THE LIMITED SUCCESS STUDENT IN SCIENCE
A survey of current practices in teaching
junior secondary science in British Columbia
by
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ABSTRACT

The purpose of this study was to:

1. Determine the status of current practices used in the teaching of science to limited success students in B.C. junior secondary schools

2. Compare the current practices in B.C. with those advocated in the literature from other countries

3. Produce a set of recommendations for the improvement of science education for limited success students

A mail questionnaire was developed, based on the information gained in a literature review of the teaching of limited success students. The questionnaire was distributed to a selected sample of 336 junior science teachers in the Province of B.C. Eighty-two percent of the sampled teachers (299) responded to the questionnaire. Teachers responded to questionnaire items on: student grouping practices; class size; curricula; methods of content determination; approaches to learning; student evaluation; teacher background and teacher experience.

The results of the responses were reported as frequency of response and percentage response. Results provided
a picture of current practices in B.C. as perceived by the teachers sampled. A comparison was made between the practices currently in use in B.C. (as teachers perceived them) and practices advocated in other countries (particularly Britain and the United States) as reported in the literature review.

Based upon the comparison between current practices in B.C. and those practices advocated in the literature, three major conclusions were arrived at:

1. A significantly large population of limited success students exists in B.C. junior secondary schools.
2. A general awareness of the existence of a population of limited success students in B.C. is evident.
3. Few special science programs have been developed for limited success students in B.C. Most junior secondary science teachers perceive the present recommended curriculum to be largely inappropriate for instructing limited success students.

In addition to the conclusions listed above a further sixteen recommendations were generated relating to the following: science curriculum; teachers and school administration; teacher training and further research.
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The impetus for this study stems largely from the writer's experience as a junior secondary science teacher for a period of three years. During this three year period the writer instructed a number of "modified" science ten classes. The students in these classes were specially grouped for science due to their previous low achievement. These students had experienced "limited success" in science for various reasons and as a result showed both poor motivation and attitude. Standard teaching methods and curricula, used with some success with average and above average students, lacked effectiveness. Teaching style, curriculum, discipline, evaluation and homework required alteration to suit the abilities and nature of limited success science students. Much alteration originated by trial and error and from occasional assistance from more experienced teachers. At best, changes were based on intuition and the evaluation of these changes was highly subjective. Teacher training did not seem to adequately prepare for dealing with limited success students, special curricula seemed to be non-existent and related teaching methods were not evident.

The experience above prompted an examination of science education for limited success students. A literature review highlighted the paucity of research done in this area
in British Columbia (B.C.). Only one formal study related to limited success science students at the junior secondary level had been carried out (Quelch 1975). The literature indicated that, in Britain and the United States, the size of the limited success student population was in excess of 20% of the total school population. It seemed reasonable to assume that a population of this size also existed in B.C.

Given the nature of limited success students, their probable numbers in the school population and the lack of research done in B.C., it seemed appropriate to investigate the current status of science education for these students. By obtaining an overall picture of science as taught to limited success students in B.C., needs were identified by comparing B.C. with other countries where research on limited success students had already occurred. Recommendations based on these needs were generated to provide a basis for further investigation of science for limited success students in the province.

To conduct a preliminary examination of science for limited success students in B.C. a mail questionnaire was developed and circulated to a sample of junior secondary science teachers. Prior to the distribution of the questionnaire and prerequisite to its development, a review of the literature related to the limited success student was conducted. Chapter one summarizes the findings of the litera-
ture review. In chapter two the process of development, implementation and analysis of the questionnaire is presented. Chapter three outlines the results of the questionnaire response in tabular form. The conclusions and recommendations of the study are presented in chapter four.
CHAPTER 1:

Literature Review and Implications: Factors which may contribute to limited success and characteristics of limited success students; teaching methods for limited success students.

In this chapter the literature is reviewed to identify both the factors which may contribute to limited success and the characteristics of limited success students.\(^1\) In addition a review of teaching methods considered appropriate is presented from the literature.

A review of the literature related to limited success students and science teaching disclosed little empirical research. The few studies carried out in a systematic manner are specially noted in the bibliography. The remaining literature arises from analyses of practical experience.

\(^1\) The term limited success student was chosen to describe a significant number of students having a variety of problems affecting their learning in science. For the purpose of this study, limited success students are defined to be those students who achieve a consistent D or E average in science (or equivalent rating), or those students who are grouped specially for the purpose of science instruction due to their low achievement. While it is the intent of this study to examine science for limited success students, the review to follow is based on a more general view of the limited success student. It is assumed that limited success in science is the same as limited success in general as reported in the literature.
Extent of the limited success student population

Many authors, while not using the term limited success student, suggest that the population of such students is of a significant size and may comprise up to 20% of the total school population (Barbe 1961, Ferguson 1961, Page 1968, Nettleship 1972, Oxenhorn 1972, Gulliford 1975). Others estimate the population to range from 15% to 50% (Tanzer 1960, Witty 1961, Newsom 1963, Havinghurst 1969, Jenkins et al. 1973). These estimates are for Britain, the United States and Australia. It is reasonable to suspect that such a population also exists in British Columbia. Although there is no systematic evidence, the writer's four years of experience in British Columbia secondary schools supports the 15% to 20% estimates given in the literature.

Categories of limited success students

In the literature the term limited success student is not used by authors. A great number of descriptive terms have been generated to describe these students. The diversity of terminology used can be reduced by considering the characteristics of these students. Based on the

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1 Other terms used include: underachievers; slow learners; low ability students; disadvantaged students; students of low educational attainment; culturally deprived students; under-privileged students; discipline problems; non-academic students; terminal science students; potential drop-outs; early school leavers; non-certificate students; reluctant learners; non-college bound students; unmotivated students and low achievers.
characteristics examined it is possible to identify three major categories, the underachiever, the slow learner and the disadvantaged student.

The underachiever is usually identified by achievement below average in spite of his above average ability (Oxenhorn 1972). The slow learner is prevented from attaining average or above average achievement by limited mental capabilities or simply by learning at a slower rate than other students (Younie 1974). The disadvantaged student may be culturally, economically, socially or intellectually disadvantaged and is often classified as an underachiever or a slow learner (Reissman 1962, Younie 1974).

Since these students (underachievers, slow learners and disadvantaged students) are said to lack successful experiences in school it is likely that they are the students who are often specially grouped together for the purpose of science instruction or achieve failing grades in an ungrouped science class. Because underachievers, slow learners, and disadvantaged students have not experienced success in school, and as they are often grouped together or considered to be of a particular achievement level, the encompassing term of limited success student is used.

Factors related to limited success in school

The purpose of this section of the literature review is to examine the factors underlying limited success and the possible causal relationships of these factors from
the perspectives of the underachiever, the slow learner and the disadvantaged student.

In examining some of the possible causal factors related to limited success in school it is clear that the problems of limited success cannot be wholly solved in the classroom. However, it is tacitly understood that teachers who recognize some of these factors will be better able to implement any suggestions forwarded to help teach these students (Bricklin and Bricklin 1967).

The underachiever

As previously mentioned the underachiever is the student who achieves below his expected potential. Bricklin and Bricklin (1967) state that from 15% to 40% of all students fall into the underachievement category. Wellington and Wellington (1965) believe that over one-half of the underachievers in schools come from average or above average backgrounds socioeconomically. Fine (1967) emphasizes that underachievers come from all walks of life. If, as Wellington and Wellington state, over one-half of all underachievers do come from average or above average backgrounds it can then be concluded that the remaining underachievers are from more disadvantaged backgrounds. Weider (1973) supports the link between underachievement and being disadvantaged by stating: "Underachievement is usually accompanied with cultural dis-advantagement and intellectual deprivation at home."^1

The child who comes from a disadvantaged background will not have the necessary pre-school skills and intellectual stimulation to succeed in a traditional school setting (Fine 1967, Weider 1973). As a result of this early failure the child tends to fall behind in the fundamental areas necessary for further schooling (Fine 1967, Oxenhorn 1972). The net effect of this failure in school may lead to the development of the low self-concept so evident in underachievers (Smith et al. 1963, Fine 1967). This low self-concept is said to produce disinterest in learning, hostility to learning or withdrawal from learning as a shield to prevent further failure (Smith et al. 1963, Bricklin and Bricklin 1967, Weider 1973).

Much of the early and continued failure of underachievers has been attributed to poor teachers (Bricklin and Bricklin 1967, Fine 1967, Wong 1978). The effect of poor teaching in one subject is thought to overlap into other subjects causing a spread of underachievement from one subject to another (Fine 1967, Oxenhorn 1972). A particularly important example of poor teaching in one subject affecting others is the area of reading which is considered to be a critical skill necessary to all other subject areas (Oxenhorn 1972).

Teacher attitude toward a student can have a significant effect upon the achievement of the student. The teacher of disadvantaged students may have a preconceived idea concerning the ability of an underachiever. If this preconceived idea guides the teacher to having low expectations for the student the student may only achieve to the expected level. If the student has a low self-
concept and the teacher's expectations maintain a failing situation then the student's low self-concept is reinforced in a self-fulfilling prophecy (Fine 1967, Oxenhorn 1972).

A more difficult task is involved when trying to isolate factors leading to the underachievement of students from average and above average backgrounds. Some of the more easily identifiable factors may be related to physical causes (vision and hearing), highly mobile families, illness and poor teaching (Fine 1967, Bricklin and Bricklin 1967). Bricklin and Bricklin suggest that over 80% of these underachievers are due to "conflicted emotional attitudes."¹ Events such as broken families and family conflicts are seen as contributors to these conflicted emotional attitudes. The parent who is "over-involved"² with the student (pushes too hard for perfection) may initiate negative feelings towards learning (Bricklin and Bricklin 1967, Fine 1967, Wellington and Wellington 1965). Fine cites a study by Shaw which indicates that permissive and underinvolved parents may be factors related to underachievement. Shaw


found positive correlations between underachieving students and parents who did not supervise their children, lacked interest in their children, had uncertainties about raising their children, did not know what to expect from their children and had low aspirations for their children. Evidently there must be an optimum parental involvement which helps avoid underachievement. Bricklin and Bricklin suggest that of the 80% of the underachievers that come from average and above average backgrounds the majority are boys.

It can be concluded that the composition of the underachieving portion of any group of limited success students will depend largely upon the socioeconomic background of the school catchment area. A need for different kinds of approaches with the underachiever will likely be necessary due to their diverse backgrounds.

The slow learner

Almost all lists of slow learning characteristics include an item related to low I.Q. This low I.Q., generally between 75 and 100, is thought to be a major factor underlying slow learning by some authors (Barbe 1961, Oxenhorn 1972, Younie 1974). These authors propose that a person's genetic make-up may largely determine his intelligence and I.Q. In other words intelligence and I.Q. are fixed at birth. Other authors take a different stand regarding I.Q. and intelligence (Simon 1953, Hughes 1973, Younie 1974,
Brennan 1975, Sturges 1976). These authors see intelligence and I.Q. as variables. They place a heavy emphasis on the impact of the environment upon the development of children's intelligence and I.Q. This idea implies that the intelligence of a student can change. In Sturges' words, "This view of intelligence makes it important not to identify low attainment with low ability...since the latter is always capable of improvement." The changeable nature of intelligence proposed by these authors suggests that identification of a student as a slow learner should be done with great care since the low intelligence component may only be a temporary phenomenon. The literature indicates the existence of two types of slow learners. One slow learner is limited by an innate lack of intellectual capability while the other may only be limited due to environmental considerations.

Several authors believe that slow learning may be explained in terms of Piaget's theory of intellectual development (Johnson 1963, Sturges 1976). Piaget's theory emphasizes that children gradually progress to abstract thinking through a series of earlier stages. The child is only able to cope with certain intellectual tasks at each stage. The stages in Piaget's theory are hierarchical, that is, a

lower stage must be fully realized before a higher stage can be developed. Johnson (1963) says that the child will be ready to learn certain concepts only when he is the correct "mental age." In discussing students at the junior secondary level it should be remembered that these students range in age from about twelve to sixteen. Piaget's stage theory states that the transition to abstract thinking occurs around the thirteenth year (Beard 1969). Since individual students progress to abstract thinking at different rates and at different ages the slow learners may be those students still working at a concrete operational level. These pre-abstract thinking students undoubtedly have difficulty understanding and dealing with the many abstractions they are asked to deal with at the junior secondary level (Gulliford 1969).

Mahan (1965) proposes that the slow learner may not be unintelligent but see things in a "different context." This hypothesis is also discussed by Weaver (1971), Dunn and Dunn (1977) where students are thought to have their own preferred method of learning (or learning style). Students

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who learn in their own style may appear to be slow learners to the teacher accustomed to more standard learning styles. A student forced to learn in a style not his own may learn less effectively and thus appear to be a slow learner.

Physical defects of vision and hearing can have deleterious effects upon the learning of a student (Featherstone 1951, Karlin 1969, Hughes 1973, Younie 1974). Students who come from backgrounds where inadequate health and hygiene are practiced may have a higher incidence of vision and hearing defects. Sight and hearing defects may be more predominant among disadvantaged students.

Physical needs such as outlined by Maslow (1954) may explain the slow learning of some students. Maslow states that everyone has four levels of need. These four, physiological needs, love needs, esteem needs and self-actualization needs are organized in a hierarchy with physiological needs requiring satisfaction before love, esteem or self-actualization needs. A student who comes to school hungry or tired (i.e. has physiological needs to be fulfilled) will not be able to proceed to higher levels of need and thus to learning until these basic needs are satisfied. Many students may come to school with these basic needs unsatisfied, particularly those students from disadvantaged backgrounds (Hulicka 1969).

Non-physical environmental effects arising from the home may be contributory to slow learning. Students who
come from homes where basic skills and intellectual stimulation necessary to succeed in school are not taught or practiced may become slow learners when they reach school (Johnson 1963, Hulicka 1969, Karlin 1969, Shelton 1971, Weaver 1971, Hughes 1973, Younie 1974, Slater 1975). Given these variables it seems evident that slow learners may come from all socioeconomic levels.

Almost without exception the literature cites low self-concept as a characteristic of the slow learner. Some authors see this low self-concept as a product of previous and continual failure in school (Brandwein et al. 1958, Mahan 1965, Crowley 1961, Glasser 1971). They see this failure as a cause of both withdrawal and aggressive behaviour often exhibited by the slow learner. Gulliford (1975) sees this low self-concept to be a product of previous teachers not providing the needed success to produce a high self-concept in the student. Students having a low self-concept often lack motivation and are unwilling to try in class. This unwillingness to try and lack of motivation is seen by Slater (1975) as a defense mechanism to avoid further failure.

Closely related to the student's lack of self-concept is the self-fulfilling prophecy. Once teachers have experienced or heard of the failure of a student or group of students they may hold low expectations for them. The teacher continues to expect low or failing work and does
not press for higher quality. As a result of these low expectations the student continues to do poorly or even fails and his low self-concept is reinforced (Mahan 1965, Ladd 1973, Quelch 1975, Sturges 1976).

Featherstone (1951) and Mahan (1965) suggest that the lower intelligence exhibited by the slow learner may be due entirely to limited reading skills. Since most school subjects depend largely upon reading and written expression it is understandable why students without these skills appear to be slow learners. Mahan says that these so-called slow learners may be able to "comprehend much more than they can express."¹

Many of the causal factors underlying the characteristics of the slow learner appear to be the same factors as those related to the characteristics of both the under-achieving and disadvantaged student.

The disadvantaged student

Much has been written about the disadvantaged student in school. In this study the term disadvantaged is used synonymously with underprivileged, culturally deprived, socially deprived, educationally disadvantaged and culturally different. While the writer recognizes the differences in meaning of the aforementioned terms it is likely that

¹Ibid., pp. 77-78.
schools do not make the distinction between them. Therefore, for the purpose of this study, these differences will not be made evident. The fact that much has been alluded to regarding disadvantaged students in the previous two sections indicates the close association between disadvantagement, slow learning and underachievement. Many of the factors underlying the characteristics of disadvantaged students are similar if not the same as those of underachievement and slow learning. The repetition of these underlying factors is felt necessary in order to emphasize the wide base of agreement between authors writing from the three different perspectives.

Johnson (1970) talks of:

groups of people whose ways of living-value systems, language systems, attitudes, beliefs, experiential background etc. - prevent them from functioning in the dominant culture.

While Johnson's statement seems somewhat sweeping and final it is easy to see that as a result of this different background, disadvantaged children may come to school unequipped with the necessary skills and experiences to be successful in a school tuned to the dominant culture (Ausubel 1966, Havinghurst 1966, Noar 1967, Tuckman and O'Brian 1967, Tuckman 1969, White 1971). The disadvantaged student may

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learn in a different manner than other children due to his different background (Reissman 1962, Giddings 1966, Webster 1970, White 1971). It may be that the disadvantaged student is largely a physical learner (Giddings 1966, Reissman 1969, Webster 1970). Physical learning is a slower process than abstract learning and therefore the disadvantaged student operating in this mode may be identified as a slow learner. Reissman (1969) adds that disadvantaged students may appear slower in their work due to their "cautious or meticulous"\(^1\) approach to school work. Ausubel (1966) and other authors believe that the initial delay in learning the basic skills of reading, writing and arithmetic due to a disadvantaged background will lead to a slower transition to abstract reasoning than other students (Giddings 1966, Loretan and Umars 1966, Malkin 1966, Faunce 1967, Noar 1967, Tuckman and O'Brian 1969, White 1971).

