"THEY CAN BE SUCCESSFUL TOO!": INCLUSIVE PRACTICES OF SECONDARY SCHOOL SCIENCE TEACHERS

by

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ABSTRACT

With the revision of school policy, students with learning disabilities are now generally placed in regular education classrooms. Though inclusion is now the predominant education practice, training of secondary teachers has not necessarily kept up with this movement. Also, since the inclusion of students with disabilities is a relatively new practice there are many regular education teachers currently teaching who have not been trained to teach exceptional students.

Though there are studies in the special education literature of how to teach science to students with learning disabilities, there is little research in the science education literature and no research done in Canada. Using interviews and observations, my research involved exploring the practices of three secondary science teachers rated as exemplary inclusive science teachers by their principal and the head of student services. By identifying the characteristics and best practices of inclusive secondary science teachers, I hoped to gain a better understanding of what teachers might do in a classroom to meet the needs of students with and without learning disabilities. I also hoped to improve my practices as an inclusive secondary science teacher and add to the limited literature in science education about teaching students with learning disabilities.

The findings of the study supported the findings of the science education literature and also the inclusive literature, but has also added practices that have not been discussed in the literature. The added practices are: self- and peer-evaluation forms for all students to encourage co-operative group work, interactive whole-class discussions and demonstrations, and holistic teaching including the teaching of life skills and social skills as well as academic skills. The results of this study have implications for teacher education programs, for teacher inclusive practices, and for further research into the practices and beliefs of inclusive secondary science teachers.

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CHAPTER 1

INTRODUCTION

This thesis concerns teacher practices in successful inclusive secondary science classrooms. In Canada, schooling for exceptional children (those who are gifted as well as those who have disabilities) has existed since 1831 when the first school for exceptional children was opened (Friend, Bursuck, & Hutchinson, 1998). While education for children with learning disabilities has a long history in Canada, it is only recently that these students are receiving their education in an inclusive environment—classes that include students with and without learning disabilities. As a result classroom teachers are facing more students in their classes who have learning disabilities, yet these teachers are not necessarily trained to teach in these inclusive classes.

My exploration of the literature reveals that there is little research in science education about teaching students with learning disabilities. Although more students with learning disabilities are taking science from non-special educators, research does not appear to be keeping up with this trend. Science education continues to be promoted as a necessary component in any young student's future. There appears to be a discrepancy between the need for a science education for all and the available research to enable teachers to effectively teach science to all students.

I have taught secondary science in a variety of inclusive settings both in and out of Canada. And although schools in Canada were better prepared to teach inclusive classes than schools in other countries where I taught, I often found it difficult to use the strategies suggested by the special education teachers in my classes of 30 students. This study is motivated by my frustration as a secondary science teacher teaching inclusive classes. I found it challenging teaching so that all of my students were included in the lesson.

Purpose

The purpose of this research was to address the question of what practices exemplary secondary science teachers used in successful classes that included students with and without learning disabilities and to provide an account of why they believed they performed those practices. I explored practices employed with a small group of teachers rated successful in inclusive classes by the principal and special education co-ordinator in their school. A second purpose that evolved when I discovered the lack of research literature from a science educator's perspective was to compare my results with those already discovered from a special educator's perspective. I predicted that good science teaching would include all students and would therefore be good for students with learning disabilities as well as those without learning disabilities.

Definition of Terms

Within this research I have adopted the same meaning for the term inclusion as did Friend, Bursuck, and Hutchinson (1998): "to describe a professional belief that students with disabilities should be integrated into general education classrooms whether or not they can meet traditional curricular standards and should be full members of those classrooms" (p. 454). Though inclusive classes may have several meanings (for example, to include students from a variety of different cultural backgrounds in one class) for this research, inclusive classes are those that include students with and without learning disabilities.

"Learning disability" is a difficult concept to define. In the 1960s, learning disabilities were thought to be caused by a dysfunction of the brain (Wong, 1996). Today, learning disabilities are more specifically attributed to processing difficulties. According to Rief and Heimburge (1996), the criteria for classifying a student as learning disabled require that the child has at least average intelligence, but shows a significant difference between intelligence and achievement in one or more academic areas (e.g., reading, math, written language). In 1987, the Interagency Committee on Learning Disabilities (ICLD) in the United States added social skills deficits as a characteristic of learning disabilities (Lerner, 2000). In general, we can say that

students with learning disabilities refers to a heterogeneous group with at least average intelligence that experience academic and non-academic problems (Wong, 1996). Because of the difficulty in defining learning disability, I have adopted the discrepant definition described above since according to the principal of education services, this is the definition used by the District School Board where I conducted my study (personal communication, May 21, 1999).

According to The Ontario Ministry of Education and Training (1999) a student with a learning disability may have a large variety of characteristics but must have these three characteristics; a marked discrepancy between achievement and ability, at least average intelligence, and a severe processing deficiency not caused by a visual or hearing impairment. Students with learning disabilities are capable of learning but may learn differently than other students.

Overview of the Thesis

This thesis is divided into five chapters. The first chapter details the purpose of the study and gives a brief introduction. In the second chapter, I review the literature on inclusive secondary science teachers' best practices, on secondary science teachers' best practices, and on secondary inclusive non-science teachers' practices showing the need for research in teaching practices in inclusive secondary science classes. After investigating the best practices of these teachers I argue that successful inclusive secondary science teachers would use the best practices of both exemplary science teachers and exemplary inclusive teachers.

The third chapter describes the specific qualitative methods chosen for this study. I begin by describing the procedure I used to select the three participants for the study. Next, I describe the techniques I employed to collect data. These include interviews, observations, and field notes taken by myself. I then give a description of the research context and of the analysis of the data.

The fourth chapter reports the analysis of the data. This chapter discusses the general pattern of the teaching that I observed and the emic themes based on the observations and interviews of Ellen, Lynn and Gary, the three teachers who participated in the study. Some of the

common themes that emerged are factors involved in deciding what and how they would teach, classroom management, and strategies for inclusive classes. Though the themes are the same, the sub-categories within each theme may vary, for example, the factors important in deciding what and how to teach are not the same for the three teachers. A similar theme from Lynn's and Gary's data, "I'm really feeling burnt out" (Lynn) and "The political situation in the province is pretty discouraging" (Gary) reflect the effect the current political situation had on these two teachers' feelings about teaching.

In the final chapter I discuss the similarities and differences among the three teachers in my study. I then compare my findings to those in the relevant science and inclusion literature. I conclude with the contributions of my research to inclusive science, the conclusions, the limitations, and the implications for future research.

An important similarity among my three participants was that all three teachers supported inclusion and created an environment supportive of all ability levels. They created these supportive environments through modelling of appropriate behaviour, using small co-operative groups, and enforcing classroom management procedures that encourage acceptance of all (for example, not allowing teasing based on student differences). Two important differences among the three participants are; successful classroom management and pedagogical content knowledge. Both Lynn and Gary could control their classes through successful classroom management practices. Ellen, a new teacher, had many difficulties controlling her class. Also, because Lynn and Gary had more experience than Ellen they had built up a larger resource of strategies and knew when and how to apply these strategies.

The findings of this study support the practices reviewed in Chapter 2. They add that when done well, interactive class discussions and demonstrations can be effective strategies in secondary inclusive science classes. In order to be effective though there has to be a supportive environment and all students must participate. Another strategy used by the teachers in my study

was peer and self-evaluations to foster co-operative groups in classes where these groups were at first unproductive.

This study supported findings that teachers need plenty of support to successfully include students with learning disabilities into regular education classes. It also showed that though the current government in Ontario supports inclusion, they have cutback many of the supports necessary for successful inclusion and teachers are really feeling the pressure.

The findings of this study thus have implications for further research, in-service and pre-service teachers, teacher education programs, and government educational funding agencies.

CHAPTER 2

LITERATURE REVIEW

Introduction

The Canadian Charter of Rights and Freedoms includes a section on the equality of rights for every individual. This includes individuals with exceptionalities. In 1982, Canada adopted the Constitution Act, which included this section on Rights and Freedoms. Since this time, the federal government has assumed a greater role in assuring equality in education for all Canadians (Friend, Bursuck, & Hutchinson, 1998). In the 1990s, with the revision of policy to place exceptional learners in the least restrictive environment, schools in Canada have been including more students with special needs in regular classes. Many of these exceptional students have learning disabilities because students with learning disabilities represent more than 50% of exceptional students in Canada (Friend et al., 1998). Although regular education classes are becoming inclusive, comprised of students with and without learning disabilities, teacher education has not kept up with this movement and many subject matter teachers are unprepared to teach these inclusive classes (Wong, 1996). Special education teachers are taught to teach students who learn differently from the average student; subject matter teachers do not necessarily receive this kind of teacher education. Also, many teachers were educated before inclusion became a common policy. By identifying the characteristics and best practices of inclusive secondary science teachers, we can better understand what teachers might do in a classroom to meet the needs of students with and without learning disabilities.

This chapter includes a review of the literature on inclusive secondary science teachers' best practices, on secondary science teachers' best practices, and on secondary inclusive non-science teachers' practices showing the need for research in teaching practices in inclusive secondary science classes. There have been few recent studies of teaching practices in inclusive secondary science classes and none conducted in Canada. There have been studies in secondary science classes (American Association for the Advancement of Science, 1989; Baird & Mitchell,

1986; Baird & Northfield, 1992; British Columbia Assessment of Science, 1991; National Research Council, 1996; Olson & Russell, 1984; Penick, Yager, & Bonnstetter, 1986; Tobin & Fraser, 1987), studies in secondary non-science inclusive classes (McCrory Cole & McLeskey, 1997; Tralli, Colombo, Deshler, & Schumaker, 1996), and a few studies in secondary science inclusive classes (George, 1974; Hacker & Rowe, 1993; Sands, 1979; Sturges, 1973). Due to the limited number of studies about teaching science in inclusive secondary classes, the literature on successful science and successful inclusive non-science teachers at the secondary level has been included. This will allow the researcher to explore potential overlap in inclusive teaching methods in science and other content areas. I argue that successful science teachers of inclusive classes will use best instructional practices of both exemplary science teachers and exemplary inclusive teachers. Successful in this study is defined as teachers who enable all students in their classes to reach their full learning potential. In the following section I discuss the literature on inclusive secondary science teachers.

Inclusive Secondary Science Teachers' Best Practices

In this section I first discuss unsuccessful early attempts at inclusion in secondary science classrooms, and why those early attempts may have failed. I then discuss the factors necessary for successful inclusion and the relevant studies I have found that support those factors. I conclude this section with the findings of four discussion papers and a recent review of the literature.

Early Attempts in Science

Inclusion of students with learning disabilities into secondary science classrooms has had an uneven history. Studies of early attempts at inclusion illuminated problems rather than successes (Hacker & Rowe, 1993; Sands, 1979). Some problems discussed were: (a) pacing so that all students are engaged in a lesson, (b) challenging the "bright" students while not frustrating the rest of the class, (c) finding the time for the teacher to plan resource material, (d) conducting safe experiments since students work at different rates, (e) using fair assessment practices for all, and (f) modifying the curriculum to meet the needs of the students (Hacker &

Rowe, 1993; Sands, 1979).

> King-Sears and Cummings (1996) summarised the aspects of effective inclusion: Before new practices can be implemented, teachers need: (a) awareness of techniques from which to choose, (b) preparation in how to use the new techniques, (c) practice that results in a comfortable level of implementation, and (d) support while they begin to implement the new techniques. (p. 217)

In the Hacker and Rowe, and Sands studies, though classrooms were changed from homogenous to heterogeneous classes, neither the curriculum nor the teaching methods were changed. Teachers knew they should adapt instruction by providing more opportunities for group work, and providing a variety of worksheets. However, they were not provided with any support, training or additional planning time (Hacker & Rowe, 1993; Sands, 1979).

Hacker and Rowe (1993) conducted a 3-year longitudinal study of nine secondary science teachers who worked with 14-year-olds in inclusive science classes. They chose three secondary schools that were changing from streamed to non-streamed classes. Their research began in the final year of streaming. They interviewed and observed the same nine teachers in an inclusive class two years later. Hacker and Rowe concluded from their results that: what teachers say and what they do can be different and, the teachers, although they believed they were using adapted instruction, were actually using the same methods they had used before inclusion and were, in general, teaching to the middle ability students in the class. The failure of this particular de-streamed class could be due to the "lack of congruence between classroom practices and policy" (Hacker & Rowe, 1993, p. 230).

Sands (1979) conducted case studies of 21 science teachers all considered to be successful "mixed ability teachers." Each teacher was observed teaching one or two lessons and they were interviewed. Head teachers were also interviewed and sent a questionnaire to complete. As discussed above teachers encountered several problems in their mixed ability classes. Researchers did find some promising practices but due to lack of administrative support, the lack

of change in curriculum and the lack of time, these practices were often difficult to implement. The promising practices were: (a) group work; (b) individual work through worksheets, though some teachers saw the difficulty for students who experienced problems reading; and, (c) practical work in the laboratory and outside although the nature of the work outside was not specified (Sands, 1979).

Factors Necessary for Successful Inclusion

In a series of studies, Scruggs and Mastropieri identified seven variables associated with successful inclusion of students with disabilities. They are: (a) administrative support; (b) collaboration with special education teachers and staff; (c) supportive classroom environments, where diversity is valued; (d) activity-oriented science programs; (e) effective instruction following the SCREAM variables, Structure, Clarity, Redundancy, Enthusiasm, Appropriate Pace, and Maximum Engagement; (f) peer assistance; (g) and disability-specific teaching skills (Scruggs & Mastropieri, 1994a; Scruggs and Mastropieri, 1994b; Mastropieri, Scruggs, Mantzicopoulos, Sturgeon, Goodwin, & Chung, 1998). Teachers in the Hacker and Rowe (1993) and Sands (1979) studies due to their philosophy and teaching approach may have encountered problems in including students with learning disabilities. If these teachers believed they had to provide the knowledge for students they would likely fail in an inclusive class. Today's curricula stress activity oriented, hands-on learning as opposed to lectures and reading textbooks to gain knowledge and understanding (Ontario Ministry of Education and Training, 1999). Curricula and teachers are moving away from the belief that knowledge is poured into the empty heads of students by the teachers and more attention is being given to teaching learning strategies (Monk & Osborne, 2000). These changes may result in inclusion becoming more successful.

Professional science organisations such as The National Science Teachers Association (NSTA) and The National Science Resource Center (NSRC) emphasised an "activity-driven, inquiry-based thematic approach to science" (Mastropieri & Scruggs, 1994, p. 73). While many schools have stayed with a traditional textbook approach that emphasised lectures and written

assignments many schools have changed to an activity-based approach. Mastropieri and Scruggs (1994), Stohr-Hunt (1996), and Scruggs, Mastropieri, Bakken, and Brigham (1993) conducted studies to compare the effects of activity-based learning to the traditional textbook approach to learning. Scruggs et al. (1993) and Stohr-Hunt (1996) studied the effects of these two curricula types on junior high students' learning of science. The first study was conducted using four junior high special education classrooms. The second used the results of a cognitive test battery designed to test science knowledge and reasoning of a random selection of eighth grade students and a self-administered teacher questionnaire providing information of the frequency of hands-on activities in their classrooms. The results of both of these studies supported that students learn better using a hands-on approach to science. Mastropieri and Scruggs (1994) examined the relation of curriculum design to characteristics of learning disabled students, for example, language and literacy abilities or psychosocial characteristics, across four elementary schools. The two types of curricula were a content or textbook approach and an activity-oriented approach to learning science. The results of this study suggested that activity-oriented curricula, especially for students who may have reading and information processing difficulties, would be more effective than a textbook approach. However, teachers should be cautious. Though activity-oriented lessons are hands-on, they must also be minds-on to be effective (British Columbia Science Assessments–Technical Report IV, 1991).

The Discussion Papers

A discussion paper by Salend (1998) agreed that students with learning disabilities could learn and better understand the content and the processes of science through active inquiry. Students are more motivated to understand science and participate fully in activities if the activity is related to their own lives. Salend suggested that field trips are one way to make learning more authentic for students. Co-operative groups are very useful in inclusive classrooms, especially those using an activity-based approach. "Cooperatively structured learning lets students formulate and pose questions, share ideas, clarify thoughts, experiment, brainstorm, and present solutions

with their classmates. Students can see multiple perspectives and solutions to scientific problems" (Salend, 1998, p. 70). Salend also encouraged the use of technology whenever possible to give exceptional students more control over their learning.

Salend (1998) discussed a learning cycle that included an engagement phase where teachers use questions or activities to motivate students and to assess prior knowledge. The next phase is the exploration phase where students can try out different hypotheses. During the development stage, which follows, students gather more information and form conclusions. During the final phase, extension, students then apply their learning to new situations. Teachers help students by providing the questions, activities, and resources if necessary. Teachers also aid in application of knowledge and hypothesising. By providing hand-on experience within the first phase of the learning cycle, students have something concrete to build their experiences and knowledge upon. Students can actively explore possibilities and increase their understanding of scientific content and processes without the interference of poor reading or writing skills, characteristics of many students with learning disabilities. This activity-based approach ensures that students' minds are engaged while performing the hands-on activities.

In addition to being activity-oriented, Ontario's new science curricula implemented in September 1999 recognised that some adaptations may be necessary to ensure inclusion of all students in the classroom. Some adaptations discussed in the Grade 9 and 10 science curriculum documents were: focused and specialised directions, additional practice in the use of equipment, the use of large-print activity sheets, the highlighting of key points on print materials, and the use of alternative texts at a suitable reading level. In addition, assessment strategies should allow all students with and without learning disabilities to demonstrate their understanding of scientific concepts in a variety of ways, such as by performing experiments, creating displays and models, and tape-recording observations. Also, the use of computers is encouraged to provide opportunities for extra scientific practice and for the recording of results (Ontario Ministry of Education and Training, 1999).

Though the research I have discussed has encouraged activity-oriented science, many science teachers, because of time constraints and class sizes, still rely on a textbook-based approach to teaching (Munk, Bruckert, Call, Stoehrmann, & Radandt 1998). Munk et al. suggested several strategies to help students with learning disabilities use their science textbook. The first of these strategies is to prioritise the material. A teacher can help by providing a photocopy of the textbook with the important areas already highlighted so students do not have to try to sift through the important material. The second strategy suggested in this article is to pre-teach the vocabulary that students will encounter in a reading; this can greatly facilitate reading and comprehension of the material. This can be done by the teacher or in pairs or small groups. The third strategy is for the students to paraphrase a passage; this can be done orally or in writing depending on the students. It is stated that the teacher will first have to teach students the art of paraphrasing or summarising before asking students to complete this task on their own. The fourth strategy is to provide study guides, graphics and organisers, this helps students focus on relevant material when reading and provides a big picture for students to see where everything fits. The final strategy for improving textbook comprehension is to supplement the text with audiocassettes; these tapes may include cues or questions to increase comprehension.

Along with providing strategies to increase text comprehension, Munk et al. (1998) also discussed strategies to improve student performance during science instruction. The strategies discussed are: mnemonics; guided notes provided by the teacher with spaces provided for students' responses; response cards, students write and hold up their responses to a teacher's or a peer's questions which allows teachers to quickly assess student comprehension of a particular area of content; and co-operative learning groups, that when structured, are beneficial to all students in inclusive classes.

The fourth discussion paper (Williams & Hounshell, 1998) considered the challenges of today's diverse classrooms in terms of gender, race, ethnicity and academic ability levels. Strategies were discussed to help secondary science teachers effectively teach the diverse students

in their classrooms, specifically those diagnosed with learning disabilities. The authors gave a brief glimpse into the daily lives and struggles of students with a learning disability and the frustrations that are encountered in almost every area of their lives, including school. Activities that many students do not even think about can be a huge challenge to students who have a learning disability, for example, note-taking, verbally answering questions, presentations, and even listening. Williams and Hounshell recommend strategies already outlined in this chapter for secondary science teachers to make science more comprehensible to students with learning disabilities and make life less frustrating for students and teachers. They add that teachers should: (a) structure class time so that enjoyable activities are placed between difficult tasks; (b) arrange the classroom furniture to reflect teaching and learning styles, also be aware of other physical features, such as, temperature, student proximity, teacher location; (c) plan assignments that focus on a primary task, and as students master one task then increase to two tasks, etc.; (d) build students' self esteem by asking them to care for the class plants or animals; and (e) remember that all students are individuals with unique goals and needs.

A Recent Review

Scruggs, Mastropieri, and Boon (1998) reviewed the literature in science education since 1992, the year their last review was published. This review included 36 empirical investigations including students with learning disabilities, mild mental retardation, and emotional disturbances with behavioural disorders. The authors divided the findings into three categories; learning characteristics, interventions, and inclusion (which they define as the inclusion of students with disabilities in the general education science classroom). Within the learning characteristics section, literature was reviewed that examined the interaction between the learners' characteristics and the curriculum and how the curriculum is taught. They concluded that hands-on, activity oriented methods and materials better-suited students with language and literacy difficulties, because less emphasis is placed on reading and writing. Traditionally science

textbooks are not well suited to students with learning disabilities and the teachers' manuals do not contain useful recommendations (Parmer & Cawley, 1993).

