TWO APPROACHES TO WRITING LABORATORY REPORTS IN SENIOR SCIENCE: THE KNOWLEDGE FRAMEWORK AND THE GENRE-BASED APPROACH TO LITERACY

by

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER'S OF ARTS

in

THE FACULTY OF GRADUATE STUDIES

(Department of Language Education)

We accept this thesis as conforming

to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

September 1994

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Date Oct. 15, 94

DE-6 (2/88)

ABSTRACT

The purpose of this study was to address the question, "is there a difference in the quality of scientific report writing at the senior secondary school level related to differences in instructional approach: The Knowledge Framework (KF) approach or the the Genre-based approach to literacy instruction. This research also examined the effectiveness of the two approaches on improving ESL and native-speaking students' writing of scientific laboratory reports in senior science.

The Genre approach to writing science was based on the model of Systemic Functional Linguistics that views language as a social semiotic that is a resource for meaning. The Genre-based approach to literary in science was concerned with exploring the structure, function and usage of scientific language in the written mode. The Knowledge Framework-based approach to pedagogy was one that emphasized the cooperative development of cognitive skills, academic language and content knowledge by focusing on thinking objectives, key linguistic and content features inherent in a topic or activity.

The methodological design for this study tested the effectiveness of the Knowledge Framework and the Genre approaches by using two pretests (Reading and Writing), one posttest of the written lab reports, and two surveys that drew upon the participants' experiences with each of the two approaches. Except for the Gates-MacGinitie Reading test, the tests and an evaluation grid for the posttest were specially developed for this study. The two pretests assessed the student participants' reading and writing abilities prior to the introduction of the two approaches while the posttest lab reports represent the lab work written by the students using the two approaches. The surveys contained itemized statements that represent the participants' opinion about the characterizing features of the two approaches: the generic structure or format and the special language features. The respondents of the surveys were to use a four-point score: Strongly Agree (1) - Agree (2) - Disagree (3) - Strongly Disagree (4).

The results from the reading and writing pretests, posttest laboratory reports, and the two surveys indicated that there is a difference in the quality of scientific report writing at the senior secondary school level related to differences in instructional approach. The results revealed that:

a) the Knowledge Framework helped to improve the quality of both native-speaking and ESL students' writing of scientific lab reports in senior Biology. The Knowledge Framework served as an organizational tool for students to focus on the linguistic features necessary for expressing key content information in their write-up.

b) the Genre-based approach helped the students to improve their awareness of "Procedure", "Procedural recount", and "Explanation" genres and focus on the language features for expressing scientific content.

c) the Knowledge Framework approach appeared to help students to improve the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology.

d) however, neither the KF nor the Genre-based approach substantially improved the quality of both mainstream and ESL students' writing of lab reports when compared to the quality of the students who were not taught either approach.

e) the mainstream and ESL students showed no significant improvement above those in the Control group after using the KF and Genre approach.

f) overall, the KF approach appeared to be more effective than the Genre-based approach to instruction in improving the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology.

g) while the study has contrasted the Knowledge Framework approach and the Genre-based approach, they were infact complementary.

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ACKNOWLEDGEMENT

I would like to thank the staff and students of Richmond Senior Secondary School for their support in this research. I would like to especially thank Dr. Jim Leung and Mr. Ken Black of Richmond Senior for their time and effort as teacher participants in the study.

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CHAPTER 1

INTRODUCTION

I. STATEMENT OF THE PROBLEM

As more English as a Second Language (E.S.L.) students and native English students choose science as their focus of academic studies in the Canadian school system, there is also a greater emphasis placed on higher standards of student performance as a measure of success in science learning. Since the learning of scientific concepts involves linking the theoretical and the practical experiences of science, student learning is often measured by their performance on tests that focus on conceptual theory and their performance on laboratory (lab) exercises that offer a "first-hand experience" with science. It has come to the attention of science educators and researchers alike that student performance on laboratory work is poor: The laboratory reports lack communicability or clear expression of the learning of scientific concepts (Beasley, 1985; Klein *et al.*, 1982; Kochendorfer, 1994; Renner, 1986; Vargas, 1986).

Science students write scientific laboratory reports to communicate their learning of scientific concepts. In writing scientific laboratory reports, students apply their language skills or linguistic knowledge to organize and construct a body of text that represents the scientific information learned and process skills attained. Upon assessing student performance on lab reports, science teachers find students are weak in their writing skills (Vargas, 1986) and are uncertain as to what information is most relevant for reporting (Beasley, 1985; Klein *et al.*, 1982; Kochendorfer, 1994; Renner, 1986; Vargas, 1986). For E.S.L. and some recently mainstreamed students, their writing of scientific lab reports poses a heightened challenge because of the language barrier.

II. BACKGROUND

Science laboratory work and reporting play a key role in science education because they provide the opportunities for students to participate in investigations and experimentation in which they exercise their own thinking, draw their own conclusions, and inform others in the scientific community, about their results (Renner, 1986; Beizenherz and Olstad, 1980). Laboratory activities involve students in the scientific enterprise of posing questions, hypothesizing, testing, problem-solving, and ultimately, making discoveries. They also give students concrete learning experiences in which they can explore new ideas and relate concepts and theories to data collected from personal observations (Renner, 1986; Klein *et al.* ,1982).

Although laboratory work has always been promoted in the teaching of science, in some periods during the history of science education it has been given a dominant role. During the major science curriculum reform movements of the 1960s some science teachers believed that "a considerable amount of laboratory work should lead, rather than lag behind, the classroom phases of science teaching" (Schwab, 1964). In the 1960s curriculum planners placed heavy emphasis on "inquiry and the processes of science by suggesting that working on problems in the laboratory is more important than finding conclusions" (Schwab, 1964). These reform recommendations for investigative laboratory work were only suitable for some students and certain purposes and in the final analysis did not provide students with sufficient educational experiences to succeed in a changing society or have greater relevance to their daily lives.

Presently, it is the science teachers who assume the responsibility of changing the way they plan, implement, and evaluate laboratory-oriented curricula so that they are appropriate for their science students. Among many factors and issues to address, for one, educators are recognizing a demographic change in their student body and are assisting their new immigrant students to adjust to a cross-cultural experience in science education. In particular, science teachers can introduce various approaches to laboratory work and reporting so that the students can better learn from their lab experiences and improve on their lab performances.

III. PURPOSE OF THE STUDY

The purpose of this study is to see how two approaches to instruction can be applied to improving ESL and native-speaking students' writing of scientific laboratory reports in senior secondary school science. One model for the integration of language and content can be described by Mohan's "knowledge framework for learning" (1986). It is an approach to Integration and Language and Content which involves the instruction and learning of both language skills and content information in a particular curriculum in an education context (Mohan, 1979, 1986; Early, 1990; Early, Mohan & Hooper, 1989; Crandall, 1987, 1993; Cantoni-Harvey, 1987; Brinton, Snow & Wesche, 1989). Another is the genre-based approach to literacy instruction for writing science (Halliday & Martin, 1993; Martin, 1992, 1993, Halliday, 1993, 1985; Christie & Rothery, 1989; Painter & Martin, 1986; Callaghan & Rothery, 1988; Christie, 1990; Rothery, 1993). Based on the model of functional grammar of systemic linguistics that views language as a social semiotic that gives meaning (Martin, 1992,1993; Halliday, 1985, 1989, 1993; Christie & Rothery, 1989) the genre-based approach to literacy in science is concerned with exploring the structure, function and usage of scientific language in the written mode.

This study will examine how the Knowledge Framework approach and the genre-based approach to literacy compare in effectiveness as each is applied to teaching ESL and native-speaking students to write lab reports. While the Genre and the Knowledge Framework approach will be contrasted, it should be understood clearly that they are not opposed alternatives. In fact, they can be combined as complementary approaches. The central question of this study asks:

Is there a difference in the quality of scientific report writing at the senior secondary school level related to differences in instructional approach: The Knowledge Framework approach or the genre-based approach to literacy instruction.

A body of anticipated research questions can be derived from the broader central topic of this study which explores the implications of the ILC and the genre-based approaches for second language learning and writing senior Biology:

1. Which approach, ILC or genre-based, is more effective in improving both native-speakers and ESL learners' writing of scientific lab reports?
2. Which approach, ILC or genre-based, is more effective with native-speakers and which is more effective with ESL learners?
3. With respect to the genre-based approach, can students identify the appropriate genre or genres to write their scientific lab reports? How do students deal with overlapping genres?

*4. Are students able to use the knowledge framework to organize the activity of writing a scientific lab report? How do students divide the activity into the "specific, practical cases" and the "general, theoretical background knowledge"? Are students using graphics for representing the knowledge structures for writing lab reports effectively? Can students identify, process, and apply the language and cognitive skills organized in the knowledge framework?

*5. How do ESL learners respond to using each of the approaches to learning language and / or scientific content knowledge?

a) How does each approach suit their learning styles?

b) What do students perceive to be the limitations of each approach (if there are any)?

* Items #4 and #5 will be addressed in a reflective analysis of the students' experiences with each approach done through an evaluation and assessment questionaire, Survey 1 and 2 (see Chapter 3: "Methodology".)

IV. SIGNIFICANCE OF THE STUDY

The significance of this study is to explore how the ILC approach and the Genre-based approach to literacy can be implemented to improve the second language student's writing of senior scientific reports.. A critical-interpretive research approach with an empirical dimension is employed to describe the nature of the improvement or lack there of in the student's scientific lab report writing upon using the ILC or the genre-based approach. The student's interaction with process writing guided by the knowledge structures of the Knowledge Framework approach or the elements of the genre-based approach will be reflected in their writing of scientific laboratory reports at the senior secondary level. This is a comparative study that explores the effectiveness of each of the ILC approach and the Genre-based approaches with respect to one another for writing scientific lab reports. It is the hope of this study to reveal the relative benefits or concerns with each approach so as to increase our understanding of language and content integration and genre and their implications for writing senior science for learners of all levels of academic language proficiency.

V. LIMITATIONS OF THE STUDY

The focus of this study is on the application of the ILC and the Genre-based approaches to writing senior science in the context of Biology. The subjects of this research are both mainstream and native-speaking, Grade 11 Biology students and those for whom English is a second language. The following list outlines the limitations of the study:

1. ESL and native-speaking students for this study are randomly selected from 3 Biology 11 classes at Richmond Senior Secondary School in Richmond, B.C.
2. Since this study focusses on writing scientific lab reports in Biology 11, the results may not be applicable to the elementary or junior secondary level courses in science, nor is it applicable to any other senior science courses such as Physics 11 or 12, Chemistry 11 or 12. However, some implications from this study may be drawn for instruction in Biology 12.
3. The native-speaking and ESL students come to this study with a variety of background knowledge about and strategies for writing. It may be not feasible to establish a common pattern of previous writing instruction strategies the students were taught before beginning this study.
4. Considering the ethnic mix of the ESL population in this study, the findings may not reflect the ability of ESL students of any particular ethnic origin or across all cultures.

5. Although a teacher's guide may be followed in instructing genre, teaching methodologies are based on the personal ideologies and philosophies of the biology/language teacher. The teacher's own theory and practice of second language learning and instruction must be considered in the study's findings.

VI. DEFINITION OF TERMS

- English as a Second Language (ESL) students - students whose first or native language (L1) is different from the language (L2) of the greater community in which they reside and whose English proficiency level is below that of native-speakers of English.
- Culture - this refers to a set of human practices (i.e, rituals, customs, traditions, social actions) that produce meaning and to the objects that are the result of those practices. It encompasses all forms of human engagement in those practices and their effects on humans acting together as a "culture". (DSP, 1989)
- The Knowledge Framework - as an approach it refers to the instruction and learning of both language and content knowledge inherent in the classroom curriculum. It focusses on the development of language and cognitive abilities as well as academic content in ESL learners. It utilizes knowlegde structures (KSs) as a means of organizing language and content knowledge for learning (Mohan, 1986).
- mainstream - this term is used to refer to students who are enrolled in school courses developed by the B.C. Ministry of Education where the curricular content is taught in one of the official languages, English or French, at the native-like proficiency level. For example, a recognized mainstream English course is English 10 and a mainstream science course is Biology 11.

- (Scientific) Discourse - systematically organized ways of talking and writing, which give expression to the values and meanings of particular institutions. Scientific discourse may refer to the way language is used to talk and write about scientific concepts and knowledge: the values and meanings are inherent in the context of science.
- Genre - any staged purposeful cultural activity in which language is used. This including oral genres as well as written language ones. A genre is said to be charactized by having a schematic structure - a distinctive beginning, middle, and end. Genres are not set in concrete or fixed and unchanging forever. They have been developed over time to achieve specific social purposes and are constantly evolving (e.g. sales exchange, interview, letter, essay, meeting, lecture, novel, joke, etc.) (DSP, 1989).
- writing - The medium in which language is available to literate groups. Like speech, writing is an entirely cultural activity and therefore has particular cultural uses and cultural meanings. (DSP, 1989)

CHAPTER 2
REVIEW OF RELATED LITERATURE

I. INTRODUCTION

This chapter contains a review of the literature in the following related topics:

1. Writing a scientific laboratory report as an academic task for the learning of science.
2. The Genre-based approach to literacy instruction for writing science.
3. The Knowledge Framework approach to writing science.

The focus of this review is to provide an introduction to each of the above related topics, examine their central themes from a critical perspective, and highlight the implications of these approaches as they are applied to this research.

A. GENERAL BACKGROUND

Second language acquisition and learning theorists believe that English as a Second Language (ESL) students in language and content-area classrooms can learn the second language more effectively if the language and content of the curricular topics are presented in a meaningful way for learning and time is alloted constructively to allow for ample opportunities for learning (Collier, 1987; Cummins, 1991; Krashen, 1981, 1982).

Krashen (1981, 1982) suggests that integrated instruction in classroom situations can present "language input" that is just above the proficiency level of the learner and link it to meaningful content. Krashen believes that target language or "comprehensible input" introduced through academic content not only facilitates the acquisition of language but also make the content knowledge accessible to second language learners (1982)

According to Cummins (1991) there is a distinction between conversational and academic proficiency: basic interpersonal communicative skills (BICS) and cognitive/academic language proficiency (CALP). BICS are skills for face-to-face communication in a social context while CALP can be described as aspects of language proficiency that are formal, abstract, "context-reduced and cognitively more demanding" (Collier, 1987). In academic-content classrooms such as science, specialized content language in assigned tasks is most difficult for ESL students to use and practice. They need opportunities to use this academic language more often in "context-embedded" situations. For example, a small group discussion on a scientific topic that invites participation by or a jigsaw cooperative learning group would give ESL students some chances to practice their L2 in a relaxed environment. It takes between 4 to 8 years for ESL students to reach national norms on standardized tests (Collier, 1987); therefore, as instructors, we cannot delay the instruction of academic content and skills.

II. WRITING A SCIENTIFIC LAB REPORT: AN ACADEMIC TASK FOR LEARNING

Students complete classroom tasks assigned by teachers to learn the content information presented in the task. For native-speaking students in the mainstream classroom the focus of learning is mainly on acquiring the conceptual knowledge in the tasks, but for second language learners, the emphasis may be on the linguistic forms (grammar, syntax, lexis, morphology, etc.), the subject matter, or both. The nature of the class curriculum, syllabus, and the learning and teaching goals and objectives in consideration of the needs of the students determine the design, implementation and evaluation of tasks in the classroom.

Before beginning a discussion on the writing of a scientific lab report as a classroom task for learning, the notion of "academic task" will be described.

A. ACADEMIC TASKS: FOR CONTENT AND LANGUAGE LEARNING

The notion of classroom 'academic task' can be conceptualized according to syllabus design (Long & Crookes, unpublished, 1992), the function or purpose of the task in engaging the teaching-learning process (for language or content learning or both), hence the different types or classification of tasks, the components of tasks that outline the steps for completion, and the environment in which the task learning takes place. A majority of the researchers appear to maintain that an 'academic task' is a classroom activity that allows students to interact with and learn about the information introduced in the task itself (Brown, 1991; Candlin, 1987; Doyle & Carter, 1984; Long, 1989; Long & Crookes, unpublished & 1992; Mohan, 1991; Nunan, 1988 & 1989).

Classrooms are places where students do work: they complete "academic tasks" (Mohan, 1991). Students do assigned work, fill in worksheets, read textbooks, participate in group projects, write essays and reports. What students actively do in the classroom reflects their learning of knowledge and information and their development in cognitive ability. Since students show achievement by doing tasks, then a task can be viewed as a "basic unit of analysis of schoolwork" (Mohan, 1991). Therefore, curriculum can be seen as a "collection of academic tasks". Taking this perspective of curriculum, Mohan suggests that the task is a common unit of analysis for content work and language work". This is most applicable to any curriculum, such as science, that caters to the learning by both mainstream and ESL students. In light of the classroom use of academic tasks that include second language learners, tasks should be designed in a way that highlights the language and content objectives for conscious learning (Mohan, 1991).

According to Doyle and Carter (1984), academic tasks are defined by

(a) the requirements for the products students are expected to hand in, such as an expository essay or test paper;
(b) the resources available to students while accomplishing work ... and
(c) the operations that are to be used to generate the product , such as as memorizing a list of words for a test.

Doyle and Carter (1984) maintain that tasks set out a plan of learning objectives for students to meet when they "do" certain activities and carry out classroom events (i.e. doing a worksheet to be handed in for marking). Students are grouped or organized in certain ways to achieve task completion, e.g., individual seatwork, group discussions, presentations, etc. (Doyle & Carter, 1984). Tasks completed in a certain manner reflect the way students think about the subject matter at hand. This seems to suggest that through the process of completing academic tasks students will acquire the content knowledge in the tasks. Can academic tasks provide a medium for the learning of both content information and language skills?

Some researchers seem to view academic tasks from a language-learning perspective in that the tasks are designed to provide opportunities for learning language or linguistic forms and do not focus on the learning of the content (Candlin, 1987; Long & Crookes, 1992; Nunan, 1989; Prabhu, 1987; Swales, 1990). They speak of "language" tasks that allow second language learners to interact with the target language while communicating about a situational topic. Working with a "traditional" language curriculum, teachers generally plan lessons to direct learners to pay attention to L2 grammar (Fotos and Ellis, 1991), vocabulary, sentence structure and other linguistic forms, and have learners respond by displaying what they learned through written texts and verbal answers, or some actions that indicate achievement. Fortunately, beliefs about effective pedagogy and successful second language acquisition (SLA) are changing and taking on a more "interactionistic" perspective: Language classroom tasks are becoming more like "communicative tasks" where opportunities to "perceive, comprehend, and ultimately internalize L2 words, forms, and structure" are offered to students (Pica, Kanagy & Falodun, 1990). Pica *et. al.* (1990) propose that task activity and goals take on many forms, and not all of these forms trigger SLA directly. Pica *et. al.* suggest 5 different types of communication tasks that allow students to interact with their target language: "jig-saw", "information-gap", "problem-solving", "decision-making", and "opinion-exchange". They make language tasks more interactive and communicative.

Do language tasks deemphasize the learning of content or is content learned through "doing" the language tasks? Mohan (1991) makes the distinction that language tasks take a language viewpoint and content tasks take a content viewpoint. Mohan asks whether these two viewpoints can be combined and a 'good' content task also can be 'good' language task. Consistent with this distinction, what types of tasks can be designed to serve a content-based program that emphasizes English for Academic Purposes (EAP) such as a science course (Brinton, Snow & Wesche, 1989; Cleland & Evans 1984)? Mohan (1991, 1989 & 1986) and Early *et. al.* (1989 & 1990) believe that the learning of language and content can be integrated in academic tasks where linguistic form, such as grammar, and subject matter are held in equal value for learning.

Whether an academic task is designed for the learning of content or language, the distinction between the language and content objectives in the task should be made known to the learner. Depending on the students' language ability and the context of curricular instruction, the "activity" of an academic task may involve students in interacting in both the linguistic component and the subject matter of the task topic. Hence, the evaluation of student learning may focus on both language skills and conceptual knowledge acquired where language is a means of expressing knowledge.

B. WRITING A LAB REPORT IN SCIENCE

Writing a laboratory report is a "multifaceted" academic task for learning of the concepts and the language of science (Pica, Kanagy, & Falodun, 1990). Through a variety of scientific skills and processes, students in a science course experiment and analyze data and exercise critical thinking abilities to formulate an understanding of the environment around them. The students embark on a "first-hand" experience with science each time they learn about and explore a particular concept or topic through laboratory work (Renner, 1986; Beasley, 1985; Klein *et. al.*, 1982; Beizenherz & Olstad, 1980). Often, they conduct scientific investigations to learn about these concepts and document their experiences and findings on a formal laboratory report (Goodman, 1986; Kanare, 1985; Biology, 1986).

A completed formal laboratory report is often composed of smaller sections that describe all the pertinent information of the laboratory work done: the purpose (objectives or a hypothesis) of the lab experiment or investigation, materials, procedures, observations and data, discussion, and a conclusion. With careful thought as to the intention of each lab section, the write-up should consist of a specific body of knowledge represented and communicated in clear writing.

The following is a more detailed description of the lab report as an academic task with regards to expectations for students completing the task:

1) PURPOSE / OBJECTIVES / HYPOTHESIS

Often "students are left with the impression that the laboratory's purpose is *verify* something that the teacher, textbook, or some other authority has told the students. Is that the proper role of the laboratory?" (Renner, 1986). It is not surprising that students are sometimes uncertain about why they do laboratory work at all. How do science students arrive at a purpose for a laboratory investigation or experiment?

Renner (1986) suggested that students should be given the opportunity to first observe and "collect data regarding an unfamiliar phenomenon. Then they could 'coordinate' those experiences and produce a 'logical system'." He went on to state that students should:

> first gather data about a concept, next, put the data together and invent a concept; and then, they expand the concept to include related ideas. The last phase of the investigation includes further laboratory investigations, questions, problems and readings.
> (Renner, 1986)

Renner's (1986) suggestion is that students should be allowed to discover scientific concepts through lab work. The initial observation of an "unfamiliar phenomenon" gives them a chance to establish a "systematic" base for lab investigation or experimentation. Then, a purpose for laboratory work is thus generated for meaningful concept exploration.

Technically speaking, this first section of a lab report should describe what the laboratory work is intended to find out. Students should make a distinction between a purpose for investigation and a hypothesis for experimentation. The "purpose" section is a clear and concise statement that consists of the most essential elements that directly apply to the lab investigation. Writing an appropriate purpose for a lab poses difficulties for some students because they fail to present the key information communicated in best language. Certain problematic features of writing the "purpose" section of a lab report stem from the lack of the use of *infinitives* and the incorrect use of the *first person* for point of view (Vargas, 1986). In situations where a hypothesis is to be written for a lab experiment the cause and effect relationship between experimental variables are sometimes poorly established.

2) MATERIALS

The "materials" section of the lab write-up should include a list of equipment and supplies, tools and utensils, chemical and/or specimen used in the lab investigation or experiment. Proper names and labels should be stated to avoid ambiguity. It may be necessary to identify the specific number or amount of the materials used in the lab to ensure accuracy and reliability. Any addition, omission, or change in materials must be documented.

3) PROCEDURES

The "procedures" to a lab can be one of the most important parts of the write-up. The procedures provide the scientist with a step-by-step account of how the lab investigation or experiment is to be conducted (Goodman, 1986; Kanare, 1985). This section contains the "instructions" to how to "do" the lab activity. It has to be clear and precise so that any scientist can understand and replicate the investigation intended in the lab work.

In writing the "procedures" section, students should describe the detailed lab information accurately by using specific language. The lab information presented should include key terms and proper names of items handled. The language features of the write-up should focus on action-oriented processes, the dimensions of time, space, and order, and voice (active versus passive) (Vargas, 1986). Safety precautions, which may not be directly involved in carrying out the procedures unless indicated, should be articulated clearly for the protection of the lab student. Given the above, it is easier to see why students encounter problems in this section because they lack certain content and linguistic elements that could otherwise make the writing of their procedures clearer.

Some science teachers prefer to restrict the term *experiment* to the type of investigation known as the *controlled experiments*, in which every effort is made to describe in the "procedures" section the controls and variables involved that can affect the results. "All factors except for the independent variable(s) are held constant, and its effects on the dependent variables are observed" (Macmillan, 1986).

In certain lab investigations the "procedures" section may be duplicated from a prescribed laboratory manual by making reference to the corresponding pages in the manual. Procedure questions can be provided to guide the students through the experiment and focus on key steps and observations in the lab. Any changes to the procedures should be noted on the lab report.

4) OBSERVATIONS AND DATA

Observation is one of the more important skills in science. By improving students' observational skills, science teachers also help their students increase their knowledge of concepts under investigation. To become careful observers, students can guide themselves by asking (Norris, 1984):

- How complete are the observations?
- How well are the observations reported?
- How correct are the reports of the observations?

Attention to completeness and detailed reporting may help students develop better observation skills, but "correctness" may not be as viable a quality to reporting an observation as the accurate or true representation of the phenomenon observed. "Correctness" is a value judgement or inference. Stressing the process skill of observation can help students become better conceptual learners who inquire and critically think about their scientific lab experience.

All observations related to the purpose or objectives of the lab must be recorded in the students' write-up. Students should visually represent their observations by drawing and labelling specimen and graphs, and data tables. All necessary calculations must be made to arrive at an arbitrary "result". The drawings should have a magnification for contrast with the real life image. Descriptions of the observations should be made to accompany the visuals.

5) DISCUSSION

In this section students need to give an interpretation of the observations and the data document. Students are encouraged to explain their results by relating their findings to relevant scientific concepts and theories that form the foundation of the lab investigation or experiment (Goodman, 1986; Kanare, 1985). They need to make cause and effect relationships between the variable factors and the outcomes of the experiment. In reporting the results any discrepancies or experimental errors should be included and sufficiently supported with logical explanations.

For some students, especially those with limited facility in English, accomplishing the written task in this section poses a challenge. These students may not see the meaningful relationships between different parts of the experiments or be able to make connections to the central ideas in the investigations. Comparing and contrasting their findings with the theoretical background is a science process skill at which students need more practice (Beasley, 1985; Beizenherz & Olsad, 1980). Students need to focus on language structures such as: cause and effect (explanations), degree of comparison and contrast, i.e. "better, greater than", and similarities -"same as" and differences - "different from". Key visuals or graphic representation of the results can also help make connections and identify distinct content and language characteristics for comparison and contrast (Mohan, 1986; Early *et. al.* 1989; Dunbar, 1992).