Bloom (1964) relates changes in I.Q. to a disadvantaged background. In his study he found that I.Q. may be affected by environment by as much as 2.5 points per year for the first four years of life. I.Q. may change at a rate of only 0.4 points per year between the ages of eight to fourteen.

Bloom's findings seem to indicate that although intelligence is not fixed at birth it becomes harder to change as a child ages. It seems that a disadvantaged background may have a negative effect upon this potential change in I.Q.

Part of a disadvantaged child's preparedness to succeed in school may stem from more basic deficiencies such as physiological and love needs (Noar 1967, Tuckman and O'Brian 1967, Tuckman 1969). These needs seem to relate to Maslow's hierarchy related in a previous section.

Most teachers do not come from disadvantaged backgrounds. As a result of the difference in background between the disadvantaged student and the teacher; non-congruent values may clash (Bettelheim 1966, Goldman 1969, Glasman 1970, Johnson 1970, Webster 1970).

In Bettelheim's words:

...middle class teachers, despite their desire to be helpful to the culturally deprived child, and despite their best intentions, often get bogged down because they cannot transcend their own value system to meet that of the children.  

This values clash may make itself most evident in the expectations held by the teacher. The teacher expects failure from these students and receives this failing behaviour. This continued failure can further depress the student's already low self-concept (Faunce 1967, Noar 1967,  

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Although being disadvantaged is most commonly associated with poverty, other factors such as broken homes and lack of parental attention are considered to be forms of disadvantage but not necessarily restricted to disadvantaged backgrounds (Malkin 1966).

Characteristics of limited success students

have many common and some unique characteristics. Table 1.1 lists those characteristics which are common to underachievers, slow learners and disadvantaged students. Table 1.2 lists those characteristics which seem to be unique to each of the three types of limited success student. Although every limited success student would not be expected to exhibit all the characteristics listed in Tables 1.1 and 1.2, several should be identifiable in an individual limited success student.

TABLE 1.1

CHARACTERISTICS COMMON TO ALL LIMITED SUCCESS STUDENTS

Limited success students
- are below grade level in overall academic achievement
- lack basic skills in reading, writing and arithmetic
- have a short attention span
- lack powers of retention
- exhibit poor attendance and are frequently tardy
- have poor work and study habits
- are disorganized and lack care of personal effects
- have negative attitudes toward school, teachers and learning
- have difficulty following directions
- exhibit poor oral and written communication skills
- lack motivation to learn
- lack interest in academic work
- resist tasks that seem non-relevant
- are underdeveloped in or lack cognitive and reasoning skills
- are underdeveloped in or lack ability to work independently
- lack curiosity and creativity
- have poor hearing, speech and other sensory-physical problems
- have a low self-concept
- are aggressive and/or hostile
- are withdrawn or detached
- are behaviour (discipline) problems
- lack ability to control their social behaviour
- have short term, unrealistic or low aspirations

TABLE 1.2
CHARACTERISTICS UNIQUE TO EACH OF THE THREE CATEGORIES OF LIMITED SUCCESS STUDENT

Underachievers
- are average or above average in ability but are below average in achievement
- are unable to accept praise and criticism readily
- volunteer rarely
- are often selfish and inconsiderate

Slow learners
- learn with less depth of understanding than other students
- lack transfer of knowledge skill
- are often nervous and exhibit marked anxiety
- avoid their areas of weakness and concentrate on strengths
- are easily confused
- have an I.Q. score ranging from 75 to 100
- often come from families who place little value on education
- have strong feelings of hopelessness and fatalism
- live in a world of concrete objects and situations

Disadvantaged students
- tend towards expediency in their work
- are often tired upon arrival to school
- often come from highly mobile families
- experience considerable family disruption
- are often hungry, underclothed and have received little medical or dental care
- speak English as a second language
- come from low income families
often experience discrimination by peers
consider peer group affiliations more important than family ties
feel few obligations

The characteristics of limited success students listed above have provided educators with a base from which they have worked toward developing appropriate methods for teaching these students.

Teaching methods for limited success students

The intent of this section is to review those methods thought most appropriate for teaching limited success students. All teaching methods will be considered with reference to the previously examined characteristics of limited success students. In order to clarify the term teaching method the Dictionary of Education (third edition 1973) was consulted and provided the following definition:

'teaching method: (1) a rational ordering and balancing in the light of knowledge and purpose, of the several elements that enter into the educational process, the nature of the pupil, the materials of instruction, and the total learning situation (2) a standard procedure in the presentation of instructional material and the content of activities.'

The term teaching method encompasses a wide spectrum of activities associated with the teaching/learning situation. Within this broad definition of teaching method the following areas have been identified: grouping practices; curriculum; teaching techniques; teaching technology; and teacher
attitude, experience and characteristics. These specific areas of teaching method will be examined now in more detail.

Grouping practices

One of the most prevalent organizational strategies used in the teaching of limited success students is the grouping of these students in separate classes for instruction (Esposito 1973). In their review of the literature on ability grouping Findlay and Bryan (1975) reported two surveys which both estimated that 77% of the school districts in the United States were using some form of ability grouping (Department of Health, Education and Welfare 1968, Findlay and Bryan 1971). In a more recent teacher survey Wilson and Schmits (1978) reported that 74% of the teachers they polled taught in situations where ability grouping was in use. Although data for Britain were not readily available at the time of writing, it is known that ability grouping has been widely practiced for many years in British schools (Sturges 1976).

There has been a great deal of controversy surrounding the use of ability grouping over the past 50 years. As a result of this controversy a number of arguments for and against this practice have been formulated. In order to establish a position on ability grouping relative to limited success students the arguments for and against this practice will be examined in detail.

Few authors reviewed were in support of ability grouping,
indeed, the positive aspects of this practice were largely reported in literature where the authors were generally negatively inclined to this strategy. Ability grouping is said to allow students to work at their own pace since all students are supposedly working at the same level. The teacher can adjust his teaching style and methods to cater to the level of the students he is instructing (Thomas and Thomas 1965, Sturges 1976). The practice of ability grouping is said to be "economic, efficient and effective"¹ (Sturges 1976). Apparently high ability students do very well under an academically grouped situation (Esposito 1973, Findlay and Bryan 1975, Halderman 1976, Morrison 1976). Teachers, administrators and parents, especially those parents of high ability students, generally seem to be in favour of ability grouping (Thomas and Thomas 1965, Findlay and Bryan 1975, Halderman 1976, Wilson and Schmits 1978).

The positive aspects of ability grouping were largely reported by proponents of heterogeneous (mixed ability) grouping. This may be an indicator of the current feelings of educators regarding ability grouping. Little of the literature reviewed favoured ability grouping. This is surprising in the light of the fact that this practice is so widely used (Wilson and Schmits 1978). Wilson and

¹Ibid., p.2.
Schmits suggest that teachers, administrators and parents may not be familiar with the research results and some of the logical arguments against ability grouping. The results of the research has been reported in a number of review articles (Ekstrom 1961, Passow 1961, Thomas and Thomas 1965, Esposito 1973, Findlay and Bryan 1975, Morrison 1976). The results of studies done on ability grouping are best summarized by Ekstrom. Ekstrom states that there is "a great variation in experimental design" resulting in "no consistent pattern of results."\(^1\) This statement made in 1961 still holds true in 1978 (Wilson and Schmits 1978). There seems to be no conclusive empirical evidence supporting the continuation of homogeneous or heterogeneous ability grouping.

There is a great number of arguments opposing the practice of ability grouping. The process of selecting students for ability levels is seen by many authors as often invalid and unreliable. (Wilhems and Westby-Gibson 1961, Passow 1966, Davies 1975, Findlay and Bryan 1975, Slater 1975, Halderman 1976, Sturges 1976). Sturges cites Simon's work (1953) which proposes the changeable nature of intelligence. The fact that intelligence may be a changing quantity is further emphasized by Johnson (1963),

Bloom (1964), Hughes (1973) and Younie (1974). Since intelligence may be a dynamic quantity it seems difficult to be both valid and reliable when placing students in ability groups. In answer to the notion that students will shift between groups as intelligence changes Davies (1975) says, "interstream transfer needed to put right mistakes in selection and grouping rarely happens."  


Rather than being a situation in which the range in ability is reduced, various authors see the low ability group as being a catchall for many different kinds of students. Slow learners, underachievers, discipline problems, apathetic and unmotivated students present a myriad of problems in a homogeneous grouping which would not be as evident in a mixed ability group (Borg 1964, Yates 1964, Thomas and Thomas 1965, Hargraves 1967, Sturges 1976).

Eash (1961), Wilhems and Westby-Gibson (1961), Borg (1964) and Sturges (1976) state that ability grouping alone will not increase achievement. Supporters of ability grouping may look to statements implying that differentiation of teaching methods and materials appropriate to each ability group may be the answer (Ekstrom 1961, Thomas and Thomas 1965, Passow 1966). Several studies, reviewed by the writer, utilizing varied methods and materials in ability grouping situations were largely inconclusive (Moody 1970, Kellough 1970, Martin 1973, Milson 1973, Bingham and Bridges 1974).

Davies (1975), Slater (1975) and Sturges (1976) suggest that the least experienced teachers are often assigned the lower ability groups. A possible result of this assignment may be a stagnation of teaching methods, boredom of both the teacher and student and student behaviour problems (Yates 1964, Leighton 1970, Reid 1970).
Findlay and Bryan (1975), whose review of the literature on ability grouping spans 1920 to 1970, conclude that the practice continues without systematic justification and, indeed, with few notable studies to point the way to a tenable synthesis of what happens when ability grouping is used.

Wilson and Schmits (1978) have produced a number of recommendations regarding ability grouping. Teacher training institutions are encouraged to familiarize their trainees and in-service clients of the research related to ability grouping. A reassessment of the literature is advocated to ascertain if certain conditions warrant the use of ability grouping. A final recommendation suggests investigation into the factors underlying the continued support of ability grouping by teachers. For the present Wilson and Schmits advocate

a switch from homogeneous ability groups to heterogeneous small classroom groups in order to limit the possible negative effects of ability grouping while still allowing the practitioner better opportunities to meet individual needs than are allowed by large group instruction.

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This last statement seems to underly the recent move in Britain away from homogeneous ability grouping to mixed ability education.

Curriculum, teaching techniques and teaching technology

A great deal has been written in the literature regarding the kind of curriculum best suited to the limited success student. Inevitably the choice of curriculum often directs the teaching techniques and technologies used. For this reason curriculum, teaching techniques and teaching technology have been included together. The examination of the literature in these three areas suggested the following set of subcategories: curriculum design; approaches to learning; ensuring success; evaluation and reporting.

Before beginning the literature review of this section a statement by Kelly (1974) may help to preface the information to follow. Kelly says:

If we accept that only the objectives of education are common, we must be prepared for quite dramatic differences of content and method to suit the dramatic differences that clearly exist in children's style of learning, interests, backgrounds, ambitions and the many other facets of their unique personalities.

Kelly's statement suggests the kind of considerations necessary for teaching students in a mixed ability class-

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room and thus includes limited success students. These considerations for teaching limited success students are evident in the literature reviewed in this section.

Curriculum design. With few exceptions the literature indicates the need for a highly student-relevant curriculum when teaching limited success students. This relevance may relate to the students' own interests, their every day surroundings and experiences or adult life. It is suggested that above all the curriculum should be at an appropriate level for the students and be close to their reality. The use of relevant content is thought to improve student motivation and enhance thinking skills. The fact that many science curricula are not relevant may be evidenced in part by limited success students' lack of interest and motivation to learn. The introduction of a relevant curriculum is said to encourage students to: be more curious; work in a more independent manner; become more motivated in their tasks; improve their attitudes towards school, teachers and learning; lengthen attention spans; utilize previously dormant learning skills and perhaps achieve at a higher level. Many authors in favour of the relevant curriculum see the need to develop this curriculum from students' needs and interests (Brandwein et al. 1958, Karlin and Berger 1969, Darke 1970, Glasman 1970, Webster 1970, Tisher et al. 1972, Kelly 1974, Scottish Centre for Mathematics, Science and Technical
Kelly cautions that we should not only work to satisfy students' interests and needs but also toward the "extension and development" of these interests. Gulliford (1969) states that

researches show that the content of courses and methods of teaching cannot be decided merely by considering what the teacher would like to achieve. He must also consider what the pupils can best study in terms of the stage of development in their thinking.

Perhaps the most desirable determination of content is suggested by Tisher et al. (1972) who state that "new courses must be a blending of what students see as important and what teachers perceive as desirable."

In order to develop a relevant curriculum the students themselves should have some say in the topics to be studied. This may involve the students actually generating the topics for a science course or having some choices among a number of highly relevant topics selected by the teacher (Newsom 1963, Scottish Education Department 1969, Tuckman 1969,

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1 Ibid., p.22.


Another method by which relevant topics may be chosen is through students participating in project work. Not only can project work provide relevance for the student, it also may enhance social interaction between students who may work in groups of two or more (Newsom 1963, Thomas and Thomas 1965, Noar 1967, Scottish Education Department 1969, Collette 1973, Kelly 1974, Schools Council 1975, Sturges 1976).

Since many limited success students leave school one or two years earlier than other students a number of authors see the need for job or vocationally-oriented science courses. Mahan (1965) argues that since special education is provided for those who intend to proceed to university it
should also be provided for those who intend to proceed directly to the working world. Both Webster (1970) and Younie (1974) propose that job-oriented curricula may provide more relevance and thus motivation to learn. While a job-oriented curriculum is what students and parents want, Newsom (1963) and Schools Council (1971) state that this curriculum should not be thought of as a guarantee of a job. The rate of technological change often excludes the possibility of preparing students for jobs which may not exist in the future or exist at the present.

Several authors advocate an emphasis on the effects of science on society and on helping students to live in a technological age (Johnson 1963, Lisonbee 1963, Newsom 1963, Loretan and Umars 1966, Oxenhorn 1972, Martin 1973, The Scottish Centre for Mathematics, Science and Technical Education 1976, Wilkenson and Bowers 1976). The literature suggests a move towards a broad curriculum in science which will promote flexibility in students who will be coping with a rapidly changing future. Webster (1970) states that an

emphasis should be placed on the quality of learning experiences as opposed to the quantity of material covered. When we look at the vast and rapid changes that are taking place in all segments of our highly complex society, we realize that it is more important for children to have qualitative experiences than merely memorizing facts that may quickly become obsolete.1

The limited success student often receives a watered down or diluted science curriculum compared to other students. In some cases the literature seems to support the idea of reduced content and complexity for these students (Featherstone 1951, Shadrach 1970, Martin 1973, Miller 1974). In other instances this diluted curriculum is seen to lack relevance and interest to students (Ladd says that as a result of the reduced content and complexity a "dull, unmotivated"1 student is produced. Most authors seem to advocate a relevant curriculum within which a student may pursue content to a level of complexity congruent with his capabilities.

The basis for a broad, relevant curriculum can be found in the rationale underlying the integrated or interdisciplinary curriculum.2 A large proportion of the literature reviewed supports the use of an integrated or interdisciplinary curriculum with limited success students (Featherstone 1951, Johnson 1963, Lange and Jorgensen 1969, Newsom 1963, Feshbach 1969, Gulliford 1969, Scottish Education Department 1969, Darke 1970, Schools Council


2Some confusion in the definition of these two terms exists with different meanings being used on each side of the Atlantic. For the purposes of this paper the term interdisciplinary refers to a science curriculum which disregards the traditional boundaries between the areas of science in the study of central themes or problems. Integrated studies further extends the interdisciplinary boundaries to other non-science areas such as English, social studies and mathematics.

Sturges states:

'The wholeness of a pupil's world should not be overlooked in the planning process. As a pupil explores things that have aroused his curiosity he will unconsciously cross boundaries between subjects. Interest and motivation in science lessons may stem from curricula which reflect these points.'

Hughes (1973) adds further weight to the use of an integrated/interdisciplinary curriculum by stating:

'Special skills in various subjects will only be useful if they are an integral part of a comprehensive 'whole'. Therefore it is necessary to integrate subjects with each other in such a way that they provide a general framework of the events of everyday living.'

In a recent article defining the integrated curriculum and offering a rationale for its use Brown (1977) states that these curricula are:

'more adequate for dealing with many social or technological problems, reflect better the structures and processes of science, enable stronger teacher-pupil relationships to be built up, remove boredom for teachers of repetition of specialist material.'