Textbook structure, strategies of how to use a textbook, technology, and mnemonics were included in the interventions section. Though these strategies did improve content knowledge, they generally correspond with a transmission model of teaching. Inquiry teaching and activity-based instruction was also examined and though activity-based instruction outperformed textbook-based instruction, poor results were found for students with learning disabilities using an inquiry approach (Mastropieri, Scruggs, & Butcher, 1997). However, if independent thinking is praised, tasks are carefully structured, and a supportive environment is maintained, it can be beneficial. In addition, inquiry approaches are more effective when prior understanding is carefully considered since there can be a very wide range of the understanding of concepts that students already hold especially in inclusive classes.

In the inclusion section of their review, Scruggs, Mastropieri, and Boon (1998) reviewed literature on teachers' attitudes, teacher education, effective teaching skills, and co-operative learning. They concluded that for inclusion to be successful teachers must: (a) have a positive attitude, and (b) exhibit effective teaching skills such as, organisation, clarity, effective classroom management, and enthusiasm. The authors also concluded that fewer than 25% of teachers felt adequately prepared to teach students with disabilities, and that co-operative learning was more effective for some students with disabilities than others, depending on the disability.

There appeared to be many empirical investigations on inclusive secondary science. However, when I examined the studies cited by Scruggs, Mastropieri, and Boon (1998), 18 of the 36 studies investigated activity-based versus textbook-based curricula and teaching methods. Of the remaining 18 studies there were: one on the psycho-social development of students with disabilities, five on students with "mental retardation," one on technology, four on mnemonics, two on inquiry-based instruction, two on teacher attitude, one on teacher education, one on effective teacher skills, and one on discovery learning. From this review of the inclusive science

literature it would appear that successful inclusive science programs would include activity-based instruction and curricula, disability-specific instruction such as mnemonics, effective teaching skills such as highly organised, co-operative learning, and a teacher who had a positive attitude toward inclusion. From my own research, I would agree with Scruggs, Mastropieri, and Boon, but would add to their list. I would argue that content and pedagogical knowledge, "hands-on, minds-on" activities, not just activities, and an accepting, safe environment, are also necessary for inclusive secondary science. I discuss these factors in the remaining sections of this chapter.

Summary of Inclusive Secondary Science Teachers' Best Practices

In summary, early attempts at inclusion in secondary science may have failed because teachers were not properly educated to include students with learning disabilities and did not receive the required support to implement a successful program. Today with inclusion being so prevalent, curricula and teachers have changed to better meet individual needs. The new Ontario science curriculum is designed to be activity-oriented which has been shown to be a more effective approach for students with learning disabilities than the traditional textbook approach. The two streams in the Ontario curriculum, Academic and Applied, are also designed to be relevant to students' destinations. This should increase student motivation and interest, which should help in inclusive classes.

The inclusive secondary science literature emphasises the benefits of activity-oriented versus textbook-oriented classrooms. In general, secondary science has been textbook oriented which could present many problems to students who have learning disabilities. Also, secondary science has been very fact oriented which again could present problems to students with learning disabilities. In order for secondary science to be inclusive it has to become activity and process oriented. Becoming only activity oriented is not the answer and this is how many secondary science teachers have tried to cope with the difficulties of inclusion. Unstructured activities can be just as difficult to a student with a learning disability as reading a textbook. The activities must be clear, and well-structured, and they must engage the students so that they think, process, and

apply the information. According to the literature cited in this section inclusive secondary science classrooms would consist of an environment that welcomes diversity and hands-on, minds-on activities. In addition, there would be a teacher who understands exceptionalities so that effective instructional and assessment adaptations could be made when necessary. I next review the literature on secondary science teachers' best practices to show that these practices are inclusive.

Secondary Science Teachers' Best Practices

I had originally begun this research looking only for studies in exemplary science teaching. However, while searching the literature I discovered that I should also be looking for studies about good science teaching practices and best science teaching practices. Because of recent questions about the effectiveness of science teaching in North America and Australia, there have been several studies conducted testing the effectiveness of science programs and from this research a picture of good science teaching has emerged. In this section I discuss five major projects and a critical book and I summarise the findings. The first two projects are of exemplary science teaching. The first project was conducted in the United States by the National Science Teachers' Association (NSTA) called the "Search for Excellence in Science Education," the second was conducted in Australia and was called "Exemplary Practice in Science and Mathematics Education" (EPSME). The third project discussed is the Project for Enhancing Effective Learning (PEEL) also conducted in Australia. The fourth and fifth projects evaluated science programs in the United States and Canada. These projects are Project 2061 and the British Columbia assessments. I conclude this section with a discussion of a book compiled by Monk and Osborne of King's College London.

The NSTA Project

There have been two main studies on exemplary secondary science teachers—one in the United States of America and the other in Australia. The American study, conducted by the NSTA called "Search for Excellence in Science Education" investigated excellence in science programs. While examining science programs, researchers also discovered characteristics of

exemplary teachers (Penick, Yager, & Bonnstetter, 1986). In 1976 results from several National Science Foundation (NSF) funded studies revealed the poor state of science education across America. These studies demonstrated a discrepancy between the practices then considered exemplary and the practices that should be considered exemplary in science education (Penick & Bonnstetter, 1983). In "Search for Excellence in Science Education" researchers identified 50 exemplary science programs throughout the country through nominations of leading science educators in each state (e.g., state science consultants). A total of 25 researchers, divided into five subject-based groups (elementary science, biology, physical science, science as inquiry, and science/technology/society) were involved with synthesising the information from the 50 programs selected (Yager, 1983). Their tasks were to describe an ideal science program, to identify the actual state of science programs, and to develop recommended actions to achieve the ideal state. Though the researchers were investigating science programs, exemplary science teachers were also identified. Despite the great variety in these exemplary teachers, Penick, Yager, and Bonnstetter (1986) saw some similarities as well.

The authors developed a profile of the teachers from questionnaires completed by 250 teachers in the 50 exemplary programs. The common characteristics for exemplary teachers included: (a) they were experienced teachers who had taught at the same school for several years; (b) they possessed more educational qualifications than teachers in general (e.g., 76% of exemplary teachers had a master's degree or higher compared to 54% for science teachers in general); (c) they were very enthusiastic about science (e.g., attend professional in-services and use professional journals in their teaching); (d) they used a process-approach to science and lectured less; (e) they were confident in their teaching abilities; (f) they put considerable time and effort into their preparation; and (g) they had high expectations for themselves and their students. Along with common teacher characteristics, Penick et al. (1986) also concluded that these teachers had similar classroom goals for their students. They wanted students (a) to see that science relates to many types of careers and to their everyday lives, (b) to be able to apply their

scientific knowledge to solve societal issues as well as scientific ones, not only in theory, but in practice as well, and (c) to be science literate.

Exemplary teachers in the United States study had very high expectations for themselves and their students, and they would go out of their way to ensure these expectations were met. They understood the needs of their students and would develop or design their own programs and curricula to meet the needs of all their students, not just the few who were able to learn from the traditional textbook approach. They would often take extra courses to prepare themselves for curriculum and program design. By providing students with a safe stimulating learning environment where they could question and seek answers without feeling threatened, these exemplary teachers would expect students to make decisions and act upon them.

The strategies these teachers used to attain these expectations and goals were: (a) hands-on learning, (b) application of the knowledge students had learned, (c) flexibility, (d) using questions for motivation and not only for assessment, (e) creating an environment where students wanted to do the work, and (f) modelling of the behaviour of active scientists, by questioning and finding solutions. Within the NSTA "Search for Excellence in Science Education" report, there was a great variety in the exemplary programs, from type of program to type of school, but they all had exemplary teachers.

The EPSME Project

The second major study of exemplary teachers was conducted in Australia, "Exemplary Practice in Science and Mathematics Education" (EPSME) by Tobin and Fraser (1987a). The nationwide search in the United States of America for excellent science education programs prompted the EPSME project. As in the USA study, the researchers in Australia also believed that a study of exemplary teachers would provide information to benefit teachers and teacher education (Tobin & Garnett, 1988). This project qualitatively and quantitatively studied 20 exemplary mathematics and science teachers from Grades 1 to 12. The teachers who participated in the study were selected by an oral nomination process. Key educators were asked to nominate

an "above average" teacher (Tobin & Fraser, 1987, p. 1). Those teachers who had been nominated most often were selected for the study. Thirteen researchers were divided into 11 teams to observe at least 8 lessons of particular teachers. Data were collected through the use of direct observations of the teacher, interviews with the teacher and their students, questionnaires, and examination of curriculum materials and student work.

Since this was a large study involving 13 researchers and 20 exemplary teachers, there were many components of this study. The components of the EPSME study were reported separately by the researchers (Deacon, 1987; Garnett, 1987; Garnett & Tobin, 1988; Tobin, 1987; Tobin & Fraser, 1989; Tobin & Fraser, 1990; Tobin & Garnett, 1988; Tobin, Treagust, & Fraser, 1988; Treagust, 1987; Treagust, 1991). All of the researchers reported similar results; the exemplary teachers: (a) used management strategies that maximised student engagement, (b) encouraged students to participate at their different levels of abilities, (c) maintained a favourable learning environment, (d) set work that had a high cognitive demand, and (e) used strategies to increase students' understanding of math and science.

The PEEL Project

About the same time that these two studies of exemplary teachers were being conducted another study in Melbourne began on how teachers can increase and improve students' learning. The PEEL (Project for Enhancing Effective Learning) project began in 1985 and involved ten teachers, five classes, plus consultants and observers (White, 1986). The goal was to involve the students more in their learning by increasing their own knowledge of their learning (metacognition). The following three factors made PEEL possible: (a) the purposes of secondary education changed from tertiary preparation to teaching all students to learn, (b) the discovery that many successful students did not understand many concepts taught in secondary school, and (c) the idea that ability is learned and not innate.

Baird (1986) discussed two studies conducted by Baird and White in 1982 that reported that students were not learning effectively and did not know that they had poor learning habits.

Students did not know about their own learning and therefore could not monitor or control it. The authors concluded that to improve the standards of learning, teachers had to use procedures that would enhance students' metacognition so that the students could assume responsibility for monitoring and controlling their own learning (Baird, 1986). A third study conducted by Baird and a high school biology teacher, Ian Mitchell, sought to use procedures to enhance students' metacognition. This study was action research where the participants were also the researchers. The results of this study indicated that students could be taught to be aware of their learning and could therefore be taught to improve their learning. However, though this was possible it would take a great effort by teachers and students. Training would have to occur by a number of teachers and over an extended period of time, maybe years. "The process would involve considerable personal change and development for both students and teachers" (Baird, 1986, p. 16). The goals of the project were:

> to foster effective, independent learning through training for enhanced metacognition; to change teacher attitudes and behaviours to ones which promote such learning; to investigate processes of teacher and student change as participants engage in action-research; and, to identify factors which influence successful implementation of a program which aims to improve the quality of students' learning. (Baird, 1986, p. 17)

Four classes participated in the study, one Grade 7, two Grade 9's and one Grade 10 class. These classes were chosen because of the number of PEEL teachers they had. The PEEL group would meet once a week to provide support and encouragement for each other but otherwise no strategies were suggested. Each teacher was to meet the goals of the project in the ways that best suited them.

In order for students to become more effective at monitoring their own learning, teachers had to change the way they taught. They had to teach so that students would take a greater responsibility for their learning. Teachers had to use a variety of techniques to encourage as many

students as possible to participate (Mitchell, 1992a). Ways to generate students' participation and engagement in tasks included co-operative learning, small group work, effective classroom management and time management, use of higher order thinking skills (e.g., as in Predict, Observe, and Explain, POE, activities) and student journals. Teachers and the curriculum needed to be flexible. If teachers are concerned about covering the curriculum they will be less likely to teach for understanding (Mitchell, 1992b).

These studies discussed in this section also recommended a "less is more" curriculum. Researchers suggest that the number of topics taught should be decreased but that the depth of those topics should increase (Mitchell, 1992b). However, changing the curriculum is not controlled by teachers. The findings from the PEEL project suggest that many things should be changed for "quality learning" to take place, these include: changes in the content, (e.g., courses would contain less content so that they could be taught in more depth to ensure student understanding); changes in the learning environment, (e.g., one of collaboration between students and teachers); and changes in assessment practices, (e.g., process as well as product should be assessed). Though teachers can contribute to making their practices exemplary, to truly make the teaching/learning process more successful change has to happen at many levels.

Project 2061

The fourth project was designed to evaluate and improve science programs in the United States, Project 2061, and consisted of three phases. The first phase, "science for all Americans," was focused on the attainment of scientific literacy (American Association for the Advancement of Science (AAAS), 1989). The second phase, benchmarks for scientific literacy and national science education standards, involved teams made up of 25 teachers and administrators representing all grade levels and focused on the development of a set of benchmarks or thresholds that students would have to achieve at particular grade levels. (AAAS, 1993; National Research Council, 1996). The third phase will consist of a long-term collaborative effort implementing the resources developed in Phase I and II (AAAS, 1989).

During Phase I of Project 2061, the National Council on Science and Technology Education developed recommendations of what "understandings and habits of mind are essential for all citizens in a scientifically literate society" (AAAS, 1989, p. 11). The report argued that how students are taught is just as important as what students are taught in the achievement of the goal of a scientifically literate society (AAAS, 1989). Effective teaching should: (a) be consistent with the nature of scientific inquiry, (i.e., start with questions about nature, engage students actively, collect and use evidence, provide historical perspectives, insist on clear expression, use a team approach, not separate knowing from finding out, and de-emphasise memorisation of vocabulary); (b) reflect scientific value, (i.e., encourage curiosity, reward creativity, encourage questioning, avoid dogmatism, promote aesthetic responses); (c) aim to counteract learning anxieties, (i.e., build on successes, provide abundant experience, support the role of girls and minorities in science, emphasise group learning); and (d) extend beyond school, (i.e., involve parents and the community) (AAAS, 1989, pp. 143-151).

Phase II of Project 2061, the Standards, developed by the National Research Council included six science teaching standards that included teacher practices for effective science teaching. The National Research Council (1996) stated:

> Effective teaching is at the heart of science education, which is why the science teaching standards are presented first. Good teachers of science create environments in which they and their students work together as active learners. They have continually expanding theoretical and practical knowledge about science learning, and science teaching. They use assessments of students and of their own teaching to plan and conduct their teaching. They build strong, sustained relationships with students that are grounded in their knowledge of students' similarities and differences. And they are active as members of science-learning communities. (p. 4)

Though it is not specifically stated that the practices are for inclusive classes the Standards does state that teachers must teach so that all students can learn. Because individual students learn in different ways effective teachers must have a broad repertoire of teaching strategies to engage all students at least some of the time (National Research Council, 1996).

Strategy knowledge is not the only thing that makes science teachers successful, they must also know when and how to use the particular strategies. "Skilled teachers of science have special understandings and abilities that integrate their knowledge of science content, curriculum, learning, teaching, and students. Such knowledge allows teachers to tailor learning situations to the needs of individuals and groups" (National Research Council, 1996, p. 62). Effective teachers need to know their students and their levels of abilities in order to predict what students will be able to learn and what they may have difficulty with. In addition, teachers must know their students' backgrounds, interests, motivations, and how they learn best. With this knowledge effective teachers can then choose appropriate content, teaching strategies, assessments, and curriculum materials. Exemplary teachers possess pedagogical content knowledge as well as content knowledge; it is not enough to know an area. Research has shown that the best methods to connect this content with the prior knowledge and abilities of the students or learners must also be known (Shulman, 1986; Shulman, 1987; Shulman & Quinlan, 1996).

According to Project 2061, effective teaching depends on more than content and strategy knowledge. Teachers must also know their students and know how to create an environment that will be conducive to risk-taking and learning.

The BC Assessments

The studies discussed thus far have been conducted in Australia and the United States. With the British Columbia (BC) Assessments the quality of science teaching in a Canadian province can be compared to the science education literature. From these assessments, an idea of what "good" science teaching should ideally look like was presented and how teachers can achieve this. These assessments are implemented approximately every four years and began in

1978. The 1991 assessment team went into 60 schools across British Columbia and looked at Grade 3, 4, 7, and 10. The research team consisted of five faculty members, two research associates, and six graduate students. All research members attended two days of training in the research procedures to be implemented in the study (British Columbia Assessment 1991-Technical Report IV).

This assessment qualitatively and quantitatively collected and examined data from both the teachers and students of chosen classrooms. Quantitatively, students completed a test developed for their particular level while teachers filled out a questionnaire. Qualitatively, observations and interviews were done with all participating teachers and selected students. Researchers were not trying to look at exemplary teachers only, but wanted a picture of the quality of science teaching and learning across British Columbia. One of five objectives of the British Columbia Assessment was to "determine how this context relates to the student outcomes of the general assessment and to a vision of 'good' science teaching based on the literature on teaching and learning " (British Columbia Assessment 1991-Technical Report IV, p. 10).

Results from the teacher questionnaires indicated that teachers used a wide variety of teaching strategies depending on the topics and objectives being taught. A comment that encompassed teachers' perspectives on instructional strategies was made by a Grade 10 teacher: "I feel variety is best and hands-on science is a must" (British Columbia Assessment of Science 1991-Technical Report 1, p. 280). The strategies discussed included hands-on activities, group work, co-operative learning, inquiry teaching, and presentations. Though all teachers in the results from the teacher observations and in-depth interviews report the importance of the use of a variety of strategies not all teachers use this variety of strategies (Bateson, Erickson, Gaskell, & Wideen, 1991). While teachers see the importance of involving students in their own learning and engaging their minds, they often do not have the administrative supports and resources to implement those types of science programs. One Grade 10 teacher commented, "As a result of resources and facilities, 90% of my teaching has to be lectures. I know it's turning off the

students, but I had no choice" (British Columbia Assessment of Science 1991-Technical Report 1, p. 280).

Most teachers in this study reported that they did have students with special needs in their classes. The most common special needs were "cognitive impairments, behavioural difficulties, and gifted" (British Columbia Assessment of Science 1991-Technical Report 1). Though teachers reported that there were challenges in dealing with classes that included students with special needs (such as dividing teacher time and the safety of all students), teachers also reported that all students participated in class activities. High student participation rates were seen to be due to the overall philosophy of teachers that science lessons should be hands-on, minds-on, inquiry based, and built on the previous subject matter knowledge of students (British Columbia Assessment of Science 1991- Technical Report IV).

A Critical Book

In 1996 and 1997 Hargreaves argued that science teacher practices are not based on educational research and that research cannot inform good teacher practice (Hammersley, 1997; Monk & Osborne, 2000). Monk and Osborne (2000) of King's College London compiled a book to counter this argument made by Hargreaves. Their research supports the claims already discussed in that good science teaching consists of cognitive, metacognitive, and motivational strategies that enable students to regulate their own learning. Good teaching strategies are those strategies that can be used by students to help construct their own understanding. Examples of such strategies are: (a) concept mapping; (b) group discussions; (c) activities that get students to think of what they already know about a topic and what they want to learn (i.e., a thinking journal); and (d) think alouds by teachers while problem solving to model problem solving practices. Other strategies these authors found to be successful are: guided self-evaluation, structured lessons, highlighted important aspects of a topic, and linked concepts to the big picture. In order for students to regulate their learning they must be given more responsibility, and high expectations must be maintained for all students especially "disadvantaged ones" (Fairbrother,

2000, p. 15). To increase motivation and encourage learning of all students, teachers should use a variety of strategies. This makes science lessons more interesting and teachers are more likely to use a strategy best liked by more students. To encourage authentic assessment, teachers can ask students how they would assess themselves and their classmates. This makes students think about what they are learning (Fairbrother, 2000). In addition to the strategies already discussed, Black and Harrison (2000) concluded that formative assessment and good instruction are indivisible. By discussing concepts with students or reading notes taken during a discussion, teachers can assess students' learning and effective teaching.

Summary of Secondary Science Teachers' Best Practices

In summary, all of the work discussed in this section shares the view of students as active learners. Effective science teachers accordingly use teaching strategies that encourage students to construct meaning and understanding. The research has shown that effective teachers have adopted a "hands-on, minds-on" philosophy and use strategies that support this philosophy. Some strengths of effective teachers are: (a) an understanding of individual students' needs, interests, and strengths; (b) a constructivist view of knowledge, (Driver, Asoko, Leach, Mortimer, & Scott, 1994); (c) a high level of expectations for self and students; (d) flexibility; (e) an enthusiasm for science; and (f) the belief that learning is a collaborative process. Strategies shown to support this philosophy are: (a) continual formative assessment to provide feedback to students and to guide further instruction; (b) use of multiple resources, including print, videos, and software; (c) use of open ended questions with no correct answer; (d) increased wait time; (e) strategies to encourage self-regulation such as thinking journals and students designing assessment tools; (f) small group co-operative learning where all input is valued; and (g) a balance of the responsibility of learning between students and teachers.