In looking at academic writing tasks for ESL students Horowitz (1986) suggests that writers should "find, organize, and present data according to fairly explicit instructions." In writing a "good" analysis and discussion of the findings, data collected needs to be "encoded into academic English" by "contextualizing" the task with sound grammar use.

6) CONCLUSIONS

In this last section of the lab report students are to concisely state a summary of their findings. If a hypothesis was tested they need to accept or reject the hypothesis based on the outcomes of their experiment. If certain numerical values serve as the result of the experiment, then they must be included. On writing science using the Genre-based approach to literacy, Veel (forthcoming) states that:

> The conclusion stage is essential in giving scientific value to experimental and observational activities. It tells the reader what type of scientific meaning can be drawn form the activity and how the activity contributes to the store of scientific knowledge.

Veel (forthcoming) identifies three reasons why students find writing conclusions challenging:

1) Projection: using mental activity of the observer (e.g."discovering, finding, learning") to "project" the world of ideas, concepts and generalization in the conclusions.
2) Generalization: Conclusions are stated in a generalized way.
3) Abstraction: Using "nominalisation" to describe a chain of related events.

In writing conclusions students should clearly reiterate the lab's most essential results and findings and relate them to the purpose of the lab investigation either by responding to the statement of purpose specifically and directly or addressing the question underlying the lab purpose.

C. SUMMARY

Students complete assigned classroom tasks in hopes of learning the information presented in the tasks. That information can be described as new language forms and/or content knowledge. Generally speaking tasks can be simple everyday activities. In other instances, tasks can be very technical and 'academic' in nature and involve complex steps in meeting the goals and processing the input in the tasks. Academic tasks introduced to students in a subject-area of science are evaluated and graded for the content knowledge learned and for the language or communicability of that knowledge. Writing a laboratory report is an example of an academic task in the content-area of science.

Beyond conceptualizing the notion of writing a lab report as an academic task for learning, there exists the perception that academic tasks are not viewed by students and teachers in the same way. Students could perceive a task to contain "explicit" instructions for a certain activity and assume the tasks can be completed sufficiently with limited prior knowledge. Some students and teachers see teacher-initiated tasks to be the only vehicle for learning. When designing a task, some teachers believe they have to guess at creating a task that captures the essence of the learning of content knowledge or language forms. All of this leads to a possible misconception of the purpose and value of an academic task such as a lab write-up in science. It is not clear to what extent teachers and students should negotiate on the purpose and function of an academic task.

III. THE INTEGRATION OF LANGUAGE AND CONTENT AND WRITING SCIENCE

What is the integration of language and content (ILC) instruction? Is language and content integration a teaching methodology and / or a prescription for a more effective curriculum for the learning of content and language? Is ILC instruction suitable for a "language" curriculum or a "content-area" curriculum? Defining language and conceptual knowledge integration involves careful consideration of the roles of the instructor and learner and their relationship in the classroom where a curriculum rich in language structures and content information serves as a medium for teaching and learning. Language can be viewed as a medium for constructing and communicating conceptual knowledge and activities of culture and society. Integrating language and content information for instruction includes the presentation of language items (grammar, syntax, lexis, morphology, etc.) and subject matter (content knowledge) with a balanced emphasis on both in a cohesive manner for learning (Brinton, Snow & Wesche, 1989; Cantoni-Harvey, 1987; Crandall, 1987, 1993; Early, 1990; Early, Mohan & Hooper, 1989; Mohan, 1979, 1986).

The notion of integration of language and content instruction emerged as the equivalent approach for content-centered language learning (Crandall, 1993). Theories and practice of second language acquisition and learning have much support for this approach since it offers a way by which students for whom English is a second language can continue to develop their cognitive skills and ability while they are also acquiring social and academic linguistic competency in the content-area classroom (Cummins, 1991; Krashen, 1981, 1982).

Researchers such as Crandall (1993) believe that language and content-area instructors can present meaningful content and modified target language to promote both second language acquisition and academic content learning:

> Language (ESL/bilingual) teachers can use content-area texts and tasks as a vehicle for developing language proficiency while helping develop academic concepts and skills. Content-area teachers can adapt the language of their texts and instructional tasks (using techniques familiar to language teachers) to make their instruction accessible to second language learners while helping students develop needed content-area language skills. (Crandall, 1993).

A. BACKGROUND

Integrating language teaching and content teaching is related to English for Specific Purposes (ESP) (Barron, 1991; Brinton, Snow, and Wesche, 1989; Crandall, 1987, 1993;). ESP programs provided English instruction in some other academic discipline. ESP instruction shifted its focus from making accessible the texts of science, business, medicine, law, and other career professions to emphasizing language features or "what" people learn instead of the learning process or "how" they learn (Crandall, 1993). Instruction in this way is similar to the integration of language and content development.

More recently instructors working with academic content curriculum have shown interest in integrated language and content learning by stressing the importance of language across the curriculum in the reading, writing, and oracy of mathematics, the sciences, or social sciences (Crandall, 1993). ILC instruction offers educators in content-area disciplines a strategy for improving "writing across the curriculum" (Crandall, 1993). A number of program models of integrated language and content instruction are available to educators of various disciplines. Table 2.1 represents 3 popular models to integrated language and content instruction discussed by Crandall (1993).

In the Canadian science classroom, ESL and native-speaking students learn both the concepts and language of science by completing academic tasks. The concepts of science are comprised of facts, principles, and theories resulting from observation, investigation, and interpretation focussed on the living world. The language of science is technical and specific. There is a certain glossary of words or vocabulary that is specific for describing the concepts in science (Brinton, Snow &Wesche, 1989; Cleland and Evans, 1984).

TABLE 2.1: Models of integrated language and content instruction (Crandall, 1993)

PROGRAM MODELS OF INTEGRATED LANGUAGE AND CONTENT INSTRUCTION			
APPROACH	**CONTENT-BASED LANGUAGE INSTRUCTION**	**SHELTERED SUBJECT MATTER TEACHING**	**LANGUAGE ACROSS THE CURRICULUM**
MODEL	THEME-BASED INSTRUCTION	SHELTERED INSTRUCTION	ADJUNCT
DESCRIPTION	• language curriculum is developed around selected topics drawn from one content area or from across the curriculum	• a content curriculum is adapted to accommodate the student's limited proficiency in the language of instruction. (may be taught through L1) • fear of diminution or reduction of content	• links a special SLL course with a content course in which both SL learners & are enrolled. • same content base, but different focus of instruction: lang. teacher = lang. skills content teacher = acad.concepts
GOAL	• to assist learners in developing academic lang. skills, thinking, study skills, and content.	• make content in L2 accessible to LEP students - make transition to mainstream	• to assist learners in acquiring both lang. and specifically content.
STRATEGIES & TECHNIQUES	• cooperative learning & other groupings • task-based / experiential learning • whole lang. • graphic organizers	• demonstrations, visuals, graphic organizers, cooperative work: NNSs with NSs. • verbal interaction vs. teacher lecture	• coordination of TWO teachers. (• lecture, group work, lab work)
TEACHER	• ESL, bilingual, or foreign lang.	• Content-area, bilingual, foreign lang.	• content-area, language
STUDENTS	• elementary -12, adult, university (theme-based)	• immersion, 2-way / bilingual, NSs	• NNSs and NSs
LEVEL OF PROFICIENCY	• all levels.	• intermediate to advanced	• Advanced

• L1 : first language; • L2 : second or target language; • NNSs: non-native speakers of English;
• NSs: native speakers of English; • LEP: limited English proficiency.

B. THE LANGUAGE OF SCIENCE

The language of science is like any other language in that it has structure, rules and exceptions. Unlike ordinary English the language of science is precise and free of association from unrelated concepts (Flood, 1960; Savory, 1971). It is specialized to convey meaning with little distortion or ambiguity. It is interesting to note that when an originally well-defined scientific term becomes a word of ordinary speech it usually suffers a widening of meaning and acquires number of associations. For instance, the word "atomic", whose meaning is quite clear to scientists, may conjure up in the public mind a picture of widespread destruction or of unlimited power.

Most scientific words have another important quality: by their form and structure they reveal something about their meaning. Many scientific words are logically built up from simpler word-elements from Latin and Greek origin and the general meaning of the whole word can be inferred from an understanding of the parts (Flood, 1960; Savory, 1971; Mandell, 1974). Some terms are self-explanatory if the Latin and Greek roots are known; they have only to be 'translated' for their meanings to become apparent in English.

Where do scientific words originate from? Scientific word in English may conveniently be divided into three groups:

a) those taken from the ordinary English vocabulary;

b) those taken virtually unchanged from another language;

c) those which have been invented (Flood, 1960)

Scientific words that are derived from Latin and Greek terms have retained their original meanings and in some cases the meanings have been restricted and rendered more precise.

Learning scientific concepts in part involves the learning of the language of science. Students are often faced with the challenge of learning a large number of new terms when studying science. Educators believe that students need to comprehend the vocabulary they encounter as they read a text. The comprehension of scientific terms becomes more important when these words are used by students to construct written texts to express their knowledge and understanding of scientific concepts. While native-speaking students may possess phonetic and syntactic knowledge about a word, the semantic knowledge is what they also require to completely comprehend a word in a given sentence. ESL students are at a greater disadvantage since most have not heard or seen some of the terms, let alone know the meaning of the word in context. For ESL students their experiences in learning science may primarily focus on dealing with the linguistic elements in scientific texts and discourse rather than embracing the rich knowledge gained from "doing" science. Therefore, it is necessary for science teachers to employ classroom approaches that assist their students in learning the language of science in order for them to better grasp the concepts of science.

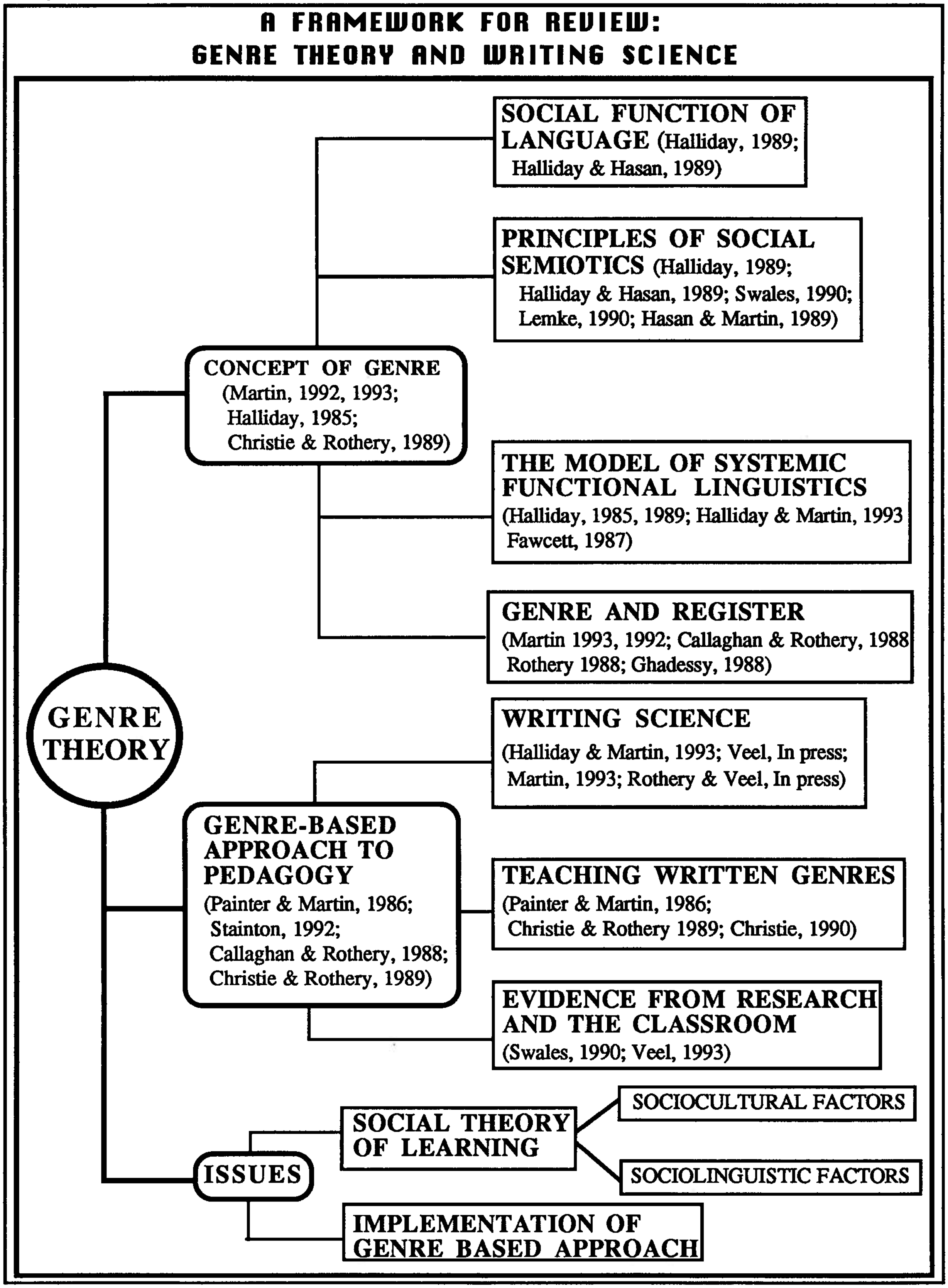
IV. GENRE THEORY AND WRITING SCIENCE

A. INTRODUCTION

The theory of genre is based on the functional grammar of systemic linguistics that views language as a social semiotic that and is a resource for meaning (Martin, 1992,1993; Halliday, 1985, 1989, 1993; Christie & Rothery, 1989). The perspective that language is realized in a social context gives rise to the concept of genre as a "staged, purposeful, goal-oriented activity" (Martin, 1993; Christie & Rothery, 1989). With implications for literacy, genres are oral or written interactions in which individuals in society engage. The process or activity of writing in the field of Science characterizes one type of genre in an educational context.

The purpose of this section of the review is to examine the theory and concept of genre in the context of education from a critical perspective. Genre as a theoretical model is addressed in the first part of this review and a "Genre-based approach" to pedagogy, specifically in writing Science, forms the focus of the second. The latter portion of this analysis of genre and scientific writing will attempt to describe the benefits or shortcomings of the theory and pedagogical approaches through case studies of writers in their discourse communities. The framework for this review section is constructed to identify some pertinent issues in the theory of genre, draw attention to some concerns with the Genre-based approach to instruction, and explore some questions for the development and further research on the concept (Figure 2.1).

Figure 2.1: A framework for reviewing the Genre Theory.



B. THE CONCEPT OF GENRE

What is *genre* ? Defining *genre* is not an easy task since the term connotes a range of glosses from the generalized one of "any socialized interaction" in the context of greater society and culture to the more popular meaning of "a distinctive categorgy of discourse of any type, spoken or written, with or without literary aspirations" (Swales, 1990). Genre is a fuzzy concept for Swales, a somewhat loose term of art. In linguistics, closer attention is given to the term *genre* . In conceptualizing *genre,* Swales (1990) cites Saville-Troike's reference of the term to a "type of communicative events" such as a joke, story, lecture, greeting and a conversation. Viewing the concept of genre in this way warrants a look at 1) the functions of language, 2) the principle of social semiotics, and 3) the model of systemic functional linguistics (Halliday, 1978; cited in 1985, 1989, 1993).

1) THE FUNCTIONS OF LANGUAGE?

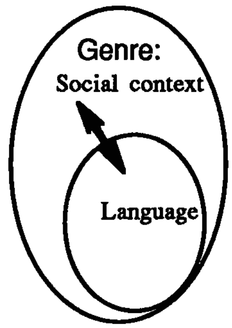
The notion of the "functions of language" refers to the way people "use" language. In the most general terms, people do different things with their language; that is, they expect to achieve by talking, writing, and by listening and reading, a large number of different aims and purposes. Halliday & Hasan (1989) view language as playing a critical role in building meaning. In Halliday's term (1978, cited in 1989), language is primarily seen as a "social semiotic" and as a resource for meaning, centrally involved in the processes by which people negotiate, construct and change the nature of their experience in a social context. Meaning is realized in language (in the form of text), which is thus shaped or patterned in response to the context of situation in which it is used (Fig. 2.2) (Martin, 1993; Halliday & Hasan, 1989). To study language then, is to concentrate upon exploring how it is systematically organized towards important social ends. In this way, language has a "social" function.

Is the function of language an "active" or "passive" one? Does one have to actively use language in conversation or writing or other output means to derive meaning from a social context? On the other hand, is it always possible to derive the social context from examining the function of language in a particular text structure? Is this function of language uniform across cultures? What about cross-cultural subtleties in second language contexts? Language as a resource of meaning suggests that explicit, conscious interaction with language within a social context is necessary in order to achieve a meaningful experience in that context.

2) THE PRINCIPLES OF SOCIAL SEMIOTICS

To articulate the concept of *genre*, it is necessary to look closer at the systemic functional linguistics treatment of language as a social semiotic (Halliday, 1989; Swales, 1990; Lemke, 1990; Halliday & Hasan, 1989). Martin (1993) states that language, as a social semiotic, "plays an instrumental role in construing the social context in which we live" and in reciprocity, "language is, at the same time, construed by social context. Is language exclusively a social semiotic system? Martin (1993) goes on to suggest that language is not the only semiotic system ("cf. Kress and van Leeuven 1990 on images, van Leeuven 1988 on music"); "nor is it claimed that the social context construed by language is identical to that construed by other semiotic systems". In Figure 2.4, Martin (1993) identifies the modelling of the "realization relationship between a social system (social context) and a semiotic system (language). He clarifies the relationship as not one of cause and effect as in other physical systems but as one that allows for a bidirectional interplay of roles and negotiation between language and social context.

Figure 2.2: Language as the realization of social context (Martin, 1993).



"Social semiotics is a synthesis of several modern approaches to the study of social meaning and social action" (Lemke, 1990; Swales; 1990). One of them, obviously, is *semiotics* itself: the study of our social resources for communicating meaning. Historically semiotics was invented as part of the effort to find scientific basis for linguistics (Bakhtin, 1986). Semiotics is the study of all systems of signs and symbols (including gestures, pictures, etc.) and how we use them to communicate meanings. Social semiotics is not new in trying to unite the study of human behaviour, especially meaning-making behaviour (talking, writing, reasoning, drawing, etc.), with the study of society. Linguistics gives particular attention to language as a semiotic resource system.

Linguistics itself is often concerned with viewing language as a tool of social action (Lemke, 1990). The way people construct meaning is determined by how language is *contextualized* in a social situation (Lemke, 1990; Swales, 1990; Martin, 1993; Hasan & Martin, 1989). In other words, scientists and artist, teachers and students, managers and workers talk and write about many subjects in characteristically different ways. They construct (or reconstruct) in their speech, writing, and reasoning the different thematic patterns that "index" or identify their social group (Lemke, 1990). In this way, contextualization is a very powerful notion. Who then decides how language is contextualized in a given situation? What linguistic features of language marks the social context? This view of social semiotics is also shared by the view of Social Constructionism in philosophy (cf. Wittgenstein, 1949; cited in Lemke, 1990). This also forms the generalization of Halliday's (1978, cited in Lemke, 1990) model of language as "meaning potential" a semantic resource. Social semiotics is basically a theory of how people make meaning. It addresses the question of how we make sense of how we relate to one another and how we make sense of the world.

Language as a "social semiotic" implies a social theory of language where language as one among a number of systems of meaning that, taken all together, comprise human culture. Why a social structure of language? The perspective of a social system of language may be contrasted with other modes of interpretation, including psychological, psychoanalytic, and aesthetic ones. This social dimension seems to be significant in language education: it is one that is often neglected in discussion in curriculum and instruction. Learning is, of course, a social process and the environment in which educational learning takes place is that of a social institution whether we think of this in concrete terms as the classroom and the school with their clearly defined social structures or in the more abstract sense of the school system, or even the educational process as it is conceived of in our greater community and society. Knowledge is exchanged in social contexts through interactions between teacher and student, classmates, or parent and child. These relationships are very much defined in the value systems and ideology of the culture. Language as a communicative medium for knowledge construction in such contexts gets its meaning from activities in which it is embedded. There remains a question about language as knowledge. For the learning of any language, somewhere along the line the attention to linguistic form as content knowledge is beneficial and critical to reaching a proficiency in the second language.

It is essential to qualify here that the review above provides only a small window into understanding the main ideas that are pertinent to conceptualizing genre. The notion of genre may be best understood when language is seen as a semiotic system that accomplishes social actions - that is, what people do.

3) THE MODEL OF SYSTEMIC FUNCTIONAL LINGUISTICS

How does the theoretical framework of systemic functional linguistics relate to the concept of genre? This model of systemic functional linguistics (SFL) describes in an explicit and systematic way the relationship between language use and its social context (Fig. 2.2) (Halliday, 1985). Although the special features of SFL are continuously evolving, the model itself has five orientations that are critical and worth characterizing (Halliday & Martin, 1993).

The first orientation describes language as a "resource for meaning" rather than as a system of rules. SFL is oriented, in other words, to speakers' meaning potential (what they can mean) rather than what they can say. The second is the distinction between SFL's concern with "texts", rather than sentences, as the basic unit through which meaning is negotiated (Fawcett, 1987). It treats grammar as the realization of discourse - from which emerges the conception of a "funtional grammar" - naturally related to its text semantics (Halliday & Martin, 1993). Third, SFL focusses on united relations between texts and "social contexts" rather than on texts as decontextualized structural entities in their own right. Halliday & Martin (1993) elaborate that SFL looks for united relationships between texts and the social practices they realize. "Fourth, SFL is concerned with language as a system for construing meaning rather than as a conduit through which thoughts and feelings are poured" (Halliday & Martin, 1993). In other words, it views language as a meaning-making system rather than a meaning-expressing one. It focuses on the role of grammar in constructing the "uncommonsense interpretation of reality" which distinguishes one context, (whether social, political, cultural, academic, or others) from another. Finally, SFL is "oriented to extravagance, rather than parsimony (Halliday & Martin, 1993). It views language, life, the universe in communicative (i.e. semiotic) terms.

The five orientations that describe the model of systemic functional linguistics clearly treat language and social context as complementary abstractions, related by the important concept of realization. This model suggests a grammatically based deconstruction of text in social context to construct meaning.

The Systemic Functional Model of Language developed by Halliday (1978; cited in 1985) is particularly relevant to education and has been implemented successfully in literacy programs around the world for more than twenty-five years. Most recently it has been used in conjunction with research in Genre-based approaches to literacy in the University of Sydney, Wollongong, Deakin, Curtin, Darwin Institute of Technology in Australia (Callaghan & Rothery, 1988). In the instructional setting across the currculum, Halliday's model provides teachers with a grammar which focusses on meaning rather than form and focusses on whole texts and their organization as well as on sentences. This means that when teachers are helping their students create texts for different purposes and audiences they can point explicitly to what has to be done. Across all academic disciplines, students no longer have to guess what is expected when they write.

4) DISCUSSIONS: CONCEPTUALIZING GENRE

Genre "refers to any staged purposeful social process through which culture is realized in a language" (Martin, 1985, cited in 1992) and this includes oral and written genres. A genre is said to be characterized by a schematic structure - a distinctive beginning, middle, and end. Genres are not concrete or fixed and unchanging forever. They have been developed over time to achieve specific social purposes and are constantly evolving (Martin, 1992; Swales, 1990). "In systemic functional linguistics this amounts to characterizing social context as a system of genres" (Martin, 1993). Martin (1993) identifies some examples of genres to be "report, recount, procedure, exposition, discussion, explanation, exploration, serial, anecdote, exemplum, observation, and news story". The term genre is used here to encompass each of the linguistically realized activity types which constitute so much of our culture.

The concept of *genre* needs to be defined clearly away from the longer established concept of *register* (Ventola, 1984, cited in Swales 1990). *Register* is a well-established and central concept in linguistics, while *genre* is a recent addition found to be necessary as a result of important studies to text structures (Martin, 1992; Callaghan & Rothery, 1988). Martin (Hasan & Martin, 1989) distinguishes genre and register to be two semiotic levels which are connotative and find their expression through language. It is these two levels that are responsible for the distinctive patterns of meanings found in texts. Register is just crucial to successful language use: its scope corresponds roughly to subject matter, audience role, and speech/writing differences. Is this not an aspect of language use that refers to the success in writing or speech? Any comprehensive account of learning about language would need to include an account of register and the way it is realized in language.

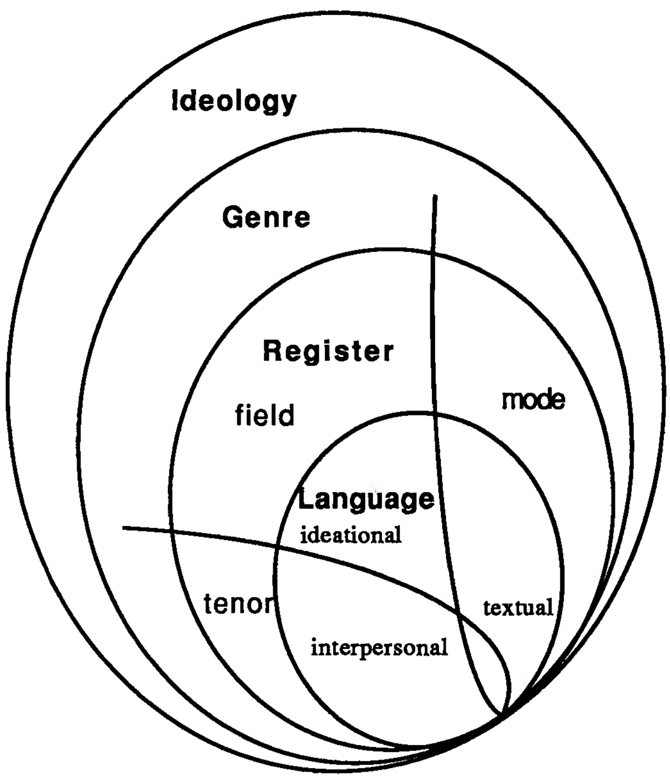
Register as a category has typically been analyzed in terms of three variables labelled *field, tenor,* and *mode* (Table 2.2; Figure 2.3; Martin, 1993). ***Field*** indicates the "type of activity in which the discourse operates, its content, ideas and 'institutional focus'" (Martin, 1993). The field can be seen as the "social action" and asks "what is actually taking place" (Martin, 1993). It is associated with the management of ideas. ***Tenor*** handles the status and role relationships of the participants (i.e. the reader and writer or the speaker and listener). Tenor refers to the "role structure" and asks "who is taking part" (Martin, 1993). ***Mode*** is concerned with the channel of communication (i.e. speech or writing, or a combination of the two). Mode is the "symbolic representation" and asks "what role language is playing" (Martin, 1993). The field, tenor, and mode seem to act collectively as determinants of text through their specification of the register; at the same time, they are systematically associated with the linguistic system through the functional components of semantics. Genre can be seen as an integration of the three variables of register (Fig. 2.3). In other words, genres are realized through registers and registers in turn are realized through language.