1 Ibid., p. 17.


The traditional curriculum is thought to allow the teacher to work in an area suited to his training and interests, will help students prepare for final examinations and university courses and is appropriate for the apparatus and materials already in the schools. Brown's analysis of interdisciplinary and disciplinary science education leads this writer to advocate the use of the interdisciplinary approach especially in the case of the limited success student.

Newsom (1963), Schools Council (1970), Hughes (1973), Wilkinson and Bowers (1976) are of the opinion that the overlap of various subjects (integration) serves to reinforce basic communication and computation skills often lacking in the limited success student. While most authors agree that reading, writing and arithmetic should play an important part in science instruction, several authors submit that there should be reduced emphasis on these skills (Collette 1973, Milson 1973, Munro 1974). Authors who advocate reduced dependence on basic skills do so to allow for the abilities of the limited success student and to ensure that success in the science course is not totally dependent upon these skills. The advocacy of an integrated/interdisciplinary approach, the necessity for tools of communication and analysis in science and the weakness of limited success students in the basic subjects seem to make the inclusion of reading, writing and arithmetic manda-
tory in a science course for limited success students. Further reinforcement of language skills is thought to be enhanced by student oral work (Newsom 1963, Tuckman 1969, Karnes 1970, Oxenhorn 1972, Kelly 1974, Schools Council 1975, Scottish Centre for Mathematics, Science and Technical Education 1976, Sturges 1976). Kelly says that a student's success in one mode of communication (e.g. oral) may lead to increased communication in other modes (e.g. reading and writing).

Approaches to learning: Limited success students seem to learn best through an inductive rather than a deductive approach (Texas Educational Agency 1972). Inductive learning (making generalizations or proving laws using specific examples) is thought to be best facilitated through a directed inquiry or problem-solving approach (Reissman 1965, Reissman 1969, Scottish Education Department 1969, Webster 1970, Van Deventer 1972, Texas Educational Agency 1972, Wilkenson and Bowers 1976, Wong 1976). In contrast to the inquiry or discovery approach where students pursue a problem by designing their own experiments, taking their own data and deriving their own conclusions, the directed inquiry approach helps to ensure the success of students through pre-selected materials and procedures. The combination of the inductive and directed inquiry approach should help to provide the initial concrete experience limited success students need to aid the development of their intellectual skills. In addition this approach may facilitate
the growth of the student's self-concept due to success at a pre-devised learning task.

If a concrete, student centered, activity-oriented process is to proceed effectively then the class should be broken up into small groups or individuals (Noar 1967, Scottish Education Department 1969, Marusek 1969, Milson 1970, Schools Council 1970, Collette 1973, Hughes 1973, Martin 1973, Bosworth 1975, Clark 1975, Fabino and Liberson 1975, Darke 1976, Sturges 1976, Wragg 1976). Sturges identifies the positive aspects of small group or individual learning as allowing for individual student differences, enabling further time for personal attention, and improvement of teacher-student relationships. Other authors focus on the composition of small groups. Kelly (1974) suggests the use of friendship grouping by sociometric techniques, to enhance the "social education"\(^1\) of the student. Several authors believe that grouping brighter students with slower or less motivated students will improve the learning in both the bright and the slow student (Karlin and Berger 1969, Shelton 1971, Sturges 1973).

Due to the nature of concrete learning in a science laboratory it is necessary to maintain small class size (Ausubel 1967, Reissman 1969, Whipple 1969, Oxenhorn 1972, Ibid., p. 80.)

\(^1\)Ibid., p. 80.
Texas Educational Agency 1972, Collette 1973, Younie 1974). The variety of activities for students in individual or small group work requires the teacher to give attention to the individuals or groups involved. In order that the teacher has adequate time to supervise all groups he should have a relatively small number of students. Younie suggests that a heterogeneously grouped class should be no larger than twenty-five students even when taught by an experienced teacher. Both Younie and Oxenhorn advocate that a homogeneously grouped class should be less than twenty-five students in size. In addition, the teacher must have a small enough class to enable adequate safety of students participating in a number of different experiments at one time (Oxenhorn 1972, Collette 1973).

One possible solution to reducing the student/teacher ratio is team teaching (Newsom 1963, Thomas and Thomas 1965, Quayle 1970, Schools Council 1971, Weaver 1971, Jenkins et al. 1973, Kelly 1974, Schillinger 1975, Sturges 1976, Wragg 1976). In team teaching two or more teachers instruct the same group of students. The addition of another teacher reduces the student/teacher ratio by a factor of two allowing twice the time for individual help and improving laboratory safety. Not only can teachers work in the areas of their own expertise and interest they also can benefit by close interaction with other teachers. Sturges (1976) is quick to point out the necessity for harmony among team
members and the need for a flexible timetable to implement this teaching technique.

A common characteristic of many limited success students is their underdeveloped or reduced intellectual skills, including their ability to abstract and make generalizations. These students are also thought to learn more easily in a firsthand and experiential mode rather than through abstraction. A number of authors think that a curriculum which actively involves students in manipulation of concrete materials can facilitate the development of concepts and abstract thinking (Featherstone 1951, Johnson 1963, Newsom 1963, Mahan 1965, Reissman 1969, Sturges 1973, Tisher et al. 1972, Younie 1974, Schools Council 1975, Scottish Centre for Mathematics, Science and Technical Education 1976, Sturges 1976). It is further suggested that an initial concrete experience is necessary to compensate for those students from disadvantaged backgrounds who have not yet had the benefit of this experience (Reissman 1969, Tuckman 1969). This approach to learning lends itself to the laboratory-oriented situation in science teaching.

Further concrete learning experiences are found in activities such as field trips, displaying student work, role playing, class discussions, demonstrations and having guest speakers. These activities are thought to facilitate concept development, language development and transfer of learning. In addition these activities are seen to be


A move to individualized or small group learning requires that students proceed at their own pace and frees the teacher to work on a one-to-one basis with students. The use of worksheets is advocated to allow for this flexibility in science classes. By providing carefully written

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1Teacher-centered learning is a more traditional or didactic approach to learning in contrast to student-centered learning where there is much student activity and involvement in the learning process.
core materials supplemented with extensions for enrichment the teacher can cater to a whole range of abilities within his class. Worksheets are also seen as aids to circumvent needless note taking, a reference and record for the student, and an aid to both the student and teacher particularly if the student has been absent from school (Newsom 1963, Kamm 1969, Scottish Education Department 1969, Jenkins et al. 1973, Schools Council 1975, Ross 1975, Darke 1976, Sturges 1976, Wilkenson and Bowers 1976).

Related to the need for individualized or small group learning is the concept of indirect teaching. In contrast to an indirect teaching style, direct teaching involves the teacher being more didactic and critical of students. Using modifications of the Flanders' System of Interaction Analysis Campbell (1971), Citron and Barnes (1970) examined the differences resulting in students instructed in a direct and indirect manner. Campbell found that "the indirect group was shown to be superior on both affective and cognitive levels for low achievers."  

1 The Flanders' System of Interaction Analysis defines an indirect teacher as one who frequently questions students, accepts and uses student ideas, praises and encourages students and accepts their feelings. The direct teacher frequently uses the lecture technique, gives directions to students, criticizes students, and attempts to justify authority.

Citron and Barnes found that "problem solving ability" and "total school performance" was significantly greater for students taught in an indirect manner. It seems that the use of this approach depends largely upon the pedagogical beliefs held by the teacher. Individualized or small group instruction seems to best facilitate the indirect teaching technique.

As limited success students have a poor attendance record, short attention span and poor powers of retention, a non-sequential curriculum is recommended by a number of authors (Tanzer 1960, Lerner 1965, Fabino 1975, Kershaw and Scott 1975). The non-sequential curriculum sets each lesson as an entity unto itself. This type of curriculum is intended to reduce the possibility of failure by helping to ensure that a student's absence, short attention span and poor memory will not be factors causing him to fall behind or become bored, frustrated and hostile. In contrast other authors advocate a small step, logically sequenced program for limited success students (Featherstone 1951, Leibherr 1966, Loretan and Umars 1966, Moore 1962, Ausubel 1967, Reissman 1969, Shelton 1971, Oxenhorn 1972, Hughes 1973, Younie 1974, Sturges 1976, Wong 1976).

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Featherstone suggests that there will be little memory development if students are not required to remember important aspects of a subject from lesson to lesson. Ausubel (1966), Bloom (1976) and Marshall (1977) believe that a student should achieve a given level of mastery before he proceeds to the next stage of a sequential program. Sturges (1976) recommends that strong links be made to facilitate concept formation when using a sequential curriculum. Both Schools Council (1975) and Wilkenson and Bowers (1976) submit that an intermediate approach using short self-contained units or modules may be the optimal methodology. Many teenagers do not have ordered lives outside the classroom and appreciate the security of a structured, sequential science course. In order to help students succeed in the sequential learning situation the steps of the sequence should be sufficiently challenging, non-trivial and within the capabilities of the students concerned (Johnson 1963, Karlin and Berger 1969, Lange and Jorgensen 1969, Reissman 1969, Tuckman 1969, Oxenhorn 1972, Glasser 1971, Tisher et al. 1972, Sturges 1976, Wilkenson and Bowers 1976).

Ensuring success. There are steps the teacher may take to facilitate success for students who have experienced limited success in the past. The creation of a comfortable classroom atmosphere is one suggested by the literature (Tansley and Gulliford 1965, Crowley 1969, Ornstein 1969, Sturges 1976). Since many limited success students do not
have ordered lives outside the classroom it is advocated that the school can create greater feelings of security by providing a structured, consistent routine in the classroom. While the establishment of routines is suggested it is also thought important to create a situation where the student has a degree of independence and responsibility (decision making). Independence and responsibility may help the development of a student's self-concept and his ability to be self-directing (Tansley and Gulliford 1965, Tuckman 1969, Hughes 1973, Jenkins et al. 1973).


The idea of mastery learning advocated by Ausubel (1966), Bloom (1976) and Marshall (1977) seems to suggest the provision of continual repetition and review in a variety of meaningful ways. Others, not specifically
advocating mastery learning, also point out the need for repetition and review (Featherstone 1951, Brandwein et al. 1958, Moore 1962, Johnson 1963, Crowley 1969, Karnes 1970, Tisher et al. 1972, Oxenhorn 1972, Martin 1973, Hughes 1973, Munro 1974, Scottish Centre for Mathematics, Science and Technical Education 1976, Sturges 1976). Repetition and review may not only help to facilitate retention and concept development but may also provide the reinforcement needed by limited success students to achieve at a higher level of attainment. The use of a variety of meaningful contexts and modes of repetition and review further helps to provide for different learning styles.

Programmed learning is thought to facilitate learning and success for limited success students (Ausubel 1967, Noar 1967, Scottish Education Department 1969, Jenkins et al. 1973, Collette 1973, Sturges 1976). Most authors advocate programmed learning as a supplement to other classroom activities. Although programmed learning may provide the necessary sequences and steps that guarantee success it reduces the need for verbal responses by students (Loretan and Umars 1966). To find appropriate programmed learning units (content, reading level and level of difficulty) or write programmed learning sequences is generally a difficult and a time consuming task. (Ausubel 1966, Loretan and Umars 1966, Younie 1974).

Each student should be made continually aware of his
progress (Whipple 1969, Janzen 1970). This serves to point out the student's strengths (positive reinforcement) and makes evident weaknesses for further repetition and review. A graphical record of progress by students is suggested by Karnes (1970) so that at all times students are aware of strengths and weaknesses.

**Evaluation and reporting.** The very nature of evaluation and reporting may cause anxiety and lead to limited success. Glasser (1971) states "any grade less than an A or a B is a failing grade." Most authors who have written about evaluation tend to advocate a type of formative evaluation (Johnson 1963, Thomas and Thomas 1965, Glasser 1971, Scriven 1967, Darke 1976, Sturges 1976, Wragg 1976). Wragg suggests the grade of C as a standard baseline. Students making positive progress would receive A's or B's, other students not making headway would receive D's or E's. In Wragg's plan a student of low ability could receive an A while a higher ability student might only achieve a B standing or less. Darke (1976) believes that evaluation should be conducted on a week to week basis.

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2 Formative evaluation, in contrast to summative evaluation (where students are evaluated and graded based on their standing compared to other students), assesses the progress of a student relative to his previous achievement and taking into account his particular strengths and weaknesses.
concentrating on identifying student's strengths and weaknesses. Glasser (1971) and Darke (1976) suggest the replacement of formal letter grades in favour of teacher-student interviews and anecdotal reports. A more realistic approach may be that advocated by Sturges (1976). Sturges suggests that a student's mark be a composite of both attainment and effort. Whatever evaluation and reporting process is chosen all authors stress the need for a broadly based evaluation scheme. Hughes (1973) states that we must take into account the psychological, physical, emotional and social aspects in order to help provide a total impression of a student for evaluation. A move to mixed ability teaching will likely require a close consideration of evaluation and reporting procedures. One such consideration may revolve about the implementation of an essentially non-competitive school situation within a highly competitive society.

Summary of appropriate teaching methods

The list below delineates those teaching methods that are advocated in the literature as appropriate for teaching limited success students. Not included in this summary list are those methods where there seems to be a difference of opinion amongst the authors of the literature (for example, the use of a sequential or non-sequential program).
A science course for limited success students should include consideration of the following practices and approaches:

- mixed-ability classes
- a relevant curriculum based on student needs and interests
- an element of student decision making
- a component of student projects
- a job or vocationally oriented program
- an integrated or interdisciplinary approach
- an inductive learning mode in a directed inquiry approach
- a concrete, activity-oriented approach
- a small group or individualized learning situation
- a use of team teaching
- a use of field trips, student display, role playing, class discussions, demonstrations, guest speakers and oral work
- a use of audio-visual aids
- a use of worksheets
- a more indirect teaching approach
- a consistent class routine
- a use of positive reinforcement
- a use of repetition and review
- a use of programmed learning
- ensuring students' awareness of their progress
- an evaluation scheme which accounts for the progress of the individual.
Teacher attitudes, training and characteristics

In teaching the limited success student Brandwein et al. (1958) state that "the teacher is the key." Of primary importance is the attitude of the teacher toward his students. The two predominant attitudes teachers of limited success students should possess are the desire to teach these students and a true respect for these students (Featherstone 1951, Johnson 1963, Ausubel 1967, Reissman 1969, Glasser 1971, Younie 1974). A teacher holding these attitudes will likely be patient; firm; consistent; sympathetic; understanding; straightforward; warm; fair and democratic as the literature has suggested they should be. While these characteristics may seem to be those of all good teachers, Sturges (1976) sees them as essential to the security needs of the limited success student.

Many authors advise that teacher training, at both the pre-and in-service level, is necessary to facilitate the growth and development of the appropriate attitudes, characteristics and the learning of the necessary skills and methods for teaching the limited success student (Johnson 1963, Leibherr 1966, Ausubel 1967, Reissman 1969, Tuckman 1969, Whipple 1969, Janzen 1970, Schools Council 1970, Schools Council 1971, Collette 1973, Martin 1973, Kelly 1974, 

Younie 1974, Quelch 1975, Schools Council 1975). Not only do teachers need teaching skills which are stimulating they should also be "immaginative intuitive and resourceful" (Schools Council 1970). Teachers should also know "the theoretical underpinnings" of education (Kelly 1974). Kelly suggests that teachers in their pre-service training should not "take too many subjects." He states that if too many different subjects are taken then the pre-service teacher "will not become expert in any...and, therefore, will be in no position to provide the pupils with an education of any real merit." Many authors state that the experienced teacher often does not teach the limited success student (if homogeneously grouped). The teaching of these groups is often left to the least experienced teachers in the school (Sturges 1976). A move to mixed ability grouping as suggested by many authors, will create a situation in which all teachers will have limited success students in their classes. Mixed ability science teaching will necessitate that pre-service and in-service instruction


2 Ibid., p. 115.

3 Ibid., p. 117.

Conclusion

This review has indicated the existence of a group of students who have difficulty in school and in particular in science. Some factors leading to these difficulties and the student characteristics resulting have been outlined. A number of teaching methods have been identified to help deal with these students who have experienced limited success in science.

The literature reviewed provided the basis for the construction of a questionnaire designed to elicit information on current teaching practices for limited success students in junior secondary science in B.C.
CHAPTER 2

Development of the Descriptive Survey Instrument

Impetus and intents of survey

At the present time in B.C. there is one curriculum suggested for all junior secondary science students. This curriculum has been in use since 1968. Any modification of this curriculum and development of related teaching methods is carried out by individual schools or teachers with little discussion or communication. A search of the literature has revealed only one study in B.C. of junior secondary limited success science students (Quelch 1975), as opposed to the large volume of literature from Britain and the United States. The probable size of the limited success student population in B.C. and the lack of local information and communication regarding these students and their science courses, has prompted the writer to become more familiar with this area of science education in B.C. schools.

As a first step in developing an understanding of science instruction for limited success students a descriptive survey has been conducted at the junior secondary level, grades eight, nine and ten.