This section reviewed the literature on the best practices of science teachers, the following section reviews the literature on the best practices of inclusive non-science teachers. I argue that successful science teachers of inclusive classes will use the best practices of science

teachers and of inclusive teachers.

Inclusive Non-science Teachers' Best Practices

So far in this chapter, I have discussed the literature of inclusive secondary science teachers and of secondary science teachers. In this section, I review the literature of inclusive secondary non-science teachers to see what strategies this literature suggests are used by exemplary teachers and how this will add to practices already discussed.

Differences Between Elementary and Secondary School

There are many differences between elementary school and secondary school. Since these differences exist, the conclusions from studies conducted in elementary inclusive science classes may not be transferable to secondary inclusive science classes. For this reason I have limited my literature search to inclusive studies conducted in secondary classrooms. The strategy studies conducted in elementary classrooms that are included are, from my experience as an inclusive secondary science teacher, also effective strategies in secondary classrooms. In this section, I review the literature on secondary inclusive practices and successful secondary instructional strategies not necessarily science specific.

Inclusion in secondary schools has a different set of considerations than inclusion in elementary schools. In secondary schools teachers are under significant pressure to cover content. Since classes are more content driven, less emphasis is placed on individual students (McCrory Cole & McLeskey, 1997). There are pressures from outside the class to cover the content, for example, mandatory departmental examinations, and business and post-secondary institutes require certain skills to be attained before students graduate from high school (McCrory Cole & McLeskey). Teacher education for secondary teachers emphasises particular disciplines, and they often cannot or will not make adaptations for special needs students, for example supplying notes to a student with a reading disability (McCrory Cole & McLeskey).

Secondary teachers work with about 130 students a day and teach them for only one period a day (Schumaker & Deshler, 1994). They do not have the same relationship with students

as teachers teaching them all day, and often do not have time to give the extra support that students with learning disabilities require (McCrory Cole & McLeskey, 1997; Tralli et al., 1996). As students with learning disabilities reach secondary school, the gap between skill required and performance grows, making success harder for these students to achieve (McCrory Cole & McLeskey, 1997; Wong, 1996). Along with these academic difficulties, students entering secondary school are at the age of adolescence, a difficult time even for those who do not have learning disabilities (McCrory Cole & McLeskey, 1997). "Because of these realities, unless classroom teachers receive proper training and support, inclusion of students with mild disabilities (e.g., learning disabilities) within secondary classrooms may be accomplished in name only" (Tralli et al., 1996, p. 204).

Successful Inclusion

There is considerable research in successful inclusion of students with learning disabilities in the regular classroom and it has been well reviewed and consolidated in the leading texts. The major ideas from this research are brought together in the following.

Many factors must be taken into consideration when discussing successful inclusion especially with the circumstances in secondary schools as described above. In order for general educators to achieve successful inclusion they must:

1. Gather information related to one or more of the curricular elements that require adaptations.
2. Implement curriculum adaptations on a regular basis for the specified amount of time.
3. Document the effectiveness of the adaptations.
4. Teach flexibly to minimize problems that may result from changes that occur as adaptations are implemented.
5. Explore options for curriculum adaptations with other educators, especially special education personnel.

1. Adapt only specific areas that require modifications and do not attempt to change too much at one time.
2. Use different adaptation techniques to achieve appropriate education for all students.
3. Implement adaptations in a manner that ensures smooth transitions into the use of different teaching and behavior management techniques.
4. Anticipate and account for potential problems that may arise from adaptations prior to implementation.
5. When possible, use adaptations that are most compatible with existing classroom structures and routines. (Hoover & Patton, 1997, p.91)

Friend, Bursuck, and Hutchinson (1998) identified the same general methods discussed above as effective methods for inclusive classes. These authors titled their method INCLUDE —Identify classroom demands, Note students' strengths and needs, Check for area of potential success, Look for potential problem areas, Use information to identify possible adaptations, Decide which adaptations are best for your classes, and Evaluate (Friend et al., 1998, p. 24).

Content Adaptations

It is important for an inclusive teacher to know the strengths and weaknesses of students and be able to make the adaptations necessary for all students to reach their learning potential (Friend et al., 1998; Hoover & Patton, 1997). One type of adaptation identified in successful inclusive secondary classes is content adaptation. This type of adaptation includes strategies to help students' identify, organise, comprehend, and retain content material. Examples of successful content adaptations are: graphic organisers (Fisher, Schumaker, & Deshler, 1995; Horton, Lovitt, & Bergerud, 1990; Hudson, Lignugaris-Kraft, & Miller, 1993; Schumaker & Lenz, 1999), visual displays (Hudson, Lignugaris-Kraft, & Miller, 1993), study guides (Fisher, Schumaker, & Deshler, 1995; Hudson, Lignugaris-Kraft, & Miller, 1993), mnemonics (Scruggs & Mastropieri, 1992), and problem solving prompts (Schumaker & Lenz, 1999). To increase

textbook comprehension students can be taught a textbook analysis strategy (Schumaker & Lenz, 1999) and there are software programs now available to supplement textbook learning (Hoover & Patton, 1997; Schumaker & Lenz, 1999).

Instructional Adaptations

A second type of adaptation found effective in secondary inclusive classes is an instructional adaptation. Effective instructional strategies include: hands-on activities (Rief & Heimburge, 1996), scaffolding (Driver et al., 1994; Schumaker & Lenz, 1999), direct strategy instruction (Rief & Heimburge, 1996), problem solving prompts (Schumaker & Lenz, 1999), peer tutoring (Fisher, Schumaker, & Deshler, 1995; King-Sears & Cummings, 1996), co-operative groups (Fisher, Schumaker, & Deshler, 1995), and clear well-structured lessons or SCREAM (Scruggs & Mastropieri, 1994a; Tralli et al., 1996). This is only a sample of the many effective instructional adaptations available, it is most important for teachers to be flexible and willing to adapt instructional strategies and to use a variety (Rief & Heimburge, 1996).

Depending on the students in a class, content may also need to be adapted. Some students may also need more time to complete assignments or a reduced amount of content (Schumaker & Lenz, 1999). Providing options in assignments also can reduce frustration in students and can increase the quality of work submitted by students with learning disabilities since they can choose an assignment to reflect their strengths (Hoover & Patton, 1997). In addition to adapting the content, teachers need to ensure that the content is fun, accessible, relevant and interesting to students (Fink, 1996; Freeman & Hutchinson, 1994; Rief & Hiemburge, 1996).

Fink (1996) and Freeman and Hutchinson (1994) showed that interest also affects learning, especially for students with learning disabilities. If the student is not interested in the topic, the material will be difficult to learn. Fink studied twelve successful adults with dyslexia, a specific learning disability manifested in reading problems, to see if she could discover what factors attributed to their success. Fink interviewed people who became attorneys, medical specialists, scientists, artists, and businessmen (all professions that require a great deal of

reading). The common thread for these professionals was their strong interest in their chosen field, an interest that drove them to study that field as much as possible. This interest also drove them to study subjects they knew they required to achieve their desired goal. One of the findings of Freeman and Hutchinson (1994) supports Fink's finding of the importance of student interest. While Freeman and Hutchinson were conducting anger management intervention sessions with Eric, an adolescent who had learning disabilities, they found that Eric learned better if he felt the information was interesting and relevant to him. If he valued the information, he was more apt to learn it. The implication of these studies is clear: the subject matter should be made as interesting and relevant to students as possible.

Many students with learning disabilities have difficulty reading and writing and many content assessments are pen and paper tests. In order to include students with learning disabilities, assessments may need to be adapted depending on the characteristics of the students (Friend et al., 1998; Hoover & Patton, 1997). As with instructional strategies, using a variety of assessment tools will ensure fair assessment of all students (Rief & Heimburge, 1996).

Support and Other Factors of Successful Inclusion

In addition to showing the need for teachers to be flexible and adapt lessons as necessary, research has shown successful inclusive teachers need the support of students, parents, and administrators, they need time in their schedules for increased planning demands, and they need to collaborate with other school professionals. In general, the results of McCrory Cole and McLeskey (1997) and Tralli et al. (1996) suggested that students needed to learn basic learning strategies (e.g., how to study for a test), and to be empowered to try their best and create positive relationships within their environments. Teachers needed to teach clear, well-structured lessons (e.g., using a concept map as an advanced organiser for students). To really make a difference, teachers needed to collaborate with one another so that strategies were reinforced and generalised. According to the authors both of these programs were considered successful. All of the students in the classes benefited from the strategies employed by the general education teachers. However,

this success could not have happened without time allotted for planning, collaboration with other general education teachers and the special education teachers, and ongoing support from school administration (McCrory Cole & McLeskey, 1997: Tralli et al., 1996)

Other factors found crucial to successful inclusion are: (a) providing a supportive environment where all students feel welcomed in the class and feel that they are valued contributors (Rief & Heimburge, 1996), (b) maintaining high expectations for all students especially for the learning disabled students (Chiappetta, Koballa, & Collette, 1998), and (c) involving students in the learning process. To create a supportive environment, teachers need to provide strong models of acceptance of diversity. Teachers often lower their expectations of the students in inclusive classrooms and then the students try to reach only those lowered expectations (George, 1974). For successful inclusion, teacher expectation cannot be lowered. Teachers should ask the students what they feel would be helpful for them since students often know how they would like to learn (Chiappetta et al., 1998). This also involves students in their learning process. Research has shown that for the inclusion of students with learning disabilities in the regular classrooms to be successful, teachers must teach using all these inclusive practices (e.g., Freeman & Hutchinson, 1994). Though making adaptations for students with learning disabilities is an inclusive practice if that is the only attempt at inclusion, these students will generally fail. If secondary students with learning disabilities do not feel welcomed and included in the classroom environment they will not attend classes and often drop out of those classes. According to one student with learning disabilities, Eric, a teacher's success with inclusion can be assessed by the number of students who drop out or do not attend that class (Freeman & Hutchinson, 1994).

Summary of Inclusive Non-science Teachers' Best Practices

The discussion in this section suggests that effective inclusive secondary teachers adapt their teaching to suit the needs of their students and make lessons hands-on, fun, and relevant to students. Teachers can do this by involving students in decision making and giving them

increased responsibility for their learning. Creating an environment that supports diversity is very important to successful inclusive classes. The strongest way teachers show acceptance for all students is by being positive role models. When textbooks are used in lessons, teachers can use direct strategies to help students with learning disabilities understand the texts. Strategies such as highlighting important information or graphic organisers can be helpful to all students not only to students with learning disabilities in the class. It is important for teachers to know their students' strengths and weaknesses and have a wide repertoire of strategies at their disposal when teaching in inclusive classes. Research suggests that the more modalities used when teaching the better the chance that all students have been reached. Knowing when to use specific strategies is as important as knowing how to use the strategy. Students with learning disabilities may need specific adaptations of lessons, for example, being given a copy of notes rather than trying to write notes from the board. According to the inclusion literature, inclusive teachers are aware of adaptations necessary and provide them as needed.

Collaboration is necessary in order to be a successful inclusive teacher, especially with the special education teachers. Special education teachers are trained to provide invaluable advice as to how to cope with specific students in classes. As I have discussed, it is very difficult for secondary teachers to know all of their students. The special education teachers can inform teachers of specific characteristics of exceptional students, and specific strategies that would help reduce frustrations for both the teacher and the student. Teachers of students with learning disabilities should also remember that these students have at least average intelligence. They are capable of doing the work; they just need a different modality than the traditional chalk and talk methodology. It is important that teachers do not lower their expectations for students, either with or without disabilities. Often when teachers lower their expectations, students will only work to meet those expectations rather than to strive for what they are capable of achieving.

In this section I discussed the literature of successful inclusion which enhanced the literature already reviewed by adding the importance of: (a) an accepting environment, (b) the

teachers' abilities to make necessary adaptations, (c) teacher collaboration, and (d) administrative support. These factors, in addition to factors discussed in the previous sections are necessary for successful inclusive secondary science.

Conclusion

The inclusive science education literature, science education literature, and special education inclusion literature all noted co-operative learning as an effective strategy for including all students. Though co-operative groups can be very beneficial to students with and without learning disabilities for learning appropriate social skills and improving attitudes towards science, themselves, and their peers (Bianchini, 1997; Johnson & Johnson, 1987; Lazarowitz, Hertz-Lazarowitz, & Baird, 1994; Lazarowitz, Hertz, Baird, & Bowlden, 1988; Stevens & Slavin, 1995), teachers should be cautious in their overuse. In order for co-operative groups to be effective an environment of equality for all should be created and all learners must first be taught how to work co-operatively (Brown & Palincsar, 1989; Cohen, 1994)

A review of the literature on the best practices of effective inclusive secondary science teachers illuminates the small number of studies done in this area. However, there are many recommendations made to teachers based on these few studies. From the research I have done for this review, it is apparent to me that we need more empirical research in techniques for teaching science to inclusive secondary classes. There is considerable empirical research on science teaching in elementary schools, either in mainstreamed or special education classrooms, and in special education science classes at the secondary level, but there does not seem to be much data for content science teachers in secondary classes. I know, from personal experience that many techniques used in special education classrooms are not practical or realistic for teachers in content area classes to use. The techniques are not designed to be used with large numbers or heterogeneous groups.

I also found during my literature search that, maybe it is not just teaching or instructional strategies that we should be looking at but ways of at least modifying the curricula without losing

the important concepts, to include all students. The textbook oriented curricula that secondary teachers now use are not conducive to learning for many students, not just those with special needs. However, teachers may not have the time to adapt curricula to suit all students. Teachers would need to be given time and resources to be able to modify the curriculum but this does not seem like a practical option to me. The strategies that I chose to focus on in this chapter, from the many strategy options available, were practical ones that science teachers could realistically incorporate in their classes. Mnemonics, co-operative groups, graphic organisers and the use of an activity-oriented constructivist approach are already in use in content classes but may need to be used more often and more effectively with the increase of heterogeneous classes.

When all the literature is taken collectively, it would appear that an effective inclusive secondary science teacher would be one who creates a safe, comfortable learning environment conducive to learning. This would include an environment that is well managed but not over managed, where students are encouraged to share their ideas and where they feel safe to do so. There would be structured small co-operative group work where students are encouraged to predict, observe and explain phenomena, where the process would be more important than the answer. Students would be able to manipulate variables to test hypotheses. Teachers would have content and pedagogical knowledge to increase their comfort so that they would allow students to explore problems that do not have pre-set answers. There would be no classroom management problems since teachers and students would have a more collegial relationship where they would work together to ensure material is interesting, relevant and challenging. An inclusive secondary science classroom would be a very busy room where students and teachers were helping each other understand the world in which we live.

In the next chapter, I discuss the methodology I used in my study of exemplary inclusive secondary science teachers' practices.

CHAPTER 3

METHOD

Introduction

This chapter discusses the specific qualitative methods I used to collect and analyse my data. I begin by describing the procedure I used to select the participants for the study. Next, I describe the techniques I employed to collect data from my participants. These include interviews, observations, and field notes taken by myself. I then give a description of the research context and of the analysis of the data.

Qualitative methods allow the researcher to look at the natural environment, at how the teacher and students interact, and at adaptations teachers may make for students. I conducted a naturalistic study to obtain the teachers' perspectives of what practices they use in inclusive classes and why they adopt those practices, not to confirm or deny the perspective of other researchers or myself. According to Firestone (1993) "qualitative research is best for understanding the processes that go on in a situation and the beliefs and perceptions of those in it" (p.22). I believe, as does Patton (1990), that interviewing and observing the participants in their natural environment will reveal their depth of emotion and their perceptions of what is happening and why. By using a naturalistic approach, I can endeavor to make sense of the practices of teachers without imposing my pre-existing expectations on effective teaching practices (Firestone, 1993; Mertens, 1998). From my experiences teaching secondary science, I feel that there is currently a problem in teaching science to inclusive classes and by using qualitative methods to research this problem we can find some "practical" (Patton, 1990, p. 94) solutions.

In naturalistic inquiry, the researcher sets out to understand and document everyday happenings in a situation without trying to change it (Patton, 1990). I did not necessarily want to change a program by suggesting what I or researchers think are effective practices. Rather, I wanted to observe what successful teachers are doing in their classrooms and to discover why they feel their practices are effective. No attempt was made to evaluate the impact of the teaching

strategies on the students.

Since my research aim was to describe the practices and beliefs of teachers from their perspective, a qualitative study best satisfied that aim. According to Firestone (1993), "Qualitative methods are useful for understanding the perspectives of students, teachers, parents, and others; for clarifying the process that takes place in classrooms, during program implementation, and in other areas; and for generating hypotheses for testing through other methods" (p. 16). In order to improve research methods and clarify my thesis question, a pilot study was conducted in the spring of 1999. This study was a qualitative investigation of the practices and beliefs of one teacher, Lynn (a pseudonym), in an inclusive secondary science classroom.

Sampling Procedure

In July 1999 I sent my proposal, an executive summary, and the required forms to the District School Board to gain permission to conduct research in the schools. At that time I also discussed my research with the principal of special services who recommended two schools that contained a diversity of students and had strong inclusion programs. I chose to use a nomination procedure for purposeful sampling as described by Mertens (1998) and Patton (1990) to identify my participants because this sampling technique had supplied rich data for studies that influenced the research design I chose (e.g., Olson, Chalmers, & Hoover, 1997; Penick & Yager, 1983; Scruggs & Mastropieri, 1994; Tobin & Fraser, 1987a). In September, after obtaining permission from the District School Board, and from the Ontario Secondary School Teachers' Federation, I contacted two principals by phone. The principal of one school then referred me to the science head while the principal of the second school I contacted recommended two teachers he thought were exemplary and he referred me to the head of student services and special education.

The head of student services and special education nominated the same two teachers nominated previously by the principal. I then called the teachers and explained my research over the phone and asked if they would be interested in participating. I had previously met one of the

teachers, Lynn, through the pilot study I had conducted in the spring. Meanwhile, the co-ordinator of the second school I contacted was going to discuss my research with the teachers at his school and notify me of their decision. In November he called to say that there were no teachers at that school interested in participating in my study. I had specifically asked for exemplary biology teachers and he explained that the biology teachers were new and did not feel qualified to participate. I thanked him and then called the co-ordinator of the first school to see if I could get a third teacher to participate. I mentioned the name of a teacher recommended to me by one of the teachers who had agreed to be in my study and the co-ordinator agreed this teacher would be a good participant.

Participant Selection

Three teachers were invited to participate in the study based on the Special Education Coordinator's recommendation, years of experience, education background and courses taught, as suggested by Penick, Yager, and Bonnstetter (1986). I had originally proposed to study three Grade 11 Biology teachers, however when I spoke to the head of student services and special education she did not recommend any Grade 11 Biology teachers. I had asked her to nominate exemplary inclusive secondary science teachers and she recommended two; one who at the time was teaching Grade 9 Science, Grade 10 Science and OAC Chemistry, the second who was teaching Grade 9 Math, Grade 10 Science and Grade 12 Physics. When speaking with one of the teachers she then recommended a third teacher for my study. The co-ordinator agreed this third teacher would be ideal, and said she had not originally recommended her because she had only been teaching for two years which did not fulfil one of my selection criteria. This third teacher was teaching two Grade 9 Sciences and one Grade 9 Geography at the time of the study. The purpose of the study was explained to each teacher and each was reminded that teaching methods would not be evaluated or critiqued. They were asked to sign a consent form (Appendix A) and informed that they could withdraw from the study at any time if they wished. I ensured confidentiality of participants by assigning pseudonyms that are used throughout the study.

Description of Participants

I have assigned pseudonyms to the three participants and to the school where they were teaching at the time of this research. I have called the three participants Ellen, Lynn, and Gary and the school Meadow Secondary school. The school is located in an urban community in Ontario. The school had a student population of about 650 students in Grades 9 through OAC. The school also enrolled adult students and contained a day care centre for young children. The school had a diverse community of students because of these different programs including ESL programs for students whose first language was not English or French. This school had a strong history of including students with exceptionalities into all classrooms therefore the concept of inclusion was not foreign to any of the teacher participants.

Before I discuss the participants, I describe the time in which the data was collected for this research study. The Conservative government of Mike Harris was in power in Ontario and this government had recently made extensive changes to the field of education: New curricula starting in Grade 9 with the phasing out of Grade 13; cutbacks in funding allotted for education resulting in cutbacks in administrative and support personnel such as guidance counsellors and educational assistants (EA's); more teaching time, and more students per class. This study was conducted in the first year that the new Grade 9 curriculum was being implemented across Ontario. The administration, the teachers, and the students were all new to this particular program and therefore, there were many difficulties that normally would not have been encountered; for example, teaching and assessing an activity-based curriculum, and new topic areas within the curriculum. These difficulties must be taken into consideration when analysing the data of the teachers of Grade 9 classes. No matter how much experience these teachers had this curriculum was totally new to all of them, and all were struggling with particular aspects of the program, for example, providing activity-based instruction to the two new destination classes titled "Applied" and "Academic," assessing students as evaluations procedures were in a state of flux, and dealing with the large mixed-ability classes they now encountered.