Based on the "intrinsic" functional organization of language itself, the traditional view of context represents a more diversified perspective. The systems and structures of language are organized by metafunctions - "interpersonal" (tenor), "ideational" (field), and "textual" (mode)" (Table 2.2) (Martin, 1993). These metafunctions refer to the meaning language construed in context of the 'reality' that is construed. This "intrinsic functionality is modelled as interacting with the organization of social context (with field, tenor, and mode respectively" (Martin, 1993).

Table 2.2: Theory of context as shaped by the organization of language (Martin, 1993).

Generalized semiotic function	**Metafunction** (organization of language)	**Register** (organization of context)
Language for construing the SOCIAL as intersubjective reality	interpersonal meaning	tenor
Language for construing EXPERIENCE as if 'natural' reality	ideational meaning	field
Language for organising TEXT/PROCESS as semiotic reality	textual meaning	mode

Fig. 2.3: Language in relation to its connative semiotics - ideology, genre and register. Modelling tenor, field, and mode as the realization of genre (Martin, 1993)



A broad definition of genre is one that describes a class of communicative events and the members of which share a set of communicative purposes (Swales, 1990). These purposes are recognized by the "expert members of the parent discourse community, and thereby constitute the rationale for the genre". This rationale shapes the schematic structure of the discourse and influences and constrains choice of content and style. In addition to purpose, exemplars of a genre exhibit various patterns of similarity in terms of structure, style, content and intended audience.

Lastly, some questions. How will teachers, students, parents, and the greater community respond to a Genre-based approach to language learning? This will be the focus of the following part of the review.

C. GENRE-BASED APPROACH TO PEDAGOGY - A FOCUS ON WRITING SCIENCE

From the perspective of genre theory and functional linguistics most of education involves language learning. Learning science, for example, involves learning to address questions, explore issues and reach solutions in ways appropriate to that discipline. This involves learning to talk and write in the ways of a scientist. Teaching science in turn means using language to enable students to talk and write new discourses - in particular, scientific discourse. It follows from this perspective that knowledge about language is absolutely critical in education. This forms the basis of Martin and Painter's (1986) recommendation of the Genre theory as model for curriculum instruction.

A Genre-based approach to language learning and instruction is applicable to promoting the implementation of language across the curriculum (Stainton, 1992) because some genres are found to be common across different academic subjects. Based on the channel of communication or *mode* genre can be expressed through the spoken or written mode. The division of class, gender and ethnicity plays a role in the accessibility to written genres for both writers and readers. Some common genres required of students in their writing include: Narratives, Report (classifying and taxonomizing), Procedure (sequencing events), Explanation (cause and effect), Description, Judgment and Exposition (Martin & Painter, 1986; Callaghan & Rothery, 1988; Christie & Rothery; 1989). These genres are based on detailed analyses of the lexicogrammatical patterning of texts. The Genre-based approach to language pedagogy then makes explicit to the learner the knowledge about language form.

1) WRITING IN SCIENCE

Language in science communicates about the relationships among the objects and abstract concepts of nature. Words and numbers are symbols that represent units of meaning in language. By representing nature symbolically we can begin to understand, predict, and manipulate it. The way that these words and numbers are organized in a structured text form the technical nature of writing in science. Bazerman (1988) supports the preceding notion by stating that although "symbols give us a picture of the way things (in science) are", a problem emerges when symbols are made precise, unambiguous, univocal, to create a clear one-to-one correspondence between object and symbol". Within the scientific community the language of science serves the competitive interests of separate individuals and research groups. For non-scientists scientific discourse becomes overwhelming and almost elitist.

For one who adopts the western view of language it is natural to think of the language of science as an instrument for expressing ideas about the nature of physical and biological processes. However, it is a rather impoverished view of language which distorts the relationship between language and other phenomena. Scientific language is distinctively more technical than "everyday language". It is *not* so natural to write the language of science to express scientific knowledge. The biggest demand that was explicitly made on a language of science was that it should be effective in constructing "uncommon-sense technical taxonomies" since scientists give technical terms and classify them to show their relationships in scientific discourse (Halliday & Martin, 1993; Martin, 1993). "Uncommon-sense accounts of processes" are also established by scientific explanations that complement taxonomizing reports. According to Martin (1993), modeling *field* in terms of taxonomies and explanations enables:

> an analysis beyond the global staging of a genre which deals directly with the uncommon-sense knowledge that the various genres are mobilized, stage by stage, to construct. This in turn provides frameworks for sensitively situating genres within a discipline. Thus, a set of genres operate in a field and are essential to the construction of registers of scientific language. (Martin, 1993)

Writing taxonomic reports in science can be viewed as documenting the 'content' of science education - the skills, processes, and knowledge that form the science curriculum.

To write effectively in science it is necessary to comprehend and use the resources of scientific terminology (lexis) and the technical grammar (nominal groups and clauses). Halliday and Martin (1993) identify these lexical and grammatical elements as emerging resources of scientific English. Scientific vocabulary is not particularly difficult to master since the teacher often defines new technical terms for students. It is often easier than the grammar. The technical terms become a problem to students, especially ESL students, when the relationships between the concepts the terms represent are too complex and not clear. Technical terms cannot be defined in isolation, each one has to be understood as part of a larger framework and each one is defined by reference to all the others.

Halliday (in Halliday & Martin, 1993) identifies seven areas of difficulties which are characteristic of scientific English: 1) Interlocking definitions - terms that are used to define each other; 2) technical taxonomies - highly ordered constructions that are based on complex semantic relationships; 3) special expressions - expressions with special grammar or "technical grammar"; 4) lexical density - a measure of the density of information in any passage of text, according to how tightly the lexical items (content words) have been packed into the grammatical structure; 5) syntactic ambiguity - ambiguity in nominalization, verbal expression, and other syntactical features; 6) grammatical metaphors - substitution of one grammatical class or structure for another, e.g. "her arrival" instead of "she arrived"; 7) semantic discontinuity - semantic "leaps" from one thought to another, and often, the language is highly metaphorical in the grammatical sense. The features that Halliday described above certainly could help science and language teachers alike to focus on problem areas to assist students in improving their writing in science. In reading and understanding science texts it is beneficial to criticize the ambiguities, analyze the expressions and metaphors, and link and make semantic relationships explicit that are implicit. Of course, this is not to suggest that reading and writing science texts routinely involves a detailed analysis of the lexical and grammatical features in the texts. Realistically, does the science teacher have the expertise to analyze grammar and teach the scientific concepts at the same time?

2) TEACHING WRITTEN GENRES

In the classroom the Genre-based approach to learning and instruction would focus on making the genres in science explicit to students (Christie & Rothery, 1989). In identifying the particular genre to the students, it is necessary to describe the generic (schematic) structure of the scientific text (i.e. procedure recount of a laboratory experiment) and point out the language features (i.e. focus on specific "participants" or tenor; use of past tense; temporal sequence of events: conjunctions; greater use of material or action processes) (Martin, 1990, in Christie, 1990; Veel, in press; Rothery, 1993; Rothery and Veel, in press). Three main stages in the Genre-based approach curriculum model for teaching different written genres have been described: Stage one is called modelling. In this stage, the context is set (i.e. the social function of genre), the scientific text is modelled, the text is organized, and the grammatical and lexical features are identified for the students. In stage two, the students and teacher jointly construct a new text that resembles the model (this stage may be optional for more able students. In the third stage, the students construct their texts independently. In evaluating the students' work, the teacher needs to assess whether students can identify situations appropriate to use a particular genre of interest to achieve their purpose, locate information and organize it into note form independently, and write the genre on their own with appropriate generic structure, text organization, and language features. This teaching cycle helps students to develop literacy in written genres in the discipline of science.

3) EVIDENCE FROM RESEARCH AND THE CLASSROOMS

There is not a great deal of qualitative or quantitative research with an empirical orientation to analysis that supports or refutes the theory of genre and its approach to pedagogy. Most research done in this area tends to be theoretically based and ethnographic in nature (this does not imply that theoretical and ethnographic research is not valid). Swales (1990) describes three case studies of individual writers. Case studies appear to be appropriate to the exploratory phase of an investigation. Given that case studies focus on one subject at a time, are longitudinal, reveal a patterns of findings that are not generalizable to all, and have no control over behaviour events, they are nevertheless useful in documenting the benefits of student academic writing.

In one of Swales' (1990) case studies, Salwa, the subject, strengthened her thesis statements in her paragraphs by focusing on the propositions in the text and by adding contextual or metadiscoursal signs. Gene, the subject in Swales' second case study, followed a different path towards recognizing subtle differences in audience in letter-writing genres and, since then, has been able to deal with his own queries. In the third case study, Ali, whose previous writing was erratic, had more control over his written texts with the use of *coda* to summarize his writing. These revisions to text appear to be lexicogrammatical and semantic editings that represent sound practice of process writing and are not exclusive to the Genre-based approach to writing. What then are the differences? Is it in the text-modelling stage of genre identification where self-analysis of writing can be appropriate for comparison or in the joint-construction stage where revisions are explicit and integral to independent construction? At the more general level, how is one genre distinguished from another? The distinction may lie with the academic context in which the genre is identified or the process writing editing is made.

Other evidence of success comes from informal, anecdotal comments made by Robert Veel of the Disadvantaged School Program, DSP, in New South Wales, Australia. The DSP program provide an educational sanctuary for the bottom 16% of all students based on socio-economic status (SES). Regarding the topic of literacy Veel stated that "there has been a 514% increase in the requests from schools for information and materials on genre" between 1990 and 1993. Veel went on to support the Genre-based approach by reporting the following:

> Three secondary schools ...have been using a Genre-based approach since 1989. All three schools have noted a significant improvement in the mean score of their students who wro te the Year 10 Reference Tests (which are conducted state-wide with approximately 70,000 students. (The approach increased the mean score of students of all levels.)

Although the above two sets of testimonies shed some light on the pedagogical account of the Genre-based approach, there are other greater issues that need to be raised with regards to its benefits and adopting it in an educational setting.

D. CONCLUSION: ISSUES FOR FURTHER RESEARCH

The genre theory can be seen as a theoretical model that is based on a social theory of learning. It adopts a sociocultural and sociolinguistic perspective on language learning since it treats language as social semiotic. Genre theorists wish, through further research, to identify and explore the implications of social and cultural factors on the construct of the model, the language environment and the learners using the language with respect to the meaning construed by the social context. These sociocultural and sociolinguistic factors include the social organization of the community and the different groups that make up society, its social classes and occupational, ethnic, cultural, and religious groups.

Back in the science (or any other academic) classroom, implementing the Genre-based approach could demand more time and effort on the part of the content-area teacher to focus both on the language features and the scientific knowledge in his or her instruction. What sort of expertise and training is necessary for content-area teachers? This could be one source of resistance to adopting this approach. A teacher with a traditional ideology of education may not find a benefit in the approach or view change as difficult.

V. THE KNOWLEDGE FRAMEWORK

In our discussion of the Knowledge Framework, as with genre, we will first discuss the Knowledge Framework as a theoretical model, and then discuss a Knowledge Framework-based approach to pedagogy.

As a theoretical model, like Martin's concept of genre, Mohan's concept of a Knowledge Framework (KF) is located within the tradition of systemic functional linguistics and language as a social semiotic. Both concepts start from the perspective of discourse in a social context. However, the KF model places special emphasis on the question of how social context is constructed. Consistent with certain views in ethnography and cognitive anthropology, Mohan see a culture as containing a large range of "activities" (that is, social situations or sociocultural practices). Doing a laboratory experiment is one example of an activity. The activity provides a convenient unit of analysis for cultural behaviour and cultural knowledge. In an activity a person acts on their world and interprets their world; in an experiment, the student takes action and interprets the experience. The investigation of an activity may involve observation of and participation in the activity, interviewing the participants, examining discourses related to the activity and reflection on one's own understanding of the activity. In the analysis, the aim is to analyse the activity as a microworld of meaning; to see how the participant uses cultural knowledge of the activity as a framework of meaning to interpret their experience and guide their actions. For this purpose it is helpful to see how this cultural knowledge is patterned into knowledge structures. Mohan suggests that for most activities there is core group of at least six structures which organise cultural knowledge: description, classification, sequence, principles, choice and evaluation.

The activity, then, is an extended, organised social context. As such it provides a contextual "home" for the discourses which occur in relation to it. Context and discourse are related. Similarly, KF and genres are not opposed alternative models; they are related, complementary and mutually supportive to each other. There is in fact a close relation between some of the main genres and the major knowledge structures. Genres are adaptable with reference to the knowledge structures in Mohan's (1986) Knowledge Framework for the integration of language and content (Table 2.3). Table 2.3 shows the main genres identified by Martin (1985; cited in 1992) and by Christie and Rothery (1989) as they are related to the knowledge structures. Similar to the KSs, the emphasis would be on both linguistic form and the content knowledge in the scientific text. However, unlike the Knowledge Framework there is less focus on key visuals as graphic representations of genres and in lowering the language barrier for second language learners.

Table 2.3: Genres and the Knowledge Framework (Martin, 1985, in 1992; Christie & Rothery, 1989; Mohan, 1991).

CLASSIFICATION	PRINCIPLES	EVALUATION
report (taxonomizing	explanation	judgement
description	recount (procedure)	"interpersonal"
DESCRIPTION	SEQUENCE	CHOICE

The Knowledge Framework-based approach to pedagogy is a model that promotes second language learning, academic language and cognitive skills development, and communicative language use (Early, Mohan, & Hooper, 1989; Mohan, 1979, 1986, 1991). The theoretical framework emphasizes the development of both language and content knowledge in a cooperative manner as opposed to learning them separately. By focusing on the intersection of language, content, and thinking objectives, the Knowledge Framework-based approach proves to be effective for ESL and native-speaking students in learning new concepts in their academic setting (Mohan, 1991).

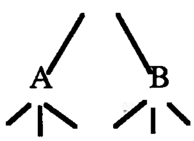
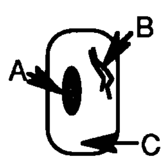
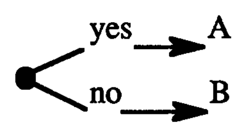
Integrating language and content using the Knowledge Framework involves organizing the information relevant to a topic or an activity into the appropriate six knowledge structures ("Description", "Classification", "Principles", "Sequence", "Evaluation", and "Choice"). Graphic conventions called "key visuals" are widely used in the Knowledge Framework as a "bridge" that links language and content (Mohan, 1986, 1991; Early, 1989). They are visual representations of semantic relations and show the relationship between ideas while lowering the language barrier.

1) KNOWLEDGE STRUCTURES

The Knowledge Framework can be used to assemble information or a topic and organize it into six knowledge structures ("Description", "Classification", "Principles", "Sequence", "Evaluation", and "Choice") that display both the theoretical background and the practical aspects of the topic in a meaningful context (Mohan, 1986) (refer to Table 2.4). Each knowledge structure has its distinct cognitive processes, language features and key visuals to graphically represent the knowledge structure. Key visuals can reduce the language demand in order for content to be better acquired. "This applies to both ESL and native-speaking learners" (Early, Mohan & Hooper, 1989).

Table 2.4: The Knowledge Framework for learning (Adapted from Mohan, 1986)

THE KNOWLEDGE FRAMEWORK

CLASSIFICATION	PRINCIPLES	EVALUATION
Thinking Processes: Classifying, defining **Language:** Content Vocabulary Structural Vocabulary **Key Visuals:** Classification tree TOPIC  	**Thinking Processes:** Explaining, predicting, inferring, understanding **Language:** Content Vocabulary Structural Vocabulary **Key Visuals:** Cause/Effect table CAUSE EFFECT	**Thinking Processes:** evaluating, judging, criticizing **Language:** Content Vocabulary Structural Vocabulary **Key Visuals:** Evaluation grid Situation Effect Evaluation A + + B − −
DESCRIPTION	SEQUENCE	CHOICE
Thinking Processes: Describing, observing, measuring **Language:** Content Vocabulary Structural Vocabulary **Key Visuals:** Diagrams  	**Thinking Processes:** sequencing, ordering spatially or chronologically **Language:** Content Vocabulary Structural Vocabulary **Key Visuals:** Flow chart A → B → C	**Thinking Processes:** deciding, problem-solving choosing **Language:** Content Vocabulary Structural Vocabulary **Key Visuals:** Decision tree 

The cognitive processes of each knowledge structure consist of related thinking skills that students exercise when they are learning about a certain topic or concept. For example, under "Classification" on the topic of types of rocks, students may engage in "classifying", "defining", "generalizing about the descriptions" or "understanding" the concepts of rocks. Each knowledge structures consists of semantic relations which are expressed lexicogrammatically in discourse; they are realized through both vocabulary and grammar.

Key visuals are graphic representations of the framework's knowledge structures. Tables, charts, cycles, trees, venn diagrams and concept maps are examples of key visuals that help to integrate language and content knowledge learning. The visuals help to reduce the language barrier by identifying important discourse structures and content items and link them in graphic form. Table 2.5 outlines the criteria for identifying key visuals (Early, Mohan & Hooper, 1989). As visual organizers, graphics clarify the purposes and the thinking processes to make the learning of information meaningful (clark, 1991).

Table 2.5: Identifying key visuals (adapted from Early, Mohan & Hooper, 1989).

CRITERIA USEFUL FOR IDENTIFYING KEY VISUALS

A KEY VISUAL IS MORE THAN	A KEY VISUAL IS
an attention stimulator	a package carrying information
an illustration	a visible framework of the shape of the content
a visual aid	an abstraction of basic information
a visual backdrop	a focus on the core of the content
a simplification of the text	a display of essential information without language involved
a representation	an explicit depiction of relationships
a particular and practical example	a general and theoretical structure
an enrichment	a core element in understanding content
a reference point	an asset, convenient to use and to develop

Early, Mohan, & Hooper (1989) identify three major applications for key visuals: "(1) generative, to promote language generation (related to content); (2) representative or explanatory, to increase content understanding; and (3) evaluative, to evaluate content and language understanding. An effective key visual of a content topic is one that emphasizes the content knowledge shaped in a way that reflects the semantic relationships among the key ideas with only the essential language elements used for communicating that knowledge. Key visuals can be utilized to extract information from academic discourse and organize it according to the knowledge structure inherent in a given text. Mohan suggests that graphics and the texts from which they are derived "are semantically comparable; the two share the same knowledge structures and essentially the same
topical meaning; but they differ in textuality" or the shaping of the text structure (1989).

Using key visuals teachers can guide students' learning of abstract concepts by pictorially making concrete connections between focal points across topics. Tang (1991) suggests that the learning of language and content through knowledge structures, and the use of graphic representations by students, are most effective under the direction of the teacher. Teachers can use graphics to help students construct and shape their written texts. When students are organizing their language, knowledge, and thinking processes into written texts, teachers can use graphics to assist them in accessing their prior knowledge so the students can make a link among the experiences, the graphics and the texts they create.

2) WRITING SCIENCE USING THE KNOWLEDGE FRAMEWORK

The Knowledge Framework approach to instruction can be applied to promote the learning of concepts, language and cognitive process skills in science. In the science classroom curricular concepts or topics can be organized into the knowledge structures of the theoretical framework in order to construct a written text such as scientific lab report that reflects the learning of the academic discourse and scientific concepts. The approach can be designed "to elicit certain knowledge and discourse structures" and can aim to develop language competencies for writing lab reports as an academic task (Mohan, 1986).

The Knowledge Framework can be a tool for organizing information for writing a scientific laboratory report. Table 3.1 (see page 66) describes how the thinking processes and the language features inherent in the topic of scientific lab reporting can be arranged into the six knowledge structures for the task of writing. Table 3.2 (see page 67) suggests some key visuals that may be appropriate for representing the cognitive processes, the language and content information within the topic as it is organized into the six knowledge structures. For example, in the knowledge structure of "sequence" the sentence " first, sterilize the inoculating loop by flaming it until it glows, and then, after the loop cools use it to transfer the bacteria onto the agar plate" demonstrates the use of language terms for chronological and spatial order for the thinking process of sequencing lab procedural steps (Table 3.1). Table 3.2 shows a visual textuality of sequencing lab procedures by emphasizing the use of imperatives and flowchart arrows for the lab steps in chronological order.

Mohan's (1986) theoretical framework promotes the organization of thoughts and ideas from the laboratory experience and the selection of appropriate language items for the concise writing of a scientific report. The way the language items and content information are organized is crucial to the pragmatics and semantics of the scientific text written. The framework helps to establish meaningful relationships between scientific discourse and content knowledge and makes the information accessible to students of varying cognitive abilities and learning strategies. The Knowledge Framework can make the new conceptual knowledge from the lab work relevant to the students and facilitate the assimilation of that information to what the students have already learned.

D. SUMMARY: ISSUES FOR RESEARCH

The Knowledge Framework as an approach for writing science can be applied to the instruction and learning of scientific concepts. The approach accommodates the learning needs of both ESL and native-speaking students by clearly identifying the language items, the content vocabulary and the cognitive processes of scientific concepts and making them easier for learning.

For the Knowledge Framework approach to be implemented for instruction in the academic science classroom curriculum planners or teachers need to examine their perspectives on the value of learning language and conceptual knowledge together in a content-area program.

Further research on the Knowledge Framework approach to learning science may focus on how science or other content-area teachers feel about teaching language structures and skills in their subject classrooms. A debate may surface regarding the roles of "language" instructors teaching "language" and "content" instructors teaching "content": It may be the perception of some teachers working with this approach that they have to modify extensively their content programs to deliver their subject material and that they may not be as well-qualified as a language instructor to teach linguistic skills. Extending the issue science teachers would probably be concerned about what language structures and what content they present to their students. Mohan (1986:19) suggests a possible solution: Content teachers can use the Knowledge Framework for developing thinking abilities; language teachers can use the Knowledge Framework for developing discourse ability.

On the issue of assessment using the Knowledge Framework, how do science teachers evaluate the learning of language skills and content knowledge? If the learning of both language structures and content information is equally valued in an integrated language and content model for instruction, should evaluation procedures be designed to appropriately measure the capabilities in both areas of learning? For some teachers, it may not be necessary to evaluate language skills unless the linguistic devices impede the communicability or expression of the content material in the students' work.

From their work on the Vancouver Research Project Early, Mohan & Hooper (1989) provide evidence that ESL students working with thematic units developed with the Knowledge Framework are successful in producing "a whole range of fluencies in using the languge academic subject matter". From her study "teacher collaboration in integrating language and content", Tang (1994) found that the "Knowledge Framework is a powerful tool for effecting teacher collaboration and for enabling ESL students to learn systematically academic English, read a novel, acquire computer literacy, develop thinking skills and socialize into the English-speaking classroom." The

ESL and the computer studies teachers in Tang's study "collaborated" in developing classroom tasks using the framework and planning contents and sequence of the instructional materials for the learning of the *Hypercard* program. These two studies by Early *et. al.* (1989) and Tang (1994) shed light on the Knowledge Framework by recommending the use of thematic units in content-area instruction and teacher collaboration as a way pooling the expertise of the language and content-area teachers for successful integration of language and content.

VI. SUMMARY

This critical review focused on providing an understanding of the related issues of writing a scientific laboratory report as an academic classroom task for learning and presented for discussion two approaches to writing science, the Knowledge Framework-based approach and the Genre-based approach to literacy instruction. It was the intent of this review to describe the two approaches and consider their benefits and shortcomings for writing science by referring to the current literature on the two concepts.

Writing a scientific lab report is an academic task for learning language and content knowledge in the content-area classroom. The task allows ESL and native-speaking students to communicate through written texts their learning of the scientific language and concepts that they have experienced when conducting their laboratory work.

One approach that is applicable to this research on writing science is the Genre-based approach. Based on the principles of language as a social semiotic and the model of Systemic Functional Linguistics, the Genre-based approach to writing scientific reports focuses on making genres in science explicit to students and identifying the appropriate genres and their schematic and linguistic choices and the context or "register" for producing language. Through the 3-stage teaching cycle of modelling of text, joint construction of new text, and independent construction of the text, students can write scientific reports using the Genre approach.

The Knowledge Framework is another approach that can be applied to writing scientific lab reports. Working within the perspective of Systemic Functional Linguistics, the theoretical framework integrates the learning of academic language and content by identifying, extracting, and organizing into its knowledge structures the linguistic devices, conceptual knowledge, and cognitive processes inherent in the topic of writing a lab report. Key visuals are graphic representations of the knowledge structures that act as a bridge for integrating language and content for learning.

CHAPTER 3

METHODOLOGY

This study was designed to answer the following question: **Is there a difference in the quality of scientific report writing at the senior secondary school level related to differences in instructional approach: The Knowledge Framework approach or the Genre-based approach to literacy instruction.** This section will describe the research methods employed to address the central question of this study by outlining the *hypotheses, participants, materials, procedures,* and *analyses* of the findings.

I. HYPOTHESES

Generated from the broader central question of this research, the following is a set of hypotheses proposed for testing in this present study:

1. The Knowledge Framework (KF) approach is more effective than the Genre-based approach to instruction in improving the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology.
2. The Knowledge Framework (KF) approach will improve the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology.
3. The Genre-based approach will improve the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology.
4. Mainstream students taught the KF approach will achieve higher evaluation scores on their scientific lab report writing than the mainstream students who were taught the Genre-based approach.