The survey addressed itself to the following questions:
1. What is the size of the limited success student population at the junior secondary level in B.C.?
2. What educational practices (grouping, curriculum, approaches to learning, evaluation and reporting) are presently being used to teach science to limited success students?
3. What is the educational background and experience of teachers of limited success students?

Using the data obtained from the answers to the questions above it was possible to address the following broader issues:

1. How do established science teaching practices in B.C. compare with those developed outside B.C.? What implications, if any, do differences in practice have for limited success students, teachers, administrators and other institutions?
2. In what ways can science education be enhanced for limited success students?
3. What further research should be conducted?

Additional intents of the survey were: to provide a foundation for further communication with the teaching community; to expose the issues debated in the literature and provide additional information on relevant curricula and teaching methods from Britain, the United States and Australia.
Survey instrument design

In order to address the broad questions outlined in the introduction to this chapter, a teacher questionnaire was developed.

Source of questionnaire items

The review of the literature revealed a number of areas pertinent to the teaching of limited success students. These areas included: the characteristics of limited success students; appropriate teaching methods for limited success students and appropriate teacher attitudes, characteristics and training. The most prevalent statements and suggestions occurring within the identified areas were used to generate the questionnaire items. For example, the literature suggested a number of different ways in which a science course for limited success students could be developed. Teachers were asked to estimate the extent to which they based their science courses on the various methods of course development suggested in the literature. Other questionnaire items were produced by the writer to fill in additional information. For example, teachers were asked to provide information on the school size and timetable for science in their particular school.

Specific information covered by questionnaire items

The items of the questionnaire asked for specific
information in the following areas:

1. Students
   - size of the limited success student population
   - distribution of limited success students by sex
   - achievement of limited success students

2. Teachers
   - undergraduate and graduate backgrounds
   - teacher training related to limited success students
   - total teaching experience
   - teaching experience with limited success students
   - present subject areas and grades taught

3. Science Programs
   - appropriateness and use of text(s) and laboratory manual(s)
   - course content determination
   - teaching methods
   - student evaluation
   - science program evaluation

4. Schools
   - grade level range
   - population of school
   - school timetable for science (full year/semester)
   - number of hours of science per week
   - science class size

Questionnaire format

Information was elicited from teachers through multiple choice questionnaire items. Whenever appropriate, space was provided to allow for teacher comment. The format of each
item was chosen by considering the nature of the information required and by modelling questions on previously successful questionnaires (Hambleton 1970, B.C. Learning Assessment Junior Secondary Science Teacher Survey 1978, Nasr 1977).

The questionnaire was divided into three major sections:

1. The first section dealt with teacher background and school information.

2. The second section was preceded by a statement indicating the double-branched nature of the questionnaire. One branch was answered by teachers who taught science to limited success students in homogeneously grouped classes. The parallel branch was responded to by teachers who taught science to these students in heterogeneously grouped classes.

3. The third section was responded to by all teachers. This section dealt with the structure and content of teachers' junior science programs.

Evaluation of questionnaire prior to distribution

Initial versions of the questionnaire were examined and revised through consultation with thesis committee members. Additional comments were elicited through administration of the questionnaire to seven junior secondary science teachers in Richmond School District. Three of these teachers taught science in homogeneously grouped classes while the remaining four teachers taught in heterogeneously
grouped science classes. The seven teachers were asked to complete a pilot version of the questionnaire and comment on its content and format. Further consultation with thesis committee members and use of the information from the pilot resulted in the final version of the questionnaire. (Appendix A). Due to the lack of major ambiguity evidenced in the first pilot a second pilot was deemed unnecessary.

Reliability

The questionnaire was designed to sample teachers' interpretation of the nature and structure of their science courses for limited success students. Teachers also reported on their educational background and teacher training. Most of the information requested was factual in origin. Kerlinger (1973), in his discussion on checking survey data, cites Parten (1950) whose work on surveys has shown that the reliability of "personal factual items" is high. It was also assumed that the kind of information requested would not change radically over the 1978 portion of the school year. Given the nature of the data constancy and the previous findings on reliability of surveys the questionnaire was judged to have a sufficiently high level of reliability.

---

Sampling plan

The population sampled was defined to be those teachers teaching at least one of science eight, nine or ten in the public schools of B.C. Many junior science teachers teach more than one grade level of science, for example grade eight and ten. Ministry of Education statistics\(^1\) report the total number of teachers instructing science eight, nine and ten. Hence a teacher might appear in the Ministry listing up to three times. Some form of sampling was required to choose teachers only once and to ensure an equal representation of teachers at each grade level. Permission was granted by the Ministry of Education to use the sampling frame recently employed by the Science Learning Assessment Survey. This sampling frame, developed by B.C. Research,\(^2\) utilized the information teachers submitted to the Ministry of Education in September 1977. The sampling frame labelled each teacher as a grade eight, nine or ten teacher according to their teaching load. For example, a teacher teaching two grade eight science classes, one grade nine science class and four classes in other subject areas would have a two-

---

\(^1\)At the beginning of each school year all B.C. teachers are required to complete form "J" for the Ministry of Education. This form requires teachers to list the training and teaching experience they have had in addition to the subjects and teaching load they presently carry.

\(^2\)B.C. Research, 3650 Wesbrook Mall, Vancouver, Canada V6S 2L2.
thirds probability of being chosen as a science eight teacher and a one-third probability of being chosen as a science nine teacher. When chosen, each teacher was assigned a grade level for science by probability and was removed from the population to prevent a second selection. The population size determined by the sampling frame yielded the following numbers:

<table>
<thead>
<tr>
<th>Science</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>439</td>
</tr>
<tr>
<td>9</td>
<td>425</td>
</tr>
<tr>
<td>10</td>
<td>444</td>
</tr>
<tr>
<td>Total</td>
<td>1308</td>
</tr>
</tbody>
</table>

Using this total it was possible to calculate the sample size (n) by applying Cochran's (1963) formula and given the following information:

- level of confidence = 95% (z = 2.00)
- maximum allowable error = 5% (e = 0.05)
- maximum variance = 50% (p = 0.5)

\[
n = \frac{Nz^2pq}{Ne^2 + z^2pq}
\]

where \( q = 1 - p \)

substituting for \( N, z, p \) and \( q \)

\[
n = 306 \text{ or } 23.4\% \text{ of the population.}
\]

---

Thirteen percent of B.C. school districts did not wish to participate in the survey. To ensure an adequate sample size in advance of contacting all school districts it was decided to add a minimum of 10% more teachers to the sample. B.C. Research suggested a sample size of 25% or 33% for the random systematic sampling method used (Appendix B). A 33% sample was chosen to allow for non-participating school districts and to provide a greater base for generalizability of results. The sampling procedure used a randomly chosen starting point and then selected every third teacher at each grade level. The number of teachers sampled at each grade level was:

Science 8 : n = 146  
Science 9 : n = 142  
Science 10 : n = 148  
Total n = 436

A final sample size of 366 (28%) was utilized after the teachers from the non-participating school districts were deleted. The final distribution of teachers was:

Science 8 : n = 125  
Science 9 : n = 122  
Science 10 : n = 119  
Total n = 366
Procedures

Superintendents of all B.C. school districts were contacted by mail prior to the distribution of questionnaires (Appendix C). Once authorization was obtained from the Superintendents to conduct the survey in their district, Principals of the teachers involved were notified of the intent of the study and asked to cooperate (Appendix D). Shortly after the letters to the Principals were mailed the questionnaire was distributed to the science teachers.

Sampled teachers received a covering letter (Appendix E) a questionnaire and a pre-stamped, self-addressed return envelope. All questionnaires were coded with a three digit number in order to implement follow-up procedures. These follow-up procedures were initiated approximately ten days after the initial questionnaire mailing (Appendix F).

Analysis

Upon receipt of the completed questionnaires, the responses were coded and punched on computer cards. The U.B.C. Multivariate Contingency Tabulations computer program (MVTAB) was used to calculate both frequency of response and percentage response to items of the questionnaire. Most analysis required only univariate considerations. However, certain comparisons between response items were required, such as between provisions for limited success students and non-limited success students in homogeneously
grouped classes. To make comparisons such as this the bivariate option of the MVTAB program was used.

The results of this analysis are discussed in the following chapter.
CHAPTER 3

RESULTS

Introduction

In this chapter the results of the questionnaire, as reported by the sample of B.C. junior secondary science teachers, are presented. Tables of related results are grouped together under the following headings:

- Questionnaire response (page 66)
- Demographic data (page 67)
- Teaching experience (page 69)
- Schools (page 71)
- Extent and composition of the limited success student population in B.C. (page 72)
- Teaching methods presently in use for limited success students in B.C. (page 77)
- Teacher attitudes and training (page 103)

Tables of results are not necessarily listed in the order that the corresponding items of the questionnaire occur. To aid cross-reference with the corresponding questionnaire item the number of the item appears in parenthesis preceding the table title. Each table reports both the frequency and percent response to the questionnaire item.

A number of questionnaire items were multiple response items (e.g. item one and thirteen). Teachers had the option
to check more than one alternative within such an item. The analysis of these items required each alternative to be considered as a separate item. Therefore the percent response reported in a related table does not necessarily total 100. The tables reporting multiple response item results have an asterisk (*) following the table number.

A summary of the major findings of the questionnaire may be found in Appendix H.

**Questionnaire response**

A total of 336 questionnaires were mailed on May 15, 1978 to the sample teachers. The school districts participating (87% of B.C. school districts) represented a wide range of rural/urban and socioeconomic areas in the Province. Approximately 220 questionnaires were returned by May 26, 1978 at which point 145 follow-up letters and questionnaires were mailed. By June 30, 1978 310 (85%) questionnaires had been returned. A total of 299 (82%) of the returned questionnaires were suitable for analysis purposes. ¹

Approximately an equal number of grade eight (n=98 or 33%), grade nine (n=94 or 31%) and grade ten (n=107 or 36%) teachers completed the questionnaire.

Of the 299 teachers responding to the questionnaire twenty-two said that both homogeneous and heterogeneous science teaching occurred in their school. These teachers replied to both branches of the questionnaire.

¹Eleven sample teachers did not teach science at the junior secondary level or were not at the school indicated by the sampling.
Demographic Data

Education background of questionnaire respondents

Tables 1.1 and 1.2 outline the undergraduate and graduate background of the respondents.

(1a) TABLE 1.1 *

UNDERGRADUATE MAJOR(S) OR CONCENTRATION(S)

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>152</td>
<td>51</td>
</tr>
<tr>
<td>Chemistry</td>
<td>117</td>
<td>39</td>
</tr>
<tr>
<td>Physics</td>
<td>64</td>
<td>21</td>
</tr>
<tr>
<td>Earth Science</td>
<td>26</td>
<td>9</td>
</tr>
<tr>
<td>Space Science</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>104</td>
<td>35</td>
</tr>
</tbody>
</table>

Of the 104 teachers reporting other undergraduate majors(s) or concentrations, twenty-nine (10%) had other areas of science listed, forty-six (15%) listed a non-science and science background (e.g. English and biology) and twenty-eight (9%) reported a non-science background (e.g. math, physical education, history).
(1b) **TABLE 1.2**

**HIGHER DEGREES**

<table>
<thead>
<tr>
<th>Degree Obtained</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No higher degree</td>
<td>239</td>
<td>80</td>
</tr>
<tr>
<td>M.Sc.</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>M.A.</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>M.Ed.</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>Ph.D. (or equivalent)</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>2</td>
</tr>
</tbody>
</table>

Of the seven teachers reporting other higher degrees one reported an M.Sc. in education, another an M.B.A. and one M.A.Sc. Four respondents did not indicate the nature of their higher degree.

**Teaching experience**

The total teaching experience of the respondents and their experience teaching science to limited success students in homogeneous groups can be determined by examination of tables 2.1, 2.2 and 2.3.
### TABLE 2.1

**OVERALL TEACHING EXPERIENCE**

<table>
<thead>
<tr>
<th>Years of Experience</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n=299)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>Second or third</td>
<td>48</td>
<td>16</td>
</tr>
<tr>
<td>Fourth to ninth</td>
<td>117</td>
<td>39</td>
</tr>
<tr>
<td>Tenth or over</td>
<td>112</td>
<td>38</td>
</tr>
<tr>
<td>No response</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Totals</td>
<td>299</td>
<td>100</td>
</tr>
</tbody>
</table>

### TABLE 2.2

**PREVIOUS EXPERIENCE TEACHING LIMITED SUCCESS STUDENTS SCIENCE IN A HOMOGENEOUS CLASS GROUP AT THE JUNIOR SECONDARY LEVEL**

<table>
<thead>
<tr>
<th>Previous Experience</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n=299)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>169</td>
<td>57</td>
</tr>
<tr>
<td>No</td>
<td>129</td>
<td>43</td>
</tr>
<tr>
<td>No Response</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Totals</td>
<td>299</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 2.3 shows that 77% of all respondents reported four years or more teaching experience. Only 23% reported three years or less teaching experience. Fifty-seven percent of respondents indicated that they did have previous experience teaching limited success students science in a homogeneous class group. Of the teachers who did report this previous experience 51% said they first taught these classes in their first or second year of teaching. Since more than half of the respondents (51%) reported their first experience with homogeneously grouped limited success science students in their first or second year it seems
evident that often previous teaching experience has not been considered before assignment to these classes.

Schools

Table 3.1 indicates the types of school (in terms of grades taught) in which the respondents reported teaching. For comparison purposes table 3.1 also gives figures as reported by Information Services of the B.C. Ministry of Education.

(6a) TABLE 3.1

GRADES TAUGHT IN SCHOOLS

<table>
<thead>
<tr>
<th>Grades Taught</th>
<th>Number and Percentage of Schools Reported by the Ministry of Education</th>
<th>Reported by Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reported by the Ministry of Education 1</td>
<td>Reported by Respondents 2</td>
</tr>
<tr>
<td>8 - 10</td>
<td>112 (34)</td>
<td>123 (41)</td>
</tr>
<tr>
<td>8 - 12</td>
<td>96 (29)</td>
<td>106 (36)</td>
</tr>
<tr>
<td>10 - 12</td>
<td>27 (8)</td>
<td>20 (7)</td>
</tr>
<tr>
<td>9 - 12</td>
<td>7 (2)</td>
<td>9 (3)</td>
</tr>
<tr>
<td>8 - 9</td>
<td>11 (3)</td>
<td>6 (2)</td>
</tr>
<tr>
<td>K - 12</td>
<td>10 (3)</td>
<td>4 (1)</td>
</tr>
<tr>
<td>Other</td>
<td>68 (21)</td>
<td>27 (9)</td>
</tr>
<tr>
<td>No Response</td>
<td>-</td>
<td>4 (1)</td>
</tr>
<tr>
<td>Totals</td>
<td>331 (100)</td>
<td>299 (100)</td>
</tr>
</tbody>
</table>

1 Numbers in parentheses refer to percentage of total schools in the categories listed.

2 Numbers in parentheses refer to percentage of response.
Table 3.1 shows more responses than schools that actually exist in the grade eight to ten category, the ten to twelve category and the nine to twelve category. Because some schools had more than one science teacher responding to the questionnaire the number of responses is in some instances greater than the number of schools. It can be seen that the types of schools, as reported by respondents, closely reflects the actual distribution as reported by the Ministry of Education.

Extent and composition of the limited success student population in B.C.

Population size

An estimation of the size of the limited success student population was provided by teachers in both homogeneous and heterogeneous teaching situations. Teachers of heterogeneously grouped science classes estimated percentages directly (table 4.2). Information from teachers of homogeneously grouped limited success science students included the total number of classes taught at each grade level which, when divided into the total number of limited success science classes taught, yielded a total percentage of teaching load (table 4.1). The estimates of teachers from both homogeneous and heterogeneous teaching situations were merged to provide an overall estimate for the Province (table 4.3). Since some respondents teach more than one grade level of homogeneously grouped limited success students
and others teach both heterogeneously and homogeneously grouped classes, the effective total response in table 4.3 was 338.

