 29 \\
2 & 4 & 6 & 8 & 7 & 12 & 17 & 22 \\
\end{array}
\]

4. Complete the patterns

\[
\begin{array}{ccccccccc}
\end{array}
\]

The rule is ____________?

5. Complete the patterns

\[
\begin{array}{cccc}
39 & 41 & 40 & 42 & 41 & & & 45 \\
\end{array}
\]

The rule is ____________?

6. Complete the patterns

\[
\begin{array}{cccc}
72 & 79 & 70 & 77 & 68 & & & 73 \\
\end{array}
\]

The rule is ____________?

7. Find the pattern fro the ones place value of the products when we multiply each of the following numbers by themselves over and over again (e.g., 3x3=9, 3x3x3=27)

a) 3

b) 7

c) 9
Appendix G

Graphs of the Results from Final Test 1-4

Test 1

Test 2A

Test 2B

Test 3A

Test 3B

Test 4A
Appendix H
Scan of Problem Solving Test 2

1. Julie was making fruit punch for her whole class. She started with 3 L of grapefruit juice. Then she added 2 L each of several different kinds of fruit juices. At the end she had 17 L of punch. How many different kinds of fruit juices did Julie use?

2. Patti saved pennies for 10 days. The first day she saved 1¢. Every day after that she saved twice as much as the day before. How much money did Patti save altogether?

3. Ron had $26.92 at the beginning of the week. He spent 10¢ the first day and 20¢ the second day, and 30¢ the third day, and so on. How much money did Ron have left after 7 days?

Continue each sequence:

5, 6, 8, 11, ?, ?, ?, ?

3, 6, 12, 24, ?, ?, ?

12, 8, 23, 7, 34, 6, 45, 5, ?, ?, ?

10, 11, 9, 12, ?, ?, ?, ?

Mrs. Nelson put wallpaper up in the guest bathroom. She used 2 sheets of wallpaper for every 3 M of wall. How many sheets of wallpaper did Mrs. Nelson use after 24 M of wall?

<table>
<thead>
<tr>
<th>Metres of wallpaper</th>
<th>3</th>
<th>6</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheets of wallpaper</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

1. Penny took six spoonfuls of cough syrup each day for 5 days. How many spoonfuls had she taken after 5 days?

<table>
<thead>
<tr>
<th>Days</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spoonfuls</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

3. How many squares are in figures A, B, C

4. How many cubes?
Appendix I

Problem Solving Test 3

1. Write the missing numbers from the pattern

<p>| | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>40</td>
<td>61</td>
<td>83</td>
<td>106</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>236</td>
</tr>
<tr>
<td>392</td>
<td>399</td>
<td>393</td>
<td>400</td>
<td></td>
<td>401</td>
<td></td>
<td></td>
<td></td>
<td>403</td>
</tr>
</tbody>
</table>

2. Margaret fertilized her plants every week. The first week, she used 4 drops of fertilizer. Each week after that, she used 5 more drops than the week before. How many drops had she fed her plants in all after 8 weeks?

<table>
<thead>
<tr>
<th>Weeks</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer Drops</td>
<td>4</td>
<td>9</td>
<td>14</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Jason was placing markers around the track. He put the first marker at 100 m. Then he put a maker every 50 m after that. How many markers would he need to reach 400 m?

4. Rick was running a 10km race. It took him 5 minutes to run the first km. He slowed down after that and it took him 1 minute more to run each Km than the one before it. How long did it take Rick to run the race?

5. Study the patterns:

   • •••
   • •••
   1 1
   2 1
   1 2
   3 2
   1 2
   3 4
   3 2

   What is the middle number in the 9th row?
   How many numbers will be in the 9th row? 20th row?
   What is the sum of the numbers in the 9th row? 20th row?

6. One road will connect 2 cities, but it may take 3 roads to connect 3 cities. Find a pattern to determine how many roads might be needed to connect 10 cities.

<table>
<thead>
<tr>
<th>Cities</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. A square piece of paper is folded in half; and then folded in half again; and so on. How many sections of paper are there after the 6th fold? Try it!
Appendix J

Journal Survey

1. What grade were you in the last time you worked with patterns (other than the current grade)?

![Bar chart showing the number of responses per grade for the first question.]

2. Put a check mark beside the grade(s) in which you have made “Patterns” with blocks or other manipulatives.

![Bar chart showing the number of responses per grade for the second question.]

Appendix J (continued)

3. Put a mark beside the grades(s) that you have been taught lessons in “patterns”

4. Put a check mark beside the grade(s) that you have been taught units in “Patterns”
Appendix J (continued)

5. What statements best describe your situation

6. What statements best describe your situation?