5. Mainstream students taught the KF approach will achieve higher evaluation scores on their scientific lab report writing than the mainstream students who were not taught either the KF or Genre-based approach.
6. Mainstream students taught the Genre-based approach will achieve higher evaluation scores on their scientific lab report writing than the mainstream students who were not taught either the KF or Genre-based approach.
7. ESL students taught the KF approach will achieve higher evaluation scores on their scientific lab report writing than the ESL students who were taught the Genre-based approach.
8. ESL students taught the KF approach will achieve higher evaluation scores on their scientific lab report writing than the ESL students who were not taught either the KF or the Genre-based approach.
9. ESL students taught the Genre-based approach will achieve higher evaluation scores on their scientific lab report writing than the ESL students who were not taught either the KF or the Genre-based approach.
10. Students taught the KF approach will understand how to use the Knowledge Framework to focus on language and content features and use key visuals for writing scientific lab reports.
11. Students taught the Genre-based approach will understand how to the use "Procedure", "Procedural Recount", and "Explanation" genres to identify the generic structures and key language features for writing scientific lab reports.

II. STUDY GROUPS

The study groups in this research were comprised of students who were enrolled in three classes of Grade 11 Biology at a senior secondary school in the Richmond School District. Twenty students in each of the three classes volunteered to participate in this study. Each class served as a study group and was designated as follows: The class that received the Knowledge

Framework approach was named the "KF" group; the "Genre" group was taught the Genre-based; the third class received neither of the above instructional approaches and therefore served as the "Control" group. The students in the study come from a middle-class background and a variety of ethnic cultures.

III. MATERIALS

• *Instructional Resources for KF approach to Writing Scientific Lab Reports.*

A unit for writing scientific lab reports implementing the KF approach was developed for this study for one of the three participant groups. The unit included a series of lessons that organizes the activity of writing a lab report using the knowledge framework for learning to identify and apply the appropriate knowledge structures and graphic conventions for language, content and cognitive processing. A set of evaluation criteria for scientific lab reports were used to assess the performance of the students using this KF approach and the Genre-based approach (see "Evaluation Criteria" below).

• *Teaching Guide for THE PROCEDURAL RECOUNT GENRE (DSP, 1989c)* .

The purpose of this guide was to illlustrate step by step and stage by stage the way to teach the procedural recount genre to one of the three Biology 11 classes in this study. When the teacher was conducting a unit from his biology curriculum, the procedural recount genre teaching guide served as the instructional methodology for that part of the unit for writing a scientific lab experiment.

• *Survey of Evaluation Criteria for Scientific Laboratory Reports (Appendix E)*

The purpose of this survey was find out what evaluation criteria senior science (Grades 11 and 12) teachers develop and use to assess student performance on scientific lab reports. It asked what aspect of "language" and "content" do science teachers evaluate in their students' lab reports.

The essential findings of this survey were analyzed and used for developing the *Evaluation Criteria for Writing Scientific Laboratory Reports* for assessing the lab reports written by all the student participants in this study.

• *Evaluation Grid for Writing Scientific Laboratory Reports (Appendix F)*

An evaluation criteria for assessing the scientific lab reports written by the participants was developed and used for all three study groups. The evaluation criteria employed a set of descriptors and numerical / value scale for each components of the lab report. This evaluation grid was used to determine the performance of the participants after working with each of the two approaches or with neither of the approaches.

• *Pretest 1: (Gates-MacGinitie) Reading Comprehension Test.*

This pretest was given to the participants in all three study groups to determine their reading comprehension ability prior to the study in order to maintain a consistent perspective on each participant group's performance and a reference for assessing their written lab reports. The source of this test was an adaptation of the Gates-MacGinitie, Level F, Form 2 for Grade 11. This test will reveal each participant's Grade Equivalent (G.E.) Reading level based on a 48-question multiple-choice test.

• *Pretest 2 : What is a Scientific Laboratory Report? (Appendix C)*

This purpose of this pretest was to identify the participants' background knowledge about writing a scientific lab report and to assess their writing ability before being introduced the two approaches (see Appendix . The first section of the pretest was a questionnaire asking for the participants previous science background level and achievement standing. The second section's objective was to find out the participant's knowledge and experience about writing scientific lab reports with an essay component. This pretest was intended to reveal how much the participants know about the topic. The essay section was evaluated using a set of writing assessment descriptors (see Appendix D)

• *Writing Assessment Criteria : Descriptors.*

This evaluation criteria will be used to assess the writing ability of all participants in the study in *Pretest 2*. It has five components (Communicability & Organization, Content, Vocabulary, Language Use, and Mechanics) with a range of values totalling 100. (See Appendix D)

• *Survey I: Using Genres to Write a Scientific Lab Report (Appendix G)*

Each of the student who participated in the Genre-based approach testing (accept those in the Knowledge Framework and the Control group) was asked to complete a survey regarding their experiences working with the three stages (modelling, joint negotiation of text, and independent construction) of the Genre approach to writing scientific lab reports. The survey was divided into FIVE sections: The first section addressed the participants' learning of procedural recount genre identification, its generic structure, and the language features associated with the procedural recount genre (i.e. past tense, temporal sequence of events, action words (verbs)). The second section asked the participants about modelling and analyzing the sample lab report for the recount genre and its related structures and features. In the third, the students were inquired about their understanding of joint negotiation and construction. Their experience with the stage of independent text construction was recalled in the fourth section of the survey. The fifth section asked for the participants' overall assessment and evaluation of their experience with the procedural recount genre approach with respect to its success for writing lab reports.

• *Survey II: Using the Knowledge Framework toWrite a Scientific Lab Report (Appendix H)*

The purpose of this survey was to inquire about the Knowledge Framework group's experience with the knowledge framework for writing scientific lab reports. The survey was divided into 3 sections focusing on:

1) identifying and using the six knowledge structures and their thinking processes to organize the components of lab report,

2) using graphic conventions (key visuals) for representing the knowledge structures, and

3) using structural vocabulary and content vocabulary for writing the lab report components.

• *A letter to School Superintendents (Appendix A)*

A letter to the School Superintendents of the Richmond School District No. 38 was sent out to obtain permission to conduct the above study.

• *A letter of Permission to Student Participants and Parents (Appendix B).*

A letter was sent out to each participating student and their parents describing the nature of this study of two approaches to writing scientific lab reports.

IV. PROCEDURES

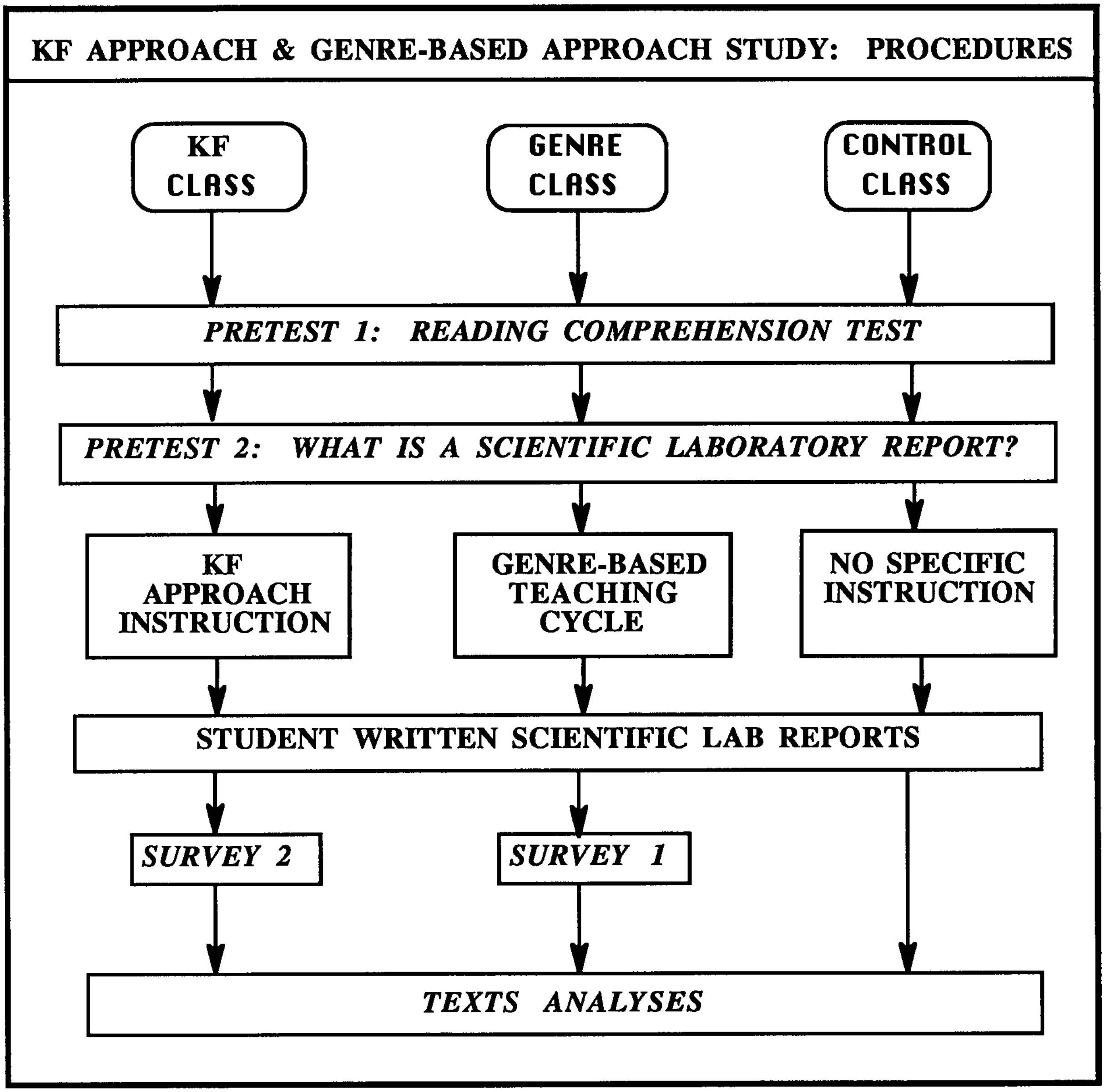
The first step of this study involved sending out the two letters (*the letter to the School Superintendent* and *the letter to Student Participants and Parents)* to obtain permission to conduct the study. The actual procedures of the study can be described in the following way (see figure 3.1):

1. The teacher / researcher selected 3 classes of mainstream Biology 11 randomly in which he was teaching. Two classes were designated "Experimental" and the third class was the "Control" group.
2. The two experimental classes were further divided into the "KF" (Knowledge Framework) and "Genre" groups. No particular preference was given for the designation.
3. Once permission from the School Board was granted, the *letter of Permission to Student Participants and Parent* was given out to each student.
4. The next step involves administering the two pretests to all three participant groups:

Pretest 1: Reading Comprehension Test and *Pretest 2 : What is a Scientific Lab Report?* The pretests results were NOT analysed by the teacher / reseacher until AFTER the KF approach and the Genre-based approach have been instructed. This was to prevent any bias in the teaching stage to compensate for the participants' reading and writing ability in English.

5. After the two pretests, the teacher / researcher began to teach the KF approach unit to the "KF" group and teach the procedural recount genre as a method for writing scientific lab reports to the student participants in the "Genre" class. To ensure no bias and overlaps exist with all three groups, an impartial observer was invited to attend a couple of the classes during instruction (see "KF Approach Instruction" and "Genre-based Teaching Cycle" below).
6. The third "control" group did not receive any of the other two instructional approaches. This group was given a "generic" lab format guideline with no special instructions from the teacher /researcher (see Appendix J).
7. At the end of the KF approach and procedural recount genre teaching cycle, all students were asked to write a formal lab report based on the current topic presented in the Biology 11 curriculum.
8. Upon completing the written scientific lab reports the reports were evaluated and analyzed using the *Evaluation Criteria for Writing Scientific Laboratory Reports*. The written lab reports were analyzed quantitatively and qualitatively.
9. Steps 7 and 8 were repeated for consistency and to allow the students to grasp the approach.
10. *SURVEY 1: Using Genres to write a Lab Report* was administered to the "Genre" group and *SURVEY 2: Using the Knowledge Framework to Write a Scientific Lab Report* was given to the "KF" group at the end of the teaching stage of the study. The surveys were analysed.

Figure 3.1: Procedures for KF / Genre study.



A. TEACHING STAGE

The teaching stage of this study was designed to implement the KF and the Genre-based approaches to each of the experimental groups. The following frameworks describe how the roles of teacher / researcher and students would interacted in the lessons as each of the approaches was introduced for writing lab reports (figure 3.2 and 3.3).

1) GENRE-BASED TEACHING CYCLE

1. In the first step of the teaching cycle the term "genre" was introduced and defined for the students. In accessing their prior knowledge, students identified the term with one that describes different varieties of music, professional situation, or social environment.

2. Next, the distinction between "written" and "spoken" genres were made. The students were then presented the genres of "procedures", "procedural recount" and "explanation" genres and their schematic structure and language features. Descriptions, explanations and examples of the genres were given.

3. In modelling the text, students were asked to describe the procedures to completing a daily chore, recount an event that happened the night before, and explain a simple scientific concept that relates to their daily lives. Next, students were directed to deconstruct a text, which was a written lab report, by identifying its schematic structure ("Aim", "Method" and "Result") and language features (past tense, etc.).

4. Since lab experimental reports consist of "procedure" and "procedural recount" genres and added dimension of "explanation" as the senior secondary level, the schematic structure for a complete scientific lab report was revised to include the following stages: "Aim", "Materials", "Method", "Results", "Discussion" ("explanation" genre) and "Conclusion" (refer to Appendix I). The students were taught the revised schematic structure and the key language features of the three genres as they are applied to each section of the lab report.

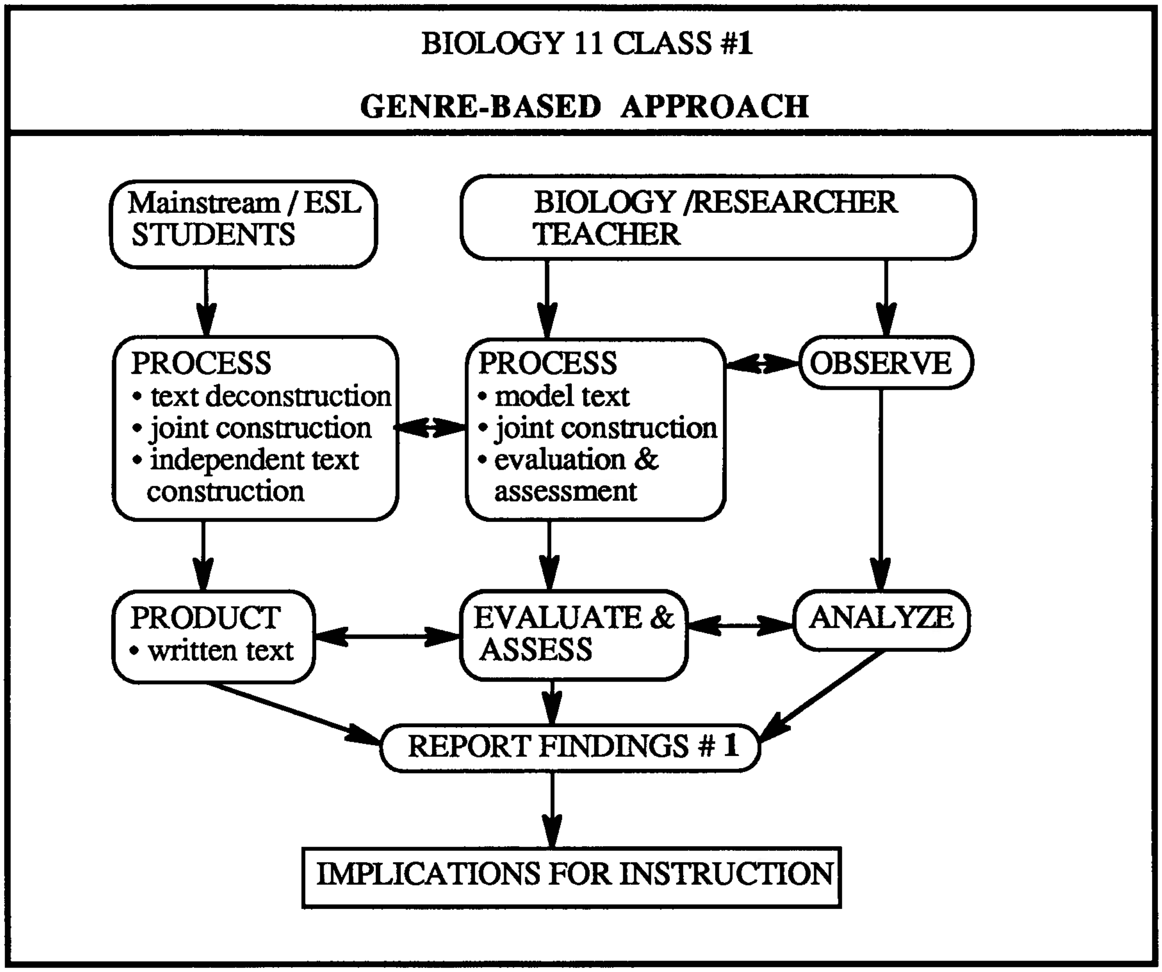
5. The topic of "Staining Bacteria" was used to present the Genre-based approach to writing lab reports. The teacher and the students jointly wrote all sections of the lab report using the 6-stage generic structure as a guide. All aspects of the key language features were demonstrated.

6. In the independent construction stage of the teaching cycle students were given a different lab investigation where they had to write their lab reports using Genre. The lab reports were then

collected for evaluation.

Figure 3.2: A framework for the study of the genre-based approach to literacy for writing senior science lab reports.

FRAMEWORK FOR IMPLEMENTING THE GENRE-BASED APPROACH FOR WRITING SCIENTIFIC LAB REPORTS



2) THE KNOWLEDGE FRAMEWORK APPROACH INSTRUCTION PROCESS

1. The Knowledge Framework and its 6 knowledge structures were first taught to the students. Each of the knowledge structures were introduced and defined. The focus, the thinking skills, the language features (structural vocabulary and content vocabulary), and the key visuals of

each knowledge structures were described.

2. An example topic was presented to demonstrate the principles of the Knowledge Framework.

3. Next, the topic of writing a scientific report for the lab investigation "Staining Bacteria" was outlined and organized to the six knowledge structures of the theoretical framework. Tables 3.1 and 3.2 show the framework was used to generate the integrated language and content information and the key visuals for writing the report for this lab.

4. Given a new laboratory investigation topic, the students were asked to conduct the lab and write a scientific report for the lab. The completed reports were then finally evaluated.

Table 3.1

THE KNOWLEDGE FRAMEWORK

TOPIC: WRITING A SCIENTIFIC LABORATORY REPORT

LIEW

	CLASSIFICATION	**PRINCIPLES**	**EVALUATION**
BACKGROUND KNOWLEDGE	**Focus:** Components of a Lab Report **Thinking Processes:** Classifying **Language:** • **generic nouns** - Purpose/Objectives/ Hypothesis, Materials, Procedures, Observations, Discussion, & Conclusion • **species nouns** - section, component part. • **verbs of possession** - have • **verbs of class membership** - be, include, place under, consist of, made up of, E.g. The "Hypothesis" is a section of a scientific lab report.	**Focus:** Formulating and testing hypotheses, explaining lab results. **Thinking Processes:** Explaining, predicting, inferring, generalizing, interpreting data, understanding/applying principles and theories, cause and effect **Language:** **Cause** - result, cause, produce, enable, due to, must, ought, should, because **Effect** (result) - so that, thus, therefore, consequently, hence, for this reason. • If...then. Example: A plaque developed around the antibiotic tetracycline because bacteria could not grow in the presence of that antibiotic.	**Focus:** Evaluating lab data and values **Thinking Processes:** criticizing, justifying lab results **Language:** **Adjectives** - sufficient, insufficient, correct/incorrect, right/wrong, effective, ineffective **Verbs** - I believe, based on, E.g. I believe the data we collected was sufficient for us to determine the most effective antibiotics for the bacteria E. coli.
	DESCRIPTION	**SEQUENCE**	**CHOICE**
ACTION SITUATION	**Focus:** Characteristic features of each component of a lab report. **Thinking Processes:** Describing, observing, comparing, contrasting. **Language:** Adjectives - descriptive, depth and length of information, format, paragraph form, detail, general, specific • Adjectives - Absolute, comparatives(-er) superlatives (-est), more, most • Adverbs - more, most • comparison - similar to, compared to, either, both, alike, equal to E.g: In the "Observations", data are compared and contrasted.	**Focus:** A step-by-step account of the procedures performed in a lab. **Thinking Processes:** Sequencing, ordering spatially or chronologically the procedures of a lab. **Language: Order** **Chronological** - first, second, next, then, before, after, finally, in the end. **Spatial** - left to right or right to left, top to bottom, near to far, inside to outside, here. E.g. First, sterilize the inoculating loop by flaming it until it glows, and then, after the loop cools use it to transfer the bacteria on to the agar plate.	**Focus:** Concluding an experiment or investigation; "Rejecting" or "Accepting" hypotheses. **Thinking Processes:** drawing conclusions, detecting errors short-comings, recommending, solving lab problems **Language:** I think, choose, in my opinion, prefer, in summary, I conclude that • The hypothesis is rejected/accepted. **Modals** - can, should, would E.g. In conclusion, our hypothesis is rejected based on this lab outcome.

Table 3.2

THE KNOWLEDGE FRAMEWORK

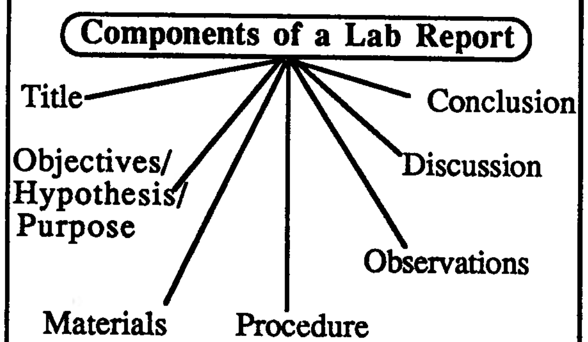
TOPIC: WRITING A SCIENTIFIC LABORATORY REPORT

LIEW

BACKGROUND KNOWLEDGE

CLASSIFICATION

Key Visuals
Classification Tree:



PRINCIPLES

Key Visuals
Cause and Effect Table: Observations & Discussions

Effects of Antibiotics on E.coli

Antibiotics	Plaque*	Lysis**
Tetracycline	Yes	Yes
Ampicillin	No	No
Kanamycin	No	No
Neomycin	Yes	Yes

* a zone of no bacterial growth
** bacterial cell wall ruptured: death

EVALUATION

Key Visuals
Evaluation Decision Grid: Discussion & Conclusion

Gram Stain Results:

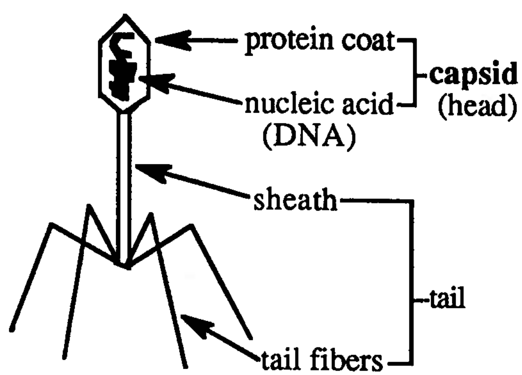
Bacteria	Cell Color	Gram*
E. coli	pink/red	(-)
B. subtilis	purple	(+)

* positive (+) or negative (-) reaction to Gram's Iodine stain.