(8)-(9) TABLE 4.1

PROPORTION OF LIMITED SUCCESS STUDENTS IN B.C. JUNIOR HIGH SCHOOLS AS REPORTED BY TEACHERS OF HOMOGENEOUSLY GROUPED SCIENCE CLASSES

<table>
<thead>
<tr>
<th>Percentage of Teaching Load</th>
<th>Grade 8</th>
<th>Grade 9</th>
<th>Grade 10</th>
<th>Total</th>
<th>Percentage of Response (%) (n = 146)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 20%</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Up to 33%</td>
<td>13</td>
<td>12</td>
<td>8</td>
<td>33</td>
<td>23</td>
</tr>
<tr>
<td>Up to 50%</td>
<td>11</td>
<td>7</td>
<td>23</td>
<td>41</td>
<td>28</td>
</tr>
<tr>
<td>Over 50%</td>
<td>13</td>
<td>18</td>
<td>18</td>
<td>49</td>
<td>33</td>
</tr>
<tr>
<td>No Response</td>
<td>0</td>
<td>6</td>
<td>8</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>Sub-totals</td>
<td>38</td>
<td>47</td>
<td>61</td>
<td>146</td>
<td>100</td>
</tr>
<tr>
<td>Sub-percentages</td>
<td>26</td>
<td>32</td>
<td>42</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
TABLE 4.2
PROPORTION OF LIMITED SUCCESS STUDENTS IN B.C. JUNIOR HIGH SCHOOLS AS REPORTED BY TEACHERS OF HETEROGENEously GROUPED SCIENCE CLASSES

<table>
<thead>
<tr>
<th>Percentage of Students</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n = 192)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 10%</td>
<td>78</td>
<td>41</td>
</tr>
<tr>
<td>Up to 20%</td>
<td>75</td>
<td>39</td>
</tr>
<tr>
<td>Up to 33%</td>
<td>25</td>
<td>13</td>
</tr>
<tr>
<td>Up to 50%</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Over 50%</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>No Response</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>192</td>
<td>100</td>
</tr>
</tbody>
</table>

TABLE 4.3
PROPORTION OF LIMITED SUCCESS STUDENTS IN JUNIOR HIGH SCHOOLS AS REPORTED BY ALL QUESTIONNAIRE RESPONDENTS.

<table>
<thead>
<tr>
<th>Percent of Overall Student Population</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n = 338)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 10%</td>
<td>78</td>
<td>23</td>
</tr>
<tr>
<td>Up to 20%</td>
<td>84</td>
<td>25</td>
</tr>
<tr>
<td>Up to 33%</td>
<td>58</td>
<td>17</td>
</tr>
<tr>
<td>Up to 50%</td>
<td>49</td>
<td>14</td>
</tr>
<tr>
<td>Over 50%</td>
<td>53</td>
<td>16</td>
</tr>
<tr>
<td>No Response</td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td>Totals</td>
<td>338</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 4.1 shows an increase in reported ability grouping from grade eight to grade ten. Teachers of heterogeneously grouped science classes (table 4.2) seem to identify a smaller population of limited success students than do teachers of homogeneously grouped classes (table 4.1). Forty-seven percent of all respondents report a limited success student population of 20% or higher.

The figures listed in tables 4.1 to 4.3 indicate that a limited success student population of significant size exists in B.C. junior secondary schools.

Composition of limited success student population

Table 5.1 shows the distribution of limited success students by sex as reported by teachers of grouped science classes. This table also shows an overall distribution of limited success students by sex obtained by combining the figures for teachers of homogeneous and heterogeneous classes. Numbers in parentheses refer to percentage response, these are preceded by figures of frequency of response.
### RELATIVE PROPORTION OF LIMITED SUCCESS STUDENTS BY SEX

<table>
<thead>
<tr>
<th>Proportion</th>
<th>Frequency and Percentage Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Homogeneously Grouped Classes</td>
</tr>
<tr>
<td></td>
<td>(n=127)</td>
</tr>
<tr>
<td></td>
<td>Heterogeneously Grouped Classes</td>
</tr>
<tr>
<td></td>
<td>(n=192)</td>
</tr>
<tr>
<td>Homogeneously and Heterogeneously Grouped Classes</td>
<td>(n=321)</td>
</tr>
<tr>
<td>All boys</td>
<td>1 (&lt;1)</td>
</tr>
<tr>
<td>Well over half boys</td>
<td>28 (22)</td>
</tr>
<tr>
<td>About half boys and half girls</td>
<td>77 (61)</td>
</tr>
<tr>
<td>Well over half girls</td>
<td>5 (4)</td>
</tr>
<tr>
<td>All girls</td>
<td>1 (&lt;1)</td>
</tr>
<tr>
<td>No response</td>
<td>15 (12)</td>
</tr>
<tr>
<td></td>
<td>1 (&lt;1)</td>
</tr>
<tr>
<td></td>
<td>53 (28)</td>
</tr>
<tr>
<td></td>
<td>124 (65)</td>
</tr>
<tr>
<td></td>
<td>9 (5)</td>
</tr>
<tr>
<td></td>
<td>1 (1)</td>
</tr>
<tr>
<td></td>
<td>4 (2)</td>
</tr>
<tr>
<td></td>
<td>19 (7)</td>
</tr>
</tbody>
</table>

Twenty-eight percent of teachers of heterogeneous classes said that the composition of these classes ranged from well over half to all boys. Twenty-three percent of teachers of homogeneous classes reported similar class composition. Twenty-five percent of all respondents reported

---

1Unless otherwise indicated items nine to twenty-one were analyzed on the basis of 321 respondents. Since twenty-two respondents replied to both homogeneous and heterogeneous grouping questionnaire branches the number of effective responses increased from 299 to 321. The teachers answering both of these branches reported doing so because both forms of grouping were practiced in the classes they taught.
that well over half of their limited success students were boys while only 4% reported well over half girls. Evidently more boys experience limited success in science than girls.

Teaching methods presently in use for limited success science students

Grouping practices

This section outlines the responses of teachers to a number of questions regarding homogeneous and heterogeneous grouping practices. Tables 6.1 and 6.3 show the extent to which various grouping practices are utilized by respondents. Table 6.2 reports on the extent to which limited success students are promoted to a higher achievement level within a homogeneous grouping system. Table 6.4 indicates the differences in class size existing between homogeneously and heterogeneously grouped classes. Further comparisons between time tables and number of hours of science for limited success students in heterogeneous and homogeneous classes are reported in tables 6.5 and 6.6 respectively.
TABLE 6.1

TYPES OF GROUPING REPORTED

<table>
<thead>
<tr>
<th>Type of Grouping</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n=299)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homogeneous</td>
<td>105</td>
<td>35</td>
</tr>
<tr>
<td>Heterogeneous</td>
<td>170</td>
<td>57</td>
</tr>
<tr>
<td>Homogeneous and Heterogeneous</td>
<td>22</td>
<td>7</td>
</tr>
<tr>
<td>No data</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>299</td>
<td>100</td>
</tr>
</tbody>
</table>

Teachers' comments indicated that both homogeneous and heterogeneous grouping does occur within a single school. Comments showed that often grade eight and nine science were heterogeneously grouped while grade ten science was homogeneously grouped.

Teacher reports indicate that ability grouping is being practiced in 42% of all respondents' schools.
Table 6.2 shows that the majority of limited success students do not progress to higher achievement levels within a homogeneously grouped system. It seems that many limited success students tend to remain limited success students within a homogeneous grouping system. This finding may also be true for limited success students in heterogeneously grouped classes, however this was not examined in this study.

<table>
<thead>
<tr>
<th>Proportion of Upward Moving Students</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n=321)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Much more than half</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>About half</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Well under half</td>
<td>31</td>
<td>10</td>
</tr>
<tr>
<td>None</td>
<td>57</td>
<td>19</td>
</tr>
<tr>
<td>No response</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Totals</td>
<td>129</td>
<td>40</td>
</tr>
</tbody>
</table>
Thirty-six percent of the respondents from heterogeneous teaching situations, group at least sometimes in these classes. The types of grouping used (as indicated by teacher comments) are varied, including: the pairing of a limited success student with a brighter student; an individualized learning program and the provision of core materials for all students with more challenging extensions for brighter students. Other teacher comments show the following further accommodations teachers make for limited success students:
- a more lenient marking scheme
- a reduced expectation for these students
- a grouping based on reading ability and previous math achievement
- a grouping based on friendship
- a grouping for special projects

Some teachers said that grouping was a very difficult and time consuming. A number of teachers said that the available laboratories and materials were inappropriate. A few said that identification of limited success students was a difficult task since they were not informed in advance who these students were.

(10a, 15a, 16) TABLE 6.4

AVERAGE CLASS SIZE

<table>
<thead>
<tr>
<th>Class Size</th>
<th>Frequency and Percentage Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Homogeneously Grouped Limited Success Students (n=321)</td>
</tr>
<tr>
<td>Less than 16</td>
<td>29 (9)</td>
</tr>
<tr>
<td>16 - 20</td>
<td>37 (11)</td>
</tr>
<tr>
<td>21 - 25</td>
<td>36 (11)</td>
</tr>
<tr>
<td>26 - 30</td>
<td>12 (4)</td>
</tr>
<tr>
<td>Over 30</td>
<td>2 (1)</td>
</tr>
<tr>
<td>No response</td>
<td>13 (4)</td>
</tr>
<tr>
<td>Totals</td>
<td>129 (40)</td>
</tr>
</tbody>
</table>
Table 6.4 indicates that 80% of homogeneously grouped science classes have twenty-five or fewer students in them. Table 6.4 also shows larger classes for non-limited success students in homogeneously grouped classes. Ninety percent of the teachers of homogeneously grouped non-limited success students state that the size of these classes is in excess of twenty-one students. A majority of teachers (59%) in heterogeneous grouping situations reported science class sizes in excess of twenty-six students. Since a class size not exceeding twenty-five students is advocated in the literature (Oxenhorn 1972, Collette 1973, Younie 1974) it appears as if many science classes of heterogeneously grouped students and homogeneously grouped non-limited success students exceed this recommended class size.
A bivariate comparison between the responses related to limited success students and non-limited success students indicated few time table differences (4%). Teachers of heterogeneously grouped science classes report a slightly higher proportion of semester system time tables than do teachers of homogeneous science classes.
A bivariate comparison between the responses related to limited success students and non-limited success students indicated few differences (4%) in the number of hours of science taught per week. Few major differences seem to exist between heterogeneous and homogeneous grouping in the number of hours of science provided per week. Dilution of science by reducing the number of hours per week does not appear to be a widespread practice in the instruction of limited success students.
Curriculum, teaching techniques and teaching technology

Curriculum

(25a) TABLE 7.1

NUMBER OF TEACHERS OFFERING SPECIAL PROGRAMS FOR THEIR LIMITED SUCCESS STUDENTS

<table>
<thead>
<tr>
<th>Programs</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special program offered</td>
<td>74</td>
<td>25</td>
</tr>
<tr>
<td>No special program</td>
<td>206</td>
<td>69</td>
</tr>
<tr>
<td>No response</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>Totals</td>
<td>299</td>
<td>100</td>
</tr>
</tbody>
</table>

(25a) TABLE 7.2

SPECIAL SCIENCE PROGRAMS AND ABILITY GROUPING

<table>
<thead>
<tr>
<th>Type of Grouping</th>
<th>Frequency and Percentage Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Special Program Offered (n=299)</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Homogeneous</td>
<td>43 (14)</td>
</tr>
<tr>
<td>Heterogeneous</td>
<td>23 (8)</td>
</tr>
<tr>
<td>Homogeneous and heterogeneous</td>
<td>8 (3)</td>
</tr>
</tbody>
</table>
Teacher reports show that almost 70% of respondents do not provide a special science course for their limited success students (table 7.1). Of the teachers that do provide a special science program for these students 58% are teachers of homogeneously grouped science classes while 31% teach in heterogeneously grouped science classes. Evidently even if ability grouping is practiced many teachers do not differentiate the science program for their limited success students.

(7) TABLE 7.3 *

SUBJECT AREAS TAUGHT IN GRADE 8, 9 AND 10 SCIENCE

<table>
<thead>
<tr>
<th>Subject</th>
<th>Frequency and Percentage Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grade 8</td>
</tr>
<tr>
<td>Physics</td>
<td>149 (50)</td>
</tr>
<tr>
<td>Chemistry</td>
<td>163 (55)</td>
</tr>
<tr>
<td>Biology</td>
<td>152 (51)</td>
</tr>
<tr>
<td>Earth Science</td>
<td>125 (42)</td>
</tr>
<tr>
<td>Space Science</td>
<td>7 (2)</td>
</tr>
<tr>
<td>Integrated Science</td>
<td>4 (1)</td>
</tr>
<tr>
<td>Interdisciplinary Science</td>
<td>7 (2)</td>
</tr>
</tbody>
</table>
### (22a) TABLE 7.4 *

**TEXT(S) AND LABORATORY MANUALS USED IN THE INSTRUCTION OF LIMITED SUCCESS STUDENTS**

<table>
<thead>
<tr>
<th>Text or Laboratory Manual</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introducing Science Concepts in the Laboratory</td>
<td>152</td>
<td>51</td>
</tr>
<tr>
<td>Developing Science Concepts in the Laboratory</td>
<td>146</td>
<td>49</td>
</tr>
<tr>
<td>Extending Science Concepts in the Laboratory</td>
<td>133</td>
<td>45</td>
</tr>
<tr>
<td>Pathways in Science (Oxenhorn)</td>
<td>31</td>
<td>10</td>
</tr>
<tr>
<td>Invitations to Investigate Science (Wong)</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>100</td>
<td>33</td>
</tr>
<tr>
<td>A combination of the above</td>
<td>46</td>
<td>15</td>
</tr>
<tr>
<td>A modification of the above</td>
<td>47</td>
<td>16</td>
</tr>
</tbody>
</table>

One-third (33%) of the teachers responding to this survey reported the use of other texts, laboratory manuals and sources than those listed in item twenty-two. A further 15% of respondents reported modifications of existing curricula. Over thirty-seven different texts, laboratory manuals and sources were listed by teachers commenting on this item. Among the more prevalent of these alternate curricula are:
- teacher prepared worksheets, notes and laboratories
- Concepts and Challenges in Science (Winkler et al.)
- Modern General Science Series
- Intermediate Science Curriculum Study
- Mixtures in Chemistry
- locally developed units
- Cambridge Work-A-Texts
- Science in Action Series
- Spaceship Earth Series
- Ginn Physical Science and Life Science

(22b) TABLE 7.5

TEACHERS' OVERALL RATING OF TEXTS AND LABORATORY MANUALS USED

<table>
<thead>
<tr>
<th>Rating</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n=299)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very suitable</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Suitable</td>
<td>36</td>
<td>12</td>
</tr>
<tr>
<td>Somewhat suitable</td>
<td>101</td>
<td>34</td>
</tr>
<tr>
<td>Unsuitable</td>
<td>121</td>
<td>40</td>
</tr>
<tr>
<td>No response</td>
<td>33</td>
<td>11</td>
</tr>
</tbody>
</table>

Teacher responses to items 22a and 22b were compared to produce an individual text rating shown in table 7.6.
Seventy-four percent of respondents said that the texts and laboratory manuals they were using were only somewhat suitable to unsuitable for teaching science to limited success students (table 7.5). Table 7.6 shows that the majority of these poorly rated texts and laboratory manuals are those suggested and supplied by the B.C. Ministry of Education. Teacher comments suggested the following reasons for rating the texts and laboratory manuals in the way they did:

<table>
<thead>
<tr>
<th>Text or Laboratory Manual</th>
<th>Frequency and Percentage Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Suitable</td>
</tr>
<tr>
<td>Introducing Science Concepts in the Laboratory</td>
<td>4 (3)</td>
</tr>
<tr>
<td>Developing Science Concepts in the Laboratory</td>
<td>3 (2)</td>
</tr>
<tr>
<td>Extending Science Concepts in the Laboratory</td>
<td>2 (1)</td>
</tr>
<tr>
<td>Pathways in Science (Oxenhorm)</td>
<td>2 (6)</td>
</tr>
<tr>
<td>Invitations to Investigate Science (Wong)</td>
<td>1 (7)</td>
</tr>
<tr>
<td>Others</td>
<td>4 (4)</td>
</tr>
</tbody>
</table>
- reading level is inappropriate for limited success students (some say this is true for most students)
- concepts and instructions are too difficult
- content boring, irrelevant and too academic
- some texts (e.g. Concepts and Challenges in Science) are insulting to students' intelligence
- Reading About Science texts are not related to laboratory work
- text layout is dull, more diagrams are needed

While a majority of respondents reported the use of the science texts suggested by the Ministry of Education and the associated curriculum (tables 7.3 and 7.4) it seems evident that most teachers rate these texts (and indirectly the closely related curriculum) poorly (tables 7.5 and 7.6). These results imply the need for a new curriculum in science.