Ellen

Ellen was in her second year of teaching. Though she did not have much experience, she was enthusiastic about teaching and wanted all of her students to succeed. Ellen's educational background was in marine biology and geography and at the time of my study she was teaching Grade 9 Academic Science, Grade 9 Applied Science and Grade 9 Academic Geography, all new curricula. She believed her classes were inclusive and that she taught inclusively When asked if she considered her classrooms inclusive she replied, "yes" (1E11)[1].

Ellen did not consider herself to be an exemplary teacher and therefore was unsure that she should participate in my study. However, she was eager to learn. She had a student teacher studying with her, and was interested in my observation notes so that she might be able to improve her current teaching practices. Ellen felt she was having difficulty with some of her Grade 9 classes particularly the class I decided to observe, but many teachers were having the same difficulties because of the new curriculum. During our initial meeting I further described my research and Ellen signed the consent form. During that initial interview I decided to observe Ellen teaching her Academic Science class since this class consisted of 31 students and had a student population with various abilities. Though to her knowledge none of these students had been officially identified with a learning disability she was aware of some that had an identified communication disability. I did not ask for specific numbers of identified students nor did I ask who were identified with learning disabilities, for my study specifics were not necessary as long as there were students in the class with and without learning disabilities and this class fit the criteria.

Lynn

Lynn was a very sociable person who had been teaching science and math for seven years. Lynn's background was in physics and math, and at the time of my study she was teaching

[1]Codes are used to identify the participant, the interview, and the line of the interview used. For example, 1E11 means interview 1, Ellen, line 11.

Grade 9 Academic Math, Grade 10 Advanced Science and Grade 12 Advanced Physics. When asked if her classes were inclusive she replied "I have all kinds of different students with different needs" (1L10). I reminded Lynn of the purpose of my research since she had participated in the pilot study and Lynn signed a consent form. During our first interview I decided to observe Lynn teaching her Grade 10 Advanced Science class since this class consisted of 32 students and there were students who were identified as gifted and one who was identified with a learning disability. This class also included several ESL students. I thought this class would show many inclusive teaching practices. Lynn was very open and easy-going and seemed to enjoy sharing her ideas on teaching science. She became very animated and shared many teaching experiences when discussing her teaching methods.

Gary

Gary had been teaching for 30 years. His educational background was in chemistry and math and he was currently teaching Grade 9 Applied Science, Grade 10 General Science, and OAC Chemistry. During our first meeting I further described my research to Gary and he signed the consent form. After the first interview with Gary we decided it might be useful to observe both his Grade 10 and his Grade 9 Science classes since they both included students who were identified with learning disabilities and those who were not. I conducted one observation in his Grade 10 class and two in his Grade 9 class. Both classes had at least 30 students. Gary spoke in detail about his many years of teaching and of the changes he had encountered through that time. When he was asked if his classes were inclusive his reply was "You mean by having a wide range of abilities? Yeah, yeah, for sure" (1G6).

Data Collection

Data for this study consisted of five interviews and three classroom observations with each of the three teachers during October 1999 to January 2000. Additionally, the field notes taken during the interviews and observations of each teacher were used. The study involved a qualitative investigation of the practices and beliefs of teachers in successful inclusive secondary

science classrooms. I investigated what teachers are doing in the classes and why they believe they are performing those practices. Good research practice requires the researcher to triangulate, that is, to use different methods and data sources to enhance the validity of research findings (Mathison, 1988). Patton (1990) agreed that research methodology is important but views the experience and portrayal of the researcher, and an understanding of the "paradigm orientation" (p. 461) that supports the study also important to the reliability and validity of research results. In order to strengthen the validity and reliability of my research and to gain the perspectives of my participants, I used individual interviews with teachers, classroom observations, and my field notes of interviews and observations as the data set.

Individual Interviews

I conducted five individual interviews of 45 minutes to one hour in length with each teacher participant in my study. I conducted an initial interview to fully explain the purpose of my study and collect background information. Following each classroom observation, I scheduled an interview to discuss the teachers' perceptions of the class and the methods they employed. The final interview was scheduled once all the data for that teacher were collected and analyzed to ensure that I had appropriately interpreted and represented information provided.

"Participant interviews can get at the categories of the participant and are often much less abstract than instruments in other research designs" (LeCompte & Preissle, 1993, p. 342). Since I wanted to obtain the views of my participants, I used a general interview guide approach (Patton, 1990) focusing on open-ended questions to uncover the participants' ideas and views of effective teaching methods in inclusive classes. I used a conversational style interview but had a question or topic guideline to ensure I covered the relevant information. (Appendix B contains a sample question guideline). Once the interview was under way I followed the natural flow of the conversation. In this way, I drew out the participants' views of the pertinent areas of interest. The conversational model, because of its familiarity to most people, is most likely to gain the confidence of the participants and to yield rich, valid responses. The interview method was

chosen because of its success in other studies revealing the teachers' perceptions (Garnett & Tobin, 1988; Johnson & Pugach, 1990; Scruggs & Mastropieri, 1994; Searles & Kudeki, 1987; Strange & Bol, 1996; Tobin & Fraser, 1987a).

The interviews were held with individual teachers, in the teachers' offices or their labs, which were generally free from distractions and noises. There was an initial interview to find out the background of the participants and for them to discuss their instructional methods. Following classroom observation there was an informal interview discussing the instructional methods observed and investigating why the teachers chose to employ those methods. All interviews were audio-taped to ensure reliability in the data collection and analysis, and to allow verbatim transcription. Once the interviews were transcribed, participants were provided with a copy for participant corroboration of the data, which strengthened the internal validity of the research. The thesis includes verbatim accounts of conversations with the participants augmenting the trustworthiness of the research, since reports are generally more credible if the participants' words are used (LeCompte & Preissle, 1993).

Classroom Observations and Field Notes

In addition to interviewing participants individually, I observed three 76 minute periods (lessons) of each of my participants' classes to view methods and how the students reacted to these methods employed. Since observations were conducted in natural settings (the teachers' classrooms) the observations reflected the participants' experience more accurately than a contrived setting (LeCompte & Preissle, 1993). Some of the studies that use classroom observations and field notes in their data collection on teacher practices are: Lazarowitz, Hertz, Baird, and Bowlden (1988); Nolet and Tindal (1994); Tobin, Espinet, Byrd, and Adams (1988); Tobin and Fraser (1987); and Treagust (1991).

By using classroom observations, a researcher can increase the richness of the data and increase the validity of the study by ensuring what teachers say they are doing matches what they are doing in the classroom (Hacker & Rowe, 1993; LeCompte & Preissle, 1993). Hacker and

Rowe (1993) concluded from their results of a 3-year longitudinal study of teachers in inclusive classes that what teachers say and what they do might be different. Teachers may not be cognisant of their teaching practices, thus it is advisable to observe teachers as well as to interview them.

The observations took place in the teachers' classrooms and were audio-taped. I viewed the teacher practices, student behaviour, and classroom climate. In addition to audio-taping interviews and observations, I made extensive field notes during and after each session. Once the interviews and observations were transcribed I gave the participants a copy and I conducted a member check to verify that my notes and transcriptions accurately reflected the participants' practices (LeCompte & Preissle, 1993; Miles & Huberman, 1984). Discrepancies became part of the data of the study (Hacker & Rowe, 1993).

This technique of using observations and interviewing presented a more comprehensive view of the data collected. By using multiple sources of data and multiple ways to collect data researchers decrease the possibility that a phenomenon may have occurred once because of specific circumstances (Patton, 1990).

Data analysis

Inductive analysis was used to examine the patterns in the interviews and observations. While transcribing the interviews, I began analyzing the data collected from each teacher. The first step was to examine the verbatim transcripts of the interviews and classroom observations after each one was complete. At that time researcher field notes were also examined to identify possible themes prevalent throughout the classes and interviews. The next step was to group similar statements made by each teacher, showing patterns and categories that emerged from the data, emic categories (McMillan & Schumacher, 1997, p. 501). By examining the data for repeated terms, concepts, and metaphors I identified the emic categories of each teacher's transcripts of interviews and observations. One way to look at the teachers' way of thinking is to examine their use of metaphor in their speech (Munby, 1986; Munby, 1987). By grouping similar

metaphors I was able to discover the teachers' thinking in their choice of instructional methods from the perspective of the teacher.

Beginning with Ellen, I started coding each line of the responses but as categories emerged, I wrote those on a new page and the lines from the interview that represented that category. For example, I coded how Ellen refers to students, "They're very intelligent but they have some motor skill difficulties" (1E15), "I just adore them, the last month or so it's just clicked, great rapport, we laugh we have fun." (4E10). I also had a code for teaching characteristics such as flexibility, "Today we didn't get into the last 20 minutes that I had planned so, I'm flexible that way" (1E13), or likes to work with individual students, "And so I am more than willing to make exceptions and to help one-on-one and that's what I'd prefer to do" (2E12). So how Ellen refers to students and teaching characteristics were two of the nineteen categories that were formed from her data.

I then followed the same procedure for Lynn and Gary. Sixteen categories emerged from Lynn's data and twelve from Gary's. Many categories had sub-categories, for example, within the category, teaching characteristics, for Ellen there were eight sub-categories; flexible, likes to work with individual students, organised, evaluates self, likes to teach as likes to learn, student interest, student responsibility, and clear expectation for self. For Lynn there were nine sub-categories; be "ultra-prepared," "particular," will not "tolerate much chatting," students are there to learn, wants to learn, relationship with students, clear expectations for self, clear expectations for students, and student responsibility. The same category for Gary had five sub-categories; likes to teach to his own strengths and interests, likes to teach what "kids would relate to," likes to work with individual students, clear expectations for self, and clear expectations for students. Of the emic categories for all teachers, seven were common: refers to students, teaching characteristics, classroom management, inclusive strategies, planning/workload, factors important for student success, and frustrations. Though the categories were the same, as with teaching characteristics the sub-categories may differ.

The next step was to develop themes from these identified categories that would identify instructional methods that had been successful for each teacher and why the teachers believed these methods to be successful. Once the data from each teacher was analyzed, I looked at similar patterns across participants to see if there were any commonalties between the teachers in the study. As previously mentioned in this section, there were seven categories common to the teachers. I was interested in the common categories but also what differentiated each teacher so that various pictures of successful inclusive secondary science teachers could be drawn. Once this was completed, I returned to the literature to see if there was any overlap between the categories.

Throughout the collection of data, I checked my results with my participants to assure validity (McMillan & Schumacher, 1997). This gave me an opportunity to ensure my interpretation of the results reflected the teachers' practices and also gave the participants an opportunity to question my interpretations. Discrepancies are also reported.

Summary

This chapter outlined the methodology I employed for my research including the rationale for choosing a qualitative study. I used a nomination process to select three teachers who would provide rich sources of information on the practices of exemplary inclusive secondary science teachers. I then collected data from these teachers through both interviews and observations of their class teaching. I audio-taped all data for transcription to ensure verbatim accounts of the teachers' practices. The method of data analysis using categories and themes is next outlined. In the next chapter, I discuss the general characteristics of my three participants teaching practices and the major themes that emerged from the interviews and observations of each teacher.

CHAPTER 4

RESULTS OF DATA ANALYSIS

Introduction

Meadow Secondary school is located in an urban community in Ontario and offers grades 9 through to OAC. There are approximately 650 teenage students, and about 200 adult students participating in a variety of programs offered through the school. The school has strong ESL and strong inclusive programs, therefore the student population is diverse. The school operates on a semestered system with students taking four courses per semester for a total of eight courses per year. Teachers instruct three of four 76-minute periods a day plus 110 minutes per week for on-calls. The school day is from 8:29 a.m. to 2:40 p.m. but the teachers in my study generally arrived at the school around 7:30 a.m. and stayed until 4:00 p.m. or later. This research is based on interviews and observations of three inclusive secondary science teachers over a period of four months from October 1999 to January 2000. The classes observed were a Grade 9 Academic Science class, a Grade 9 Applied Science class, a Grade 10 General Science class, and a Grade 10 Advanced Science class. This chapter discusses the general pattern of the teaching that I observed and the emic themes that emerged from the observations and interviews of Ellen, Lynn and Gary.

Ellen

In this section I discuss first the general pattern of Ellen's teaching that I saw during the three classes that I observed. I then discuss the themes that emerged from Ellen's data.

Introduction to Ellen

Previous research has shown that years of experience was a criterion for exemplary teaching so I initially did not plan to include Ellen because she had only 2 years of teaching experience. Yet her enthusiasm and her desire to learn and improve her practice in addition to her recommendation made me change my mind. Ellen was teaching only Grade 9 classes during my research and, as I discussed in chapter 3, the implementation of the new Grade 9 curriculum was

problematic. According to the teachers, they were given insufficient time to prepare and rules were being changed as the courses progressed. The Ontario Ministry of Education's new report card was released during the time of my research, new assessment practices were being adopted, and new topics were being introduced into the curriculum. These changes put considerable amounts of stress on all teachers especially those with less experience. Ellen was making a valiant effort to juggle all of these new problems with the implementation of the curriculum and the 31 students in her class. Although Ellen was not informed by the school of any student's formal identification when this research was conducted, either the students or the parents of at least three students in her Academic Science class had informed her that they had communication learning disabilities. During our initial hour-long interview in October, Ellen and I arranged a time for me to observe her Grade 9 Academic Science class. We also arranged for a 45-minute to one-hour interview to follow that class. Since the class I observed was Ellen's last class for the day, our follow-up interview was immediately after the class. At each interview we arranged our next observation and follow-up interview. I gave Ellen the transcribed interviews and observations at the following interview. I observed two classes on a Monday and because of scheduling difficulties my last observation and fourth interview were on a Wednesday. I then informed Ellen I would be returning for the final interview after all of her data had been analysed.

Ellen's laboratory, where her classes were also conducted, consisted of 12 double benches and 4 long benches in the back of the class. Most of the students sat at the front benches with two to a bench, three students sat in desks by the window, and four students sat separately at the back four long benches.

Ellen's Teaching

The Grade 9 Academic class was during the fourth period, following lunch everyday. When the bell rang many of the students were already in the classroom as Ellen generally kept the lab open for students during the lunch hour. Ellen had a "mind bender" for the day on the board, and wrote the agenda on the board. While students settled into their seats the classroom was quite

noisy and Ellen often had to tell the students to quieten down. She would say "I'm waiting" and if they were still noisy then, "I'm timing," meaning she was deducting the time that she had to wait from their "fun" time on Fridays. In the three classes I observed, classes began with a mind bender for the day, for example, "look u leap" or, "On the table is a carton containing 6 eggs. If six people each take an egg, how can it be that one egg is left in the carton?" She would ask one student to read it out then asked students to raise their hands and tried to call on one student at a time to suggest solutions. Often however, many students would call out the answers and Ellen had to wait for the class to be quiet again to continue. Once a suitable solution was reached she moved on to a brief teacher-directed review of the previous day's concepts and how those concepts fit with the new material. Ellen requested that students raise their hands to respond. Several students did raise their hands but many students responded without raising their hands. Ellen again waited until students were relatively quiet.

Ellen then began the new information with either a teacher-led lesson or an activity. When Ellen gave notes she would first ask students what they already knew about the new concept (which would often not be new to all students), they would discuss it and then she used an overhead projector and wrote the notes during the class. She would write some notes, read them, then walk around checking the students' work. When the majority of notes were written, Ellen would add more to the overhead and proceed in this fashion until all notes were given. Ellen would often then have an activity for students to complete in either pairs or small groups. They were supposed to work in the pairings that Ellen had deliberately arranged, but often the students would move to pair up with someone other than their assigned lab bench partner.

Sometimes the activity would be preceded by a demonstration but clear instructions were always given both verbally and written. While the activity was proceeding, Ellen moved around the class, asked individual students questions, and checked students' work. When the allotted time was up, Ellen asked students to focus their attention on her. This generally took many attempts, and Ellen often had to wait several minutes before students stopped talking. She then

led a discussion on the activity, there were several main students that Ellen called on to answer her questions but she did at times call on other students who did not often offer answers. If the activity had not been completed, then the students had to complete it for homework. Often Ellen collected these assignments and sometimes assigned a grade. Before students left, Ellen wrote the homework on the board and any assignments or lab write-ups that were due, and asked students to write the information in their daily planner. About six students actually wrote the information down, some seemed to look for their planner, while others put away their books and prepared to leave. Ellen called for the students' attention wanting them to sit quietly before she would dismiss them. Many students complied but several of the students kept talking. When the class was generally quiet the students were dismissed.

Ellen had difficulty controlling her class and spent much of her time on class management. Though some of this may be attributed to Ellen's easy-going manner and friendly disposition, and some may be due to her lack of experience, some must also be attributed to the group of students. Ellen assured me not all of her classes were the same, and all of the teachers in my study said that the Grade 9's were a particularly energetic group that year.

Ellen's Themes

The themes that emerged from my observations and interviews with Ellen were: (a) teaching characteristics, (b) factors important in deciding what and how to teach, (c) classroom environment, (d) classroom management, and (e) strategies in inclusive classes.

Ellen characterises her teaching. I decided to look at the characteristics of each of the teachers in my study to see if there were any common teaching characteristics among exemplary secondary inclusive science teachers. Ellen thought of herself as flexible: "Today we didn't get into the last 20 minutes that I had planned so, I'm flexible that way" (1E13). She preferred to work with individual students, "And so I am more than willing to make exceptions and to help one-on-one and that's what I'd prefer to do" (2E12). Ellen liked working with individuals to be able to assess how each student was progressing and to ensure individual understanding.

> You know walking around afterwards, which is why I would like to have more time, have more assignment time because walking around like that and having people asking questions and seeing whether or not it clicks. I mean, that's a real indication there. So, I think it's important to have that time in the classroom. Because then that is really individual.... So, walking around and getting individual assessment is the best for me. (3E9)

In addition to assessing how students were progressing Ellen preferred to work with individuals or small groups also to ascertain how individuals learned: "I really like that [small group co-operative work] because then I can get around and see how different students are learning..." (1E17). Ellen also liked to be very organised as she felt it helped her teaching:

> I always like to know exactly where I am going a week ahead of time and then plan when I get to that day, and say okay this is what we didn't get done, and this is what didn't work, and this is why I am going to change this and that's how my planning.... (1E13)

In addition, Ellen liked to teach as she liked to learn, "Just personal experience. I don't like to be talked at and lectured and I want to learn and explore myself" (2E23). Further, Ellen felt that students must take some responsibility for their learning:

> Now I might see it in the classroom and then I'll go and try to set up a time with them, but ultimately it's up to them to take that first step, the initiative.... Because I think it's a good quality to have. (1E17)

Ellen had clear expectations for her students, an example of how clear her expectations were follows:

> And they have a sheet, instructions for writing formal lab reports and it tells exactly what is expected for the purpose, hypothesis and what it is and we've been through it in the introductory unit. We discussed the scientific method. They

> also have a lab-marking scheme, a rubric that is going to be the same rubric all year... So the expectation is right there. (2E14)

Finally, it was important to Ellen to make the material both interesting and relevant to students.

> Well, I explain to them that it's not just [in] science that you are going to see this for one thing. If you go to study psychology or sociology, arts or science, when you do research there's a method that you follow. It keeps everything in sequence, it helps you understand what you are learning about, it encourages coming to class prepared and keeping organised. So, there's a bunch of social aspects to it as well. And you can encounter it in any day in your life, in a workplace. (2E14)

"...I do it that way because they seem to enjoy that" (2E5). Ellen's teaching characteristics including relevance and interest of material, and student expectations affected the strategies Ellen chose to use to teach.

Deciding what and how Ellen would teach. The topics other teachers chose, the curriculum, the time available, and what Ellen felt was relevant to students had an impact on the topics Ellen decided to teach. "I asked the chemistry teacher, since we are now doing chemistry, did you do this? And whatever he is doing, I know it's pretty pertinent" (2E27).

> It is expected in the curriculum and I've talked with other teachers at other schools and that's what they're expecting of their students. It's always useful to know when they get to Grade 11 chemistry or anything else, to know the most common elements that you're going to need in everyday life. (3E13)

Ellen also took time and student ability into consideration when choosing topics:

> Okay, when I'm doing my lessons plans, yes time is a factor because I have the quarters [the semester is divided into four quarters to teach the four units in that course], I need to be able to get all the material completed in that time. Also, for example today, I thought that the material was too difficult out of their textbook

> so I had to go to another source and find more related questions. So, taking into account where I think the students are in their learning and what kind of questions they can handle. So that, I take into consideration. (3E12)

How Ellen taught was influenced by her teaching characteristics already discussed. She chose "activity based" (3E12) material and activity suggestions that were included in the textbook to enhance students' learning because she preferred hands-on activities. "Well when they come up in the textbook, that's one thing, honestly. Hopefully, you have a nice textbook that has these activities and stuff that you can use" (4E4).