ACTION SITUATION

DESCRIPTION

Key Visuals
Diagram of a virus: Observations

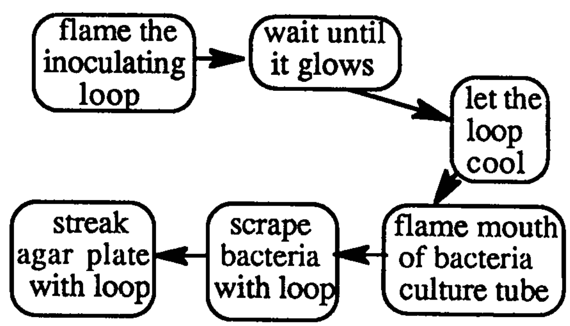


bacteriophage T4
length = 225 nanometers (nm)

SEQUENCE

Key Visuals
Flow Chart: Procedures

Culturing Bacteria: Plate streaking



CHOICE

Key Visuals
Decision Tree: Conclusion

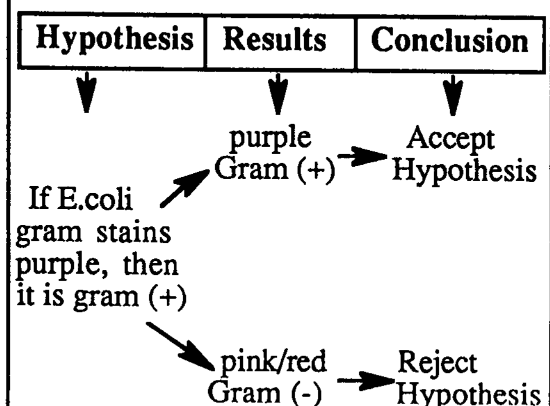
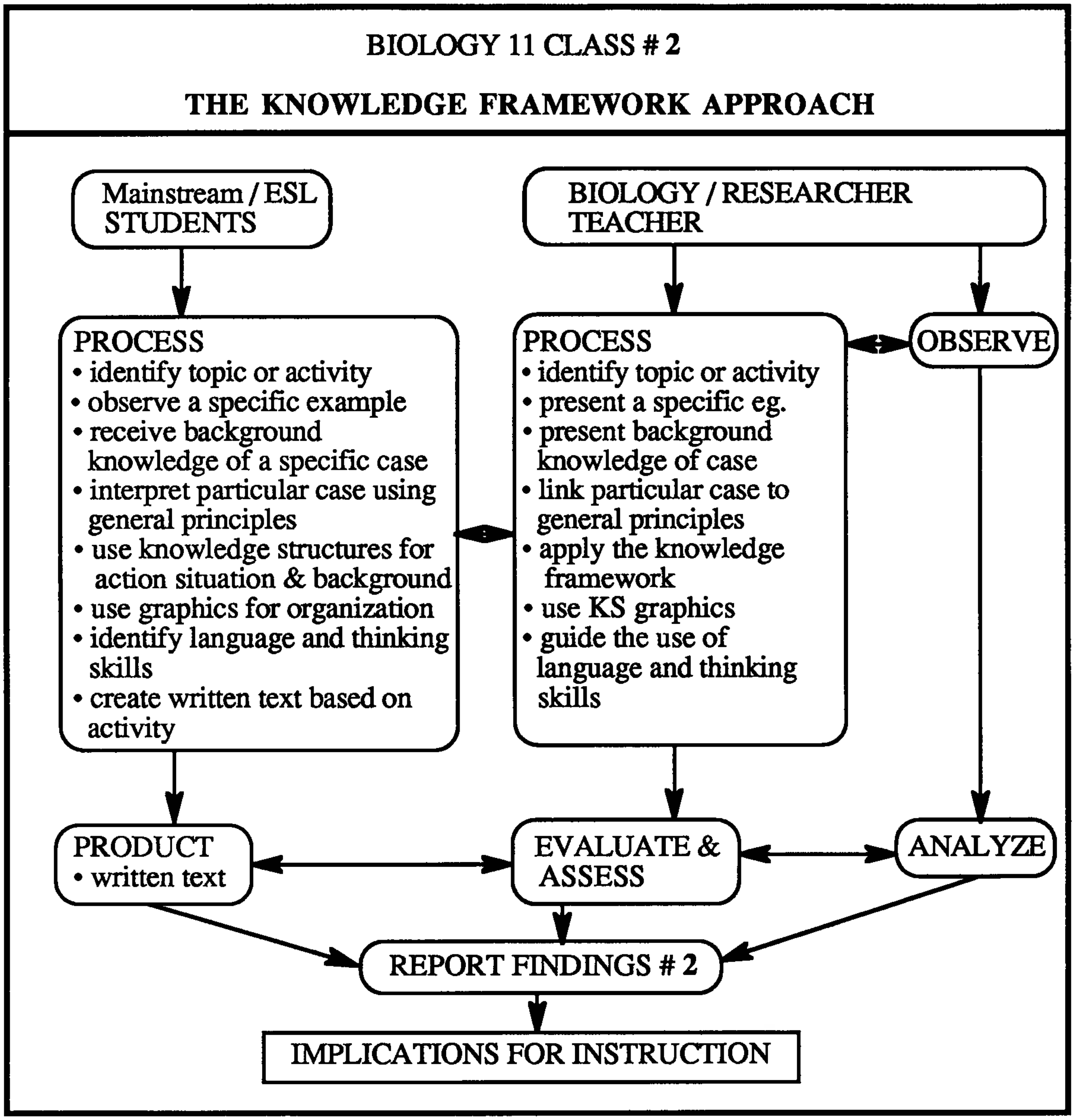


Figure 3.3: The framework for the study of KF approach to writing senior science lab reports .

FRAMEWORK FOR IMPLEMENTING THE KF APPROACH FOR WRITING SCIENTIFIC LAB REPORTS



V. ANALYSES

A. QUANTITATIVE

KF APPROACH AND GENRE-BASED APPROACH: LAB REPORTS.

One format of evaluation criteria as a means of quantative analysis was developed to assess the lab reports written by all three participant groups. The evaluation grid for the lab reports examined the language and content information using a set of descriptors with an assigned value for each of the components or sections of the lab report (refer to Appendix F).

B. QUALITATIVE

KF APPROACH: LAB REPORTS

The lab reports written by the students in the "KF" class can be analyzed qualitatively using the following qualitative assessment grid (Figure 3.4):

Figure 3.4: Qualitative evaluation framework for KF approach.

KF APPROACH: QUALITATIVE EVALUATION	
COMPONENTS	**DESCRIPTION**
• IDENTIFICATION & USE OF KNOWLEDGE STRUCTURES LAB COMPONENTS	
• THINKING PROCESSES	
• USE OF CONTENT VOCABULARY	
• USE OF STRUCTURAL VOCABULARY	
• USE OF KEY VISUALS (where appropriate)	

GENRE-BASED APPROACH: LAB REPORTS

Each survey was numbered and each statement item response was numbered. The written texts can be analyzed in terms of:

a) GENERIC STRUCTURE: overall text structure. In the procedural recount genre (including "procedures" and "explanations" genres), the 6 sections of staging are: "Aim", "Materials" "Method", "Results", "Discussion" and "Conclusions" (see Figure 3.5)

Figure 3.5: (Modified) procedural recount genre in the scientific lab report.

GENRE-BASED APPROACH SCHEMATIC STRUCTURE	LABORATORY REPORT COMPONENTS
AIM	• PURPOSE / OBJECTIVES / HYPOTHESIS
MATERIALS	• MATERIALS
METHOD	• PROCEDURES
RESULTS	• DATA AND OBSERVATIONS
DISCUSSION*	• DISCUSSIONS AND ANALYSIS
CONCLUSIONS	• CONCLUSIONS

* This stage was added as the schematic structure modified for writing lab reports at senior science level.

b) KEY LANGUAGE FEATURES (adapted from Veel, forthcoming):

The following linguistic features characterize written texts constructed employing the Genre-based approach for writing science:

PROCEDURE GENRE

i) **Material Processes:** e.g. "*Hold your* inoculating loop..."

ii) **Steps expressed as commands:** e.g. "*Put* on your apron..."

iii) **Sequence words:** e.g. "*Secondly*, label your petri dish."

iv) **Dependent clauses of time:** e.g. "Flame the loop *until it glows...*"

v) **References to place and manner:** e.g. "Streak the plate *with the loop.*"

PROCEDURAL RECOUNT GENRE

i) **Material Processes in "Results":** e.g. "We *removed* the lid of the petri dish."

ii) **Mental Processes:** e.g. "We performed an investigation to*test* the effects of antibiotics on the growth of E. coli bacteria."

iii) **Human Participants** (optional): "*We* noticed that..."

iv) **Past tense:** e.g. "We saw plaque ..."

v) **Circumstances of time and space:** e.g. "*After 48 hours* ...", "*In the test tube...*"

EXPLANATION GENRE: Sequential, Causal, Theoretical, Factorial, or Consequential

Example: **CAUSAL EXPLANATION**

i) **Sequencing devices:** e.g. "The antibiotic can *then* stop the growth of the E. coli."

ii) **Causal conjunctions:** e.g. "*As a result*, there was a clear area around the antibiotic."

iii) **Dependent clauses of cause:** e.g. "*Since there was no plaque,* this antibiotic was ineffective in preventing bacteria growth."

iv) **Circumstances of cause:** e.g. "There was a plaque *because* the antibiotic worked."

v) **Processes of Causation:** e.g. "The chemicals in the antibiotics *caused* the bacteria to lyse."

vi) **Nominalisations:** e.g. "The *prevention* of bacterial growth ..."

vii) **Complex nominal groups:** e.g. "*Chemical substances in the antibiotics* caused..."

CONTROL CLASS: LAB REPORTS

The lab reports written by this class will be analyzed by using a wholistic means that draws from the above KF and Genre-based approach evaluation format. Specifically, the focus of the evaluation here is on the linguistic quality and content information written in each section of the lab report ("Hypothesis", "Materials", "Procedures","Observations", "Discussion & Conclusions", etc.).

VI. SUMMARY

The preceeding information described the design and methodology for conducting this research.

CHAPTER 4

RESULTS

The following chapter presents the results of the study. The first section consists of the results of the two pretests (the Gates-MacGinitie Reading Comprehension Test and the Writing test: "What is a Scientific Laboratory Report?") and the evaluation of the laboratory reports written by students in the three study groups. The second section will focus on the analysis of the data. This section will also describe the qualitative data derived from the two surveys and the open -ended comment section found at the end of each of the survey forms and will address the hypotheses of this study.

I. PARTICIPANTS

Richmond B.C. is a "bedroom" community located immediately south of Vancouver, British Columbia. The Richmond school district has approximately 25,000 students from various cultural backgrounds. The participants for this study were senior secondary school students from Richmond who were enrolled in the senior science course of Biology 11.

Twenty mainstream and ESL students in each of three Biology 11 classes volunteered as participants for this study. All 60 were enrolled in regular, mainstream Biology 11 classes in which no other "special" second language instruction was given. Three classes were randomly selected and designated as the "KF", the "Genre", and the "Control" groups to test the effectiveness of the approaches. The "Control" group received no instruction in either the KF or the Genre-based approach. The proficiency levels in reading and writing English of the these students were determined with pretests referred to as "Pretest 1" and Pretest 2". ESL students were randomly selected with proficiency levels at low to upper intermediate to advanced (Level 3, 4 or 5). Out of 60 participants there was a total of 8 ESL students (those students whose English proficiency level was below that of native-speakers): 3 in the "Genre" group, 3 in the "KF" group and 2 in the "control" group.

Gender representation of the participants were determined by the nature of each classroom mixture. The ages of the participants were consistent with those of their Grade 11 cohorts at approximately 16 to 18 years old. Taking into consideration the demographics of the ESL student population in the Vancouver Lower Mainland, the majority of the students in Richmond schools were of Asian descent. Approximately 40% of the total student population in the Richmond school district is ESL and over 80% of whom speak an Asian language (Chinese, South Asian, Tagalog, Japanese, Korean) as their first language (Richmond School District #38, 1994). Of the 60 students participating in this study, 14 were Cantonese speakers, 4 were Mandarin, 4 were Tagalog, 4 were Punjabi , 2 were Spanish, 1 was Swahili, 1 was Polish, and 1 was Japanese. The ethnic backgrounds of the participants for this study. Table 4.1 displays the percentages of the first languages of the student participants in this study.

Table 4.1: Percentages of first languages (L1) of student participants.

PERCENTAGE OF FIRST LANGUAGES	
FIRST LANGUAGE (L1)	**PERCENTAGE (No.)**
ENGLISH	48.3 % (29/60)
CANTONESE	23.3 % (14/60)
MANDARIN	6.7 % (4/60)
TAGALOG (PHILLIPINO)	6.7 % (4/60)
PUNJABI	6.7 % (4/60)
SPANISH	3.3 % (2/60)
SWAHILI	1.7 % (1/60)
POLISH	1.7 % (1/60)
JAPANESE	1.7 % (1/60)

The socioeconomic status of the participants was quite similar. The mainstream and ESL students in the study groups at this Richmond school could be said to be of middle-class status.

Although the students varied in intellectual ability and attitude, they had relatively the same background knowledge or educational level in science upon enrolling in the Biology 11 courses. The students in these classes had at least achieved a Science 10 standing in B.C.,the equivalent, or higher from schools around the country and the world. Most students had some prior knowledge of writing scientific lab reports in secondary science.

II. STUDY

The quantitative data were collected from 3 tests (Pretest 1, Pretest 2 and Posttest 1 lab reports administered to the student participants in each group. An impartial observer sat in on all three study conditions and reported no apparent bias in teaching approach.

A. ALL STUDENTS: ESL & MAINSTREAM

PRETEST 1: GATES-MACGINITIE READING COMPREHENSION TEST

The purpose of the Gates-MacGinitie Test was to determine students' reading ability. This test provided an estimate of the overall reading comprehension level of the participants in the three groups. The reading level of each student participant was represented by a score out of a possible 48 on the multiple-choice test. The following Table 4.2 displays the means and standard deviations on the reading test (Pretest 1) for each group of participants in the study:

Table 4.2: Means and Standard Deviations of Pretest 1 scores by all students.

OVERALL PRETEST 1: GATES-MACGINITIE READING COMPREHENSION TEST			
GROUP	**MEAN**	**STANDARD DEVIATION**	**CASES**
GENRE	40.90	6.28	20
KF	37.25	8.17	20
CONTROL	36.10	7.52	20

The results in Table 4.2 indicated that mean scores varied from **36.10 (7.52)** for the Control group, **37.25 (8.17)** for the KF group, to **40.90 (6.28)** for the Genre group. The Genre group had the highest mean score of **40.90** on Gates-MacGinitie Reading Comprehension Test. There was difference of **3.65** in mean scores between the Genre group and the KF group.

PRETEST 2 (WRITING): WHAT IS A SCIENTIFIC LABORATORY REPORT

The writing component in Pretest 2 attempted to access students' prior knowledge of laboratory work and report writing skills. The students' writing was evaluated using the*Writing Assesment Criteria* which focused on topic communicability and organization, adequate content, vocabulary, language use, and punctuation and mechanics (see Appendix D). Each student writing was given a score out of 100. Table 4.3 shows the means and standard deviations of the Pretest 2 writing test obtained by the three study groups.

Table 4.3: Pretest 2 results for all students in the study groups.

OVERALL PRETEST 2: WRITING TEST			
GROUP	**MEAN**	**STANDARD DEVIATION**	**CASES**
GENRE	80.68	5.73	19
KF	78.70	7.16	20
CONTROL	79.35	6.67	20

The results of Pretest 2 revealed fairly close mean scores. On this writing test the Genre group had the highest overall mean score among the three groups with **80.68 (5.73)**. It was necessary to note that the mean score for the Genre group was based on 19 of the 20 participants. The KF group had a mean score of **78.70 (7.16)** while the Control had **79.35 (6.67)**.

POSTTEST 1: SCIENTIFIC LAB REPORTS (ALL STUDENTS)

The student participants in all three study groups wrote scientific lab reports using the instructional method that was presented to them in their classes for this research. Collectively, the lab reports written by the students in the three groups were refered to as "Posttest 1". These lab reports represent the "product" of the two instructional approaches applied by the participants and those reports written by students in the Control group who received neither of the two approaches tested in this study. Each lab report was assessed for its quality using an *Evaluation (Criteria) Grid for Writing Scientific Laboratory Reports* that was developed specificly for this research. Since both the Genre-based and the KF approaches emphasized the use of relevant linguistic features and key topic information, the evaluation grid was used to isolate those language and content features that were significant and characteristic of academic writing appropriate for scientific lab reporting. Each component or section of the lab report was assessed and given a mark. The total possible score attainable by each student for a complete lab report was 25. The following table 4.4 illustrates the means and standard deviations for the evaluated lab reports:

Table 4.4: Posttest 1 results of lab reports written by all students.

OVERALL POSTTEST 1: LAB REPORTS			
GROUP	**MEAN**	**STANDARD DEVIATION**	**CASES**
GENRE	16.05	2.72	20
KF	17.15	2.46	20
CONTROL	16.75	2.34	20

Posttest 1 results showed a mean score of **17.15 (2.46)** for the KF group, **16.05 (2.72)** for the Genre group, and **16.75 (2.34)** for the Control group. Further analysis of these Posttest 1 results in the next section of this chapter will reveal the possible significant differences among the three study groups.

B. MAINSTREAM STUDENTS

The mainstream students in the study groups comprised 52 of the 60 sample population. The following results show the mainstream students' means and standard deviations on the two reading and writing pretests (1 and 2) and Posttest 1.

MAINSTREAM PRETEST 1: GATES-MACGINITIE READING COMPREHENSION TEST

Table 4.5 displayed the mean scores and standard deviations for the mainstream students in all three study groups:

Table 4.5: Pretest 1 results of mainstream students

MAINSTREAM PRETEST 1: GATES-MACGINITIE READING COMPREHENSION TEST			
GROUP	**MEAN**	**STANDARD DEVIATION**	**CASES**
GENRE	43.00	3.28	17
KF	39.42	6.33	17
CONTROL	37.50	6.51	18
OVERALL	39.92	5.95	52

The KF group with 17 mainstream students had a mean score of **39.42 (6.33)** while the Genre group had mean of **43.00 (3.28)**. The result also showed a mean score of **37.50 (6.51)** for the Control class. The overall mean for the three groups was **39.92 (5.95)**.

MAINSTREAM PRETEST 2 (WRITING): WHAT IS A SCIENTIFIC LABORATORY REPORT

The mainstream students in all three study groups posted fairly similar mean scores. Table 4.6 displayed the results of the mainstream writing tests:

Table 4.6: Mainstream writing pretest results.

MAINSTREAM PRETEST 2: WRITING TEST			
GROUP	**MEAN**	**STANDARD DEVIATION**	**CASES**
GENRE	81.50	5.42	16
KF	80.41	6.05	17
CONTROL	80.61	5.68	18
OVERALL	80.82	5.63	51

A total of 51 mainstream students in the three study groups wrote pretest 2 prior to the presentation of the two instructional approaches. The results show a mean score of **81.50 (5.42)** for the Genre group. The Control group had a mean score of **80.61** while the KF had a mean of **80.41** on these pretests.

MAINSTREAM POSTTEST 1: SCIENTIFIC LAB REPORTS

The following data in table 4.7 report the quality of the lab reports written by mainstream students in the three study groups. A mark out of 25 was given to reflect each student's performance on writing the lab report using the instructional method he or she was introduced to that group.

Table 4.7: Posttest 1 results by mainstream students.

MAINSTREAM POSTTEST 1: LAB REPORTS			
GROUP	**MEAN**	**STANDARD DEVIATION**	**CASES**
GENRE	16.18	2.92	17
KF	17.65	2.21	17
CONTROL	16.83	2.35	18
OVERALL	16.88	2.53	52

The results in table 4.7 showed a range of means and standard deviations that varied from **16.18 (2.92)** for the Genre group, **16.83 (2.35)** for the Control group, to **17.65 (2.21)** for the KF group. The overall mean score and standard deviation for the three mainstream groups was **16.88 (2.53)**. A closer examination into these mainstream Posttest 1 results will be presented in the "Analysis" section of this chapter.

C. ESL STUDENTS

The number of ESL students in the three study groups was identified and special attention was given to their results on Posttest 1: the lab reports written by the students in the study. Out of the total random population of 60 students, there were only 8 ESL students in the study. The following table displays the results of the ESL students' means and standard deviations for Pretest 1, Pretest 2 and Posttest 1.

ESL PRETEST 1: GATES-MACGINITIE READING COMPREHENSION TEST

The following data show the means and standard deviations of the ESL students on Pretest 1 Reading Test:

Table 4.8: Pretest 1 results of ESL students.

ESL PRETEST 1: GATES-MACGINITIE READING COMPREHENSION TEST			
GROUP	**MEAN**	**STANDARD DEVIATION**	**CASES**
GENRE	29.00	6.24	3
KF	25.00	6.92	3
CONTROL	23.50	0.71	2
OVERALL	26.13	5.57	8

The above results indicated that the Genre group had a mean score of **29.00 (6.24)** while the KF group had a value of **25.00 (6.92)**. The mean and standard deviation for the Control group was **23.50** and **0.71** respectively. The overall mean for the ESL students on Pretest 1 was **26.13 (5.57)**.

ESL PRETEST 2 (WRITING): WHAT IS A SCIENTIFIC LABORATORY REPORT

Pretest 2 Writing Test results were also collected from the ESL student samples. The following table displays the data:

Table 4.9: ESL writing pretest results.

ESL PRETEST 2: WRITING TEST			
GROUP	**MEAN**	**STANDARD DEVIATION**	**CASES**
GENRE	76.33	6.43	3
KF	69.00	5.29	3
CONTROL	68.00	2.83	2
OVERALL	71.50	6.09	8

The results reported a range of means and standard deviations varying from **68.00 (2.83)** for the Control group, **69.00 (5.29)** for the KF group, to **76.33 (6.43)** for the Genre group. The overall mean for the three groups was **71.50** and the standard deviation was **6.09**.

ESL POSTTEST 1: SCIENTIFIC LAB REPORTS

The following data in Table 4.10 show the means and standard deviations for the Posttest 1 lab reports written by the ESL students in the three groups:

Table 4.10: Posttest 1 results by ESL students.

ESL POSTTEST 1: LAB REPORTS			
GROUP	**MEAN**	**STANDARD DEVIATION**	**CASES**
GENRE	15.33	1.15	3
KF	14.33	2.08	3
CONTROL	16.00	2.82	2
OVERALL	15.13	1.81	8

The ESL Posttest 1 results illustrated that the Genre group achieved a higher mean score of **15.33 (1.15)** while the KF group had a mean of **14.33 (2.08)**. Table 4.8 also showed a mean value **16.00 (2.82)** for the Control group. The overall mean score on Posttest 1 for the ESL students was **15.13** with a standard deviation of **1.81.**

III. ANALYSES

Analysis of Covariance (ANCOVA) was used to test the above hypotheses of the study (see "Chapter 3"). Means and standard deviations for Pretest 1: Gates-MacGinitie Reading Comprehension test, the Pretest 2 writing test, and the Posttest 1: Lab Reports for all students (ESL and Mainstream combined) by study group are reported in Tables 4.2, 4.3, and 4.4 respectively. By nature of the cultural mix in all three classes, the number of ESL students included in the random sample was low, representing less than five cases in each cell, i.e., 3, 3, and 2 (Tables 4.8, 4.9 and 4.10). The ESL students as a group were, therefore, not included in the ANCOVA. An Analysis of Covariance to measure differences due to study group with Pretest 1 and Pretest 2 held as covariates was conducted revealing significant differences due to group

(F(2,58) = 3.09, p = .05). There were significant differences in Pretest 2 **(F(1,58) = 31.04, p = .02)**, but not Pretest 1 **(F(1,58) = .09, p = .76)**. ANCOVA is an omnibus test that reveals there are significant differences, but does not specify what they are. Three a priori contrasts were computed using procedures recommended by Shavelson (1981).

Mean differences were -1.31, -0.91, and 0.4 (Genre-KF, Genre-Control, KF-Control). One significant contrast at alpha 0.05 between the Genre and KF group was observed, while the other two constrasts were not significant. The KF group scored significantly higher than the Genre group.

A. SURVEY 1 AND 2

Survey 1 and 2 were designed to inquire about the participants' experiences working with each of the two instructional approaches to writing scientific lab reports. Survey 1 was conducted with the Genre group since the items in the survey dealt with features of the "procedure", "procedural recount", and "explanation" genres and the three-stage teaching cycle for implementing the Genre-based approach. The KF group received Survey 2 which focused on the Knowledge Framework and the use of its knowledge structures, language features, and key visuals for writing lab reports.

The respondents read each itemized statement about a particular feature or topic of the survey and then choose from a four-point scale a response that represented their opinion: **STRONGLY AGREE (1) - AGREE (2) - DISAGREE (3) - STRONGLY DISAGREE (4).**

A comparative representative of overall student responses to both Survey 1 (Genre-based approach) and Survey 2 (KF approach) will be displayed. The means and standard deviations for these two surveys will be used to address the hypotheses of this study. The format for reporting these results will allow for the comparison of survey responses and experiences related to the instructional approaches that share a common base for discussion. Each of the items from the Survey 1: Genre (37) and Survey 2: KF (38) will be presented.

The following three sets of results represent the participants' understanding of the concept of Genre and the Knowledge Framework and their defining characteristics (Table 4.11), the students writing of scientific lab reports using the Genre-based approach and the Knowledge Framework (KF) (Table 4.12), and the participants' overall impression and experience working with Genre and the Knowledge Framework (Table 4.13):

Table 4.11: Survey 1 and 2 means and standard deviations for Items 1-12.

IDENTIFYING GENRE AND UNDERSTANDING THE KNOWLEDGE FRAMEWORK (KF)					
SURVEY 1 GENRE			SURVEY 2 KNOWLEDGE FRAMEWORK		
*ITEM	MEAN	STD. DEV.	*ITEM	MEAN	STD. DEV.
1. Understand "genre"	1.80	0.41	1. Understand use of Knowledge Framework	1.80	0.41
3. "Procedure" genre	1.45	0.61	2. Identify six knowledge structures (KS)	2.15	0.59
4. "Procedural Recount" genre	1.55	0.68			
5. Identify parts of a lab report	1.45	0.51	3. Knowledge Framework to organize lab report	1.95	0.69
6. Identify "Procedure" genre for lab report components	1.75	0.55	4. Identify all components of a lab report	1.60	0.89
7. Identify "Procedural Recount" genre for lab	2.05	0.76			
			5. Identify THINKING SKILLS for KS	2.30	0.73
8. Identify LANGUAGE FEATURES for genre	1.85	1.04	6. Identify LANGUAGE for KS	2.00	0.65
			7. Identify STRUCTURAL & CONTENT vocab	1.90	0.64
			8. Identify KEY VISUALS	1.85	0.75
11. Identify LANGUAGE: tense, sequence words, verbs	1.90	1.02	11. Identify LANGUAGE for each lab component	2.15	0.88
12. Identify "human participants", time, space	1.80	0.62			
			12. Identify appropriate KEY VISUALS for each lab component	1.90	0.72

* The item number corresponds to the that on the appropriate survey (1 or 2).
The number of cases for all items in both surveys is **20**.

Table 4.12: Means and standard deviations for Items 13-28 from Survey 1 and 2.

WRITING THE LAB REPORT USING THE GENRE AND KF APPROACHES					
SURVEY 1 GENRE			SURVEY 2 KNOWLEDGE FRAMEWORK		
ITEM	MEAN	STD. DEV.	ITEM	MEAN	STD. DEV.
13. Identify purpose of lab activity	1.95	0.61	13. Identify purpose of lab activity	1.95	0.94
			15. Able to apply THINKING SKILLS	2.50	0.83
16. Able to use LANGUAGE	1.95	0.89	16. Able to use STRUCT. & CONTENT vocab	2.25	0.85
17. Use of diagrams, tables charts to write lab	1.80	0.77	17. Use of diagrams, tables charts to write lab	1.75	0.72
19. Able to write the AIM	2.00	0.86	18. Able to write PURPOSE or HYPOTHESIS	1.70	0.57
20. Able to write the MATERIALS section	1.60	0.75	19. Able to write the MATERIALS section	1.50	0.76
21. Had difficulty writing METHOD section	2.55	0.68	20. Had difficulty writing PROCEDURES section	2.45	0.94
22. Able to use imperatives in METHOD section	2.20	0.89	21. Able to use imperatives in PROCEDURES	2.10	0.79
23. Able to use sequence words in METHOD	1.85	0.67	22. Able to use sequence words in PROCEDURES	1.85	0.67
24 Able to use prepositions to indicate time & space	1.80	0.70	23. Able to use prepositions to indicate time & space	2.00	0.73
			24. Visuals were helpful in OBSERVATIONS	1.45	0.60
25. Able to use past tense in RESULTS	2.00	0.65	26. Able to use past tense in RESULTS	2.05	0.51
26. Use "explanation" genre for DISCUSSION	2.45	0.89	27. Use STRUCTURAL vocab in explaining DISCUSSIONS	1.80	0.62
28. Writing CONCLUSION	1.80	1.06	28. Writing CONCLUSION	2.30	0.80

Table 4.13: Means and standard deviations for items 30 to 38 from Survey 1 and 2.