Table 7.7 shows the extent to which teachers of limited success students use various means to determine science course content for these students.
<table>
<thead>
<tr>
<th>Proportion of Course</th>
<th>Based on Student Interest (n=299)</th>
<th>Based on Student Choice (n=299)</th>
<th>Based on Job-Oriented Science (n=299)</th>
<th>Based on Content Reduction (n=299)</th>
<th>Based on Reduction of Complexity (n=299)</th>
<th>Based on Core Curriculum (n=299)</th>
<th>Based on an Alternative Sequential Program (n=299)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None of the course</td>
<td>62 (21)</td>
<td>159 (53)</td>
<td>140 (47)</td>
<td>58 (19)</td>
<td>56 (19)</td>
<td>19 (6)</td>
<td>131 (44)</td>
</tr>
<tr>
<td>Less than half the course</td>
<td>120 (40)</td>
<td>76 (26)</td>
<td>93 (31)</td>
<td>60 (20)</td>
<td>58 (19)</td>
<td>29 (10)</td>
<td>48 (16)</td>
</tr>
<tr>
<td>About half the course</td>
<td>46 (16)</td>
<td>7 (2)</td>
<td>13 (4)</td>
<td>53 (18)</td>
<td>45 (15)</td>
<td>74 (25)</td>
<td>32 (11)</td>
</tr>
<tr>
<td>More than half the course</td>
<td>19 (6)</td>
<td>1 (&lt;1)</td>
<td>6 (2)</td>
<td>42 (14)</td>
<td>35 (12)</td>
<td>65 (22)</td>
<td>10 (3)</td>
</tr>
<tr>
<td>Almost all the course</td>
<td>9 (3)</td>
<td>2 (1)</td>
<td>3 (1)</td>
<td>42 (14)</td>
<td>63 (21)</td>
<td>73 (24)</td>
<td>22 (7)</td>
</tr>
<tr>
<td>No response</td>
<td>43 (14)</td>
<td>54 (18)</td>
<td>44 (15)</td>
<td>44 (15)</td>
<td>42 (14)</td>
<td>39 (13)</td>
<td>56 (19)</td>
</tr>
</tbody>
</table>

The results of item twenty-three above show a relatively high non-response. This non-response is possibly due to teachers neglecting to circle the zero option of this item.
Only 29% of respondents said that they based a portion of their science course for limited success students on student choice. Sixty-five percent reported that they did use student interest to provide some basis for their science course. Apparently few teachers allow their limited success students significant decision making powers in course content determination. However, a majority (65%) seem to see a need to work from student interests in their curriculum planning.

The use of science course content reduction and a reduction of content complexity appears to be wide-spread. Forty-six and 48% of respondents reported that one-half or more of their course was based on a reduction of content or complexity.

Few teachers (7%) reported that one-half or more of their science course for limited success students was based on job-oriented science.

Seventy-one percent of all respondents reported basing one-half or more of their science course for limited success students on the present B.C. Core Curriculum. Only 21% of respondents said they used an alternative structured sequential program as a basis for one-half of their course or more.
Teacher comments related to science programs

Teachers' comments indicated their desire for changes in the present science curriculum specifically oriented towards limited success students. The comments of these teachers outlined the following areas of need:

- a need for variety requires a modular approach
- a need for a simple structured text with diagrams to supplement laboratory text
- a need to dilute the existing course
- a need for a highly structured program with short steps
- a need for programmed learning and fill-in-the-blanks worksheets
- a need to modify the existing program on an individualized basis
- a need for an appropriate reading level, writing to be kept to a minimum and less mathematical emphasis
- a need for a hands on approach including a more general laboratory manual and textbook
- a need for a more individualized program.

Approaches to learning

Table 8.1 outlines the responses of teachers indicating the frequency that they involve their limited success students in a variety of approaches to learning.


<table>
<thead>
<tr>
<th>Frequency of Involvement</th>
<th>Frequency and Percentage Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>3 (1)</td>
</tr>
<tr>
<td>Once or twice a term</td>
<td>11 (4)</td>
</tr>
<tr>
<td>Once or twice a month</td>
<td>36 (12)</td>
</tr>
<tr>
<td>Once or twice a week</td>
<td>166 (55)</td>
</tr>
<tr>
<td>Almost every class</td>
<td>63 (21)</td>
</tr>
<tr>
<td>No response</td>
<td>20 (7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency of Involvement</th>
<th>Frequency and Percentage Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Demonstrations (n=299)</td>
</tr>
<tr>
<td>Never</td>
<td>5 (2)</td>
</tr>
<tr>
<td>Once or twice a term</td>
<td>45 (15)</td>
</tr>
<tr>
<td>Once or twice a month</td>
<td>130 (44)</td>
</tr>
<tr>
<td>Once or twice a week</td>
<td>64 (28)</td>
</tr>
<tr>
<td>Almost every class</td>
<td>15 (4)</td>
</tr>
<tr>
<td>No response</td>
<td>22 (7)</td>
</tr>
</tbody>
</table>

The results of item twenty-four show a relatively high non-response. This non-response is possibly due to teachers neglecting to circle the zero option of this item.
**Labwork.** Seventy-six percent of respondents reported using teacher arranged labwork to instruct limited success students at least once or twice a week while only 35% said they use the discovery method to the same extent.

**Small group and individualized learning.** Sixty percent of all respondents reported that they never or rarely (once or twice a term) use a small group or individualized approach while 15% say they use this kind of approach at least once a week. The use of either of these approaches to learning to a major extent does not appear to be widespread in B.C. These results indicate a preference to whole class teaching a good deal of the time.

**Project work.** Twenty-six percent of respondents reported that they never involve their limited success students in project work during the school year. Given this significant proportion of respondents it is evident that many limited success students may not have the opportunity to choose a topic of interest to them which project work can facilitate.

**Lecture and notes.** Fifty-three percent of respondents reported that they use the lecture and notes approach at least once a week with their limited success students. These results support those related to small group and individualized learning.

**Worksheets.** Twenty-three percent of all respondents said that they use worksheets at least once or twice a
week while 70% use worksheets once or twice a month or less to instruct their limited success students. Apparently worksheets are not in widespread use on a frequent basis for limited success science students in B.C.

Audio-visual aids. Thirty-five percent of respondents reported using audio-visual aids at least once a week while 59% said they use audio-visual aids once or twice a month or less to instruct their limited success students. The use of audio-visual aids, on a day-to-day basis, seems relatively rare among a majority of science teachers of limited success students.

Class discussion. Eighty-two percent of all respondents reported involving their limited success students in class discussion on at least a monthly basis. A further 76% said that they presented demonstrations with at least the same frequency as class discussions. Forty percent of all respondents said that they did not involve their limited success students in field trips. Evidently many limited success students are not exposed to the concrete experiences facilitated through a field trip.

Oral presentations. Thirty-five percent of respondents reported using oral presentations with limited success students while 57% said they never used this approach with these students. Since oral skills may work to enhance other communication skills it seems that many limited success students may not have the opportunity to improve these
non-oral skills in their science classes.

**Review.** Eighty percent of respondents indicated that they reviewed once or twice a month or more when instructing limited success students. Forty-six percent said they review on a weekly or daily basis. Relatively frequent science review seems to be a common occurrence in the teaching of limited success students.

**Programmed learning.** Sixty percent of respondents said that they never used programmed learning to instruct their limited success students while 28% reported using this approach at least once or twice a term.

Further differences existing between teachers of homogeneously and heterogeneously grouped science classes

Some comparisons have already been made between the practices of teachers of homogeneously and heterogeneously grouped science classes. Further differences in both content determination and approaches to learning were evident between these two groups of teachers. Upon comparison of teaching methods with type of grouping it was found that a significantly greater percentage (in excess of 10%) of teachers of heterogeneously grouped science classes reported using the laboratory texts suggested by the Ministry of Education than did teachers of homogeneously
grouped classes.

Teachers of homogeneously grouped classes reported using both student choice and student interest to determine course content to a greater extent than did teachers of heterogeneously grouped classes.

Teachers of homogeneously grouped science classes reported reducing content and complexity of course content for limited success students to a greater extent than did teachers of heterogeneously grouped classes.

Teachers of heterogeneously grouped science classes reported using the core curriculum to a greater extent than did teachers of homogeneously grouped science classes.

Teachers of heterogeneously grouped science classes reported using a lecture and notes approach to a greater extent than did teachers of homogeneously grouped science classes.

It is apparent that more freedom of choice is experienced by both teachers and students of homogeneously grouped science classes. More attention appears to be paid to the interests of the students in homogeneous classes than heterogeneous classes. Evidently reducing content and complexity of a course for limited success students is more common in homogeneously than heterogeneously grouped science classes.
Evaluation and reporting

Tables 9.1 to 9.4 outline teachers' responses to questions related to the evaluation and reporting of the progress of their limited success students. Table 9.1 reports on the extent of student involvement in evaluation. Table 9.2 reports the major areas in which limited success students are evaluated. Table 9.3 shows the extent to which testing is used when instructing limited success students. Table 9.4 shows the usage of the various methods of reporting student progress.

(26a) TABLE 9.1¹

EVALUATION OF THE PROGRESS OF LIMITED SUCCESS STUDENTS

<table>
<thead>
<tr>
<th>Evaluator(s)</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n=299)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher only</td>
<td>132</td>
<td>44</td>
</tr>
<tr>
<td>Mainly by teacher, partially by student</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>Equally by student and teacher</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mainly by student, partially by teacher</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Student only</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>No response</td>
<td>145</td>
<td>49</td>
</tr>
</tbody>
</table>

¹Item twenty-six had a high incidence of non-response. An error of numbering following item 25a resulted in the lack of teacher response to this item.
Eighty-six percent of respondents reporting on the evaluation of student progress stated that this evaluation was based solely on the teacher while 14% indicated some limited success student involvement in their own evaluation.

(26b) TABLE 9.2 *

COMPONENTS USED TO EVALUATE LIMITED SUCCESS STUDENTS

<table>
<thead>
<tr>
<th>Evaluation Component</th>
<th>Frequency and Percentage Response</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Component Used</td>
<td>Component Not Used</td>
</tr>
<tr>
<td>Student laboratory write-ups</td>
<td>145 (93)</td>
<td>11 (7)</td>
</tr>
<tr>
<td>Projects</td>
<td>99 (63)</td>
<td>57 (37)</td>
</tr>
<tr>
<td>Oral talks</td>
<td>44 (29)</td>
<td>111 (71)</td>
</tr>
<tr>
<td>Tests</td>
<td>141 (90)</td>
<td>15 (10)</td>
</tr>
<tr>
<td>Attitude</td>
<td>102 (66)</td>
<td>53 (34)</td>
</tr>
<tr>
<td>Attendance</td>
<td>69 (44)</td>
<td>87 (56)</td>
</tr>
<tr>
<td>Other</td>
<td>35 (23)</td>
<td>120 (77)</td>
</tr>
</tbody>
</table>

Student laboratory write-ups and tests were reported to be used by the majority (93% and 90% respectively) of respondents answering this item (26b). Approximately 65% of respondents reported including components of attitude and project work in their evaluation of limited success students. Forty-four percent of respondents said that they included attendance in their assessment while less than 30% reported including oral talks or other forms of
assessment. Most teachers appear to use two to three different evaluation components to assess the progress of their limited success students. Teachers also reported evaluation based on: worksheets and notebooks; participation in class; workhabits; student assignments and oral explanation to the teacher; a final exam on the core curriculum; effort; reading assignments; writing skills with long term learning and field work by students.

(24) TABLE 9.3

TESTING: FREQUENCY USED IN THE INSTRUCTION OF LIMITED SUCCESS STUDENTS

<table>
<thead>
<tr>
<th>Frequency of Use</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n=299)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Once or twice a term</td>
<td>40</td>
<td>13</td>
</tr>
<tr>
<td>Once or twice a month</td>
<td>180</td>
<td>60</td>
</tr>
<tr>
<td>Once or twice a week</td>
<td>41</td>
<td>14</td>
</tr>
<tr>
<td>Almost every class</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>No response</td>
<td>20</td>
<td>7</td>
</tr>
</tbody>
</table>

Seventy-five percent of respondents said that they tested with a monthly to daily frequency. This result seems to be consistent with the result reported in table 9.2 where testing was said to have a heavy emphasis in the overall evaluation of limited success students.
(26c) TABLE 9.4 *

FREQUENCY OF VARIOUS METHODS OF REPORTING PROGRESS
OF LIMITED SUCCESS STUDENTS

<table>
<thead>
<tr>
<th>Reporting Method</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n=299)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formal letter grades (A,B,C,D,E)</td>
<td>150</td>
<td>50</td>
</tr>
<tr>
<td>Satisfactory/unsatisfactory</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Pass/fail/incomplete</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>Anecdotal</td>
<td>53</td>
<td>18</td>
</tr>
<tr>
<td>Other</td>
<td>15</td>
<td>5</td>
</tr>
</tbody>
</table>

Many teachers indicated the use of anecdotal reporting in conjunction with formal letter grades. Some of the other reporting schemes teachers reported were:

- complete/incomplete
- H (honours), S (satisfactory), S- (minimal pass)
  I (incomplete/fail)
- Pass/Fail used only in final report if mark is below a C+
- A,B,C,D/not mastered or incomplete
- C/Pass/Fail
- 1,2,3,4,5 scale 1 being the best

Further analysis of the data showed that formal letter
grades were used by a larger proportion (16% more) of teachers of homogeneous than heterogeneous science classes.

Teacher attitudes and training

Tables 10.1 to 10.13 outline the training that respondents received related to limited success students and in addition examine some of the factors which may relate to the attitudes of these teachers.

(14) TABLE 10.1

TEACHERS OF HOMOGENEOUSLY GROUPED CLASSES: WILLINGNESS TO TEACH LIMITED SUCCESS STUDENTS IN HOMOGENEOUS CLASSES.

NUMBER OF CLASSES

<table>
<thead>
<tr>
<th>Number of Classes</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n=321)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>51</td>
<td>16</td>
</tr>
<tr>
<td>1</td>
<td>33</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>No Response</td>
<td>26</td>
<td>8</td>
</tr>
<tr>
<td>Totals</td>
<td>129</td>
<td>40</td>
</tr>
</tbody>
</table>
Forty-two percent of the teachers from homogeneously grouped class situations reported that they would be willing to teach at least one homogeneously grouped science class of limited success students. Forty percent of the teachers of homogeneously grouped classes indicated that they did not wish to teach these students in a special science class.

(21a) TABLE 10.2

<table>
<thead>
<tr>
<th>Position on Ability Grouping</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n=321)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wish to group all limited success students</td>
<td>94</td>
<td>29</td>
</tr>
<tr>
<td>Do not wish to group limited success students</td>
<td>91</td>
<td>28</td>
</tr>
<tr>
<td>No response</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Totals</td>
<td>194</td>
<td>60</td>
</tr>
</tbody>
</table>
### (21b) TABLE 10.3

**TEACHERS OF HETEROGENEously GROUPED CLASSES:**

**DESEnT TO TEACH LIMITED SUCCESS STUDENTS SCIENCE IN A SEPARATE CLASS GROUP**

<table>
<thead>
<tr>
<th>Desire to Teach Limited Success Students in a Separate Class</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n=321)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Would teach these classes</td>
<td>64</td>
<td>20</td>
</tr>
<tr>
<td>Would not teach these classes</td>
<td>114</td>
<td>36</td>
</tr>
<tr>
<td>No response</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>194</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>

### (21c) TABLE 10.4

**TEACHERS OF HETEROGENEously GROUPED CLASSES:**

**WILLINGNESS TO TEACH LIMITED SUCCESS STUDENTS IN HOMOGENEOUS CLASSES. NUMBER OF CLASSES**

<table>
<thead>
<tr>
<th>Number of Classes</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n=321)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>78</td>
<td>24</td>
</tr>
<tr>
<td>1</td>
<td>64</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>32</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No response</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>194</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>
About one-half (49%) of the teachers of heterogeneously grouped science classes indicated their desire to group limited success students into a separate science class (table 10.2). Fifty-nine percent of these teachers also said that they would not choose to teach these separate classes of limited success students (table 10.3). Fifty-three percent said that they would be willing to teach at least one class of separately grouped limited success students (table 10.4).

In order to interpret teachers' position on ability grouping more clearly the results of tables 10.2 and 10.3 have been compared and reported in table 10.5 which shows four possible positions teachers may hold regarding ability grouping.

(21a)-(21b) TABLE 10.5

TEACHERS OF HETEROGENEOUSLY GROUPED CLASSES:
DESIRE TO GROUP AND TEACH LIMITED SUCCESS SCIENCE STUDENTS IN A SEPARATE CLASS

<table>
<thead>
<tr>
<th>Teachers' position</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Would group and teach limited success students</td>
<td>45</td>
<td>14</td>
</tr>
<tr>
<td>Would group but not teach limited success students</td>
<td>48</td>
<td>15</td>
</tr>
<tr>
<td>Would not group but would teach separate groups of limited success students</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>Would not group and not teach separate groups of limited success students</td>
<td>66</td>
<td>21</td>
</tr>
<tr>
<td>No response</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>Totals</td>
<td>194</td>
<td>60</td>
</tr>
</tbody>
</table>
Twenty-nine percent of respondents indicated that they would group limited success students into separate classes for science instruction. About half of these teachers in favour of ability grouping reported that they were willing to teach these classes. Sixty percent of teachers of heterogeneously grouped classes said they would not be willing to teach limited success science students in a separate class group.

By combining the results of tables 10.1 and 10.4 a partial picture of teacher commitment to teaching limited success students may be generated (table 10.6).