Ellen would have liked to try many strategies with her classes but felt she did not have enough time. She frequently discussed time as a regulator and also as a limitation. In our second interview Ellen said, "There wasn't enough time for the activity base" (2E15). Also during the second class that I observed Ellen said "Folks if you stop talking we can get this done a lot quicker" (Field notes of Observation 2). Ellen would have liked to use an individual informal assessment but again, she felt time did not allow it:

> I think the biggest thing if we're not talking about formal assessment, the biggest thing is seeing them on an individual basis and I would probably like having more conferences with them and stuff, but time just doesn't allow it. (3E10)

Ellen said she would have liked to use more small group co-operative work but felt that students did not use the time wisely when involved in this type of activity. Therefore, she restricted how often she used those activities. There is a tension between how she would like to teach and how she does teach.

> I really like that [small group co-operative work] because then I can get around and see how different students are learning but, with the noise level and what with [them] abusing that time I find I have to take some of that away sometimes. (1E17)

Classroom management. Ellen felt that the classroom environment was important to

learning "I'm not discouraging that [students' talking], but it needs to be an environment that everybody can work successfully" (2E25). However, she also felt that because she was new to the profession that she might lack the resource base to provide an environment conducive to all students' learning. When asked what worked best for her particular classes, she replied, "I haven't learned yet. I don't know" (2E22). Ellen also felt she needed more classroom management techniques, "Your question, the best techniques, I don't know right now, truthfully. I need more techniques" (2E23). The environment in her class influenced the strategies Ellen would try. Because she felt students were wasting their time during small co-operative group work, Ellen limited their use even though she said that using co-operative groups was one of her preferred methods of teaching.

Classroom management took up a lot of Ellen's time and energy: "...half of that time in a classroom is putting out fires" (1E16). Ellen felt that she and the students would accomplish more content and would have a better relationship if she did not have to contend with discipline:

> Yes, because I could teach so much more effectively and I could explain things better and if ... But if I wasn't waiting for them for 7 minutes out of every class then I think we could have a better relationship, and a more open relationship. I'm not talking about friends obviously, but more co-operative learning, more bouncing things off of each other. I think I would be a lot more successful and their marks would be a lot more successful as well, and their understanding, and their comprehension of the material. (2E24)

Ellen used various forms of classroom management from trying to focus students' attention to speaking to parents. Frequently throughout her lessons Ellen would use phrases to get the students to focus on her, for example, "looking at me please," "all eyes on me please," or "Okay can I have your attention please, up here." She also felt that trying to focus students took time away from students who wanted to learn: "So how can I sit or help an individual who's having genuine difficulty when I'm asking these people over here (motions with hand) to sit down and

focus and do their work. That's a huge frustration" (1E16).

Ellen had tried several seating arrangements of students to see if that would decrease time spent on classroom management. "I moved him in front of the class last week, they had gotten a new seating plan" (2E11). She said that sometimes she would change the activity to note taking.

> If they're [the students] talking too much, then I'll just say, "okay fine you can't do this work right now. You're not getting anything done so we're going to do a note". Because that keeps them relatively quiet and at least they are getting something into their notebook and if they're not learning from their activity anyways then they may as well be doing something constructive so that they have something there to look at and to study from. (2E23)

And for some students Ellen would involve the parents to see if they could help, for example, "Yes, it's students like him where I am at a loss. I've communicated with his dad a fair bit" (2E12).

Strategies for inclusive classes. Ellen consciously used strategies that would benefit all students in her classes, this is how she believed she made her classroom inclusive. However, Ellen limited the strategies she used because classroom management consumed so much of her time and energy. One of her approaches was to strategically partner students or put students in small groups:

> ...the way I simply pair people up in the classroom, at the lab benches because they all work in pairs. Or the way I group people for small group learning and I put weaker students with stronger students so that the stronger students can help them out and give them some more understanding of the material. (1E12)

A second strategy was to assign group projects and to assign students to each group:

> And my explanation this morning was: "I am trying to make it more of a real life situation; they're never going to get away from not [sic] working with others. So, it's all about co-operation and participation and getting along with their peers and

> also I mean these are big projects, some of them, I've given them and in my opinion it's a lot of work for one person to do. So, if they can divvy up the work they have the opportunity to share ideas and come together and bounce ideas off each other and two or three minds are better than one". (3E8)

To increase productivity and accountability of groups Ellen had students conduct peer evaluations:

> If there happens to be a group member who is slacking off, they do a peer evaluation of each other. It's kept confidential. It works really well especially if there are 3 people in the group or more because you can take a look. Are the numbers compatible? (3E8)

She used many strategies to accommodate individual differences, for example, the use of different modalities to teach (e.g., observation 2), the use of material to suit student ability (e.g., 3E5; 3E12; 4E7), the use of an alternate environment for some students when required (e.g., 3E18), and the use of different expectations for different students (e.g., 4E6). Ellen would also write her notes more slowly to accommodate most students in her class (e.g., 3E14; 3E15).

Ellen preferred her lessons to be activity-based including labs: "Also, supporting the work with activity-based stuff and the labs and what not" (3E12). She also preferred to make her lessons hands-on if time and experience allowed for it: "In my case, I mean if I could make it all hands-on, I think I would" (4E4). She preferred hands-on because she felt that students with learning disabilities learnt better that way: "Because studies show that these kinds of students are more tactile and they're thinking from one side of the brain as opposed to the other side and the learning style is different" (4E4). An example of a hands-on activity used by Ellen was students had to map the phases of the moon using models and a flashlight. Small groups of students worked together to discover the position of the earth, the sun, and the moon, and draw the lunar phases as they saw it with their models.

Though Ellen felt she could not make all of her classes hands-on: "But sometimes, time and resources [and] being as inexperienced as I am, just doesn't allow me. I don't have the resource base to do that right now without spending 24 hours a day"(4E4) she did use several types of activities throughout her lessons. One type of activity that Ellen did in her lessons was worksheets:

> If I have something that can help explain it, or if there is something to complement it or support it then if it's a difficult concept and it's in the curriculum and I know I am supposed to be teaching it well then I will look for something that's going to, or I'll make a worksheet or I'll look for easier wording. (4E7)

Another activity was demonstrations and to get the students "up and moving" when possible: "I thought that getting them up to the front to demonstrate the electron thing and...getting them up and moving" (3E7). A further activity was questions and answers and whole class discussions. Ellen often reviewed and introduced material in this manner. One form of question and answer activity she used was a Jeopardy game used for review purposes.

In addition to using activities, when students asked Ellen questions she would try to prompt students to discover the answer instead of just giving the answers:

> By not giving them [the students] the answer every time they ask. Directing them and pointing them, or I prompted them with that first question and then they realised that that [the answer] was terrifically easy, I should have got that myself. But by doing that they were able to get the tougher rules [rules for naming chemical compounds]. The tougher questions that the pattern may not have been as obvious. (2E23)

Ellen felt that when students determined the answer for themselves that they would have a sense of accomplishment and would also demonstrate a better understanding of the concept.

Summary

In summary, Ellen was flexible and liked working with individuals. She had clear expectations for her students and liked making the material interesting and relevant. Ellen structured her lessons so that she followed a routine and started her lessons with a mind bender to grab students' attention. She tried to use activity-based lessons and inclusive practices. Ellen thought that a supportive classroom environment was important to learning but, because of classroom management difficulties and a lack of resources, she had difficulties attaining this. The factors important in deciding what and how Ellen taught were: the topics other teachers chose, the curriculum, the time, student ability and what she thought was relevant, interesting material. She then taught those chosen topics using a variety of strategies, for example, strategic pairings and groupings, demonstrations, discussions, questioning, and worksheets.

Lynn

In this section I discuss first the general pattern of Lynn's teaching that I saw during the three classes that I observed. I then discuss the themes that emerged from Lynn's data.

Introduction to Lynn

This was Lynn's seventh year teaching math and science. Over the years she has been teaching, her classes have included a wide variety of students; thus inclusion was not a new concept to Lynn. During our initial interview in November, Lynn and I arranged a convenient time to observe her Advanced Grade 10 science class and to conduct a follow-up interview. Lynn's Grade 10 class occurred during the second period so I returned after school on the same day to conduct the follow-up interviews. One follow-up interview was rescheduled for the next day because of an in-service presentation on the new curriculum. At each follow-up interview the preceding interview transcripts were discussed for clarity. At the last follow-up interview I informed Lynn that I would call to schedule our final interview when her data was analysed. As with Ellen all interviews were from 45 minutes to one hour.

Lynn also taught in a lab. Her lab was large with 30 single desks in front with a blackboard at the front and on the left side. Behind the 30 desks were six long lab benches. In front of the benches was Lynn's office. There were no other science labs in this wing of the school. On the back of the door Lynn had a large sign with all important dates written on it (e.g., when assignments and lab write-ups were due, when tests were scheduled). On the board to the left of the class there were some challenge questions, and some science websites.

Lynn's Teaching

The students started entering the classroom a couple of minutes before the bell went. Lynn was at the front of the class writing out the agenda in the corner of the front board. The bell went and Lynn waited for all students to sit at their desks. Students came in and sat down and took out their books, there was some chatting as students entered. After another couple of minutes Lynn asked for everyone's attention, she said the name of those students who were not immediately quiet—usually only one or two—and then the class was quiet. Lynn started her classes with an overview of what they were doing that day and where that fit into their unit. She then asked if there were any questions about their homework and discussed those if there were any, often asking students to answer any questions. During some classes she then asked a student to go to the front of the classroom to give their "what's in the news" presentation.

Lynn's class was made up of two groups of students; all students were taking advanced science but some of those students were also doing an enriched program. Though these students were following the same curriculum, the enriched students were to be provided with more of a challenge. One way Lynn accomplished this was to have these students present something of interest to them on a current event happening in science. These presentations were called "what's in the news." During one of my observations a student presented information on meteorite showers and informed the class that one would be happening within the next few days. The student led a brief discussion with the class and answered any questions.

Once the presenter sat down, Lynn started the class by reviewing their material and then began the new material; she did this by a teacher led discussion. This class participated well with many students asking and answering questions. Lynn would comment on answers and sometimes expanded or asked the student to expand but, in general, the students answered as well as asked the questions. The enriched students overall tried to dominate the discussion but Lynn called on all students and would involve students without their hands raised. Lynn found this one of her challenges; to keep the enriched students challenged and involved without losing the interest of the rest of her class. She had 30 students in this class and the numbers were about equal for enriched and advanced.

After the discussion Lynn asked students to take out some paper to write a note and would draw the note out of students by asking questions and would either write on the board or an overhead what the students were saying. The discussion might be prompted by a demonstration and then students had to explain their observations. During demonstrations the class was very quiet and usually one student was speaking at a time. Occasionally more than one started talking but Lynn quickly stopped this and asked one to continue at a time.

One day Lynn then had a video and passed out a worksheet for students to complete while the video was playing. Another day she had planned a lab so after explaining the instructions in detail, and showing them how to correctly set up the equipment and where all the necessary equipment was located, she told students to move to the back part of the classroom and work in groups. Students quickly moved to the six long lab benches and began setting up their equipment. I asked Lynn if they were assigned groups and she replied only if the groups they formed themselves were not participating in the lab activity or were being non-productive. The third day Lynn had a page of word problems. While students were completing the planned activity Lynn circulated around the room asking and answering questions though she often would just keep prompting until the students would answer their own questions, and she would check

the students' work for their understanding of the material. After the lab or activity was completed Lynn then got everyone's attention and all students returned to their seats.

In the first two classes, Lynn then went over the results with the class in a teacher-led discussion, and made sure students were clear on their homework. The third class Lynn led students through a few examples of their problems but students actually suggested possible methods for solving the problems. All answers were accepted but eventually the best answer would come out and Lynn would write it on the board. Students were asked to complete whatever they had not finished at home.

Lynn was always in control of her class; she never had to speak more than twice to any of the students, but all the students did participate in the class. She had created a supportive environment for the students and had a positive relationship. The students seemed to respect her but were not afraid to try out their answers. Once the homework had been assigned and the bell rang, students were dismissed.

Lynn's Themes

The themes that emerged from my interviews and observations with Lynne were: (a) teaching characteristics, (b) factors important in deciding what and how to teach, (c) classroom management, (d) view of successful teaching, (e) strategies in inclusive classes, and (f) feelings about teaching.

Lynn characterises her teaching. The importance of control to Lynn is evident through the number of times she discusses it (1L13; 1L23; 2L8; 3L2; 3L4; 4L7; 4L9). For example, "I would give them a little more freedom in this class. .... I don't have to have as strict control as I do with the Grade 9 class" (3L4). Or, "in order to teach effectively in your new classes you have to have control of your class. You are not going to get anywhere if you don't have control and have respect from the very beginning" (4L9).

Along with having to be in control of her classes Lynn would not "tolerate much

chatting": "I am pretty uptight about asking kids to be quiet and I don't tolerate much chatting when I'm chatting, so I try to address it right away" (2L7).

Lynn also liked to be "ultra-prepared" when she taught so that she felt comfortable and so that in her view the classes would run more smoothly:

> Even in the Grade 10 science although straightforward, the concepts have to be reviewed thoroughly, yourself, so that [you] make sure they're covered properly and you haven't forgotten something. You've done your homework. You've done the kids' homework. You know the questions, you anticipate the questions that are going to be asked. Now you can't always anticipate everything but certainly.... That's the only way that I feel comfortable getting in front of the class is when I am ultra-prepared. (1L19)

And:

> I'm someone, I like to be thoroughly planned. The better planned you are then the smoother it is going to go and the more fun you can make it, the more smoother it's going to go. So, the more time you have to sort of get all that together the better off everybody is. (4L4)

In addition to wanting to be in control of her classes and being prepared, Lynn had clear expectations for herself and for her students. Lynn believed her role was one of support but that students must be willing to ask for that support (4L8). Along with support Lynn believed her role was to provide an atmosphere, where all students could be successful and be comfortable, and to encourage enthusiasm for science (4L6; 4L7; 4L8).

> I want everybody to be successful and I try to remind them of that. That's my role here, I will do everything that I can do to make you a successful student... I want to give them enthusiasm for science... I want my students to enjoy it...So, a teacher can make a big difference, I think, in what you perceive [the students] to

be good at or fun or whatever. I don't want to turn anybody off that's for sure. (4L6)

Lynn's expectations for her students were clear and, she let students know what her expectations were and the consequences if they were not followed (1L19; 1L23; Field note of Observation 1; 2L9; 2L12; 2L14; 2L15; Field note of Observation 2; Field note of Observation 3; 4L7; 4L9). "Right from the beginning they [students] know that these are my expectations..." (1L19).

> I tell them on day one that we're here to learn and when I assign work in class I expect you to do it. And you know I do it in a very serious way. I am not looking to be liked on the first day or even the first month. I'm serious about this, I am here to help you be successful and you will do the work in class and if you do not do the work in class or, in class primarily, I will find an alternative setting for you to do the work. And then I follow up on that. (2L15)

Lynn had found a difference over the years of her teaching in her ability to set clear expectations for students and the importance of setting the expectations very early:

> And I have noticed a difference over the years as well. This is my seventh year teaching and I've noticed that I'm much better at making clear my expectations and, you know, because I've made mistakes basically. I have not set expectations well, I've not followed through on things well and I've seen the consequences. Kids start, they take advantage and they realise that they don't really have to do the work as assigned because there isn't follow through, so.... I've learned, the hard way. (2L15)

Lynn also believed in teaching her students more than academics, she believed in teaching holistically and working with an individual student's strengths and weaknesses whatever they may be.

> Mostly with him, I think it's social things that we should be working on. I mean he's very antisocial, he doesn't work well with people. And so, partly by insisting that he co-operate with his lab partner, it's more than just getting data down and understanding the lab. He understands the lab, just fine. I'm not worried about that but I am worried about his level of co-operation with his lab partner. Because to me, it's not all just writing down a few numbers and drawing a graph, it's the whole interaction, teamwork here... So, he, I can't, I don't know how to motivate him very effectively. I'm mostly working on just trying to relate to him a little bit. Asking about his novels, you know try to get a relationship there so when I go to do an activity, now he is not saying "that's stupid, I'm not doing that" he's getting up and doing it and he's reading his novel in between readings. I've made some progress with him. But I am not worried about him academically I'm worried about him socially.... He's just not working to his potential. (3L6)

Deciding what and how Lynn would teach. The curriculum, the textbook, Lynn's past teaching experiences, collaboration with other teachers, her comfort level with the class and the students' abilities influenced what topics Lynn chose to teach and what strategies she used. According to Lynn, she relied on the textbook more when deciding what to teach and how to teach the new Grade 9 Math course than she would a course she had previously taught:

> So, at this point, the first time through the curriculum, I am going through the textbook and looking at the concepts that need to be covered and I am trying to come up with lessons that, mostly Socratic lessons probably at this point although I know we are to move away from that. But, making math all activity based, when you don't know where you're going with the curriculum, is challenging. (1L19)

Along with following the textbook, Lynn also collaborates with another teacher to plan her lessons for the new course:

> So, we're following the textbook, I say "we" because I am teaching this course with another teacher, doing a different section, but we are planning together. Planning a lesson, trying to make sure that I give very concrete examples moving to the abstract. I will chop a period up with usually a few mini-lessons and some seat work or group work based on what I have taught. (1L19)

Student ability also affects how Lynn chooses to teach: "It [the new Grade 9 curriculum] is supposed to be more activity based, more group work but my group is not very functional in the group work area. So I have found that I just have to abandon it because they are not productive" (1L19). Since her students do not work well in groups, Lynn does not often use that strategy.

Lynn's prior experience affected what and how she taught: "Well, I've taught the course a few times so the preparation is becoming easier" (1L19). And because of her experience and her feeling that she can better manage her classes she has more time to spend on class activities (1L23; 2L15). As a result Lynn could concentrate on creating a comfortable environment for all her students. The comfort level and rapport she had developed with her students also influenced what strategies Lynn would use to teach (1L9; 1L10; 2L8; 2L9; 41; 4L7).

> At the beginning of the year, and I felt a little frustrated at times because I couldn't get their attention, but I think you just develop a rapport with them. Some of it, I guess I am conscious of doing but I think some of it is you just get to know them and you develop strategies, almost without thinking about them, you know dealing with different kids. I've managed to build a fairly positive rapport with them. They respond really well to instruction. I don't really have any attitude problems in the class. They are just a great bunch of kids. (3L2)

Classroom management. Classroom management was not a problem for Lynn. This may have been due to Lynn's determination to set clear expectations for the students and to follow through with them as discussed in her teaching characteristics section. Lynn felt that by setting

the tone early in the semester, being consistent, reinforcing good behaviour, and following through when there is a classroom management issue, those issues very quickly came under control (2L9; 2L14; 2L15; Field notes of Observation 2; 3L12; 4L3; 4L9). "I find you have to be pretty strict at the beginning and really follow through on things cause if you let stuff slide then they realise you're going to let stuff slide. So, I'm very strict at the beginning" (2L15). "Generally the class has improved and I think that is again following through on my expectations" (2L9).

When Lynn did have a classroom management problem, for example students talking, she said the students' names and then continued with the lesson. If the problem was an unproductive group or a student behaving inappropriately, Lynn would talk to the students privately, either after class or in the corridor during the class.

> I mean there are combinations that are sometimes not very positive and less productive. But if that's the case I will identify those and suggest... and pull them aside and say: "this doesn't seem to be working. If it doesn't work we'll have to make a different arrangement." I do step in and make those changes. And they're "no, no, no, we can work together, we promise". So they know if they want to choose their partner then they have to be productive. (2L12)

"And so I went up to him quietly at the end just before getting the class' attention and addressed that with him" (3L6).

When there has been a discipline problem or when a student or a group of students was being disruptive Lynn has sent students to the vice-principal (2L15) and has also removed the students from the class until they could explain to Lynn why they deserved to be returned to the class:

> Oh right, he came with a letter and I discussed with him whether he, he was one of the Grade 9 students in my class who I removed because he was so disruptive and I had told them, this group of kids that I removed, that they could only go

> back in the class if they spoke to me and told me why they deserved to be in the regular class and he came with a letter. I said they could write a letter or come and talk to me personally. (4L1)

Lynn has also involved the parents when she thought it might benefit the student. This was to try to encourage some students or to reward others: "And I've made a few phone calls home, you know, for students who seem really unmotivated or who aren't doing well.... And I try to also call home for the kids who are doing really well as well" (2L9).

Lynn's view of successful teaching. Another factor that emerged as important to Lynn's choice of strategies was what she considered as success for herself and her students. For her teaching to be successful she thought it important that all students participate (2L3; 2L4) and that all students felt successful:

> And to keep them feeling positive, that they can succeed and that my whole goal is, my role as a teacher is to help them be successful. Hopefully I'm making them feel very positive about being successful early on. So I'm not saying if you don't do this work you're going to fail, blah, blah. But I'm saying if you do, do this work you're going to be successful all the time. And so I really try to reinforce that and encourage them to come for help and encourage them to get their work done and call home when it's not. (2L9)

Lynn also gauged her success as a teacher by the students' enthusiasm for science: "Secondly, a teacher who is able to instil some enthusiasm for the subject. You know I really hope that I am getting across an enthusiasm in general for science therefore they will stick with science" (2L10).