EXPERIENCE WITH USING THE GENRE AND KF APPROACHES					
ITEM	**MEAN**	**STD. DEV.**	**ITEM**	**MEAN**	**STD. DEV.**
30. Understand how to use Genre approach	1.85	0.67	30. Understand how to use Knowledge Framework	2.20	0.70
31. Did not understand the concept of Genre	2.45	1.00	31. Did not understand Knowledge Framework	2.50	0.83
32. Prefer Genre approach	2.55	0.69	32. Prefer Knowledge Framework (KF)	2.20	0.83
33. "Genre" helped to write better lab reports	2.55	1.00	33. KF helped to write better lab reports	2.15	0.59
34. Importance of Language in writing lab reports	1.80	0.52	34. Importance of Language in writing lab reports	1.90	0.72
35. Learning LANGUAGE features was difficult	2.05	0.94	35. Learning LANGUAGE features was difficult	2.30	0.80
36. "Genre" helped to focus on the language of science	2.20	0.52	36. KF helped to focus on the language of science	1.90	0.45
37. After using Genre, writing of reports did NOT change	2.60	0.60	37. After using KF, writing of reports did NOT change	2.50	0.61
			38. Able to focus on LANGUAGE & CONTENT	2.00	0.65

The preceeding tables compared the responses to items on the two surveys that share similar topical features that relate directly to each of the two approaches. Each item included the mean and standard deviation of the student responses along a four-point scale. The means represented the students' opinion about that feature of the approach.

B. HYPOTHESES

The above results were used to address the hypotheses of this study.

1) OVERALL STUDENTS: MAINSTREAM AND ESL COMBINED

1. The Knowledge Framework (KF) approach is more effective than the Genre-based approach to instruction in improving the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology.

Results of the study supported this hypothesis. Overall Posttest 1 results in Table 4.4 showed that the group taught the KF approach **(17.15)** achieved a significantly higher mean scores than the group taught the Genre approach **(16.05)**. An Analysis of Covariance conducted to measure differences due to study group with Pretest 1 and Pretest 2 held as covariates revealed a significant difference due to group **($F(2,58) = 3.09$, $p = .05$)**. A mean difference between the Genre and KF groups was noted at -1.31 (Genre - KF). There was a significance constrast at alpha 0.05 between the Genre and KF group observed.

Upon analyzing survey 1 and 2 results in Tables 4.11, it was apparent that **65%** of students in the KF group **agreed (2.15)** with the statement that the Knowledge Framework helped them write better lab reports (Table 4.13, Item 33). Another **10%** of the KF students **strongly agreed** that their lab reports were better in quality after using the Knowledge Framework approach. The mean and standard deviation for the Genre survey reveal that most students **disagreed (2.55)** with the statement that the Genre approach helped them write better quality lab reports (Table 4.13, Item 33). Further analysis shows that only **35%** of the Genre class students **agreed** and **15% strongly agreed.** Comparing the percentages in this survey item 33, a total of **75%** of the students in the KF group either **agreed** or **strongly agreed** with the approach while only a total of **50%** of the Genre group students either **agreed** or **strongly agreed** with their approach.

Some students provided additional comments reflecting their overall impression of the two approaches for writing scientific lab reports. The following are some excerpts from the surveys:

THE KNOWLEDGE FRAMEWORK

- "Intentions and ideas were great but learning the "knowledge framework" takes up a lot of time."
- "Overall it was helpful. I liked the key visuals."
- "The Knowledge Framework helped to write lab reports but were much more time consuming."
- "I think it is good that the knowledge framework helps kids who had troubles with lab reports become better students. Thanks for the new ideas."

THE GENRE-BASED APPROACH

- "The Genre way of writing lab reports was a little confusing and hard to understand."
- "It was hard to understand what Genre was."
- "It (Genre) was difficult to get used to."

The comments the students made about the two approaches appeared to be negative. The students found it appropriate to use the comment section to criticize the approaches since the initial portion of the survey focussed on the benefits or positive qualities of the two approaches. Generally, the KF students found the Knowledge Framework approach "helpful" but "time-consuming". The students working with the Genre approach felt the concept of Genre was difficult to apply and "get used to" to writing lab reports.

Responses to item 30 on Table 4.13 indicates that **75%** **(2.20)** of the KF students understood how to write a scientific lab report using the Knowledge Framework even though **55%** **(2.50)** of these same students did not understand the concept of the Knowledge Framework and its knowledge structures very well. **Ninety-five percent** **(1.85)** of the Genre students said they understood how to use procedure and procedural recount genres to write lab reports. However,

50% **(2.45)** of the Genre students did not understand the concept of genre for writing scientific lab reports. It appears that the students generally understood how to apply the concepts of Genre and Knowledge Framework but did not fully understand the "underlying idea" or concept of these approaches.

Examining other means and standard deviations in Table 4.13, item 32 showed that **55%** **(2.20)** of the study participants working with the KF approach preferred Knowledge Framework method of writing lab reports. Item 32 in the Genre survey displayed a mean of **2.55**, indicating that the students did not prefer the Genre approach to other lab report instructional formats and approaches. Frequency analysis of the student groups showed that only **35%** preferred the Genre approach. Item 37 illustrated that **55%** **(2.50)** of the KF students **disagreed** with the statement that the Knowledge Framework (KF) approach did NOT change their writing of lab reports compared to **50%** **(2.60)** of the Genre students who **disagreed.**

Although there were no direct comparisons made, the above results and analyses seem to support the hypothesis that the Knowledge Framework approach is more effective than the Genre-based approach to instruction in improving the quality of students' writing of scientific lab reports in senior Biology.

2. <u>The Knowledge Framework (KF) approach will improve the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology.</u>

In addressing the above hypothesis the means and standard deviations of the Overall Posttest 1 for the KF group and the Control group were to be compared. Table 4.4 showed that the mean score for the lab reports written by KF students **(17.15)** was higher than that for those reports written by the Control students **(16.75)**. When the means were analyzed, there was no significance contrast at alpha 0.05 between the KF group and the Control group. One explanation for these results might involve the reliability and sensitivity of the *Evaluation Grid* (see Appendix F) used for assessing the lab reports written by the students in all three study groups. Rating by two independent raters were entered in the SPSS Reliability Program to test for inter-rater reliability. Results revealed a correlation of **0.93** between the two raters. There was an alpha score of **0.96** indicating an extremely high inter-rater reliabililty. Although the *Evaluation Grid* was reliable, it might not have been sufficiently sensitive to detect a great significant difference between the KF and the Control group.

The results in Table 4.13 above showed that KF students prefer the Knowledge Framework approach over other formats and approaches they have used. **These results, along with the slightly higher mean value for the KF group, were not sufficient in substantiating the hypothesis that the KF approach will improve the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology.**

3. The Genre-based approach will improve the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology.

The results of this study do not substantiate the hypothesis that the Genre-based approach will improve the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology. Evidence for this came from Table 4.4 which revealed a higher mean score for the Control group (**16.75**) than for the Genre group (**16.05**). The mean difference between these two group is -0.91 (Genre-Control) and represented no significant constrast at alpha 0.05. Consistent with these findings is that **65%** of the students in the Genre group did not prefer the Genre approach to other formats and approaches to writing scientific lab reports. However, the Genre approach did have its benefits: **Fifty percent** of the Genre students either **agreed** or **strongly agreed** that the genre approach helped them to write better lab reports. Other positive qualities of the Genre approach will be presented below.

2) MAINSTREAM STUDENTS

4. Mainstream students taught the KF approach will achieve higher evaluation scores on their scientific lab report writing than the mainstream students who were taught the Genre-based approach.

Due to the limitaions of the sample population of the study, it was not possible to analyze the mainstream students as a group. However, the results showed that all of the participants in the KF group scored significantly higher on the lab reports than those in the Genre group, suggesting that the mainstream students benefited from the KF approach.

The responses to items 32, 33, and 37 on Survey 1 and 2 suggested a high preference for the Knowledge Framework approach to writing better lab reports (Table 4.13). **The above results supported the hypothesis that mainstream students taught the KF approach will achieve higher evaluation scores on their scientific lab-report writing than the mainstream students who were taught the Genre-based approach.**

5. Mainstream students taught the KF approach will achieve higher evaluation scores on their scientific lab report writing than the mainstream students who were not taught either the KF or Genre-based approach.

The results of this study were not able to support the hypothesis that mainstream students taught the KF approach will achieve higher evaluation scores on their scientific lab report writing than the mainstream students who were not taught either the KF or Genre-based approach. A comparison of the group mean values between the mainstream students in KF group and those in the Control group in Table 4.7 revealed that the KF group (**17.65**) attained a mean difference of **0.82** higher than the Control group (**16.83**) (KF-Control). Considering the mean scores of these two groups of mainstream students, the 0.82 mean difference did suggest that the mainstream students in the KF class achieved higher evaluation scores than those in the Control class.

6. Mainstream students taught the Genre-based approach will achieve higher evaluation scores on their scientific lab report writing than the mainstream students who were not taught either the KF or Genre-based approach.

Table 4.7 illustrated the means and standard deviations of the mainstream Posttest 1 lab reports. The mainstream Control group (**16.83**) had a higher mean score than the mainstream Genre group (**16.18**). Although the small mean difference favours the Control group, there was no significant difference at alpha 0.05. **These results appeared to suggest that mainstream students taught the Genre-based approach do not achieve higher evaluation scores on their scientific lab report writing than those students who were not taught either the KF or Genre-based approach (Control group).**

3) ESL STUDENTS

The following hypotheses were developed to include the observations of the ESL student participants in the study. It was the intent of this study to test these hypotheses and reveal the ESL students' experience working with the two approaches to writing lab reports. Posttest 1 results in Table 4.10 yielded insubstantial evidence to either support or reject hypotheses 7, 8, and 9. The data were invalid for analysis since the random sample was too low, and therefore, the findings for ESL are inconclusive.

7. ESL students taught the KF approach will achieve higher evaluation scores on their scientific lab report writing than the ESL students who were taught the Genre-based approach.

It appeared that if the sample size for the ESL population was increased,

the expected results might substantiate the hypothesis that ESL students taught the KF approach do not achieve higher evaluation scores on their scientific lab reports than the ESL students who were taught the Genre-based approach.

8. ESL students taught the KF approach will achieve higher evaluation scores on their scientific lab report writing than the ESL students who were not taught either the KF or the Genre-based approach.

9. ESL students taught the Genre-based approach will achieve higher evaluation scores on their scientific lab report writing than the ESL students who were not taught either the KF or the Genre-based approach.

Table 4.10 results of ESL Posttest 1 suggested that the ESL students in the Control group achieved higher evaluation scores on their scientific lab reports than the ESL students who were taught the KF or the Genre-based approach.

3) WRITING LAB REPORTS USING THE KF AND THE GENRE APPROACHES

10. Students taught the KF approach will understand how to use the Knowledge Framework to focus on language and content features and use key visuals for writing scientific lab reports.

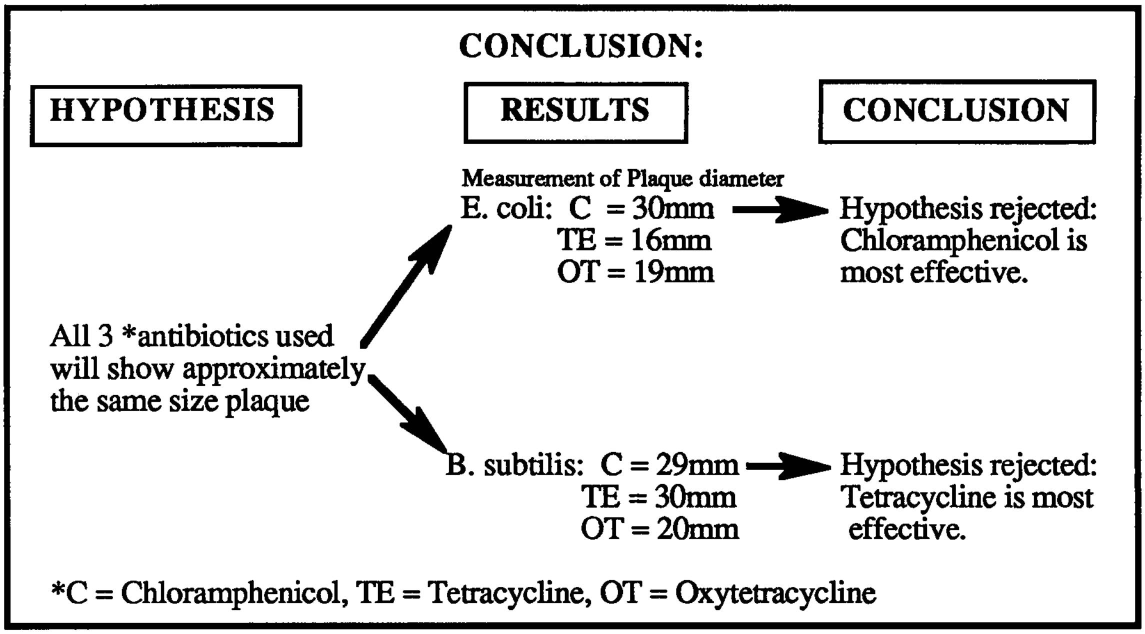
Survey 2 responses illustrated in Table 4.11 and 4.12 as means and standard deviations provided the study with the student participants' understanding of the concept of the Knowledge Framework and its knowledge structures and key visuals for writing scientific lab reports. In Table 4.11, the responses to items 1 and 2 show that **100%** of the students in the KF group understood how to use the Knowledge Framework to writing lab reports (**1.80** or **agree**) and **75%** of the KF students were able to identify the six knowledge structures of the Knowledge Framework (**2.15** or **agree**). The responses to items 30 and 31 in Table 4.13 indicated that **75%**

the students understood how to write scientific lab reports using the Knowledge Framework (**2.20** or **agree**) and **45%** of the students understood the concept of the Knowledge Framework and its knowledge structures for writing lab reports (**2.50** or "somewhat" **agree**).

The Knowledge Framework can be used as an organizational tool for structuring a topic in a way that focuses on its thinking process skills, language items and content knowledge for successful learning (Mohan, 1991, 1986; Early, Mohan & Hooper, 1989) In this study, the theoretical framework was applied to integrate systematically the language and content features of the topic of writing a scientific lab report (Figures 3.3 and 3.4). The results of Survey 2 in Table 4.11 suggest that the KF students (**80%**) understood how to use the Knowledge Framework to organize the components of the scientific lab report (Item 3: **1.95** or **agree**). Responses to items 5, 6, and 7 on the survey indicated that most students in the KF group **agreed** with the statements that they were able to identify the thinking skills (**2.30**) and the language features (**2.00**) of the framework's six knowledge structures ("Classfication", "Principles", "Description", etc.), and distinguish the difference between structural vocabulary and content vocabulary of each of the knowledge structures for writing lab reports (**1.90**). For each component of the lab report, the KF students were able identify the thinking skills (**65%**) and the linguistic features (**65%**) (Table 4.11).

One of the main defining features of the Knowledge Framework is the use of key visuals or graphic representations of the knowledge structures to reduce the language barrier for the learning of content information (Mohan, 1991, 1986; Early, Mohan & Hooper, 1989; Tang, 1994, 1991). The responses to the survey statements in Table 4.11 and 4.12 revealed that **80%** of the students in the KF group were able to identify key visuals that are appropriate for each of the six knowledge structures of the framework (mean = **1.85**) and **16 of the 20** students could identify the appropriate key visuals or graphics for each component of the lab report (**1.90**). **85-95%** of the KF students found the use of diagrams, tables, charts, etc. helped them in writing the "Observation" section of their labs (Table 4.12, item 17 and 24). The following figure is an example of a visual created by a student in the KF group for her lab report (Posttest 1):

Figure 4.1: A key visual designed by a student in the KF group.



In Figure 4.1, the KF student used a decision tree to demonstrate the knowledge structure of "Choice". The student's statement of hypothesis alluded to testing the 3 antibiotics for plaque (a zone of no bacterial growth). However, the student did not include in her hypothesis on which bacteria she was testing the antibiotics. In her "results" column it appears that E. coli and B. subtilis are the two species of bacteria on which the antibiotics Chloramphenicol, Tetracycline, and Oxytetracline were tested. According to the student's key visual, the hypothesis was set up to be rejected in order to reveal one of the three antibiotics to have an most outstanding effect on the growth of each of the two bacteria. Identifying the most effective antibiotic for each of the bacteria formed the student's conclusion. The following is an excerpt from her lab write-up:

> "Every antibiotic worked on both E.coli and B. subtilis . Chloramphenicol (C) worked the best on the E. coli bacteria while Tetracycline (TE) worked the best on the B. subtilis bacteria."

In writing the scientific lab reports, the KF students **agreed** that they were able to apply the appropriate thinking skills of the knowledge structures (**50%**) and use structural and content vocabulary correctly in writing various sections of their labs (**60%**) (Table 4.12, items 15 and 16). In writing their "Procedures" section the lab, **17 out of 20** students in the KF group knew how to use "sequence" words such as "first" and "next" and prepositions to indicate time and space for linking the pertinent steps of the lab experiment (Table 4.12, items 22 and 23). The responses to item 21 in Table 4.12 suggested that the students in the KF group knew how to use key words in the imperative form to describe the activities in the lab procedures (**2.10**).

Items 25, 26 and 27 in Table 4.12 illustrated that the KF students were able to compare and contrast their experimental findings with the theoretical background knowledge of the lab topic and activity (**75%**), analyze and explain their findings using past tense (**85%**), and use structural vocabulary such as "as a result" or "because" to establish cause and effect relationships (**70%**) in writing the "Discussion" section of their labs. In writing their conclusions to the lab work, the students were able use the phrase "In conclusion, we found..." to begin their statements of findings (Item 28, mean = **2.30**).

Overall, the students (**80%**) in the KF group felt they understood the importance of language features in the Knowledge Framework to writng better lab report. **Forty-five percent** of the students thought the learning of the language features was difficult. In the final analysis of survey 2 responses, **eighty percent** of the KF students thought the Knowledge Framework allowed them to focus on the language and content features for writing scientific lab reports.

The above results substantiated the hypothesis that students taught the KF approach will understand how to use the Knowledge Framework to focus on language and content features and use key visuals for writing scientific lab reports.

11. <u>Students taught the Genre-based approach will understand how to the use "Procedure",</u>

"Procedural Recount", and "Explanation" genres to identify the generic structures and key language features for writing scientific lab reports.

Survey 1 responses displayed in Table 4.11, 4.12, and 4.13 support the hypothesis that Students taught the Genre-based approach will understand how to the use "Procedure", "Procedural Recount", and "Explanation" genres to identify the generic structures and key language features for writing scientific lab reports.

Items 1 and 2 in Table 4.11 showed that **100%** of the Genre students understood and could explain the term "genre" (mean =**1.80**) and **70%** of these students knew that there are "written" and "spoken genres". **Ninety to ninety-five percent** of the students in the Genre class knew that the "Procedure" genre was used to describe a sequence of activities to do in a lab (**1.45**) and the "Procedural recount" genre was used to record the conduct and results of experimentation or to record a set of observations made in a laboratory exercise (**1.55**). The students introduced the Genre-based approach were able to identify the "Procedure" genre for the "Aim, Materials and Method" sections of an experimental report (**1.75**) and the "Procedural recount" genre for the "Results" and "Conclusion" sections of the report (**2.05**). The students (**75%**) were also able to identify the language features (past tense, sequence words, action words) for the "Procedure" and "Procedural recount" genres in writing scientific lab reports.

At the independent construction stage of the teaching cycle where students were directed to write the lab reports on their own, the Genre students found it easy to write the "Aim" (**2.00**) and the "Material" (**1.60**) sections of their labs (Table 4.12, items 19 and 20). In writing the "Method" section their labs, **70-85%** of the students **agreed** that they knew how to use imperatives, sequence words (i.e. conjunctive adverbs), and prepositions for indicating time and space. The following are two samples taken from student lab reports written using the Genre-based approach:

Figure 4.2: "Method" section from a lab report written with the Genre approach.

SAMPLE 1

"METHOD:

First, smear the samples of E. coli and B. subtilis into separate petri dishes. Then, on the outside of the dishes, in pen, divide the dish into four equal sections. Now put a tablet of tetracycline in one of the sections in each dish. Next put a tablet of oxytetracycline in one of the sections in each dish. Finally put a tablet of Chloramphenicol in one of the sections of each dish making sure there is one empty section in each dish."

SAMPLE 2

"METHOD:

5. Thereupon, sterilize your inoculating loop. To do this, hold the loop under the flame under the flame until it glows red. Then, let it cool without letting it touch any surfaces.

The sample writing and the responses in the survey above indicated that the students in the Genre group were able to use linguistic features to represent the appropriate **material processes** ("*sterilize your* inoculating loop."), write lab activity **steps expressed as commands** (i.e. "Put", "divide", etc.), use **dependent clauses of time** ("...until it glows red.") and make **references to place and manner** ("...under the flame"). The responses to item 25 in Table 4.12 showed that **80%** of the students used past tense in writing their "Results" section. Also, **80%** of these students found the use of graphic conventions helpful in writing their lab reports. There were no specific graphics recommended by the Genre approach and therefore, the use of visuals were optional. Those students who used visuals needed additional direction and assistance in making the diagrams, tables, and graphs workable and appropriate for representing their experimental findings.

The Genre approach emphasizes the application of the "Procedural recount" genre and its features to writing the "Results" section of the lab report. The responses to item 12 in Table 4.11 suggested that students did use **human participants** ("we") and the **circumstances of time and space** ("...in each petri dish."). Upon closer analysis **90%** of the students either **agreed** or **strongly agreed** with items 12 statement and **80% agreed** with the statement that they used **past tense** in writing their "Results" section.

In writing the "Discussion" section of their labs, **55-60%** of the Genre students were able to give and select the appropriate "Explanation" genre format (i.e. "theoretical", "sequential", "causal", etc.) (Table 4.12, items 26 and 27). In the joint construction exercises, the students expressed difficulty in identifying the characteristics of each of the various "Explanation" genre formats. Students were not always able to use **conjunctions, dependent clauses, circumstances,** and **processes** for the **causal explanation** genre in writing the "Discussion" section. The sample writing below illustrates the use of **causal conjunctions** ("therefore") and **dependent clauses of cause** ("if the plaque... was larger):

Figure 4.3: Sample "Discussion" section from the Genre lab reports.

SAMPLE

"DISCUSSION:

According to our knowledge of antibiotics, we were aware that they would prevent the building of bacterial cell walls. Therefore, if the plaque, or field of dead bacteria, was larger, then the antibiotic was more effective."

The Genre students were able to use the "In conclusion, we found..." in writing their conclusions (**75% agreed**).

Overall, the students in the Genre group felt that they understood the importance of language features in writing better lab reports (**95%** either **agreed** or **strongly agreed**) and thought the genre approach to writing lab reports allowed them to focus on the language of science so that they were could better express in writing what they learned from the lab activity (**75%**).

IV. SUMMARY

The results from Pretest 1 Reading test, Pretest 2 Writing test, Posttest 1 laboratory reports, and Survey 1 and 2 indicated that there is a difference in the quality of scientific report writing at the senior secondary school level related to differences in instructional approach. In this study, the KF approach was successfully implemented to writing lab reports by focusing on the learning of the language of science and the content knowledge in the lab activity. The Genre-based approach was also successfully applied to teaching the writing of lab reports. This approach helped students to focus on "genre" and its generic structures and linguistic features for writing lab reports. The posttest results coupled with Survey 1 and 2 responses revealed that each of the two approaches made a positive difference to various degrees in the student participants' lab reporting.

The data from the various tests in this study were able to show the effects of each of the two approaches on writing scientific lab reports and delineate the quality of performances by the ESL and mainstream students. The results of this research yield the following information regarding the implications of the KF and Genre-based approach on writing lab reports:

a) The KF approach helped to improve the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology. The Knowledge Framework served as an organizational tool for students to focus on the linguistic features necessary for expressing key content information in their lab write-up.

b) The Genre-based approach helped the students to improve their awareness of

"Procedure", "Procedural recount", and "Explanation" genres and focus on the language features for expressing scientific content.

c) The KF approach appeared to help students to improve the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology. The Genre-based approach did seem to have helped students write significantly better quality lab reports in senior Biology.

d) However, neither the KF nor the Genre approach substantially improved the quality of both mainstream and ESL students' writing of lab reports when compared to the quality of the students who were not taught either approach. Again, there were no significant differences between the each of the experimental group and the Control group.

e) The mainstream and ESL students as two distinct populations showed no significant improvement above those in the Control group after using the KF and Genre approach. The mainstream students taught the KF approach did achieve higher evaluation scores than those in the Control group, but the difference was not signficant. The mainstream students who were taught the Genre-based approach did not achieve higher evaluation scores than those who were taught neither of the two approaches. The small sample size of the ESL students in all three groups did not allow for analysis.

f) Overall, the KF approach appeared to be more effective than the Genre-based approach to instruction in improving the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology.

CHAPTER 5

DISCUSSION AND IMPLICATIONS

I. PROBLEM

There appears to be a greater emphasis placed on higher standards of student performance as a measure of success in learning for both English as a Second Language (E.S.L.) and native English students alike who choose science as their focus of academic studies in the Canadian school system. Since the learning of scientific concepts involves linking the theoretical and the practical experiences of science, student learning is often measured by their performance on tests that emphasize conceptual theory and their performance on laboratory exercises that offer a "first-hand experience" with science. It has come to the attention of science educators and researchers alike that student performance on laboratory work in science is poor and the student laboratory reports lack communicability or clear expression of the learning of scientific concepts (Kochendorfer, 1994; Vargas, 1986; Renner, 1986; Beasley, 1985; Klein *et al.*, 1982).

In science students write lab reports, they apply their language skills or linguistic knowledge to organize and construct a piece of writing that represents the scientific concepts learned and process skills attained. Science teachers find students are weak in their writing skills (Vargas, 1986) and are uncertain as to what information is most relevant for reporting (Kochendorfer, 1994; Renner, 1986; Beasley, 1985; Klein *et al.*, 1982). For E.S.L. and some recently mainstreamed students, the writing of scientific lab reports poses a heightened challenge because of the language barrier.