**TABLE 10.6**

**TEACHER COMMITMENT TO TEACHING LIMITED SUCCESS STUDENTS**

<table>
<thead>
<tr>
<th>Commitment</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Show a desire to teach limited success students</td>
<td>116</td>
<td>36</td>
</tr>
<tr>
<td>Prefer not to teach limited success students</td>
<td>48</td>
<td>15</td>
</tr>
<tr>
<td>Not analysable</td>
<td>117</td>
<td>37</td>
</tr>
<tr>
<td>No response</td>
<td>40</td>
<td>12</td>
</tr>
</tbody>
</table>
The 117 respondents not analysable were those teachers in table 10.1 who indicated that they did not wish to teach any separate classes of limited success students plus those teachers in table 10.5 who said they would not group or teach limited success students in a separate class. The results indicate that a significant number of B.C. junior secondary science teachers do not hold a commitment to teaching limited success students.

(13) TABLE 10.7 *

**METHOD OF TEACHER ASSIGNMENT TO HOMogeneously GROUPED CLASSES OF LIMITED SUCCESS SCIENCE STUDENTS**

<table>
<thead>
<tr>
<th>Method of Assignment</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n=321)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own choice</td>
<td>35</td>
<td>11</td>
</tr>
<tr>
<td>Science department decision</td>
<td>27</td>
<td>8</td>
</tr>
<tr>
<td>Assignment by department head</td>
<td>16</td>
<td>5</td>
</tr>
<tr>
<td>Assignment by principal</td>
<td>59</td>
<td>18</td>
</tr>
<tr>
<td>Other</td>
<td>15</td>
<td>5</td>
</tr>
</tbody>
</table>

Most teachers checked only one of the methods listed in table 10.7. The results show that teachers report that assignments to specially grouped science classes for limited success students are made by either the principal or de-
partment head (23%). By considering only those teachers of homogeneously grouped science classes the proportion increases to 68%. Only 11% of all respondents (28% of teachers in homogeneous grouping situations) report having the option to teach these classes. The list below presents some of the alternate methods of assignment reported by respondents:

- assignment on a rotational basis by science teachers
- assignment by counsellor recommendation
- assignment by random time tabling
- assignment by vice-principal

Teachers were asked to report the number of separate science and non-science classes that they taught. In addition the total number of blocks in teachers' timetables was reported. Using these two figures it was possible to determine what free time teachers had available per timetable cycle (table 10.8).

(6) TABLE 10.8

FREE TIME OF JUNIOR SECONDARY SCIENCE TEACHERS

<table>
<thead>
<tr>
<th>Number of Classes Per Cycle</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%) (n=299)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>32</td>
<td>11</td>
</tr>
<tr>
<td>1</td>
<td>172</td>
<td>58</td>
</tr>
<tr>
<td>2</td>
<td>27</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>36</td>
<td>12</td>
</tr>
<tr>
<td>No Response</td>
<td>19</td>
<td>6</td>
</tr>
</tbody>
</table>
Fifty-eight percent of respondents reported one spare class per timetable cycle while 11% said they did not have any free time. Thirteen percent had two to three spare classes per cycle. Thirty-six respondents (12%) obviously misinterpreted the nature of item six and so were classified as miscellaneous in table 10.8.

(2a) TABLE 10.9

PRE-SERVICE TEACHER TRAINING RELATED TO LIMITED SUCCESS STUDENTS

<table>
<thead>
<tr>
<th>Pre-Service Training</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have received pre-service training</td>
<td>64</td>
<td>21</td>
</tr>
<tr>
<td>Have not received pre-service training</td>
<td>233</td>
<td>78</td>
</tr>
<tr>
<td>No response</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

(2b) TABLE 10.10

EXTENT OF PRE-SERVICE TEACHER TRAINING RELATED TO LIMITED SUCCESS STUDENTS

<table>
<thead>
<tr>
<th>Amount of Pre-Service Training</th>
<th>Frequency of Response</th>
<th>Percentage of Response (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A whole course</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Half a course</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>A few hours of a course</td>
<td>23</td>
<td>8</td>
</tr>
<tr>
<td>An hour of a course</td>
<td>1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Incidentally during a course</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>No response</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>
The results in table 10.9 show that 78% of respondents reported no previous training related to limited success students. Of the teachers who did report some special training (only 21%) 30% said they received a whole course or half a course related to these students. The balance of these teachers with special training (69%) reported receiving a few hours or less of this training (table 10.10). Seventy percent of teachers who did receive prior training indicate that this training was at least of some use to their subsequent teaching of limited success students (table 10.11).
Most teachers (81%) reported that they did not receive in-service training related to limited success students (table 10.12). Of the teachers who said they did receive...
some special in-service training 77% reported that they had found this training to be at least of some use (table 10.13).

The results outlined in this chapter have suggested a number of conclusions and recommendations which are presented in the following chapter.
Conclusions and Recommendations

Introduction

This chapter presents the major conclusions and recommendations derived from the survey. Conclusions and recommendations were only generated on the basis of (1) 10% or more respondents reporting under one option of a questionnaire item or (2) where a difference of 10% or more responses existed between the options of a questionnaire item. The same 10% level was used when bivariate comparisons were made between questionnaire items. The use of 10% as a guideline was based upon this percentage as the lower limit for the acceptance of a problem area as having educational significance.

This chapter is divided into two sections; the first section details the results and discussion leading to the conclusions and section two details the results and discussion leading to the recommendations also listed in this section.

Since all conclusions and recommendations are based on teacher perception and not validated observation caution must be exercised before acceptance, rejection or implementation of the findings.
Conclusions

Forty-seven percent of respondents reported the proportion of limited success students in their science classes to be in excess of 20% (table 4.3). Forty-two percent of respondents said that they taught limited success science students in homogeneously grouped classes (table 6.1). A further 21% of teachers reported some form of grouping within their heterogeneously grouped classes (table 6.3). In total 63% of respondents reported using some form of ability grouping for the limited success students they taught. The numbers of limited success students reported and the widespread attempt to deal with these students indicates both the significant size of this population and a general awareness of its existence.

Twenty-five percent of respondents reported using a special program to teach their limited success science students (table 7.1). The remaining teachers said they used the curriculum and laboratory texts presently suggested by the Ministry of Education¹ (tables 7.3, 7.4 and 7.7).

¹Curriculum guides: British Columbia Ministry of Education Junior Science Curriculum Guides - Grade 8, Grade 9, Grade 10, 1970.

An average of 82% of respondents reported that these laboratory texts were only somewhat suitable to unsuitable for the instruction of limited success science students (table 7.6). Teacher comments (in Chapter three and Appendix G) further indicate additional drawbacks of the present curriculum and the need and desire for an appropriate new curriculum for these students.

Based on the data collected three major conclusions can be drawn:

1. A significantly large population of limited success students exist in B.C. junior secondary schools
2. A general awareness of the existence of a population of limited success students in B.C. is evident
3. Few special science programs have been developed for limited success students in B.C. Most junior secondary science teachers perceive the present recommended curriculum to be largely inappropriate for instructing limited success students
Recommendations

Curriculum

Only one quarter (25%) of respondents reported the development of a special science program for their limited success students (table 7.1). Of the teachers reporting special programs 14% were teachers of homogeneously grouped science classes (33% of all homogeneous teachers) while 8% were teachers of heterogeneously grouped science classes (table 7.2). The majority of respondents reported the use of the curriculum and associated laboratory texts suggested by the Ministry of Education (tables 7.3, 7.4 and 7.7). An average of 82% of respondents reported that the suggested laboratory texts (and the closely related curriculum) were only somewhat suitable to unsuitable for the instruction of limited success science students (table 7.6). From 5% to 33% of respondents reported using other curricula and sources than those suggested by the Ministry of Education (tables 7.4 and 7.7), however these alternative curricula were not rated more suitable than the recommended curriculum (table 7.6). Forty-six percent of respondents reported that at least one-half of their science course for limited success students was based on reduced content compared to other students, while 48% reported that subject matter of reduced complexity comprised at least one-half of their
science course for limited success students (table 7.7). Fifty-three percent of respondents said they did not base any portion of their science course for limited success students on student choice (table 7.7). Twenty-one percent said they did not base any portion of their science course for these students on student interests.

The literature indicates that effective teaching within ability grouping requires that appropriate materials and curriculum be provided to each ability level (Ekstrom 1961, Thomas and Thomas 1975, Passow 1966). The lack of specially developed science programs in B.C., the adherence to the existing texts and curriculum and the respondents' lack of faith in the existing curriculum indicates a major variance with the suggestions of the literature. Two major curriculum approaches for limited success science students in B.C. appear to be reduction of course content and complexity compared to other students. The literature indicates the inappropriateness of such a diluted curriculum (Johnson 1963, Ladd 1972, Collette 1973, Sturges 1973, Younie 1974). The fact that many teachers say they modify or reject the existing curriculum indicates a concern among teachers regarding the adequacy of this curriculum. Allowing students choice within a curriculum, basing part of a curriculum on students' interests and the job-oriented aspects of science is said to help improve the self-concept of limited success students and provide

1. It is recommended that a new science curriculum be developed which reflects the wide ability range of B.C. junior secondary students in general and limited success students in particular.

Teachers and school administration

Teachers' science background. Nine percent of all respondents reported a non-science undergraduate background (table 1.1). The literature suggests that teachers of limited success students should have expertise in science rather than being generalists. Accordingly students will benefit from a teachers' expertise in one area (Kelly 1974).

2. It is recommended that teachers with science background be chosen to teach science at the junior secondary level.

Teaching experience. Fifty-one percent of teachers who had previous experience with homogeneously grouped classes of limited success science students reported that they first taught these classes in their first or second year of
teaching (table 2.3). The literature indicates that often the least experienced teachers are assigned to instruct classes of homogeneously grouped limited success students (Sturges 1976). In choosing teachers of homogeneously grouped limited success science classes it is not evident that teachers with some experience are selected for these assignments.

3. It is recommended that teachers with some teaching experience be assigned to teach special science classes for limited success students.

Teacher commitment. At least 15% of respondents indicated that they would be willing to group limited success students for science but were not willing to teach these classes (table 10.5). Thirty-six percent said that they would be willing to instruct these students under any grouping circumstances (table 10.6).

Sixty percent of respondents who taught homogeneously grouped science classes said that they were assigned to these classes by a Principal or department head. Only 28% of these teachers said they chose to teach such classes (table 10.7). Eleven percent of respondents reported that they did not have any spare class time during the week (table 10.8).

The literature states that teachers of limited success students should be committed to teaching these
students (Featherstone 1951, Johnson 1963, Ausubel 1967, Reissman 1969, Glasser 1971, Younie 1974). Teacher reports indicate that a significant proportion of B.C. junior secondary science teachers do not appear to be committed to instructing these students. The literature also states that the instruction of limited success students is difficult and time consuming, requiring adequate preparation time (Kelly 1974). Evidently a significant number of B.C. junior secondary science teachers do not have spare time.

4. It is recommended that teachers be assigned to classes of homogeneously grouped limited success students only if they hold a commitment to teaching these students. It is further recommended that teachers be assigned to heterogeneously grouped classes only if they hold a commitment to teaching students of a wide ability range.

5. It is recommended that teachers be given some choice in the classes they teach and adequate spare time for preparation.

Class size. Eighty percent of teachers of homogeneously grouped science classes reported class sizes of twenty-five students or less while 11% reported class sizes in excess of twenty-five students (table 6.4). Approximately 38% of teachers of both homogeneously grouped non-limited success students and heterogeneously grouped classes reported class
sizes of twenty-five students or less.

The literature recommends that all science classes, whether homogeneously or heterogeneously grouped, should not exceed twenty-five students (Oxenhorn 1972, Younie 1974). Although the majority of homogeneously grouped science classes for limited success students in B.C. fall within the suggested guidelines of the literature, 11% still maintain a class size of twenty-six students or more. The majority of heterogeneously grouped science classes and homogeneously grouped classes for non-limited success students seem to exceed the suggestions in the literature.

6. It is recommended that all science classes be reduced to twenty-five students and in particular homogeneously grouped science classes for limited success students.

Student evaluation. Eighty-six percent of respondents reporting on the evaluation of limited success science students indicated that evaluation was determined solely by the teacher while only 14% reported minimal student involvement (table 9.1). Most teachers reported using tests (90%) and student laboratory write-ups (93%) to evaluate their limited success students, while fewer used projects (60%), student attitude (66%), student attendance (44%), oral talks (29%) and other evaluation components (23%) (table 9.2). Seventy-five percent of teachers reported that they tested with a frequency of at least once or
twice a month (table 9.3).

The literature indicates that student involvement in decision making may improve student self-concept, help remove student feelings of hopelessness and fatalism and, by participating in their own evaluation, give an opportunity for realistic self-evaluation (Newsom 1963, Scottish Education Department 1969, Ladd 1972, Sturges 1973, Younie 1974, Sturges 1976, Wragg 1976). A wide evaluation base is advocated to provide both a broad picture of student progress and to ensure that a student has an opportunity to do well at something congruent with his learning style (Hughes 1973). By testing frequently (and in general evaluating frequently) the student is made aware of his strengths and weaknesses which may be built upon or remediated as necessary (Darke 1976).

The survey results indicate that it is a rare occurrence where teachers relinquish the responsibility of evaluation to students. Evaluation of limited success students in B.C. science classes seems to be based upon only two or three different components. Although these components include both cognitive and affective (attitude) areas it would seem that a narrow base of evaluation is inadequate to evaluate the potential of any student.

7. It is recommended that teachers increase the number of components they use to evaluate the progress of their limited
success students and include more opportunities for students to evaluate their own work and progress.

Teacher training

Pre-service training. Twenty-one percent of respondents reported taking some pre-service training related to limited success students (table 10.9). Thirty percent of these teachers said they took a half course or more while 70% reported that they experienced a minimal amount (a few hours or less) of special training (table 10.10). Seventy percent of teachers who experienced some pre-service training said that this training was of some use to their subsequent teaching of limited success students (table 10.11).

The literature suggests that pre-service training should include some components related to limited success students (Schools Council 1970, Schools Council 1971, Kelly 1974, Schools Council 1975, Sturges 1976). Since it seems that few B.C. junior secondary science teachers have had little, if any, pre-service training in this area, it is likely that they will take some time to acquire the skills of teaching these students.

8. It is recommended that a required course or portion of a course, related to limited success students, be included in the pre-service training of science teachers.
In-service training. Less than one-fifth (19%) of respondents reported having received any in-service training related to limited success students (table 10.12). Seventy-seven percent of these teachers said that this training was of some use to their teaching of limited success students (table 10.13). Since little pre-service training was reported it is surprising that more compensatory in-service training has not been provided.

9. It is recommended that in-service training related to limited success students be increased.

Approaches to learning. Eighty-eight percent of respondents reported using a directed inquiry approach (teacher directed experiments) at least once or twice a month (table 8.1). Only 58% reported using a discovery approach as frequently (table 8.1). Forty percent of respondents reported that they never involved their limited success students in field trips (table 8.1) and 76% said they utilized class demonstrations at least once or twice a month (table 8.1). Thirty-five percent of respondents reported that they used audio-visual aids frequently (at least once or twice a week) while 59% reported less frequent use (once or twice a month or less) (table 8.1). Thirty-nine percent of respondents reported that they
never used a small group or individualized approach and over one-half (53%) said they used the lecture and notes approach frequently (at least once or twice a week) (table 8.1). Worksheets were reported to be used at a maximum of once or twice a month by 70% of respondents and at least once or twice a week by only 23% of respondents (table 8.1). Forty-six percent of respondents reported the use of frequent review (at least once or twice a week) (table 8.1) and 60% said they never used programmed learning (table 8.1). Seventy-one percent of respondents said they involved their limited success students in class discussion at least once or twice a month (table 8.1), however, 97% reported they never involved these students in oral presentations (table 8.1). Twenty-six percent of respondents said they never used the project approach in the instruction of limited success science students (table 8.1).

The literature advocates that limited success students should learn by concrete experience (Featherstone 1951, Johnson 1963, Newsom 1963, Reissman 1969, Younie 1974, Sturges 1976). Laboratory work, field trips and demonstrations are seen to help provide these concrete experiences. Audio-visual aids are thought to be an extension to concrete learning experiences and help provide alternate modes of learning to allow for students' diverse learning styles (Featherstone 1951, Ausubel 1965,
Bloom 1966, Webster 1970, Jenkins et al. 1973, Kelly 1974, Younie 1974, Sturges 1976). Individual and small group learning is said to help the teacher to deal more individually with the students, resulting in better teacher-student relationships, improved individual attention to allow for student differences and a more indirect teaching style (Scottish Education Department 1969, Milson 1970, Schools Council 1970, Collette 1973, Hughes 1973, Darke 1976, Sturges 1976, Wragg 1976). The use of worksheets (especially in a small group or individualized learning) is advocated to free the teacher to deal with students on an individual basis, to allow students to proceed at a pace congruent with their ability and to prevent needless student note-taking (Newsom 1963, Kamm 1969, Jenkins et al. 1973, Schools Council 1976, Darke 1976, Sturges 1976). Since limited success students lack successful experiences in school the provision of a directed inquiry approach, frequent review and supplemental programmed learning are thought to help provide short steps learning with pre-arranged, but non-trivial, success (Reissman 1969, Webster 1970, Texas Education Agency 1972, Wilkenson and Bowers 1976, Ausubel 1967, Jenkins et al. 1973, Collette 1973, Sturges 1976). Students' communication, in other than oral modes, is thought to be promoted by both oral presentations and class discussion. These oral approaches are also considered to be useful for the limited success

While it appears as if some B.C. junior secondary science teachers are involved in all approaches discussed above it is apparent that a significant percentage of respondents do not involve their limited success students in the following approaches: small group or individualized learning; student projects; worksheets (on a weekly basis); frequent use of audio-visual aids; field trips; oral presentations and frequent review (at least once or twice a week).