Finally, Lynn felt herself successful as a teacher if her students achieved their individual potential:

> Well, let's see, it seems to be measured by the mark they get. First of all, being successful in a course in other words passing. But for different students success is

> really quite different, for some students I find, well maybe it's teacher success, I find it successful if I get them to lift their head off the desk and answer a question or two. So, it's all relative. But, certainly a successful student is someone who learns something. I mean why are we here? Someone who learns some science and someone who gains maybe some enthusiasm for science or whatever subject it is. Is able to work to their potential whatever that is. (2L11)

Strategies for inclusive classes. Lynn's strategies in her classes had changed over the seven years she had been teaching. Lynn now felt better able to deal with classroom management, which had freed up time to try more strategies.

> I have really improved in this over seven years, being able to monitor everything that's going on. There's so much going on so often that you can't get around to doing certain things. So, I have just gotten better at co-ordinating all of that calmly from the front observing instead of running around in a panic, around the class. It is, because I'm better able now to anticipate the questions and so you can cover things before they even get there. I find that all the time I am getting better at my classroom management. Co-ordinating a class of 31 is not so bad anymore. (1L23)

Depending on the group of students, Lynn liked to use small groups for student activity to enable her to work with individual students. By working with students individually she could assess how the students were doing and assess the teaching strategies she had been using. "I'll have more feedback in terms of going around and asking them how they're doing and the questions from them will tell [me] how well they've learned the material through me teaching or through them paying attention" (2L7). Lynn also liked working with individuals to get to know her students better: "I found the sooner you can work on the one-on-one relationships because then I can get to know them better because we are all working together better. And so it leads to

being in touch with the kids even" (4L9). By being in touch with her students, Lynn could better decide which strategies worked best for individual students.

Because of the variety of student ability in Lynn's classes, Lynn liked to vary the activities in each lesson and also to vary the modalities she used to teach:

> Hopefully by repeating or verbalising what's going up on the board it's a reinforcement, subconsciously. So, that's a conscious effort that I make to do that. To sort of try to address different learning styles. And, I try to have a variety of lesson types as well so that I feel there's enough. I don't feel there is enough [variety] in the Grade 10 [class]. But so that there is some hands on and there's some discovery based learning, and there's some taking down notes, problem solving, seat work, and there's some whatever else, discussion. You know, there's a variety of things going on. I think most teachers do that, it's pretty normal, because it's boring [otherwise]. (4L5)

Lynn discussed varying strategies and modalities many times during our interviews (for example, 1L9; 1L23; 2L12; 4L5) and I observed this strategy in each of my three classroom observations.

Lynn would vary her strategies by varying her activities. Some of the variations she used were videos, assignments or worksheets, puzzles, labs, demonstrations, and co-operative work (3L7; 3L9).

> Very often there's a video or show. We've seen a lot of videos. National Geographic puts out a lot of good stuff. I try to vary it up. Sometimes I have them do an assignment for class, like a worksheet, or if we're doing a lab usually the day before they've had to prelab.... (1L23)

She also tried to involve all students in class discussions both teacher and student led (2L12; 3L4). She involved students using a variety of question and answer techniques (Field notes of Observation 1, Field notes of Observation 3), but always maintained control. Though a few students tried to dominate classroom discussion, Lynn would not allow it: "the main thing I

do on a daily basis is try to acknowledge people that have the answers.... And I'll wait however long it takes to get other people to offer in discussion" (2L12).

As well as activities, Lynn varied her classes by including a "Socratic lesson," however, instead of dictating or writing notes for students to copy, Lynn attempted to draw the note from the students. She accomplished this through the use of questions and answers and class discussions.

> And a Socratic lesson with a note is typical and often demos interspersed throughout. I take care too as I write notes I hate having the notes prewritten. I basically draw the note from them. So very often I'll start a sentence and then I'll start asking questions to sort of draw concepts... and then as we draw them from the class they get up on the board. So, in a way they're having input into this note, it seems, though I know everything that's going up there. But I really try to keep them involved the whole way. (1L23)

Lynn encouraged her students to "be successful all the time." She did this by creating a comfortable environment, talking to the students one-on-one, and talking to the parents when necessary (2L9; 2L12; 2L13). "And so I really try to reinforce that [being successful] and encourage them to come for help and encourage them to get their work done and call home when it's not" (2L9).

Lynn also said she liked to:

> Talk to them one-on-one like, "you should go ahead and give that answer, you know, I know you have this done, go ahead I'd love to hear." And you know, encourage them a bit on the side. But, you don't want to embarrass anyone. (2L12)

Besides varying classroom activities, Lynn also accommodated individual students by supplying enrichment material (1L9), using materials and methods suitable for individual student ability (3L4; 3L6; 3L9; 3L11), being sensitive to particular learning disabilities (4L8), and

providing a copy of the notes (4L8) as necessary. Lynn also had different expectations for different students; "But for different students success is really quite different... Is able to work to their potential whatever that is" (2L11).

Lynn involved students in their own learning: "But I really try to keep them [the students] involved the whole way" (1L23). She made her lessons fun, and interesting to her students, and in this way hoped to motivate her students to reach their full learning potential, whatever that might be for each student (1L23; Field note of Observation 1; 2L1; 2L3; 2L4; 2L7; 2L13; 3L6; 3L7)

Lynn created an environment where everyone was comfortable and able to learn but she was also willing to provide an alternative environment if needed:

> I'm serious about this, I am here to help you be successful and you will do the work in class and if you do not do the work in class or, in class primarily, I will find an alternative setting for you to do the work.... And might send them to, there is something called the resource room where they can go and they are monitored by a teacher and they tend to get right down to it when they get down there. Or I'll send them to another classroom, maybe something that I have arranged previously with another teacher, OAC calculus class or something. (2L15)

Lynn thought routine important in her classes. By following a particular routine, students could anticipate what would happen next and be prepared for it, for example, "I would come in I would ask them to get out their homework, typical routine, they know I'm going to be taking out the homework. They get out their homework, they often have questions before I even start" (1L23).

<u>"I'm really feeling burnt out".</u> The government in power in Ontario at the time of this research made many changes within the education field. These changes included more teaching time for teachers, fewer administrators including heads of departments, and less in-class support for teachers and students by reducing the numbers of adolescent care workers and educational

assistants. In addition, a new curriculum was introduced with one year to prepare. This research was conducted during the first year the new Grade 9 curriculum was being taught.

Lynn really enjoyed teaching, you could see it in her enthusiasm during her lessons, but she said that she was "really feeling burnt out" because of all the support cutbacks and all the extra duties now being placed on the classroom teachers.

> But, with government cutbacks we're really feeling the pinch. There are many fewer EA's, educational assistants, in the school. I think maybe they were cut in half.... That really hurts in the classroom. And class sizes have gone up. We have fewer administrators because that has been cutback, administrative money has been cutback. So, sending kids for discipline is not as easy because we just don't have as much time for the administrators. The administrators we don't have. Guidance has been cut way back. So, supports for... We're really feeling that there's less support all the time.... So, all over the place, from all these different levels the classroom has been affected in terms of support.... I'm really feeling burnt out. (1L22)

When asked what could be done to make her job a little easier, she replied,

> Have more planning time.... reasonable class sizes.... I think being able to get out and see other teachers teach and get new ideas and we don't really have the opportunity for that and our professional development time has been cutback. There's less time to communicate with other teachers. And it's a real shame because there's a lot, to keep yourself sort of, enthused and creative you need to communicate with other people, I like to see what other people are doing. And I find, our department here is so spread out, I don't get that interaction even with my department very much which having been in several schools, that's really valuable, talking to other people on a regular basis about what you are doing in your class and how you're handling certain students and sort of ongoing casual

> conversation. I would like to be able to network with teachers more... There are lots of little things, I wish I had more time for, I guess you could call it professional development. More research outside of class, more stuff that might not be directly linked to what I am doing but can enrich the classroom. (4L4)

Summary

In summary, Lynn liked to maintain control in her class at all times. She liked getting to know her individual students so that she could learn their strengths and needs and be sensitive to any learning disabilities and gifts. She had clear expectations for herself and her students and liked making the material interesting, relevant, and suitable for their abilities. Lynn structured her lessons to follow a routine so that students could anticipate what would happen next in her lessons. She consciously used activity-based lessons and inclusive practices (for example, the use of enrichment material) because of the multiple ability levels of her students. She created a supportive environment from the first day, modelling accepting behaviour and not tolerating teasing or name-calling. The factors important in deciding what and how Lynn taught were: the curriculum, the textbook (if the curriculum was new), student ability, collaboration with other teachers, her past experiences, and her comfort level with the class. She then taught those chosen topics using a variety of strategies, for example, videos, worksheets, student presentations, and interactive discussions and demonstrations.

Gary

In this section I discuss first the general pattern of Gary's teaching that I saw during the three classes that I observed. I then discuss the themes that emerged from Gary's data. I conclude this chapter with a summary of my data analysis.

Introduction to Gary

Gary had been teaching science and math for 30 years. Gary's initial interview and first observation were in December; the second and third observations and follow-up interviews were in January following the Christmas holidays. In December, I observed Gary's Grade 10 class

which was during the second period and I conducted the interview after his last class for the day. In January, I observed two lessons of Gary's Grade 9 class, these classes were during Gary's final period for the day so our follow-up interview was directly after the class. Again, all interviews were between 45 minutes to one hour.

Gary's lab was similar to Ellen's except it contained 18 double lab benches and no long benches. There was a board and a screen at the front of the room, a sideboard on the left and windows on the right. On the back-bench next to the window there was an aquarium with one fish and some plants. The teacher's bench was at the front of the room and was raised. In front of this bench, to the side of the classroom was the teacher's desk. There were 30 students in the Grade 10 class, two of them had been identified with learning disabilities but Gary did not know the name of the specific disabilities. Of the 34 students in the Grade 9 class there were five students identified with learning disabilities.

Gary's Teaching

As with Ellen and Lynn's classes Gary started his classes by settling the students. He did this by waiting a few minutes until the majority of the students had entered the class and then told them they were going to begin. After saying what they would be doing that day and how that material related to their last class Gary then usually began his classes either with a demonstration where he asked students to predict what would happen and then they discussed the results, or by correcting homework from the previous lesson. Gary's lessons were a combination of demonstrations, labs, group activities, and note writing. His classes were very interactive, even when students were taking notes; Gary first asked students questions to ascertain what they already knew. When Gary wrote the notes on the overheads, unless students had not said anything on the topic he wrote what students were saying, frequently, then verbally expanding on their ideas. When students did not respond to Gary's questions, instead of telling them a response he prompted students until they started responding.

During demonstrations Gary again encouraged active participation of students. He asked students to predict what would happen, then he performed the demonstration, and students offered explanations of their observations. Gary performed several demonstrations, and even when some demonstrations did not go as planned he used that opportunity for students to explain why the demonstration did not work as predicted. Both Gary and the students appeared to enjoy the demonstrations: Gary was very enthusiastic and energetic, and the majority of the students asked and answered questions and participated.

While students were conducting experiments, writing notes, or doing their group activities, Gary moved around the class checking with all students throughout the lesson. I noticed in the Grade 9 class that Gary concentrated on a particular group of students, checking with them more frequently than with any other group in that class. Before dismissing students Gary got the attention of the class, ensured they knew what to do for homework, and ensured that their areas were cleaned up. He then dismissed them.

It appeared that Gary had a great rapport with his students, they usually chatted to him on the way in and out of class and Gary did joke around with students but all seemed to know there was a time and a place for joking. Though students joked individually with Gary, they were well behaved during class. Gary seemed to have control of the class most of the time. The Grade 9 class talked more than the Grade 10 class and Gary had to remind them more often to stop talking, but when he told the class or an individual to be quiet, there was compliance.

Gary's Themes

The themes that emerged from my observations and interviews with Gary were: (a) teaching characteristics, (b) factors important in deciding what and how to teach, (c) classroom management, (d) view of success, (e) strategies in inclusive classes, and (f) feelings about teaching.

Gary characterises his teaching. Gary said that he liked to teach to his own

interests and strengths: "I go with my strengths, things that I am interested in, things that would have lots of stuff that I think those kids would relate to, and you can avoid repeating what they've already done before" (2G5). He also liked to teach what his students were going to relate to, "I rather do it that way [activity oriented], you know, like I could stand up here and I could just write notes and stuff but that's not very exciting, you know, for me or for them" (4G11).

Gary gave several reasons that he preferred to work with small groups and individual students and to teach activity-based lessons whenever possible.

> If they're doing something on their own like a lab or like a worksheet or whatever, then I can be out there [points to the desks] and not up here [points to the front of room] and then I can relate more one-on-one and I can help them individually. And I like that better, but I don't always get to do it as much as I like to. I don't think the kids like to have to sit there and listen to somebody up in the front all the time. And I don't like to stand here and talk all the time either. I can circulate and that, it's easier. Then you can hone in on specific things that they miss rather than, with the large group, you have to cover the whole thing. Parts of it are straightforward and parts of it aren't, but it's not till they actually get doing it that you find out where they get stuck and not everyone gets stuck in the same place. But that's just, that's what I prefer. (3G10)

Gary set clear expectations for his students and kept them "on track" throughout the lesson (Field notes of Observation, 1, 2, & 3).

> Yeah, I make a point of maybe every 15-20 minutes, I might even say the same thing but I know I don't catch them all, every time I say it, just sort of to keep them on track, and you know this is where you should be at and this is where we're going next. (3G3)

Deciding what and how Gary would teach. The students' previous knowledge, his interests and strengths, the students' interests, and the curriculum influenced what Gary taught (2G4; 2G5; 4G5). "I guess in some courses, especially the basic level ones you tend to build on what they've [the students] done before" (2G5). Gary liked to teach topics that he felt he had a strong background in and those topics that he was interested in and to teach topics of interest to his students and topics that they could relate to (2G5). He was also aware of the material that students should have been previously taught and would try not to re-teach it. Gary knew that he had to follow the curriculum even though not all of those topics were of interest to his particular group of students: "Now, not all of the stuff is fun and I have to follow the curriculum and what not" (2G4).

> Gary felt that the ability and reliability of students in his classes affected how he taught: I guess you have to gear it to the ability of the kid. You know if it's like a writing assignment you gear it to their level and ability of writing. I guess you base it on attention span, like how much can you do in a given amount of time and they are going to absorb it. (3G10)

He said that he taught using more "hands-on stuff" when his students were reliable (2G5). As well as student ability, the number of students in the class, and the particular group of students also influenced the strategies Gary chose:

> Yeah, I think, and it really has been unfortunate with this large group, but I tend to try to avoid this me at the front kind of stuff with the junior classes. I want to do more hands-on stuff and I want to do more one-on-one stuff, because I think that's much more effective. But sometimes you're really handicapped. And even if the group was a little bit smaller this group is probably unfocused enough that you'd still be putting out the brush fires, you can't sort of leave three quarters of the class to work while you're helping, one little corner of the room, and then

> move around and have everybody kind of stay busy as you're moving around, that wouldn't happen with this group. (4G10)

Gary liked students to be active and work in small groups:

> I'm a bit frustrated with this new curriculum because it lacks hands on. Now that doesn't make it easier to teach but it makes it, from my perspective it makes it a better course. If it's more experimental and the kids are doing more rather than listening to it. (4G11)

Collaborating with other teachers was also important to Gary. He liked to share methods and ideas with other science teachers:

> And in a small school like this one you don't have anybody else to ask either. I'm the only guy that does chemistry. And when we had 3 of us in the building you could always bounce stuff off one another. You know, you come across a new kind of a problem and you didn't know how to do it cause you hadn't done it since you were an undergraduate, you know, 25 years ago, you could ask. You know, I'm it flying by the seat of my pants. (4G8)

He also found collaborating with other professionals energising and useful to learn new ideas.

> Yeah I must say and when we do get together ... there's almost an electricity. Like this astronomy session they ran out at [name of high school] they had, they took 2 science teachers from every high school so there were maybe 16 or 18 of us there... So that was a long session and we had dinner and it was really kind of neat and there was all this interaction from people that you see once every 3 or 4 months at meetings of science teachers or PA days where it happens to be subject oriented. But even those don't happen as often as they used to it seems. (End of interview 4)

Gary's experience had affected what and how he said he taught. "I think, maybe I do some things automatically and I don't do them consciously anymore. Because I certainly don't

approach 2G's [Grade 10 general] the way I approach OAC's so..." (2G8). He also said that he does not rely on the textbook now as much as he did when he began teaching:

> So, you'd probably rely on the textbook. And, sometimes that's okay and sometimes that's not great.... And I'm to the point now that I don't really use the textbook very much at all. Because I've kind of, over the years I've pulled stuff out of a whole lot of different books and now I have kind of a file of things that I like to do and I know they work, get the point across and the bugs have been worked out. (4G8)

Classroom management. From my observations, classroom management was not an issue in Gary's classes. This could have been due to Gary's 30 years of teaching experience and to some things that he now does automatically and is no longer aware that he does (2G8). The lack of problems may have also been due to Gary's strategic seating plan:

> But I did try some different arrangements just to, you know, get some trouble makers near the front, like these four guys [points to the four seats in the front to the left of the teacher] if they were at the back god knows what would happen, so they got front and centre. And I don't know, I played with that sort of thing early on. And I do that till I get to know the names. Once I get to know the names, it's okay. (3G9)

Gary did talk about "putting out brush fires" (4G10), but he avoided those problems by using effective strategies. For example with that particular class Gary said that group work was not effective, therefore, he did not use group work with that class.

When students did talk or did not pay attention, Gary would say the name of the student or students and continue with his lesson (Field notes of Observations 1, 2 &3).

Gary's view of success. Gary said that one factor he thought imperative to a successful teacher was someone who liked teaching: "I guess somebody who still likes doing it [teaching] because there's a lot of things in the system nowadays that wear you down" (1G12). He felt that:

"if you like teaching, most of the kids are fun to be with and interesting to talk to and do neat things" (1G13).

He said that a successful student was one who achieved his or her individual potential and that was not necessarily measurable by grades:

> Successful, I guess sort of the generic definition is one that gets over 50% in all her courses but I think there is more to it than that. I guess kids that want to learn, kids that care, kids that take a little pride in their work, there's a whole lot of things that make for a successful student.... (1G14)

Strategies for inclusive classes. Gary said he preferred a "hands-on" approach to science. He believed that the students learned more if they performed scientific experiments instead of only hearing about the results (4G11). Gary spoke many times about his preference for using a hands-on approach (for example, 1G9; 2G5; 3G5; 3G10: 4G5; 4G10).

Gary also used strategies that he thought his students would enjoy. He performed demonstrations that were visually exciting, for example with electricity. "Oh yeah, yeah, especially when you stick your elbow up to it and jump and squeal and anyway yeah, they [the students] sort of get a kick out of that" (1G12). Or he organised exciting labs for his students to conduct (4G11).

Gary liked to use different modalities when teaching and he preferred to teach small groups where he could spend more time with each student:

> The less time I spend up front and the more time I spend out there [pointing to the class] ah, with them doing stuff, the better. You know, whether it's a lab where they have equipment or whether it's worksheets where I can just circulate. That's why I like to have a little smaller group so I can get around and help them one-on-one... Now they might write down most of what you write down, but, I

guess I try to say it twice write it down once, then give them a worksheet and circulate. (2G6)

Some of the many strategies Gary used when teaching were; demonstrations, labs, note writing, videos, worksheet, questions and answers, and discussions (1G12; 4G5; Field notes of Observations 1, 2, & 3).

> Typically it might be a video, where the video would replace the lab, you know like an introduction and a worksheet, and take it up and, this one, this series we have on astronomy are quite short, so we've had a few days where we've run through 2 they're 11 minutes each. The sequence we've got. So we can get through 2 of those in a class quite nicely with a little bit of you know, preamble or postscript at the end. I do demonstrations, we do worksheets, we do a lot of different things. There's usually three, four or five different things. [goes to get his planning book] Let me see, okay for instance yesterday I had drawn a picture on the sideboard of lightning, like lightning cloud to ground, cloud to cloud, lightening rods, all that stuff. So, then what I did the next day, because we ran out of time because there was something from the day before, I set up the Van de Graaff generator with another aluminium ball beside it hooked to the taps and I had these big sparks jumping and I related that to the diagram. And then what I, after that to get into something a little more theoretical I walked them through a whole worksheet on gold leaf electroscopes, charging by induction, charging by contact, positive charges, negative charges, all the stuff to do with static electricity. (1G12)

Gary often used many of these different strategies within the same lesson: "You know, I think with these kids, like I was saying, I probably do three or four different things in a class a day" (3G10). Gary thought that varying the strategies he used would help maintain the students' interest and motivation:

> I find that very difficult with that kind of group of kids though. The long periods just you know, even when you try to do 2 or 3 different things, you lose them, then you have to try to bring them back, and then you lose them again and you have to bring them back. (4G2)

Beyond varying classroom activities, Gary also accommodated individual students by: photocopying notes (1G8), printing on the board and not using cursive writing (2G8; 3G5), using an Educational Assistant (EA) to write notes and tests for a student (3G5), choosing materials and methods to suit student ability (1G12; 2G5; 2G8; 3G2; 3G8), teaching holistically, not only teaching academics (1G14; 3G5; 4G9), and providing an alternative environment as necessary (3G4).