II. BACKGROUND

Science laboratory work and reporting play a significant role in science education because they give students a chance to participate in investigations and experimentation in which they exercise their own thinking, draw their own conclusions, and inform others in the scientific community about their results (Renner, 1986; Beizenherz and Olstad, 1980). Laboratory activities give concrete learning experiences by involving students in the scientific enterprise of posing questions, hypothesizing, testing, problem-solving, and ultimately, making discoveries (Renner, 1986; Klein *et al.* ,1982).

Although laboratory work has always been promoted in the teaching of science, in some periods during the history of science education it has been given a dominant role. During the major science curriculum reform movements of the 1960s some science teachers believed that "a considerable amount of laboratory work should lead, rather than lag behind, the classroom phases of science teaching" (Schwab, 1964). In the 1960s curriculum planners suggested that working on problems in the laboratory was more important than finding conclusions. (Schwab, 1964). These reform recommendations for laboratory work in the final analysis did not provide students with sufficient educational experiences to succeed in a changing society or have greater relevance to their daily lives.

Science teachers presently assume the responsibility of changing the way they plan, implement, and evaluate laboratory-oriented curricula so that they are appropriate for their science students. Among many factors and issues to address, for one, educators are recognizing a demographic change in their student body and are assisting their new immigrant students to adjust to a cross-cultural experience in science education. In particular, science teachers are exploring various approaches to successful laboratory work and reporting so that their students can better learn from their lab experiences and improve on their lab performances.

Science students complete classroom tasks assigned by teachers to learn the content information presented in the task. Writing a scientific laboratory report is an academic task (Biology, 1986; Brown, 1991; Candlin, 1987; Doyle & Carter, 1984; Goodman, 1986; Kanare, 1985; Long, 1989; Long & Crookes, unpublished & 1992; Mohan, 1991; Nunan, 1988 & 1989; Pica, Kanagy, & Falodun, 1990). For native-speaking students in the mainstream classroom the focus of learning is mainly on acquiring the scientific conceptual knowledge in the tasks, but for second language learners, the emphasis may be on the linguistic forms (grammar, syntax, lexis, morphology, etc.), the subject matter, or both.

Second language acquisition and learning theorists believe that ESL students in language and content-area classrooms can learn the second language more effectively if the language and content of the curricular topics are presented in a meaningful way for learning and time is alloted constructively to allow for ample opportunities for learning (Cummins, 1991; Collier, 1987; Krashen, 1981, 1982). Krashen (1981, 1982) suggests that integrated instruction in the academic classroom should present "language input" that is just above the proficiency level of the learner and link it to meaningful content. Cummins (1991), who makes the distinction between conversational (BICS) and academic proficiency (CALP) believes that ESL students need opportunities to use specialized academic language in "context-embedded" situations in content classrooms such as science. It takes between 4 to 8 years for ESL students to reach national norms on standardized tests (Collier, 1987); therefore, the instruction of academic content and skills cannot be delayed.

Two approaches to instruction that focus on language skills and academic content can be applied to improving ESL and native-speaking students' writing of scientific laboratory reports in senior secondary school science: The Knowledge Framework approach, which involves using the Knowledge Framework for the instruction and learning of both language skills and content information in a particular curriculum in an education context (Mohan, 1979, 1986; Early, 1990; Early, Mohan & Hooper, 1989; Crandall, 1987, 1993; Cantoni-Harvey, 1987; Brinton, Snow & Wesche, 1989) and the Genre approach is based on a model of functional grammar of systemic linguistics that views language as a social semiotic that gives meaning (Halliday & Martin, 1993; Martin, 1992, 1993, Halliday, 1993, 1985; Christie & Rothery, 1989; Painter & Martin, 1986; Callaghan & Rothery, 1988; Christie, 1990; Rothery, 1993). The Genre-based approach to literacy in science is concerned with exploring the structure, function and usage of scientific language in the written mode.

A. THE KNOWLEDGE FRAMEWORK APPROACH TO WRITING SCIENCE

Integrating language and content information for instruction includes the presentation of language items (grammar, syntax, lexis, morphology, etc.) and subject matter (content knowledge) with a balanced emphasis on both in a cohesive manner for learning (Mohan, 1979, 1986; Early, 1990; Early, Mohan & Hooper, 1989; ; Crandall, 1987, 1993; Cantoni-Harvey, 1987; Brinton, Snow & Wesche, 1989). The Knowledge Framework approach for learning is one model of KF that promotes second language learning, academic language and cognitive skills development, and the communicative language use (Mohan, 1979, 1986, 1991; Early, Mohan, & Hooper, 1989). The theoretical framework emphasizes the development of both language and content knowledge together by focusing on the intersection of language, content, and thinking objectives.

Applying the Knowledge Framework involves identifying language structures and content vocabulary in a particular text or discourse situation and organizing the information into the six knowledge structures of "Description", "Classification", "Principles", "Sequence", "Evaluation", and "Choice", which are based on the cognitive processes intended in the text or situation. Key visuals are graphics used in the Framework as a "bridge" that links language and content (Mohan, 1986, 1991; Early, 1989) and helps to lower the language barrier.

In the science classroom, the knowledge structures of the theoretical framework can be used to organize curricular concepts or topics for writing a scientific lab report. The approach can be designed "to elicit certain knowledge and discourse structures" and can aim to develop language competencies for writing lab reports as an academic task (Mohan, 1986).

B. GENRE-BASED APPROACH FOR WRITING SCIENCE

Based on a functional grammar of systemic linguistics that views language as a social semiotic that gives meaning, genre can be viewed as a "staged, purposeful, goal-oriented activity" (Martin, 1992,1993; Halliday, 1985, 1989, 1993; Christie & Rothery, 1989). Consistent with Halliday & Hassan (1989), Martin (1993) believes that language, as social semiotic, "plays an instrumental role in construing the social context we live" and in reciprocity, "language is, at the same time, construed by social context".

The concept of *genre* can be defined as distinctly different from the longer established concept of *register* (Ventola, 1984, cited in Swales 1990). Martin (Hasan & Martin, 1989) distinguishes genre and register to be two semiotic levels which are connotative and find their expression through language. Register as a category can be analyzed in terms of three variables labelled *field* (the content activity of the situation), *tenor* (the social action), and *mode* (the channel of communication).

A Genre-based approach can be applied to promoting the implementation of language across the curriculum approach (Stainton, 1992). Some genres are found to be common across different academic subjects. Report (classifying and taxonomizing), Procedure (sequencing events), Explanation (cause and effect) are examples of genres required of students in their writing (Martin & Painter, 1986; Callaghan & Rothery, 1988; Christie & Rothery; 1989). The Genre-based approach makes explicit the knowledge about language form to the learner.

The Genre-based approach to writing scientific lab reports focuses on identifying the appropriate genres and their schematic and linguistic choices and the context or "register" for producing language for each component of the lab report. Through the 3-stage teaching cycle of modelling of text, joint construction of new text, and independent construction of the text, students apply the key language features for "Procedure", "Procedural Recount", and "Explanation" for writing scientific reports.

C. SUMMARY

In summary, the body of research and literature in area of language education appears to suggest the KF and Genre approaches can be applied across the curriculum. Both the Knowledge Framework approach and the Genre-based approach can be implemented for writing lab reports in senior science. Both are well-founded on theories of language learning that emphasize the importance of discourse abilities for expressing meaningful content knowledge in the academic task of writing. The research presented suggests that students, especially ESL, can benefit immensely from the purposes of the KF and Genre-based approach for writing scientific laboratory reports. To answer the central question of this study, "is there a difference in the quality of scientific report writing at the senior secondary school level related to differences in instructional approach, the Knowledge Framework approach or the genre-based approach to literacy instruction", two pretests, one posttest for evaluating scientific lab report writing and two surveys were developed and conducted to test the effects of the two approaches on writing science. Data collected from this study were used to test the following hypotheses:

1. The Knowledge Framework (KF) approach is more effective than the Genre-based approach to instruction in improving the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology.
2. The Knowledge Framework (KF) approach will improve the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology.
3. The Genre-based approach will improve the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology.
4. Mainstream students taught the KF approach will achieve higher evaluation scores on their scientific lab report writing than the mainstream students who were taught the Genre-based approach.
5. Mainstream students taught the KF approach will achieve higher evaluation scores on their scientific lab report writing than the mainstream students who were not taught either the KF or Genre-based approach.
6. Mainstream students taught the Genre-based approach will achieve higher evaluation scores on their scientific lab report writing than the mainstream students who were not taught either the KF or Genre-based approach.
7. ESL students taught the KF approach will achieve higher evaluation scores on their scientific lab report writing than the ESL students who were taught the Genre-based

approach.

8. ESL students taught the KF approach will achieve higher evaluation scores on their scientific lab report writing than the ESL students who were not taught either the KF or the Genre-based approach.
9. ESL students taught the Genre-based approach will achieve higher evaluation scores on their scientific lab report writing than the ESL students who were not taught either the KF or the Genre-based approach.
10. Students taught the KF approach will understand how to use the Knowledge Framework to focus on language and content features and use key visuals for writing scientific lab reports.
11. Students taught the Genre-based approach will understand how to the use "Procedure", "Procedural Recount", and "Explanation" genres to identify the generic structures and key language features for writing scientific lab reports.

III.THE STUDY

This study examined how the KF approach and the genre-based approach to literacy compared in effectiveness as each was applied to teaching ESL and native-speaking students to write lab reports. The study groups in this research were comprised of students who were enrolled in three classes of Grade 11 Biology at a senior secondary school in the Richmond School District. Twenty students in each of the three classes volunteered to participate in this study. Each class served as a study group and was designated as follows: The class that received the KF approach was named the "KF" group; the "Genre" group was taught the Genre-based; the third class received neither of the above instructional approaches and therefore served as the "Control" group. The students in the study came from a middle-class background and a variety of ethnic cultures.

Three classes of mainstream Biology 11 were randomly selected for the study. The research began with administering two pretests to all three (Genre, KF, and Control) participant groups: *Pretest 1: Reading Comprehension Test* and *Pretest 2 : What is a Scientific Lab Report?* After the two pretests, the teacher / researcher began to teach the KF approach unit to the "KF" group and teach the "Procedure", Procedural Recount" and "Explanation" genres to the Genre class. The Control group did not receive any of the other two instructional approaches. At the end of the KF and Genre teaching cycles, all students were directed to write formal lab reports based on the current topic presented in the Biology 11 curriculum. The lab reports were then evaluated and analyzed using the *Evaluation Criteria for Writing Scientific Laboratory Reports*. *SURVEY 1: Using Genres to write a Lab Report* was administered to the "Genre" group and *SURVEY 2: Using the Knowledge Framework to Write a Scientific Lab Report* was given to the "KF" group at the end of the study. The surveys were analysed for student responses to their experiences with the approaches.

IV. PARTICIPANTS

The participants for this study were senior secondary school students from the Richmond School District who were enrolled in the senior science course of Biology 11. A total of 60 participants in three classes were randomly selected and designated as the "KF", the "Genre", and the "Control" groups to test the effectiveness of the approaches. "Pretest 1" and "Pretest 2" were used to determine the students' proficiency levels in reading and writing English. Out of 60 participants there was a total of 8 ESL students (those students whose English proficiency level was below that of native-speakers): 3 in the "Genre" group, 3 in the "KF" group and 2 in the "control" group. The proficiency levels of the ESL students ranged from low to upper intermediate to advanced (Level 3, 4 or 5). Eight different first languages other than English were represented in the study groups. The students varied in intellectual ability, attitude, motivation for learning.

V. RESULTS

A. PRETEST 1

The Gates-MacGinitie test gave an estimate of the overall reading comprehension level of the participants in the three groups. Overall (mainstream and ESL combined) Pretest 1 mean scores in Table 5.1 ranged from **36.10 (7.52)** for the Control group, **37.25 (8.17)** for the KF group, to **40.90 (6.28)** for the Genre group. The mainstream and ESL students in the KF group (**37.25**) had a lower mean score than those in the Genre group (**40.90**) on the Gates-MacGinitie Reading Comprehension Test.

Table 5.1: Means and Standard Deviations of Pretest 1 scores by all students.

OVERALL PRETEST 1: GATES-MACGINITIE READING COMPREHENSION TEST			
GROUP	**MEAN**	**STANDARD DEVIATION**	**CASES**
GENRE	40.90	6.28	20
KF	37.25	8.17	20
CONTROL	36.10	7.52	20

Looking at the mainstream and ESL students as separate populations on the Reading Test (Table 4.5 and 4.8), the mainstream students in the KF group had a mean score of **39.42 (6.33)** while the ESL students in the same KF group had a value of **25.00 (6.92)**. The mainstream Genre students had a mean of **43.00 (3.28)** on the Gates-MacGinitie while the ESL Genre students had a mean value of **29.00 (6.24)**. Comparing the mainstream and ESL students in the Control group, the results also showed a mean score of **37.50 (6.51)** for the mainstream students and a mean of **23.50 (0.71)** for the ESL student. The overall mean for mainstream students in the three groups was **39.92 (5.95)**. The overall mean for the ESL students on Pretest 1 was **26.13 (5.57)**.

B. PRETEST 2

In Pretest 2, the students' prior knowledge of laboratory work and report writing skills were assessed. Table 5.2 shows the means and standard deviations of the Pretest 2 writing test obtained by the three study groups. The results of overall Pretest 2 revealed a range of mean scores from **78.70 (7.16)** for the KF group, **79.35 (6.67)** for the Control group, to **80.68 (5.73)** for the Genre group.

Table 5.2: Pretest 2 results for all students in the study groups.

OVERALL PRETEST 2: WRITING TEST			
GROUP	**MEAN**	**STANDARD DEVIATION**	**CASES**
GENRE	80.68	5.73	19
KF	78.70	7.16	20
CONTROL	79.35	6.67	20

The Pretest 2 results in Table 4.6 showed a mean score of **81.50 (5.42)** for the mainstream Genre group, **80.61** for the mainstream Control group, and **80.41** for the mainstream KF group. There was total of 51 out of 52 mainstream students in the sample population wrote Pretest 2. For the ESL students, the Pretest 2 results varied from **68.00 (2.83)** for the Control group, **69.00 (5.29)** for the KF group, to **76.33 (6.42)** for the Genre group (Table 4.9). The overall mean for the ESL students in the three groups was **71.50** and the standard deviation was **6.09** while the overall mean for the mainstream students on the Pretest 2 Writing Test was **80.82 (5.63)**.

C. POSTTEST 1

Posttest 1 results showed the evaluation of the lab reports written by students in the three study groups. In Table 5.3, overall Posttest 1 data illustrated a mean score of **17.15 (2.46)** for the KF group, **16.05 (2.72)** for the Genre group, and **16.75 (2.34)** for the Control group.

Table 5.3: Posttest 1 results of lab reports written by all students.

OVERALL POSTTEST 1: LAB REPORTS			
GROUP	**MEAN**	**STANDARD DEVIATION**	**CASES**
GENRE	16.05	2.72	20
KF	17.15	2.46	20
CONTROL	16.75	2.34	20

From Tables 4.7 and 4.10, the results showed means and standard deviations of **16.18 (2.92)** for the mainstream students in the Genre group and **15.33 (1.15)** for the ESL students in the Genre group. In the KF group, the mainstream students had a mean of **17.65 (2.21)** while the ESL participants had a mean value **14.33 (2.08)**. Comparing the students in the Control group, the mainstream participants had a mean score of **16.83 (2.35)** for the Control group while the ESL students had a mean of **16.00 (2.82)**. The overall mean score and standard deviation for the three mainstream groups was **16.88 (2.53)**. The overall mean score on Posttest 1 for the ESL students was **15.13** with a standard deviation of **1.81.**

D. SURVEY 1 AND 2

The two surveys (Survey 1 and 2) were administered to obtain students' responses that reflected their understanding and overall impression of the KF and the Genre-based approaches for writing science. The results of the surveys indicated that the two groups of students on the whole did find the two approaches helpful in writing scientific lab reports.

In identifying and applying the generic structure and linguistic features of the "Procedure", "Procedural Recount", and "Explanation" genres for writing each component of a scientific lab report, **one hundred percent** of the students in the Genre group could explain the term "genre" and **90-95%** of the students knew the purpose and function of the most appropriate genre for writing each section of the lab (Table 4.11). **75%** of the students in the Genre group **agreed (1.95)** that they were able to identify the language features such as imperatives, past tense, sequence words, etc. for each genre. Overall, the Genre students thought the approach helped them to focus on the language of science so they could write better lab reports (**75%**).

A high percentage of students understood and knew how to apply the Knowledge Framework and its knowledge structures, language features, and key visuals for writing scientific lab reports. From Survey 2, the students responses indicated that **100%** of the KF students understood how to use the Knowledge Framework for writing labs, **85%** expressed that they were able to identify the six knowledge structures, and **80%** of them understood how to use the theoretical framework to organize the sections of their labs. Further analyses of these surveys suggest that **85-95%** of the KF students found key visuals helpful in their lab write-up. Overall, **80%** of the students in the KF group felt they understood how to recognize and use the appropriate linguistic features for writing a better lab report. **Eight percent agreed** that the Knowledge Framework allowed them to focus on the language and content features of a scientific lab report.

One common thread of dislikes shared by the students in the two experimental groups was the length of time it took for them to learn and write the labs using the two methods. They thought writing using the approaches was very time-consuming. Nevertheless, it was understood that, with anything new, some time needs to be alloted to learn it.

Generally, the students working the KF approach preferred it more than those working with the Genre approach. Item 32 in Table 13 reveal that **55% (2.20)** of the KF students preferred the Knowledge Framework while only **35% (2.55)** of the Genre students preferred it to other lab report instructional formats and approaches.

VI. CONCLUSION

The Knowledge Framework (KF) and the Genre-based approaches have made a difference in the students' writing of scientific lab reports in senior Biology. The data from the study showed that the Knowledge Framework was effective, but not significantly, in improving the quality of the students' lab reports. Generally, the students who were introduced the Genre-based approach found that it helped to write better lab reports. The following is a final summary of the findings of this research:

1. **The KF approach was more effective than the Genre-based approach to instruction in improving the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology.**
2. **The KF approach did not subtantially improve the quality of both mainstream and ESL students' writing of scientific lab reports in senior Biology.** The was a difference in favour of the KF approach over any other approaches with which the students have worked.
3. **The students taught the Genre-based approach did not show a significant improvement on the quality of their scientific lab-report writing.** However, fifty percent of the Genre group agreed that the genre approach helped them to write better lab reports.
4. **The mainstream students who were taught the KF approach achieved higher evaluation scores on their scientific lab reports than those who were taught the Genre-based approach.**

5. **The mainstream students who were taught the KF approach did not achieve significantly higher evaluation scores on their scientific lab reports that the mainstream students who were not taught either the KF or Genre-based approach.** However, the mainstream students in the KF group did attain a higher mean score than the mainstream students in the Control group.

6. **The mainstream students taught the Genre-based approach did not achieve higher evaluation scores on their scientific lab report writing than those students who were not taught either the KF or Genre-based approach (Control group).**

7. **ESL students taught the KF approach did not achieve higher evaluation scores on their scientific lab reports than the ESL students who were taught the Genre-based approach.** The statement hypothesis was supported by data collected from a significantly low sample population of ESL students, and therefore, might not be valid.

8. **The ESL students in the Control group achieved higher evaluation scores on their scientific lab reports than the ESL students who were taught the KF approach.** This statement of hypothesis was supported by low sample data and might not be valid.

9. **The ESL students in the Control group achieved higher evaluation scores on their scientific lab reports than the ESL students who were taught the Genre approach.** This statement of hypothesis was supported by low sample data and might not be valid.

10. **The students taught the KF approach understood how to use the Knowledge Framework to focus on language and content features and use key visuals for writing scientific lab reports.** The students found the use of key content and structural language features and key visuals to be very beneficial to writing lab reports.

11. **The students taught the Genre-based approach felt that they understood how to the use "Procedure", "Procedural Recount", and "Explanation" genres to identify the generic structures and key language features for writing scientific lab**

reports. The students also expressed that they were able apply the generic structures and the key language features of the three types genres to writing the sections of their lab reports.

12. While the study has contrasted the Knowledge Framework approach and the Genre-based approach, the two approaches are infact complementary.

VII. LIMITATIONS OF THE STUDY

This study intended to examine how the Knowledge Framework (KF) and the Genre-based approaches could be implemented into the secondary school science for the learning of academic language and content through writing a scientific lab report. This research attempted to address all aspects of the two approaches in the context of the classroom situations and the students from the Richmond school district who participated in the study. The following is a description of the limitations of this study:

A. STUDENTS

1. The ESL and mainstream students who volunteered to take part in this study were from three randomly chosen classes of Biology 11 at Richmond Senior Secondary School in Richmond, B.C. The number of ESL students in the sample population was low at 13%, 8 out of 60 participants, and was insufficient and insubstantial in making the ESL results valid for addressing the hypotheses that concerned ESL students in the study. The ESL population represented in these classes was different from the Richmond School District norm of approximately 40% across the curriculum. In other courses, the percentage often exceeds over 40% depending on the English usage demand of the course (i.e. Mathematics, Physics, or Computer Science). Nevertheless, it was the nature of the senior Biology course that there was a low number of ESL students compared to that of mainstream students. One reason for the low percentage of ESL students in these Biology classes could be that the language usage in the course content was at the mainstream or native-speaking level.

2. The three groups of student participants were involved in the research: Two groups were the experimental and one served as the Control group. Each of the experimental groups was taught one of the two approaches to writing scientific lab reports. The KF group was introduced to the Knowledge Framework and its knowledge structures and the Genre group was presented the "Procedure", "Procedural Recount", and the "Explanation" genres. The success of each approach was partly dependent on the presentation of the teaching cycle for learning. The students' response to each stage of the teaching process was crucial to their learning of the new approaches. The teacher/researcher monitored the progress of each group throughout the teaching cycle as the key characteristic features and benefits of each approach were presented. The students' learning of each approach was reflected in their sample write-up and formal lab report submitted and evaluated as Posttest 1 results.

3. The background, intellectual and natural ability of the student participants play a significant role in their learning of the new approaches for writing Science. Students who have consistently achieved high standings in science courses may have found little difficulty in the learning of scientific content regardless of whether there was a specific lab writing methodology at the senior secondary school level. This may explain why the Control group had a higher mean score on the Posttest 1 lab report that the Genre group (Table 4.4). Although the students in the Control were not taught a particular approach to writing science, as Grade 11 science students they have learned many techniques to writing lab reports in their past schooling and had applied them succesfully in this study.

4. The study was conducted over a 3-month period with 60 student volunteers. The actual instructional process of each of the approaches (not including the time for the two pretests to be written) took approximately 2-classroom hours. The students in each group were given three months to apply the approaches to writing 3 labs (certain lab activities and demonstrations did not require lab write-ups) with the knowledge that the third lab report would be evaluated for the study. Three months might not have been sufficient time for the students to grasp the concepts and techniques of the two approaches. It is possible that with more time for learning the approaches

the lab reports would be better written.

5. One of the limitations of this study might be the sample size of the student participants. Twenty students for each study group represented 67% of the total number of students (30) in a standard classroom in the Richmond School District. A higher number of the student population for the study could yield more substantial results.

6. The three classes of Biology 11 students that comprised the study groups for this research were taught by the same teacher/researcher. The elimination of any teacher bias by introducing two other teachers into the study could produce more significant results since the overlap of approaches in the teaching process would be reduced. However, the teacher/researcher for this study did have a impartial visitor to his class lessons to observe and help the researcher to reduce teacher bias.

7. The *Evaluation Grid* for assessing the Posttest 1 lab reports in all three study groups was developed in conjunction with 8 different science teachers from Richmond (see appendix). The *Evaluation Grid* had criteria descriptors that focused on the language and content knowledge features of each section of the lab report. Even though it was reliable, the grid might not have been sensitive to show a great significant difference among the three groups of lab reports. Table 4.4 reveals fairly similar means and a low variability for the groups indicating that the 60 students had a narrow spread of scores.

VIII. IMPLICATIONS FOR FURTHER STUDY

The Knowledge Framework and the Genre-based approaches have their benefits and the potential to improve the quality of scientific writing at the senior secondary school level. The two approaches have many implications for teacher education, second language learning, and science education. This study has shown how instructional approaches that emphasize the language features and content knowledge inherent in a particular academic or social context can be implemented in the learning of science. The following is a series of questions related to the topic of language learning through writing science that was not addressed in this research study:

1. What is the value of the learning of academic language for teachers across the curriculum? In an academic content curriculum does an instructor have the expertise, resources, and time to teach the language of their discipline? How should the language of science be taught without de-emphasizing scientific content?
2. Should students be offered a course at the secondary school level that focuses on academic or technical writing skills? Will an English for Academic Purposes (EAP) writing course better prepare students for the task of writing across the curriculum at the secondary school level (Leki & Carson, 1994)?
3. Should teachers evaluate language and/or content in their academic content classrooms? What is the value of formal language skill assessment in the content-area of science?
4. How is the KF approach or the Genre-based approach applied to bilingualism education? This raises the question as to how far the knowledge structures and the genres vary across languages and cultures.

Further research should be designed to explore these issues. Science is often considered to be the cornerstone of research and development and important to a country's technological advancement. We need to assure that our students receive the best instruction possible and continue to pursue their interests in Science.

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APPENDIX A

THE UNIVERSITY OF BRITISH COLUMBIA

Department of Language Education
2125 Main Mall
Vancouver, B.C. Canada V6T 1Z4
Tel: (604) 822-5788
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Edwin Liew
118 East 62nd Ave.
Vancouver, B.C.
V5X 2E6

October 4, 1993

Mr. J. I. Rantanen
District School Superintendent
School District #38 Richmond
7811 Granville Ave.
Richmond, B.C.

Dear Mr. Rantanen:

I am a teacher who is currently teaching Biology 11 and ESL at Richmond Senior Secondary School. I am also a graduate (M.A.) student completing my second year of research studies with the Language Education Department at the University of British Columbia. Presently, I am conducting a study on comparing "Two Approaches to Writing Laboratory Reports in Senior Science: The Integration of Language and Content Approach and the Genre-Based Approach." The focus of this study will be on the implementation of these two instructional approaches to writing in science and determine their effectiveness on student writing of scientific laboratory reports. I believe this research will have significant implications for the instruction of ESL learners in the secondary school setting.