Throughout Gary's years of teaching experiences he has learned some other useful strategies that he used in his classes. For example, Gary now makes assignments "short and to the point" and had students hand them in that day:

> The thing is it has to be short and to the point, you have much better luck getting stuff in if it has to be handed in that day. Like if they have to hand it in tomorrow, they're going to lose it, they're going to forget about it, they'll have a hundred excuses. But if, not nearly as many will get done as if you have it in class, hand it in at the end of the period. It's done, okay. That works. The longer it's extended, the worse it gets. (4G7)

He also "walks students through" an activity before he leaves them to continue on their own:

> If it's a day where we're doing a lab then I just kind of go over what's involved in the lab, what we're looking for, where all the equipment is. And depending on the group I may sort of walk them through it, you know in terms of how difficult it is to do if it's not self-explanatory.... And then if there is time you could maybe go over the highlights of it and, get them to write a quick something up

> and hand it in. I find with those kinds of classes the only way I can get them to do anything is to say well you got to hand this in, and I'll mark it. (1G12)

Though Gary felt that not marking assignments would free up some of his time for planning, he felt that he learned valuable information about his students and about the success of strategies used.

> But the problem is, it wouldn't work cause it's the marking that enables you to figure out the kids. Like you get a handle on the kids' abilities and you also get a handle on what you didn't teach and what you did teach. There's a certain amount of feedback from the stuff you mark for your own benefit, but it's really how you get to know the kids. (End of Interview 4)

"The political situation in the province is pretty discouraging." The way Gary talks about teaching and the fact that he has been teaching for 30 years are indications of how much he enjoys teaching. However, as with Lynn he felt that the position the current government has taken regarding education was making teaching more difficult than it needs to be. Gary discussed many changes that the government had made that he did not consider positive: the changes in the curriculum (1G9; 4G8; 4G11), the semestering of the schools (1G9; 3G3; 4G2), and the large number of students in classes (1G13; 2G5; 4G10). Gary felt these factors added to the stresses already placed on a classroom teacher.

Summary

In summary, Gary really enjoyed teaching. He liked to teach material that was interesting to him and to his students. Gary's classes followed a routine, generally starting with an overview of that day's lesson and relating that to what they had previously learned. Gary's classes were very interactive and hands-on, with students performing exciting labs. Gary had clear expectations for his students and liked to keep them "on track" throughout a lesson. He liked getting to know his students individually and making the material interesting, relevant, and suitable for their abilities. He would accommodate individuals, for example, by printing notes or

providing alternative environments. He created a supportive environment by modelling accepting behaviour and not tolerating teasing or name-calling. The factors important in deciding what and how Gary taught were: his own strengths and interests, students' interests, students' previous knowledge, collaboration with other teachers, his past experiences, and the curriculum. He then taught those chosen topics using a variety of strategies, for example, videos, worksheets, labs, videos, and interactive discussions and demonstrations.

Summary

This chapter described the practices and themes of three inclusive secondary science teachers. Though all teachers in my research followed a routine, there was room for variety within the routine and though activities were well structured, student creativity was encouraged. All of the teachers were flexible and believed in knowing their students as individuals as well as knowing them as part of a group. This individuality helped make their classrooms inclusive by recognising that all students do not learn the same and being sensitive to students' needs and differences. Teachers accommodated individuals by using variety of teaching strategies, for example, using different modalities, providing enrichment materials or alternate materials to suit student learning needs, using small co-operative groups, and providing alternative environments. The teachers believed in inclusion and created supportive environments and made adaptations and accommodations to their lessons when necessary. Classroom management difficulties in Ellen's class made attaining a supportive environment difficult. In addition to being open to inclusion and using inclusive practices the teachers knew science. Again, Ellen knew science and knew some strategies to teach it but because of her limited experience she sometimes had difficulty choosing a strategy that would work for her particular students. Lynn and Gary had more experience and chose from a vast supply of resources, both material and knowledge, that they had built up over the years.

In this chapter I outlined the general pattern of Ellen's, Lynn's and Gary's

teaching. I then discussed the themes that emerged from their data. I focused on themes I felt were relevant to my study on practices of successful inclusive secondary science classes and why the teachers chose those particular practices. In the next chapter, I discuss the similarities and differences among the three teachers in my study, I then compare my findings to those reported in the relevant science and inclusion literature. I conclude my thesis with the contributions this study has made to the literature, the limitations, and implications for future research.

CHAPTER 5

DISCUSSION

Introduction

The purpose of this study was to explore the practices of teachers who, according to the principal and the head of student service, were exemplary inclusive secondary science teachers. By examining the practices of teachers who were successful in including students with learning disabilities into their secondary science classrooms I wanted to improve my own teaching practices and those of other practising or future inclusive secondary science teachers.

The three teachers in this research, Ellen, Lynn, and Gary were inclusive secondary science teachers. Each of their classes was composed of students who had a variety of levels of abilities. Though each teacher's practices were inclusive their classes had many differences as well as similarities. In this chapter I discuss the similarities and differences of the three teachers in my study. I then compare my findings to those in the relevant science and inclusion literature. I close with the contributions of my research to inclusive science, the conclusions, the limitations and the implications for future research.

Similarities

During my research I discovered that the three teachers in my study had several factors in common. They all created an accepting environment, accommodated individual differences, conducted activity oriented lessons, varied the strategies used, had some of the same teaching characteristics, and liked to collaborate with other educational personnel. I discuss each of these similarities in the following section.

Supportive Environments

All three teachers discussed and practised providing an accepting, supportive environment for all students (2E25; 2E26; 3E18; 1L10; 1L19; 2L18; 2L12; 2L19; 3L2; 4L1; 3G4). They ensured all students were comfortable physically, mentally, and socially by using mixed groupings, strategic seating, alternative environments, humour, and they all modelled

accepting behaviour. Though all of their classes consisted of students from a variety of cultures and of mixed ability, I did not observe any discrimination in the classes and all students appeared to be treated equitably. This does not mean that all students were treated the same as some were given special considerations (e.g., allowed to write tests in the resource room) so that they would have a fair chance. Classes appeared relaxed and the teachers had a good rapport with students, this added to the supportive environment. Though Ellen had some difficulty attaining a supportive environment she knew it was important in order to achieve an inclusive class. This was one inconsistency between Ellen's beliefs and practices as discussed in the consistency section later in this chapter.

Accommodating Individual Differences

The second similarity among these three teachers was that they all used strategies to accommodate individual students. Though all of the strategies were not the same they did all use strategies that would accommodate individuals and they all expressed a preference for working with individual students to discover their strengths and weaknesses. For example all three teachers discussed: providing alternative environments when necessary for students (3E18; 2L15; 4L1; 3G4), using co-operative groups (1E17; 2E22; 3E7; 1L19; 3G10; 4G10), using different modalities to teach (Ellen Observation 1; 1L23; 4L5; 1G12), using material to suit student ability (3E5; 3E12; 4E7; 3L4; 3L9; 3L11; 1G12; 2G5; 2G8; 3G2; 3G8), and using "hands-on" activities (4E4; 1L19; 4G10). Each teacher let students who needed an alternative environment write their tests in the resource room. They also taught using videos (for weak readers and visual learners) and would use different textbooks depending on students' ability. Some other strategies discussed to accommodate students were: partner strong and weak students (1E12), write notes slowly on the overhead to allow all students a chance to copy them into their notebooks (3E14; 3E15), have different expectations for different students (4E6; 2L11; 4L1), supply enrichment material (1L19), motivate students by challenging them (3L3), teach holistically including social skills as well as academics (3L6; 1G4; 3G5; 4G9), have an EA write for students who are not able to write

(3G5), print (2G18; 3G5) and provide notes for students who had difficulty copying them (1G8; 4L8).

Activity Oriented Lessons

The third similarity was that all three teachers preferred to teach using activity oriented or hands-on lessons though they all stated that this was not always possible due to large class sizes or due to classroom management issues. They believed that because they learned better through activities so would their students (2E23; 3E7; 3E12; 3E14; 4E4; 1L19; 1L23; 3L9; 4L4; 1G9; 2G5; 3G5; 3G10; 4G5; 4G10). Ellen also mentioned that she had read that students with learning disabilities learned better through active lessons (4E4). Ellen, Lynn and Gary used a variety of activities, for example, labs, co-operative group activities, worksheets, teacher-led and student-led discussions, student presentations, and interactive demonstrations in which students would first have to make predictions and then explain observations.

Students Take Responsibility for Learning

The fourth similarity was that they all believed that in order for students to learn, the students would have to increase their responsibility for their learning (1E17; 1E18; 2E12; 2E16; 2L9; 4L7; 4L8; 4L9; 1G14). All three teachers were willing to help students after school but they all preferred that students approached them for help rather than the teacher asking the students to come for assistance. They agreed they would ask struggling students if they wanted to come for help but in general preferred to announce their availability after school and those who wanted extra help would take the responsibility to make an appointment.

Strategy Variety

The fifth similarity was that Ellen, Lynn and Gary all preferred to use a variety of strategies when teaching (Ellen Field notes of observation 1, 2, & 3; 4L5; 1G2). They all believed that this technique maintained student interest and motivation to learn. Some of the strategies that they all used were: small co-operative groups, activity-based lessons including labs and not just "hands-on" but also "minds-on," the use of different modalities in all their lessons but particularly

when giving notes, large and small group discussions, demonstrations, high student involvement during any strategy, prompting students to answer questions instead of giving answers, videos, and worksheets. Since lessons were 76 minutes long the teachers thought it especially important to change activities frequently to maintain student concentration on a task.

As well as varying the activities to maintain student interest and motivation, Ellen, Lynn and Gary also believed that variety was important to suit the different learning styles of each student. The more the variety in strategies the better the chance of teaching all of the students at least some of the time. For example, auditory learners as well as students with reading disabilities may prefer videos to reading their textbooks to acquire information. And, by following a video with either a small group activity, a worksheet, or a class discussion a teacher can increase the use of different modalities and increase students' involvement in the activities.

Teaching Characteristics

The teaching characteristics that these three teachers had in common were that they were all flexible, they worked with individual students, they had clear expectations for their students, they liked to make the material interesting, relevant and fun for students, and they liked to be "ultra-prepared" for their classes. Another characteristic that all these teachers had in common was their enthusiasm for teaching. Though they each had their frustrations, especially the political situation at the time of this research, they all loved to teach science. Gary said it well when he defined a successful teacher, "I guess somebody who still likes doing it [teaching], because there's a lot of things in the system nowadays that wear you down" (1G12).

Collaboration

All the teachers in my research also thought that opportunities for collaboration with educational staff were vital to inclusive science education. Ellen liked to collaborate to get new ideas to help her with pedagogical content knowledge. She wanted to learn techniques that other teachers found successful so that she could try them in her own classes (2E10; 2E25; 2E27; 4E5). Lynn and Gary liked to collaborate with other teachers to brainstorm new ideas and techniques

(4L3; 4L4; 4G8; End of Gary's interview 4). All three said that collaboration was invigorating and generated new ideas. They thought it important to discover strategies and practices that other teachers found to be successful and to share what had been successful for them.

Differences

Though the teachers in my study had many teaching behaviours and characteristics in common there were also several differences. The main differences that I discovered were: classroom management, consistency, follow-up, pedagogical content knowledge, and reasons for making adaptations and accommodations for students.

Classroom Management

The most obvious difference among the three teachers that I noticed during my research was the amount of time Ellen spent managing her classroom when compared to Lynn or Gary. As I discussed in chapter 4, Ellen felt that she spent too much time trying to control the class and this allowed less time for the teaching of science (1E16; 2E24). Though she had planned to use many inclusive strategies to teach new concepts, due to the students' behaviour she often changed her plans and gave the students notes saying that task "keeps them relatively quiet" (2E23). Though Gary and Lynn both discussed the difficulties controlling the grade 9 classes, during my observations they both spent very little time on classroom management. They may have said a student's name and asked them to be quiet or to leave the room, but then they continued with the planned activities. And if they spoke to a student to ask him or her to behave, the student was only spoken to once. Ellen often had to speak to a student several times to ask him or her to be quiet.

Classroom management has been found to be a common trait of exemplary teachers (Tobin & Garnett, 1988). Exemplary practice does not involve giving most of one's time to controlling the class.

Consistency

A second difference found during my research was the consistency of the teachers; consistency in belief and practice, and consistency within practice. Though Ellen believed in inclusion and planned activities to include all students, as discussed above, she would often change those activities to ones in which the students would be quiet. Examples were taking notes or doing a written worksheet, which were not necessarily inclusive activities as students who have difficulty reading or writing would have difficulty with those activities. Because of student behaviour there was sometimes an inconsistency between Ellen's beliefs and her teaching methods. There was also an inconsistency in Ellen's classroom management practices, for example, sometimes Ellen would enforce her rule "no speaking without raising your hand" and sometimes she would not. I could see no pattern in when she would listen to a student who had not raised a hand and when she would not listen. In contrast, Lynn and Gary were consistent in their practices especially in their classroom management. Students were allowed to speak to each other during group work but not during whole class activities, and students had to raise their hands to speak to the whole class. These rules were always enforced during my observations.

Though both Lynn and Gary discussed many frustrations with teaching, their practices were consistent with their beliefs. Both believed in inclusion and they used inclusive strategies because they did not have classroom management problems. They also both believed in making science fun, relevant, and exciting to students. By using interactive discussions, dangerous looking demonstrations, and activities, their practices matched their belief. I think Ellen shared this belief and at times did achieve this in her activities, but again these often failed because of classroom management problems.

Follow-up

A third difference in the participants is in the extent to which they used follow-up. Lynn thought follow-up was very important in establishing a relationship with her students. If she said a student would have to leave her class because of behaviour, then if that behaviour was exhibited

that student would be asked to leave the class. Lynn may have asked them to step into the corridor until she had the time to talk to them, to go to the resource room, to go to the vice-principal's office or sometimes Lynn had arranged for students to go into another classroom (2L9; 2L12; 2L15; 3L6; 4L1). During my observations I did notice that Lynn had sent three students out of the classroom into the corridor, but she did not interrupt the rest of the class to do this. Then, when all the students understood their present activity and were busy, Lynn stepped out to talk to the students and then they all returned to the class. Neither Ellen nor Gary discussed the importance of follow-up to them, nor did I see any evidence of follow-up during my observations of their teaching.

Pedagogical Content Knowledge

The fourth difference was in the amount of pedagogical content knowledge. As a result of Gary's 30 years of teaching experience, he had a vast resource of strategies to use and knew when to use them. In contrast, Ellen had just begun her teaching career and had yet to build up a large resource of strategies to have at her disposal. She knew what she should be doing and had the science content knowledge but was unsure of how to best teach the information. Lynn had seven years of teaching experience and had managed in that time to build a resource of strategies, she also knew when and how to use a particular strategy.

My data analysis showed that teachers need to have qualities of both a good science teacher and a good inclusive teacher to include all students and provide the opportunities to learn science. Or plenty of opportunities to learn science may be provided but students with learning disabilities may be excluded. From my observations and interviews my premise appears correct: an exemplary science teacher is an inclusive teacher, and to be a good science teacher, teachers need to know not only science content and processes but also how to teach the content and processes. If the ability of students is not taken into account, then lessons will not be of much value. However, the converse is not also true; a good inclusive teacher may not necessarily also be a good science teacher because he or she may lack the content knowledge to facilitate learning

of science. Exemplary teachers possess pedagogical content knowledge as well as content knowledge; it is not enough to know the content of an area. Research has shown that one must also know the best methods to connect this content with the prior knowledge and abilities of the students or learners (Shulman, 1986; Shulman, 1987; Shulman & Quinlan, 1996).

Of the three teachers in this research, two could be considered exemplary inclusive science teachers because they used inclusive practices to include all students in their classes and they provided the opportunities for all students to learn science. The third teacher, though using inclusive strategies, was not an exemplary inclusive science teacher because she lacked the pedagogical content knowledge and resource base to provide students with the variety of strategies necessary to learn the science content.

Reasons for Adaptations and Accommodations

The final difference between the teachers in my study was the reasoning behind making adaptations and accommodations for certain students. Though they all used disability specific teaching strategies and would therefore adapt their lessons or make specific accommodations, their reasons for their decisions varied. Both Lynn and Ellen had knowledge of exceptionalities and had studied exceptionalities within their teacher education. Gary had been teaching for 30 years, and though he knew that students with learning disabilities learned differently he could not supply a definition of learning disabilities when asked. Ellen and Lynn discussed information they had read on how students with learning disabilities learn. For example, Ellen said that research suggests that students with learning disabilities learn better through hands-on activities. Though Gary accommodated individual differences, he tended to do so because those accommodations had worked for him in the past, not necessarily because a student was identified with a learning disability. He did not view the identification of students as important (3G9). He said that whether students are identified or not is not as important as dealing with the particular strengths and weaknesses that individual students had which may not necessarily be caused by their ability to learn but may be due to their life situations (3G9).

Summary

In summary, though I started my research observing teachers recommended to me as exemplary secondary inclusive science teachers I discovered that two of these teachers were exemplary inclusive science teachers while one was an exemplary inclusive teacher. Because of lack of experience causing a reduced resource base and thus a reduction in pedagogical content knowledge this one teacher was teaching reduced science content in the class I observed. From my observations, it appeared that she was following the same practices as the other two teachers. The preceding discussion highlighted that she does have many factors in common with the exemplary teachers such as varying strategies, accommodating individuals, and being flexible. She also shared many of the same beliefs such as including all students, and making material interesting and relevant. However, the major differences were the amount of experience and the classroom management skills.

A Comparison with the Relevant Literature

The preceding section compared the findings of the three teachers in my research study. I now compare those findings with the relevant literature discussed in Chapter 2. Combining the findings from the literature on inclusive secondary science teachers' best practices, secondary science teachers' best practices, and inclusive non-science teachers' best practices, an exemplary inclusive secondary science teacher would practice the seven factors of successful inclusion. In addition to applying successful inclusion practices an exemplary inclusive secondary science teacher would understand the needs of individual students, have effective management skills to maximise student engagement, use a variety of strategies to encourage student participation, encourage scientific process through inquiry and questioning, build on students' previous knowledge, increase cognitive demand, and teach metacognitive strategies so that students could take a greater responsibility for learning. Further, teachers should remain flexible in both practices and beliefs. In this section I discuss how the practices of the teachers in my study compared with the practices of exemplary inclusive secondary science teachers.

The Seven Factors of Successful Inclusion

According to a series of studies, there are seven variables associated with successful inclusion of students with disabilities. They are: (a) administrative support, (b) collaboration with special education teachers and staff, (c) supportive classroom environments, (d) activity-oriented science programs, (e) effective instruction following the SCREAM variables, (f) peer assistance, (g) and disability-specific teaching skills (Scruggs & Mastropieri, 1994a; Scruggs and Mastropieri, 1994b; Mastropieri, Scruggs, Mantzicopoulos, Sturgeon, Goodwin, & Chung, 1998). Both the inclusive literature and inclusive science literature emphasised the importance of following these seven factors for successful inclusion. The three teachers in my study taught at the same school within the same department and therefore received the same amount of administrative support. According to these teachers, though administrative support was reduced because of government cutbacks, the school administration did what they could to support teachers. The teachers agreed that support was necessary to successful inclusion and that the government cutbacks were making their job of including all students more difficult then they thought it should be.

The second factor of successful inclusion was collaboration with special education teachers and staff. All three teachers also discussed the importance of collaboration between school personnel. Though they met with the head of student services and special education to discuss exceptional students and they collaborated with other teachers when possible, all my participants felt a need for more collaboration among science teachers. Again, because of government cutbacks there were fewer opportunities provided for professional development and peer collaboration.

The third factor of successful inclusion was providing a supportive classroom environment. As I discussed earlier in this chapter Ellen, Lynn and Gary saw the importance of providing a supportive class environment so that all students felt physically, mentally, and socially comfortable. Though Ellen experienced some difficulties maintaining this environment

because of behavioural problems, she did discuss the importance of a favourable learning environment.

The fourth factor was teaching using activity-oriented science programs. When reviewing the practices of the three participants in my study, I noted that all three of the teachers preferred to use activity oriented lessons, however, all three would sometimes forego activities because of large class sizes or disruptive student behaviour. This was a tension between belief and practice with the teachers: they believed in the use of activity oriented lessons but frequently felt they could not use hands-on activities because of lack of control of the students.

The fifth factor was effective instruction following the SCREAM variables (Structure, Clarity, Redundancy, Enthusiasm, Appropriate pace, and Maximum engagement). Though none of the teachers in my study specifically discussed using the SCREAM variables, they did talk about the importance of providing structure and routine in their classes. Ellen gave an example of a strategy she was trying to keep an appropriate pace as her students told her she was giving her notes too fast. Ellen tried to write each word on the overhead very slowly so that all students were writing the same word at the same time (3E14). None of the teachers specifically mentioned redundancy but both Lynn and Gary discussed presenting the same information in several different ways and several different times, in hopes that through repetition the students would learn the information. All of the teachers discussed the importance of enthusiasm in their subject matter and Lynn said that she also tried to instil that enthusiasm in her students (4L6). They all emphasised that they preferred to teach material that was fun and relevant to students to maintain student interest. Though they did not say they were maintaining interest to maximise student engagement, according to Fink (1996) and Freeman and Hutchinson (1994) students are engaged when learning material that is fun, accessible and relevant to them.

The sixth factor of successful inclusion was peer assistance. Peer tutoring and peer assistance through small group work were emphasised by all of the teachers in my study. Because all of their classes consisted of students with varying ability levels Ellen, Lynn and Gary said they

used peers to help out when they could. Ellen discussed strategically partnering students so that their strengths and weaknesses complimented each other (1E12). She would do this with both in-class assignments and large take home projects. Lynn used small groups of students to help each other especially in social skills. Gary used peer tutors to help students. He assigned one peer-tutor to one particular student who was identified with learning disabilities and had difficulty with reading. The other two peer tutors moved around the class assisting all students.

The final factor discussed in the literature for successful inclusion was the use of disability specific teaching strategies. All the teachers used disability specific teaching skills. For example, Gary discussed printing because one of his students could not read cursive writing (2G8); Lynn used small co-operative group work to increase the social skills of one of her students who had a learning disability (3L6); Ellen allowed one of her students to write his tests in the resource room because of an anxiety disorder (3E18). Though the reasoning behind their choices differed as I discussed above, they all did use strategies to maximise student learning.

These were the factors necessary to successful inclusion of students in a regular class. I next discuss factors necessary to successful inclusive science as discussed in the literature.

Other Factors for Successful Inclusive Science

To be a good inclusive science teacher, teachers needed to know their students' strengths and weaknesses as well as how their students learn best (National Research Council, 1996; Penick et al., 1986; Williams & Hounshell, 1998). Using this knowledge of student learning strategies, teachers could then choose appropriate methods to instruct. All of the teachers in my study talked about using strategies to know their students better individually because this helped them teach the class more effectively (1E17; 2G6; 3G10; 4G10; 2L7; 2L9; 4L9).

The three teachers in my study followed the variables for successful inclusion. However, there was a difference in effective classroom management. When looking at classroom management there was a variety of levels of effectiveness. Lynn maintained control in her classes possibly because of her belief in and practices of consistency and follow through. Gary also had

strict control of his classes and I did not observe any classroom management problems while I was in his classes. In contrast, Ellen had many difficulties in the area of classroom management and on occasion did not maintain control of the class. There was considerable research stating that effective management skills were a major contribution to exemplary teaching, much of the research I cite was in science (for example, Deacon, 1987; Garnett, 1987; Garnett & Tobin, 1988; Scruggs, Mastropieri, & Boon, 1998; Tobin, 1987; Tobin & Fraser, 1989; Tobin & Fraser, 1990; Tobin & Garnett, 1988; Tobin, Treagust, & Fraser, 1988; Treagust, 1987; Treagust, 1991). Because Ellen could not effectively control the classes that I observed, she could not use the strategies, adaptations, or accommodations she knew were necessary to teach the science content to all of her students. There was a definite tension between what Ellen wanted to do and what she could do in her classes. In our final interview Ellen thought that she needed to follow through in her discipline of students. She said that even some of her students had told her that she made "empty threats" and they knew she would not follow through on them, for example threatening to send a student to the vice-principal because of behaviour but never sending him. Ellen said she was presently trying not to make threats that she did not follow-through. She said she was also working on her consistency of classroom management.

Along with effective management skills there was also substantial research on the importance of using a variety of strategies in the inclusion and science literature (for example, Bateson et al., 1991; British Columbia Assessment of Science 1991-Technical Report 1; Fairbrother, 2000; Mitchell, 1992a; Rief & Heimburge, 1996; Strange & Bol, 1996). The three teachers in my study knew they should vary their strategies so that they could maintain students' attention and they thought that by using a variety of strategies, they could reach all of their students' preferred methods of learning. Lynn and Gary were more effective in varying their strategies due to effective classroom management.

For students to understand science they must understand the science process not just memorise scientific fact (for example, AAAS, 1989; Bateson et al., 1991; Deacon, 1987; Garnett,

1987; Garnett & Tobin, 1988; Tobin, 1987; Tobin & Fraser, 1989; Tobin & Fraser, 1990; Tobin & Garnett, 1988; Tobin, Treagust, & Fraser, 1988; Treagust, 1987; Treagust, 1991). This is especially true for students with learning disabilities (Mastropieri & Scruggs, 1994). In order to learn the scientific process students need to perform science not just read and discuss science. This supports an activity-based approach. One way in which the science literature suggested teaching science process is through inquiry and questioning. Though this method may effectively teach science processes, Mastropieri, Scruggs, and Butcher (1997) caution that inquiry approaches with students with learning disabilities often fail. In order for students with learning disabilities to be successful using this approach they must first be taught questioning techniques, must be in a supportive environment that encourages independent thinking, and the activity must be highly structured. The teachers in my study used inquiry techniques, but all that I observed were teacher-led and very structured. The inquiries that I observed were often in the form that the teacher presented a problem and the students in the class would have to solve the problem through questioning the teacher and other students. Gary also used demonstrations to encourage hypotheses, predictions, and explanations.

Another method suggested in the relevant literature to increase students' understanding of science was to build on the students' previous knowledge (for example, AAAS, 1989; Monk & Osborne, 2000; National Research Council, 1996; Salend, 1998). This method is especially helpful to students with learning disabilities (Mastropieri, Scruggs, & Butcher, 1997). All of the teachers in my study always reviewed previously taught material and integrated new material. Before teaching a new unit or section Ellen, Lynn and Gary generally asked students questions in a teacher-led question and answer session to ascertain how much information students already knew on a topic. All teachers said they did not test for previous knowledge, but all were aware of its importance and used informal methods such as the question and answer sessions to determine student previous knowledge on a topic.

Ellen, Lynn and Gary preferred to teach material that was fun, interesting, and relevant to

their students. They also liked the material to challenge their students. According to the inclusion and science literature it is important to challenge students and to increase the cognitive demand (for example, Chiappetta et al., 1998; Deacon, 1987; Fairbrother, 2000; Garnett, 1987; Garnett & Tobin, 1988; Mitchell, 1992b; Penick et al., 1986; Tobin, 1987; Tobin & Fraser, 1989; Tobin & Fraser, 1990; Tobin & Garnett, 1988; Tobin, Treagust, & Fraser, 1988; Treagust, 1987; Treagust, 1991). When teachers lower cognitive demand and expectations, students will generally not strive to reach their potential if higher than that set by the teacher (George, 1974). The teachers in my study varied the demand depending on the student, thus trying to challenge students without intimidating them.

The PEEL project stressed teaching metacognitive strategies so that students could take a greater responsibility for learning (Baird, 1986; White, 1986) Other research has supported this finding, for example, Chiappetta et al., (1998) and Monk and Osborne, (2000). Though the teachers in my study wanted students to take a greater responsibility for their learning I did not observe or discuss any direct teaching of metacognitive strategies.

All the literature I read for this thesis emphasised the importance of flexibility for successful teachers. The teachers in my study exhibited flexible behaviour on more than one occasion. For example changing topic when they realised that most of the class was away for a basketball tournament, changing a lesson because the demonstration did not work as planned, or trying another teaching strategy because students did not understand the material being taught. These are only a few examples of the many flexible behaviours I observed during my research.

Summary

In summary, the three teachers in my study who were recommended to me as exemplary inclusive secondary science teachers held many of the same beliefs attributed to exemplary teachers and did perform many of the same behaviours. The main difference was in Ellen's belief and practice, and though she believed in inclusion and had many of the same beliefs as exemplary teachers discussed in the relevant literature, such as the belief that all students should be placed in

the least restrictive environment, that an accepting environment should be provided, that lessons should be activity-oriented, and that material should be relevant, interesting and fun, she could not put these beliefs into practice because of ineffective classroom management and a lack of pedagogical content knowledge. Pedagogical content knowledge might be increased with experience; for example, teacher education programs could increase practicum experiences so that novice teachers would start to build a resource of strategies during their teacher education.

Lynn and Gary's practice was more consistent with their beliefs. As a result of their experience and effective classroom management skills they could put their belief of activity oriented lessons and small co-operative group work into practice. As shown in the previous section, Lynn and Gary's beliefs closely matched those cited in the relevant inclusion and science literature.

Contributions of This Research to Inclusive Science Teaching

One thing I noticed as an inclusive secondary science teacher was that often when I was given advice by the special education teacher, the strategies suggested were impractical for a class of 25-35 students. I wanted to see what other teachers were doing and then see how their practices related to the current relevant literature. I noticed that the three teachers in my study exhibited many of the behaviours and characteristics of exemplary inclusive science teachers cited in the literature I discussed in Chapter 2, thus reinforcing this literature. They also used some strategies that the literature suggested were successful, but they found that some of those strategies were not always very successful in practice. For example, the literature agreed that small co-operative groups were good in science classes and in inclusive classes, however the teachers in my study were having difficulty using co-operative groups. Their students would not focus on assigned tasks and when put in groups chaos would generally result. Ellen and Lynn started using peer and self-evaluations to try to incorporate successful, productive use of co-operative groups. These evaluations included rating scales for the students to rate themselves and their peers on participation, productivity, co-operation, contributions, and level of focus

maintained (3E8, 1L19, 3L5). Both teachers reported that the use of these evaluations was quite successful in their classes. Gary did not discuss the use of peer and self-evaluations with me during our interviews.

Two techniques that the teachers used in my study with success, interactive whole-class discussions and demonstrations, were not discussed much in the literature though one of the exemplary teachers in the EPSME project successfully used interactive whole-class discussions. These techniques can only be successful if it is the whole class participating and not just a few target students answering the teachers' questions. In the interactive discussions and demonstrations that I observed the teachers ensured that all of the students were participating in some way. With the discussions, the teacher generally started the discussion but then became a monitor with students both answering and asking questions. All students were participating by either asking or answering questions or adding their views on the topic. These teachers had developed a supportive environment for their students to participate without fear of teasing or taunting. All questions and answers were listened to and accepted. The teachers started developing this environment as soon as their students walked into class on the first day. Along with providing strong role models of acceptable behaviour, neither Lynn nor Gary allowed name-calling or teasing and treated all students equitably. If they did not see a student participating they would go to the student's desk to individually ask how the student was doing. During one of my observations in Lynn's class a student called another student a name. Without stopping the discussion, Lynn told the first student to "get out." When all students were participating, Lynn left the room to privately talk to the student that she asked to leave and after a few minutes they both returned. I also observed Gary tell a student that his behaviour was not appropriate when the student tried to dominate a discussion. I think it was very important that Lynn and Gary created such a supportive, accepting environment that allowed these discussions to take place. If the students were intimidated they may not feel comfortable participating in whole class events. The interactive demonstrations also worked well in both Lynn and Gary's classes. These types of

demonstrations made the students become active participants instead of observers. This encouraged scientific thought as recommended in the science literature discussed in Chapter 2. In addition to a supportive, accepting environment the teacher also needed to have control of the class for the success of these two strategies. This may be why this technique was not as successful in Ellen's class though she tried to use both strategies. In Ellen's class there were generally a few students that participated while the remaining students were off task, chatting.

Another factor not largely discussed in the literature was the need to teach holistically. In order to teach inclusively the teachers in my study taught life skills, and social skills as well as academic skills. This is an important element in creating a supportive environment especially for students with learning disabilities as these students often have difficulty with social skills as well as their academics. Only helping one area will not help the students especially in high school since a big part of high school is fitting in. If students with learning disabilities are going to fit in they need to learn social skills as well as the subject matter.

Conclusions

In conclusion, the purpose of this research was to view a sample of exemplary inclusive science teachers' practices to improve the inclusive practices of science teachers and to add to the small amount of literature on inclusive secondary science. According to the literature and my observations there is no one particular style of teaching or set of strategies that would make an exemplary inclusive science teacher. Lynn and Gary had many of the characteristics that the literature stated were necessary for exemplary inclusive science teaching. Ellen too had many of the characteristics but seemed to lack two that made a large difference in what she could do in the class. From my study, though it is important for inclusive science teachers to be flexible and want to know the strengths and learning styles of all their students, the factors that made the largest differences in my study were effective classroom management and pedagogical content knowledge. Though the teachers in my study were trained science teachers and knew science content, Ellen lacked knowledge of a variety of ways of teaching that content because of her lack

of experience. This does not mean that because a teacher has the experience, that teacher would automatically be exemplary, the other factors such as sensitivity to student abilities, are also important. This has implications for teacher education programs. Teacher candidates should have many opportunities to start to build a vast resource of strategies and also to learn the conditions under which to best use these strategies. For example, some teacher education programs now include mandatory courses on exceptional children and incorporate useful strategies for teaching a variety of exceptional students.

Throughout the literature variety of strategies was stressed as important; therefore, we can conclude that variety is one essential component to inclusive secondary science classrooms. Some components not common to the three sets of literature but that I view as important components are: to maintain high expectations for all students, to collaborate with special education personnel, to be flexible and provide a strong role model, to apply knowledge, to encourage student responsibility for learning, and to teach using the SCREAM variables (Structure, Clarity, Redundancy, Enthusiasm, Appropriate Pace, and Maximum Engagement).

Limitations

Though this research contributes to the research on successful inclusive practices in secondary science there are also some limitations. Since qualitative research examines naturalistic events it is almost impossible to replicate them exactly or generalise them across populations. However, the use of rich descriptions, for example, of the participants, of the researcher, and of the contexts, can inform the readers of the conditions under which the results were found and if those results would apply to their particular situation.

Next, I used purposeful sampling to obtain the participants in my study. Though, according to Patton (1990), and McMillan and Schumacher (1993), one can learn a great deal about the issues of importance by selecting a particular set of participants (in this case, exemplary inclusive secondary science teachers) the results do not provide information of the general population of teachers. However, my purpose was to observe practices of successful inclusive

secondary science teachers to benefit my practices and those of other pre-service and in-service inclusive science teachers.

What I Learned From the Study

As I have already discussed, I am an inclusive secondary science teacher and will be returning to teach in a high school in September. Before I returned to university to complete my Master of Education, I found teaching in large mixed ability classes challenging and I wanted to see what successful inclusive teachers were doing so that all of their students had the opportunity to learn. Through this study I found that when I return to teaching in a secondary school the first thing I will have to do to for a successful inclusive classroom is to create a supportive environment where diversity is welcomed. I will do this by beginning the semester with getting-to-know you activities and by setting up guidelines of acceptable behaviour with my students and of consequences if those boundaries are crossed. Once we have set up the rules I will be consistent with them and follow through with the agreed consequences. I will not tolerate teasing of student difference and will model enthusiasm for diversity.

My lessons will include of a variety of activities using a variety of modalities. I will learn my students' individual strengths and weakness and use strategies to enhance their strengths and to strengthen weak areas. Some of the strategies I plan to use are: small group co-operative activities, videos, computer simulations, labs, interactive demonstrations, interactive discussions, and a variety of assessments. I will also accommodate individuals and adapt my lessons as necessary.

The most important things I learned from this study were to create a supportive environment, to maintain control in my class, to be sensitive to my students' needs and to listen to how they say they best learn, and to get to know my students individually.

Implications

There are many implications for further research from this study, the most prevalent is the need for further research into effective science teaching in inclusive secondary classrooms

and what makes it effective. There have been several studies by special educators (e.g., Mastropieri, et al. 1998; Scruggs & Mastropieri, 1994a; Stohr-Hunt, 1996) of how to improve inclusive science classes, but there are no studies by science educators. There is one review in a special edition of Remedial and Special Education, 15 by science educators Doran and Sentman (1994), where the authors review methods for improving inclusive science education by special educators. The articles reviewed by Doran and Sentman were about the benefits of activity-based science programs versus text-based programs. The authors agreed with the special educators findings that activity-based lessons are better for all students and discussed science studies such as, AAAS, and the National Science Education Standards already discussed in this review that reported similar findings. Doran and Sentman suggested a need for collaborative research between science educators and special educators to really solve the dilemmas of effective inclusive secondary science. Though there are no studies of inclusive secondary science by science educators, there are definite commonalties between the best practices of science teachers and the best practices of inclusive teachers lending support to my hypothesis that successful science teachers of inclusive classes will use best instructional practices of both exemplary science teachers and exemplary inclusive teachers. However, research is needed in this area to further study this premise and discover the best practices of inclusive secondary science teachers.

Though I started this research with the purpose of studying the inclusion of students with and without learning disabilities in secondary science classes and not intending to study the inclusion of students from various cultural backgrounds, I found that when studying inclusion all forms are significant. To be inclusive, researchers have found that the environment should be accepting of difference, this would be difference in ability or difference in culture. I also found during my research that inclusion is giving or allowing the opportunity for all students to participate in classes.

These findings also have implications for teacher education programs to include courses that highlight individual differences, how to create environments where these differences are valued, and how to best teach these classes with a variety of individuals.

In summary, this research has supported my premise that exemplary science teaching is inclusive. In addition, my research has shown several useful strategies employed in successful inclusive secondary science classes. It has supported the findings of the science education literature and also the inclusive literature, but has also added strategies that have not been discussed in the literature. Future research could investigate the use of specific practices used in inclusive classes by science teachers and add to the small amount of inclusion research conducted in secondary science classrooms. An example of a follow-up study would be to research the use of suggested strategies (e.g., concept maps, graphic organisers, small group co-operative learning, computer simulations, interactive demonstrations, and disability specific strategies) and the usefulness of those strategies in a science classroom. Secondary science teachers would be asked to choose several strategies from a list of strategies described as successful in the science and inclusion literature and put those strategies into practice in their classrooms. Daily observations and interviews could describe the usefulness of implementing these specific strategies in different science classrooms. In this way, research can show the utility of specific inclusive strategies in science classrooms.

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Appendix A

Letter of Consent

I am asking you to participate in a formal research study I am to undertake to fulfil the requirements of the Master of Education program at Queen's University, Kingston, Ontario. Under the supervision of Professor Hugh Munby, Faculty of Education, I am completing a thesis that will involve the collection and analysis of original data collected through interviews with teachers and observations of their classes.

The focus of my research is the practices or teaching methods that teachers use in inclusive secondary Science classes to aid teachers currently in this teaching situation and to shape future teacher education programs. The research involves an initial interview and final interview and approximately three classroom observations, each followed by an informal interview.

The interviews will be approximately 45 minutes in length and will be audio-taped. I will prepare an exact verbatim transcription of the interview, concealing your identity by using fictitious names. I will also be asking you to allow me to observe you in the classroom at times that are convenient to you. Following each of these classroom observations, I would like to schedule an interview to discuss your perceptions of the class and the methods you employed. During the final interview, once all data is collected and analyzed, I would like to ensure that I have interpreted the data appropriately and that I have correctly represented the information you have provided. Participation in this study would require approximately four or five hours of your time outside of your classroom time over a period of about two months.

Each interview and observation will be conducted at a time and place agreeable to you and all information will remain confidential. The transcriptions may be discussed with members of my thesis committee for purposes of interpreting the data, but your name will not appear in the thesis nor in any publication. If you wish, I will provide you with a copy of all transcriptions.

In asking you to participate in this study, I am assuring you that the study is not a critique of your teaching methods, that you may withdraw from the study at any time without pressure and that I will protect your identity. At any time you may contact myself (533-7722), Hugh Munby, Faculty of Education (533-6260), or Rena Upitis, Dean of the Faculty of Education (533-6000 ext. 77238) for further information and concerns.

Student name: Karol Lyn Edwards

Signature:

Date:

Phone number: (613) 533-7722

If you are willing to participate in this study, please sign the following:

I have read the above description of the information of the informal research exercise and understand that I may withdraw at any time, that the information I provide will be treated as confidential, and that my identity will be protected.

Participant's name:

Signature:

Date:

Appendix B

Sample Question Guideline

Go through study, sign consent letter, check tape recorder

1. First, since I am not from [city name] could you tell me a little about your school e.g., total # of students, class size, typical day (length of periods and how many)?

2. What is your educational background?

3. What do you teach now?

4. How long have you been in this position?
   Have you taught other grades and or subject areas?

5. What grades do you teach now?

6. What subjects do you teach?

7. Do you consider your classroom inclusive? What makes it inclusive?

8. How are students with different needs identified in your school?

9. What is the average number of students in your class?

10. Do you have any exceptional students in your classes?

11. What kinds of special needs do these students have? Do these students have IEP's?

12. Do you have exceptional students in all of you classes? Is there a most common exceptionality in your science classes?

13. How do you typically plan for your classes? How much time is allotted in your timetable for planning?

14. What factors do you take into account when you are planning?

15. What supports do you have available with in the school system?

16. How would you describe a typical science class? Start when the students/you enter the class till the students/you leave.

17. How would you define a successful teacher? Successful student?

18. How do you know if a technique/practice is good or bad for your classes?

19. If I were a new teacher in your school and about to teach in inclusive classes for the first time, what recommendations or advice would you have for me?

20. What are 3 things that would make teaching _____ easier for you?