The Integration of Language and Content (ILC) approach and the Genre-based approach can be implemented in both the language and content-area classroom for instruction of the four language skills of English, particularly in reading and writing. The two instructional approaches utilize standard teaching strategies (i.e. lecture, group work, etc.) and emphasize the purpose, use and function of language in the academic context. Hence, the approaches are applicable to teaching writing in a senior science class such as Biology 11.

In order to acquire a frame of reference for assessing the student participants' reading and writing ability, a pretest in reading and writing will be administered prior to the study. The Gates McGinite Reading Comprehension Test will be used as a pretest for the participants in the Biology 11 classes. A writing pretest will be developed for this research.

I would like ask for your permission to conduct the above research and to administer the Gates-McGinitie Reading Comprehension Test to the Biology 11 student participants as the first step of the study. All data collected will be kept confidential with documentation and reporting strictly for the purpose of this research study. I anticipate the study will take approximately two months to complete. I will submit a report of the findings of the study to you after the study has been completed and the data have been analyzed.

If you should have any questions or concerns regarding the details of this study, please feel free to contact me at Richmond Senior at 668-6400 (or at home at 322-7663) or my faculty advisor, Dr. Lee Gunderson, at the UBC Department of Language Education at 822-6287. I would like to thank you for your consideration, and I look forward to hearing from you.

Sincerely yours,

Edwin Liew

APPENDIX B

E C O L E   S E C O N D A I R E

R I C H M O N D

S E N I O R   S E C O N D A R Y   S C H O O L

7171 MINORU BLVD. RICHMOND, B.C., V6Y 1Z3 PHONE (604)668-6400 FAX 668-6405

Principal	Vice Principal	Vice Principal
Robert T. Carkner	Dieter R. Momeyer	Robert D. Scarr

January 4, 1994

Students and Parents
Biology 11 Classes
Richmond Senior Secondary School

Dear Students and Parents/Guardians:

I am a teacher who is currently teaching Biology 11 and ESL at Richmond Senior Secondary School. I am also a graduate (Master's of Arts) student completing my second year of research studies with the Language Education Department at the University of British Columbia. I would like to inform you that I am presently conducting a study on comparing "Two Approaches to Writing Laboratory Reports in Senior Science: The Integration of Language and Content Approach and the Genre-Based Approach." The focus of this study will be on the implementation of these two instructional approaches to writing in science and determine their effectiveness on student writing of scientific laboratory reports. I believe this research will have significant implications for the instruction of ESL learners and mainstream Science students in the secondary school setting.

The Integration of Language and Content (ILC) approach and the Genre-based approach can be implemented in both the language and content-area classroom for instruction of the four language skills of English, particularly in reading and writing. The two instructional approaches utilize standard teaching strategies (i.e. lecture, group work, etc.) and emphasize the purpose, use and function of language in the academic context. Hence, the approaches are applicable to teaching writing in a senior science class such as Biology 11. These two approaches are by no means pedagogically extraordinary or adversely different from other standard methodologies used by teachers at the secondary level.

In order to acquire a frame of reference for assessing the student participants' reading and writing ability, a pretest in reading and writing will be administered prior to the study. The Gates McGinite Reading Comprehension Test will be used as a pretest for the participants in the Biology 11 classes. A writing pretest will be developed for this research.

The Richmond School District and the administrative staff at Richmond Senior Secondary School have given me the permission to conduct the study. I would also like to ask for your (student and parents) permission to take part in the above study and be included in the research data collection. Your participation would be, of course, voluntary. *Please note that there is no jeopardy to the student's status in the Biology 11 course if he/she should refuse to participate.*

All data collected will be kept confidential with documentation and reporting strictly for the purpose of this research study. I anticipate the study will take approximately two months to complete. All student participants will be informed of the result of the study once it has been completed and the data have been analyzed.

If you would like to be part of the above study and its data collection, please indicate with your signatures in the spaces below.

> My daughter / son I would like to participate in the above study:
>
> STUDENT SIGNATURE:____________________________________
>
> PARENT/GUARDIAN SIGNATURE:____________________________
>
> DATE:____

If you choose **NOT** to be included in the study and its data collection, please indicate below with your signatures.

> My daughter / son and I would **NOT** like to take part in the above study:
>
> STUDENT SIGNATURE: ____________________________________
>
> PARENT/GUARDIAN SIGNATURE: ____________________________
>
> DATE: ____

If you should have any questions or concerns regarding the details of this study, please feel free to contact me at Richmond Senior at 668-6400 or my faculty advisor, Dr. Lee Gunderson, at the UBC Department of Language Education at 822-6287. I hope you will be able to contribute to this research, and I would like to thank you in advance for your co-operation.

Sincerely yours,

Edwin Liew

APPENDIX C

ILC & GENRE STUDY
Pretest 2

PRETEST 2:
WHAT IS A SCIENTIFIC LABORATORY REPORT?

NOTE: The purpose of this pretest is to identify the student participants' knowledge of scientific laboratory reporting and their writing ability. The results of this test will NOT be included in the Biology 11 course grade standing.

PART A: ANSWER THE FOLLOWING QUESTIONS AS BEST AS YOU CAN

NAME:____

BLOCK: ____________ DATE:____________ GRADE: ____

1. Which of the following science course(s) have you taken before Biology 11 and what **letter grade standing** did you obtain in the courses?
   Place an "X" beside the course(s).

   ☐ Science 10................................Letter Grade: ____

   ☐ Science and Technology 11............Letter Grade: ____

   ☐ Physics 11................................Letter Grade: ____

   ☐ Chemistry 11.............................Letter Grade: ____

   ☐ Earth Science 11..........................Letter Grade: ____

   ☐ Others: ____________________ Letter Grade: ____

2. Which of the following science course(s) are you taking NOW? Place an "X" beside the course(s).

   ☐ Physics 11 ☐ Physics 12

   ☐ Chemistry 11 ☐ Chemistry 12

   ☐ Earth Science 11 ☐ Others: ____________________

PART B: WRITE A BRIEF, CONCISE 100-WORD COMPOSITION ON THE FOLLOWING TOPIC.

TOPIC: What is a scientific laboratory report? Discuss why scientists write lab reports. Consider and include the different components or sections of a typical lab report. Give details and examples. *Please use the space below.*

COMPOSITION:

3 of 3

APPENDIX D

Student's Name: ______________________ Test Date: ____________

Components	Range	Description
Communicability & Organization	20-18	**Excellent to Very Good:** fluent expression • ideas clearly stated/supported • succinct • well-organized • points logically developed • cohesive
	17-14	**Good:** somewhat choppy • loosely organized but main ideas stand out • limited support • weak logic
	13-10	**Fair to Poor:** non-fluent • ideas confused or disconnected • locks logical sequencing and development
	9-7	**Very Poor:** does not communicate • no organization • (OR) not enough written to evaluate
Content	30-27	**Excellent to Very Good:** substantive • thorough development of thesis • relevant to assigned topic
	26-22	**Good:** adequate range • limited development of thesis • mostly relevant to topic, but general
	21-17	**Fair to Poor:** little substance • inadequate development of topic
	16-13	**Very Poor:** non-substantive • irrelevant • (OR) not enough to evaluate
Vocabulary	20-18	**Excellent to Very Good:** sophisticated range • effective word/idiom choice and usage • shows word form mastery • appropriate register
	17-14	**Good:** adequate range • occasional errors of word/idiom form, choice, usage, but meaning not obscured
	13-10	**Fair to Poor:** limited range • frequent errors of word/idiom form, choice, usage • meaning confused or obscured
	9-7	**Very Poor:** essentially translation • little knowledge of English vocabulary, idioms, word form • (OR) not enough to evaluate
Language Use	25-22	**Excellent to Very Good:** effective complex constructions • few errors of subject-verb agreement, tense, number, word order/function, articles, pronouns, prepositions
	21-18	**Good:** minor problems in complex constructions • several errors of subject-verb agreement, tense, number, word order/function, articles, pronouns, prepositions, but meaning seldom obscured
	17-11	**Fair to Poor:** major problems in simple/complex constructions • frequent fragments, run-ons, deletions and errors of subject-verb agreement, tense, number, word order/function, articles, pronouns, prepositions
	10-5	**Very Poor:** virtually no mastery of sentence construction rules • dominated by fragments, run-ons, deletions and errors of subject-verb agreement, tense, number, word order/function, articles, pronouns, prepositions • (OR) not enough to evaluate
Mechanics	5	**Excellent to Very Good:** demonstrates mastery of conventions • few errors of spelling, punctuation, capitalization, paragraphing
	4	**Good:** occasional errors of spelling, punctuation, capitalization, paragraphing
	3	**Fair to Poor:** frequent errors of spelling, punctuation, capitalization, paragraphing
	2	**Very Poor:** no mastery of contentions • dominated by errors of spelling, punctuation, capitalization, paragraphing • (OR) not enough to evaluate

Total Score Reader Comments

APPENDIX E

EVALUATION OF FORMAL SCIENTIFIC LABORATORY REPORT

TO: MEMBERS OF SCIENCE DEPARTMENT

FROM: ED LIEW

RETURN TO ED BY 3:00PM, TUESDAY, SEPT. 14, 1993.

RE: A SURVEY OF EVALUATION CRITERIA FOR LAB REPORTS ACROSS THE SCIENCES.

Dear Colleagues:

I am conducting a survey of the evaluation criteria developed by science teachers to assess student achievement on scientific lab reports. This survey is part of a greater research project that compares two instructional approaches (the integration of language and content approach and the genre-based approach to teaching science) for writing scientific reports that place emphasis on both the language usage and the content matter in reporting the lab work. The project focus here will have direct instructional implications for ESL learners in science classrooms.

I would like to invite your participation in this survey by describing how you evaluate your students lab reports in the evaluation grid below. The grid is structured to include the "standard" COMPONENTS of a scientific lab report. You may modify this grid to suit your preference or attach a sample of the lab evaluation criteria you are currently using. I would like to emphasize TWO features of this evaluation grid that are significant to this survey:

1. LANGUAGE: Under this heading, please list or describe any linguistic items or qualities you look for in your evaluation. The language items may include: grammar, spelling, diction, proper tense, simple versus complex sentence structures, style, conciseness, coherence, repetitions, proper use of parts of speech (e.g. "photosynthesis" (noun), "photosynthesize" (verb)), note form versus complete sentences, and others.

2. CONTENT: Under this heading, please list or describe the content items or information you expect your students to include in their scientific reporting. The content knowledge and information may include: specialized vocabulary and terms, accuracy of reporting, clear description of "hypothesis, purpose or objectives", "materials", etc., "procedure" or "discussion" questions answered, graphs, tables, drawings, calculations, error analyses, clear "conclusion", specifics versus generalizations, and others.

LAB REPORT EVALUATION GRID

Please complete the following grid:

LAB COMPONENTS	LANGUAGE	CONTENT	VALUE
TITLE			VALUE
HYPOTHESIS or PURPOSE or OBJECTIVES			VALUE
MATERIALS			VALUE

PROCEDURES			**VALUE**
DATA & OBSERVATIONS			**VALUE**
DISCUSSIONS & ANALSIS			**VALUE**

CONCLUSIONS			VALUE
OTHERS			VALUE

QUESTIONS:

1. a) Do you use an OVERALL MARKING SCHEME? ___ yes / ___ no

   b) What are the COMPONENTS and the VALUE of each section?

COMPONENTS	VALUE
Total mark value	

2. If you any additional comments about LAB REPORT EVALUATIONS, please feel free to use the space below.

I would like to thank you very much for participating in this survey. I hope to publish the results when they become available.

APPENDIX F

EVALUATION GRID			
LAB COMPONENTS	**LANGUAGE**	**CONTENT**	**VALUE**
• TITLE (Given)	• meaningful title and representative of experiment • proper tense, spelling	• specific to lab experiment	0
• HYPOTHESIS or PURPOSE or OBJECTIVE(S) or AIM	*If HYPOTHESIS is used* • "IF - THEN" statement • complete sentence structure	• testable • give "educated guess" or tentative explanation	5
	• proper use of scientific words • use of infinitives: "To investigate..." • clear meaningful relationship among key words • fluent expression • appropriate tense	• coherent ideas • completeness • background info. relate to lab • guide the planning of the experiment or investigation	
• MATERIALS	• point form • no sentence form required • use of numbers and Standard Internatonal (SI) units of measurement	• list of materials used • note changes to materials list • detailed description of materials used. • safety precautions for hazardous materials	2
• PROCEDURES or METHOD	• clear sentence structure • proper tense • use of imperatives, logical and chronological connectors • prepositions for space & time • "Refer to procedures on page .."	• make note of modifications to procedures • detailed description using equipment names and units of measurement correctly • optional: use of visuals	5

• DATA & OBSERVATIONS	• sentence form of description of charts, tables, diagrams • visual organization	• use sentences sparingly • completeness of graphics • all axes & parts properly labelled • "qualitative" and "quantitative obs. described separately • accuracy	5
• DISCUSSIONS & ANALYSIS of RESULTS	• proper sentences • paragraph use • clarity, conciseness • communicability • language use: past tense • mechanics: spelling, punct. • structural vocab: e.g. cause & effect - "because", "result in"	• good interpretation, • critical assessment • relate to theory and background knowledge • comprehensive explanations • calculations • compare findings to "known" or "true" results. • answer all questions • generate questions • Error analysis: - numerical errors - attempt to explain	5
• CONCLUSIONS	• sentence form • past tense • conciseness • clear statement	• reject or accept hypothesis • definite conclusions	3
		TOTAL VALUE:	25

APPENDIX G
ILC & GENRE STUDY
Survey 1

**SURVEY 1:
USING GENRES TO WRITE
A SCIENTIFIC LAB REPORT**

The following survey is designed for the study: "Two Approaches to Writing Laboratory Reports in Senior Science: The Integration of Language and Content Approach and the Genre-Based Approach." The purpose of this survey is to find out the student participants' experiences in working with the three stages (modelling, joint negotiation of text, and independent construction) of the GENRE approach to writing scientific lab reports.

Your participation in this survey is voluntary. *You are under no obligation to take part and there is no jeopardy to your class standing in Biology 11 if you choose not to participate.* If you decide to take this survey, the information you give will be kept confidential. Your input is most appreciated. Please take 5 -10 minutes to complete the following questions. There are 5 sections:

INSTRUCTIONS:

PLEASE USE THE FOLLOWING SCALE TO INDICATE YOUR OPINION OR FEELINGS ABOUT EACH OF THE STATEMENTS THAT DESCRIBES USING THE GENRE APPROACH:

**A = STRONGLY AGREE
B = AGREE
C = DISAGREE
D = STRONGLY DISAGREE**

PLEASE USE THE SCANTRON SHEET PROVIDED TO MARK [▬] YOUR ANSWERS.

SECTION 1: PROCEDURAL RECOUNT GENRE IDENTIFICATION

1. I understand and can explain what the term " genre" means.

2. I knew that there are "written" and "spoken genres".

3. I knew that the "Procedure" genre is used to describe a sequence of activities to do in a lab.

4. I knew that the "Procedural recount" genre is used to record the conduct and results of experimentation or to record a set of observations made in a laboratory exercise.

5. I was able to identify the parts (Aim, Materials, Method, Results, Discussion & Conclusion) of a lab experimental report.

6. I was able to identify the "Procedure" Genre for the "Aim, Materials, and Method" parts of the experimental report.

7. I was able to identify the "Procedural Recount" genre for the "Results" and "Conclusion" sections of a lab experimental report.

A = STRONGLY AGREE	C = DISAGREE
B = AGREE	D = STRONGLY DISAGREE

8. I was able to identify the LANGUAGE features (past tense, sequence words, action words) for the Procedure and Procedural Recount genres in writing scientific lab report.

SECTION 2: MODELLING: SETTING THE CONTEXT

9. Analyzing the sample lab report and its parts help me to understand the procedure and procedural recount genre.

10. The 6 parts of an experimental report that represent the generic structure of the procedure and procedural recount genres were clearly identified on the sample lab report.

11. I could identify the use of **past tense, sequence words, action verbs** in the sample lab report.

12. I could identify the **human participants** (e.g. "we") and the **circumstance of time and space** (e.g. "on the slide" or "for 5 minutes")

SECTION 3: JOINT NEGOTIATION

13. In the joint negotiation exercise, I was able to identify the purpose of my lab activity.

14. I found the joint negotiation exercise useful and beneficial for writing my own lab report

15. I found it helpful when the teacher wrote the AIM, MATERIALS, METHODS, RESULTS, DISCUSSION, and the CONCLUSION sections of the lab with us together.

16. I was able to use the LANGUAGE features (past tense, temporal & sequence words, action words) in the joint negotiation exercise.

17. I found the use of diagrams, tables, charts, etc. was helpful in writing the lab together with the teacher.

SECTION 4: INDEPENDENT CONSTRUCTION

18. In writing my own lab, I found it difficult to set up the 6 sections of the lab.

19. In writing my own lab, I found it easy to write the AIM for my topic.

20. In writing my own lab, I found it easy to write the MATERIAL section in list format.

21. In writing my METHOD section of the lab, I had difficulty knowing what to write.

22. In writing my METHOD section of the lab, I knew how to use key words such as "put", "collect", "label", "place",etc. at the beginning of each of my sentences.

23. In writing my METHOD section of the lab, I knew how to use sequence words such as "first", "then", "next", "finally", etc.

A = STRONGLY AGREE	C = DISAGREE
B = AGREE	D = STRONGLY DISAGREE

24. In writing my METHOD section of the lab, I knew how use phrases such as "in the dish", "for 5 minutes", "in the test tube", etc. to indicate **time** and **space**.

25. In writing my RESULTS section, I used past tense.

26. In writing my DISCUSSION section, I knew how give "theoretical", "sequential", or "causal explanations " for my lab results.

27. In writing my DISCUSSION section, I was able to select the appropriate "explanation" genre format (i.e. "theoretical", "sequential", "causal", etc.) for my lab results.

28. In writing my CONCLUSION, I started with the phrase "In conclusion, we found..."

29. I went over my rough draft with a classmate and did peer editing before writing a good copy.

SECTION 5: USING THE GENRE APPROACH

30. I understood how to write a scientific lab report using the procedure and procedural recount genre approach.

31. I did not understand the concept of genre for writing scientific lab reports.

32. Compared to other formats and approaches to writing lab reports, I prefer using the genre approach.

33. The genre approach helped to write better lab reports.

34. I feel I understand the importance of language features in writing a better lab report.

35. I think learning the language features was difficult.

36. The genre approach to writing lab reports allows me to focus on the language of science so I can better express in writing what I learned from the lab activity.

37. After using the genre approach, I feel my writing of lab reports did NOT change.

IF YOU HAVE ANY ADDITIONAL COMMENTS PLEASE USE THE SPACE BELOW:

END OF SURVEY

THANK YOU FOR TAKING PART IN THIS SURVEY.
Ed Liew (668-6400)

APPENDIX H
ILC & GENRE STUDY
Survey 2

SURVEY 2 :
USING THE KNOWLEDGE FRAMEWORK
TO WRITE A SCIENTIFIC LAB REPORT

The following survey is designed for the study: "Two Approaches to Writing Laboratory Reports in Senior Science: The Integration of Language and Content Approach and the Genre-Based Approach." The purpose of survey 2 is to ask about the student participants' experiences with the knowledge framework for writing scientific lab reports.

Your participation in this survey is voluntary. *You are under no obligation to take part and there is no jeopardy to your class standing in Biology 11 if you choose not to participate.* If you decide to take this survey, the information you give will be kept confidential. Your input is most appreciated. Please take 10-15 minutes to complete the following questions. There are 3 sections:

INSTRUCTIONS:

PLEASE USE THE FOLLOWING SCALE TO INDICATE YOUR OPINION OR FEELINGS ABOUT EACH OF THE STATEMENTS THAT DESCRIBES USING THE GENRE APPROACH:

A = STRONGLY AGREE
B = AGREE
C = DISAGREE
D = STRONGLY DISAGREE

PLEASE USE THE SCANTRON SHEET PROVIDED TO MARK [▬] YOUR ANSWERS.

SECTION 1: THE KNOWLEDGE FRAMEWORK: KNOWLEDGE STRUCTURES.

1. I understand how the Knowledge Framework is used for writing lab reports.

2. I was able to identify the six knowledge structures (i.e. Principles, Sequence, etc.) of the knowledge framework.

3. I understand how to use the knowledge framework to organize the components of the scientific lab report.

4. I was able to identify all the components or sections ("Purpose", "Materials", "Procedures" etc.) of a scientific lab report.

5. I was able to identify the THINKING SKILLS for each of the six knowledge structures.

6. I was able to identify the LANGUAGE features for each of the six knowledge structures.

7. I could identify the difference between STRUCTURAL vocabulary and CONTENT vocabulary for each of the six knowledge structures.

A = STRONGLY AGREE	C = DISAGREE
B = AGREE	D = STRONGLY DISAGREE

SECTION 2: KNOWLEDGE STRUCTURES FOR WRITING LAB REPORTS.

8. I was able to identify the KEY VISUALS (graphics) that are appropriate for each of the six knowledge structures.

9. I was able to identify the appropriate knowledge structures for each component of the lab report (i.e., "Sequence" is can be used for organizing and writing the "Procedures" section.)

10. I was able to identify the THINKING SKILLS for each component or section of the lab report.

11. I was able to identify the LANGUAGE features for each component of the lab report.

12. I could identify the appropriate KEY VISUAL or graphics for each component of the lab report.

SECTION 3: WRITING THE SCIENTIFIC LAB REPORT

13. In writing my lab report, I was able to identify the overall purpose of my lab activity.

14. I found it easy to list all the components ("Hypothesis", "Materials", "Procedures", etc.) of a scientific lab report.

15. I was able to apply the THINKING SKILLS in writing my lab reports.

16. I was able to use STRUCTURAL and CONTENT vocabulary correctly in writing the various sections of my lab.

17. I found the use of diagrams, tables, charts, etc. helpful in writing the lab.

18. In writing my own lab, I found it easy to write the HYPOTHESIS (PURPOSE) for my topic.

19. In writing my own lab, I found it easy to write the MATERIALS section in a list format.

20. In writing my PROCEDURES section of the lab, I had difficulty knowing WHAT and HOW to write it.

21. In writing my PROCEDURES section of the lab, I knew how to use key words such as "put", "collect", "label", "place",etc. at the beginning of each of my sentences.

22. In writing my PROCEDURES section of the lab, I knew how to use sequence words such as "first", "then", "next", "finally", etc.

23. In writing my PROCEDURES section of the lab, I knew how use prepositions in phrases such as "in the dish", "for 5 minutes", "in the test tube", etc. to indicate **time** and **space**.

24. In writing my DATA & OBSERVATIONS section, I found the use of tables, charts, and diagrams very helpful.

A = STRONGLY AGREE	C = DISAGREE
B = AGREE	D = STRONGLY DISAGREE

25. In writing my DISCUSSIONS & ANALYSIS section of my lab, I was able to compare and contrast my findings in the lab with the theoretical background knowledge of the lab topic and activity.

26. In writing my DISCUSSION section, I was able to analyze and explain my findings using **past tense.**

27. In writing my DISCUSSION, I was able to explain cause and effect relationships using STRUCTURAL vocabulary such as "as a result", "because", "therefore", "caused by..." etc.

28. In writing my CONCLUSIONS, I started with the phrase "In conclusion, we found..."

29. In writing my CONCLUSIONS, I would use the phrase, "The hypothesis was rejected (or accepted) because...", when there was a HYPOTHESIS for my lab.

30. I understood how to write a scientific lab report using the KNOWLEDGE FRAMEWORK.

31. I did not understand the concept of the Knowledge Framework and its knowledge structures for writing scientific lab reports.

32. Compared to other formats and approaches to writing lab reports, I prefer using the Knowledge Framework.

33. The Knowledge Framework helped to write better lab reports.

34. I feel I understand the importance of language features in writing a better lab report.

35. I think learning the language features was difficult.

36. The Knowledge Framework approach to writing lab reports allows me to focus on the language of science so I can better express in writing what I learned from the lab activity.

37. After using the Knowledge Framework, I feel my writing of lab reports did NOT change.

38. The Knowledge Framework allows me to focus on the LANGUAGE and the CONTENT features of a scientific lab report.

IF YOU HAVE ANY ADDITIONAL COMMENTS, PLEASE USE THE SPACE BELOW:

END OF SURVEY

THANK YOU FOR TAKING PART IN THIS SURVEY.
Ed Liew (668-6400)

APPENDIX I

GENRE: WRITING LAB REPORTS

GENRE	GENERIC STRUCTURE & TEXT
PROCEDURE	AIM
	MATERIALS
	METHOD
PROCEDURAL RECOUNT	RESULTS
EXPLANATION • SEQUENTIAL • CAUSAL • THEORETICAL • FACTORIAL • CONSEQUENTIAL	DISCUSSION
PROCEDURAL RECOUNT	CONCLUSION

APPENDIX J

CONTROL GROUP

LABORATORY REPORTING IN BIOLOGY

TITLE • The NAME of the laboratory (lab) investigation

***HYPOTHESIS** • The hypothesis is what you think will happen during the investigation. It is often posed as an "If...then" statement.

* **PURPOSE** or **OBJECTIVES**: In some lab investigations, you are asked to examine the anatomy or structures and functions of biological specimens such as plant or animal cell slides or sample dissections.

MATERIALS • A list of all the equipment and other supplies you will need to to complete the investigation.

PROCEDURE
- The procedure is a step-by-step explanation of exactly what you did in the investigation.
- PROCEDURE QUESTIONS: Often, there will be questions in the procedure section that will help you understand what is happening in the investigation.

OBSERVATIONS • Your data is what you have observed. It is often recorded in the form of tables, graphs, and drawings

DISCUSSION
- It **explains** what you have learned.
- Your hypothesis: **Accept** or **Reject** it.
- **Discuss** the THEORY behind the experiment you conducted
- **Talk** about your results and your sources of ERRORS.
- **Complete** all discussion questions in the lab manual

CONCLUSION • **Write** a statement of conclusions.