10. It is recommended that pre-service and in-service training include instruction on the methods necessary to facilitate student involvement in: small group and individualized learning; project work; oral presentations and review. This training should encourage teachers to use and/or produce appropriate audio-visual aids, worksheets and programmed learning.
Ability grouping. Sixty-three percent of respondents reported the existence of some form of ability grouping in their science classes (tables 6.1 and 6.3). Forty-two percent reported homogeneously grouped science classes for limited success students (table 6.1). Twenty-one percent said they grouped occasionally within their heterogeneously grouped science classes (table 6.3).

Forty percent of the teachers of homogeneously grouped science classes reported that they would teach at least one class of separately grouped limited success science students (table 10.1). Fifty-three percent of the teachers of heterogeneously grouped science classes reported that they were willing to teach at least one of these classes (table 10.4). Nearly one-half (49%) of teachers of heterogeneously grouped science classes wished to group all limited success students into separate science classes (table 10.2).

While there is no conclusive evidence in support of the effectiveness of either homogeneous or heterogeneous ability grouping, the latter practice is the most favoured in the recent literature (Esposito 1973, Davies 1975, Findlay and Bryan 1975, Wilson and Schmits 1978). Although the practice of ability grouping in B.C. is significantly less than indicated in the literature it is evident that the practice is still favoured in many B.C. junior secondary schools. The types of grouping occurring in heterogeneously grouped classes (see chapter three) indicate
that a variety of methods is used with no consistent province-wide pattern evolving.

The expressed willingness of many teachers to teach separate classes of limited success students and the stated desire of many respondents for specially grouped science classes indicates a large body of teacher acceptance of ability grouping. Presently in B.C. there appears to be mismatch between what teachers think and the position advocated in the literature on ability grouping.

11. It is recommended that debate and discussion be stimulated on the current status of research and educational thinking on ability grouping.

12. It is also recommended that pre-service and in-service training provide instruction in appropriate methods of grouping within heterogeneous classes.

Further research

Composition of the limited success student population.

Twenty-five percent of respondents reported that well over half of their limited success students were boys while only 4% reported that well over half were girls (table 5.1). This higher proportion of male limited success students is reported by teachers of both heterogeneously and homogeneously grouped science classes. The imbalance of boys and girls is also noted in the literature but little explana-
tion is forwarded for its occurrence (Bricklin and Bricklin 1967). It seems desirable that further investigation be carried out in this area.

13. It is recommended that research be carried out to help identify some of the causal factors underlying the higher proportion of male limited success students.

Once these factors have been identified it will then be possible to develop appropriate measures to reduce the overall numbers of limited success students and in particular the number of boys in this category.

Inter-group transfer in homogeneous ability grouping. Less than one-fifth (18%) of respondents reported that any of their homogeneously grouped limited success students advanced to a higher ability group at the same grade level (table 6.2). This lack of inter-group transfer is also alluded to in the literature (Davies 1975). Two interpretations of this reduced upward mobility are possible: the nature of present systems of grouping may be too inflexible to allow mobility of limited success students or the students themselves may progress very little and thus not warrant inter-group transfer.

14. It is recommended that further research be conducted to determine the causal factors underlying the tendency for limited success students to remain in special science classes.
Increase of limited success students with higher grade level. Of the teachers reporting homogeneously grouped science classes 26% reported grouping in grade eight, 32% reported grouping in grade nine and 42% reported grouping in grade ten (table 4.1). It is evident that there is an increase in the incidence of special grouping with higher grade level. The increase in the number of special science classes indicates an increasing population of limited success students with higher grade level. The nature and causes of the increase with grade level is not known at this time.

15. It is recommended that further investigation be initiated to determine the causal factors underlying the reported increase of limited success science students with increasing grade level.

Limited success student identification in homogeneously grouped classes. Six percent of teachers of homogeneously grouped science classes reported that 20% or less of their students were limited success students (table 4.1). Eighty percent of teachers of heterogeneously grouped science classes reported that 20% or less of their students were in the limited success category (table 4.2). Eighty-four percent of teachers of homogeneously grouped science classes reported that their classes were composed of 20% or
more limited success students (table 4.1). Less than one-fifth of teachers of heterogeneously grouped science classes reported a limited success student population in excess of 20% (table 4.2). Homogeneous grouping seems to identify a greater proportion of limited success students than heterogeneous grouping.

16. **It is recommended that further investigation be conducted to determine the factors causing the higher incidence of limited success student identification in homogeneously grouped science classes compared to heterogeneously grouped science classes.**

**Study Conclusion**

Two hundred and ninety-nine junior secondary school science teachers responded to the questionnaire (82% of a sample of 336). A previously tested sampling frame was used. The high level of response and the tested sampling frame gave significant results and the data should provide a good basis for the consideration of appropriate curricula and teaching methods for limited success students in B.C. As with any survey, caution is urged before acceptance, rejection or implementation of the findings.
APPENDIX A

Questionnaire Format
The Limited Success Student* in Science:
A survey of current practices in junior secondary science in British Columbia

*For the purposes of this study limited success students are defined as:

a) those students achieving a consistent D or E average in science or

b) those students specially grouped for the purposes of science instruction due to previous low achievement.
In order to obtain a clear picture of current practices in B.C. junior secondary science for limited success students, we ask you for a few minutes of your time to complete this questionnaire.

The questionnaire has a branching pattern so this means you will not be required to do every page.

Your response is completely confidential. The number on this questionnaire is solely for follow-up purposes. The data obtained will be used only by the principal researcher and his advisor. Our report will consist only of group percentages and no identification of individual teachers, schools or school district will be made.

NOTE: Please check or circle the appropriate response for each item. On some items, more than one choice may be marked. Such items will be preceded by '(Multiple Response Item)'. All other items are to be responded to only once.

Please return the completed questionnaire in the self-addressed, pre-stamped envelope provided. The return of this questionnaire is requested by May 24, 1978.
LIMITED SUCCESS STUDENTS

Limited success students are defined as:

a) those students achieving a consistent D or E average (or equivalent rating) in science or

b) those students specially grouped for science instruction due to their low achievement.

PLEASE PROVIDE THE FOLLOWING BACKGROUND INFORMATION

1. (Multiple Response Item)

   a) Please check your undergraduate major(s) or concentration(s).
      - biology . . . . . . . . . . . .
      - chemistry . . . . . . . . . . .
      - physics . . . . . . . . . . . .
      - earth science . . . . . . . . .
      - space science . . . . . . . . .
      - other (please specify) . . .

   b) (Multiple Response Item)
      Higher degrees
      - no higher degree . . . . . . .
      - M.Sc. . . . . . . . . . . . .
      - M.A. . . . . . . . . . . . .
      - M.Ed. . . . . . . . . . . . .
      - Ph.D. (or equivalent) . . . .
      - Other (please specify). . . .
2. a) Did you receive any instruction in the teaching of limited success students at your teacher training institution?
   Yes □ No □ (if No please proceed to question 3)

   b) Since you received special instruction at your teacher training institution, approximately how much instruction was provided?
      a whole course. . . . . . . □
      half a course . . . . . . □
      a few hours of a course . . . □
      an hour of a course . . . . □
      incidentaly during a course . . □

   c) Since you received special instruction at your teacher training institution, how useful has this instruction been to your teaching?
      very useful . . . . . . . . . □
      of some use . . . . . . □
      of little use . . . . . . □
      of no use . . . . . . □

3. In what year of your teaching career are you at present?
   first . . . . . . . □
   second or third . . . . □
   fourth to ninth . . . . □
   tenth or over . . . . □

4. a) Have you taught junior science (grade 8, 9 or 10) to limited success students in a separate class group, at any previous time in your teaching career?
    Yes □ No □ (if No please proceed to question 5)

   b) Since you have taught junior science to limited success students in separate class groups, in what year of your teaching career did you first teach these students?
      first . . . . . □
      second . . . . . □
      third . . . . . □
      fourth . . . . . □
      fifth or above . . □
5. a) Have you attended any in-service training to assist you in teaching limited success students?
   Yes □   No □ (if No please proceed to question 6)

b) Since you have received some in service training how useful has this training been to your teaching?
   very useful . . . . . . . . □
   of some use . . . . . . . . □
   of little use . . . . . . . . □
   of no use . . . . . . . . □

6. a) What grades are taught in your school?
   K 1 2 3 4 5 6 7 8 9 10 11 12

b) What is the total student population of your school?
   less than 200 . . . . . . . . □
   200 - 400 . . . . . . . . . . □
   400 - 600 . . . . . . . . . . □
   600 - 800 . . . . . . . . . . □
   800 -1000 . . . . . . . . . . □
   1000 -1200 . . . . . . . . . . □
   More than 1200 . . . . . . . . □

c) How many separate classes in all subject areas do you presently teach?
   1 2 3 4 5 6 7 8 9

d) What is the total number of separate blocks in your timetable?
   1 2 3 4 5 6 7 8 9 10
7. (Multiple Response Item)

Please check the subject areas you presently teach in junior science.

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Science 8</th>
<th>Science 9</th>
<th>Science 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>physics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>chemistry</td>
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<td></td>
</tr>
<tr>
<td>biology</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>earth science</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>space science</td>
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<td></td>
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<tr>
<td>integrated*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>interdisciplinary**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>other (please specify)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* integrated - disciplines of science (eg. chemistry and biology)
** interdisciplinary - subject areas other than science (eg. social studies) enter into the study of themes of a scientific nature.

8. Please indicate number of classes presently taught at each grade level.

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Science 9</td>
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<td></td>
<td></td>
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<tr>
<td>Science 10</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TO COMPLETE THIS QUESTIONNAIRE
PLEASE READ THE FOLLOWING

PRESENT TEACHING RESPONSIBILITIES

If your limited success students are grouped in separate classes for science instruction please proceed to Question 9 of this questionnaire.

If your limited success students are not grouped in separate classes for science instruction please proceed to Question 16 of this questionnaire.
9. Of the junior science classes you teach how many are grouped specifically for limited success students?

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

10. a) What is the average size of your classes for limited success students?

- less than 16
- 16 - 20
- 21 - 25
- 26 - 30
- over 30

b) How is science presently timetabled for limited success students in your school?

- regular or full year
- semestered
- quartered
- other (please specify)

c) Approximately how many hours of science per week are provided for your limited success students?

- 0 - 1 hour
- 1 - 2 hours
- 2 - 3 hours
- 3 - 4 hours
- 4 - 5 hours
- 5 - 6 hours
- over 6 hours
11. Of the limited success science students you teach what is the distribution of these students by sex?

- all boys ....................................... □
- well over half are boys .................. □
- about half boys and half girls .......... □
- well over half are girls .................. □
- all girls .................................... □

12. Over the period of a year what proportion of your limited success science students are promoted to a higher achieving group at the same grade level?

- all .......................................... □
- well over half ................................ □
- about half .................................. □
- well under half ............................. □
- none ......................................... □

13. (Multiple Response Item)
How were you chosen to teach these limited success students?

- own choice .................................. □
- science department decision .............. □
- assignment by department head ........... □
- assignment by principal .................... □
- other (please specify) ..................... □

14. Given your choice and your present teaching load, how many classes of science for limited success students would you be willing to teach?

0 1 2 3 4 5 6 7 8

15. a) What is the average size of your non-limited success science classes?

- less than 16 .................................. □
- 16 - 20 ...................................... □
- 21 - 25 ...................................... □
- 26 - 30 ...................................... □
- over 30 ..................................... □
b) How is science presently timetabled for non-limited success students in your school?

- regular or full year
- semestered
- quartered
- other (please specify)

(Select one)

(c) How many hours of science per week are provided for your non-limited success students?

- 0 - 1 hour
- 1 - 2 hours
- 2 - 3 hours
- 3 - 4 hours
- 4 - 5 hours
- 5 - 6 hours
- over 6 hours

(Select one)

Comments related to this portion of the questionnaire: ______________________

__________________________

__________________________

__________________________

__________________________

PLEASE PROCEED TO QUESTION 22
16. What is the average size of your science classes?

- less than 16
- 16 - 20
- 21 - 25
- 26 - 30
- Over 30

17. Approximately what percentage of the science students you teach are limited success students?

- up to 10%
- up to 20%
- up to 33%
- up to 50%
- over 50%

18. Of those students you consider to be limited success what is the distribution of these students by sex?

- all boys
- well over half boys
- about half boys and half girls
- well over half girls
- all girls

19. Do you group students according to their ability within your science classes?

- Yes
- No
- Sometimes

Comments
20. a) How is science presently timetabled in your school?

- regular or full year □
- semestered □
- quartered □
- other (please specify) □

b) Approximately how many class hours of science per week are provided for your junior science students?

- 0 - 1 hour □
- 1 - 2 hours □
- 2 - 3 hours □
- 3 - 4 hours □
- 4 - 5 hours □
- 5 - 6 hours □
- over 6 hours □

21. a) Given the choice would you group all limited success students into separate classes for science?

- Yes □
- No □

b) Given the choice would you opt to teach these separate science classes for limited success students?

- Yes □
- No □

c) Given the choice and your present teaching load, how many separate classes of limited success students would you be willing to teach?

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Comments related to this portion of the questionnaire

________________________
________________________
________________________
________________________

PLEAS TURN TO QUESTION 22
22. a) (Multiple Response Item)
What text(s) or lab manual(s) do you use with your limited success students (grouped or ungrouped)?

Introducing Science Concepts in the Laboratory (Schmid et al) ........................................... □

Developing Science Concepts in the Laboratory (Schmid et al) ........................................... □

Extending Science Concepts in the Laboratory (Schmid et al) ........................................... □

Pathways in Science (Oxenhorn et al) .................. □

Invitations to Investigate Science (Wong et al) .................. □

Other(s) (please specify) ................................. □

A combination of the above ............................... □

A modification of the above (please specify) ............ □

Other comments .............................................


b) How do you rate the text(s) and/or lab manual(s) you are using for your limited success students?

very suitable ........................................... □

suitable ............................................... □

somewhat suitable ...................................... □

unsuitable ................................................ □

Comments ................................................................
........................................................................
........................................................................


23. How much of your science course for limited success students (grouped or ungrouped) is based on the following?

**SCALE:**

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>none of the course</td>
<td>much less than half the course</td>
<td>about half the course</td>
<td>much more than half the course</td>
<td>almost all the course</td>
</tr>
</tbody>
</table>

- Job-oriented science
- Reduced content compared to other classes and students.
- Present B.C. Ministry of Education Core Curriculum
- An alternative structured, sequential science program
- Content determined by teacher through students' interests.
- Content chosen by students.
- Less complex activities compared to other classes and students.

24. How often do you involve your limited success students in the following activities and approaches?

**SCALE:**

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>Once or twice a Term</td>
<td>Once or twice a month</td>
<td>Once or twice a week</td>
<td>Almost every class period</td>
</tr>
</tbody>
</table>

- Students doing experiments (teacher arranged)
- Discussion
- Lecture and notes
- Demonstrations
- Students doing experiments (discovery method)
- Programmed learning
- Project work
- Work sheets
- Field trips
- Individualized or small group learning
- Testing
- Oral presentations
- Review to reinforce skills and concepts
- Use of audio-visual aids (eg. films, overheads, slides)
25. a) Have you developed a special science program for your limited success students?

Yes □ No □ (if No please proceed to question 27)

b) (Multiple Response Item)
Since you have developed a special science program for your limited success students (in a grouped or ungrouped situation), in what way is this program evaluated?

- Evaluated by student achievement based on standardized tests . . . . . . . . . . . . . . □
- Evaluated by student achievement based on teacher designed tests . . . . . . . . . . □
- Evaluated through student attitude and interest . . . . . . . . . . . . . . . . . . □
- Evaluated through formal science department discussions . . . . . . . . . . . . . . □
- Not formally evaluated . . . . . . . . . . . . □
- Other (please specify)

26. a) Who evaluates the progress of your limited success students?

- Evaluation solely by teacher . . . . . . . . . . □
- Evaluation mainly by teacher, partially by student . . □
- Evaluation equally by teacher and student . . . . □
- Evaluation mainly by student, partially by teacher . . □
- Evaluation solely by student . . . . . . . . . □
- Other (please specify) . . . . . . . . . □

b) Approximately what percentage do each of the following contribute to the evaluation of your limited success science students?

<table>
<thead>
<tr>
<th></th>
<th>0 up to 20%</th>
<th>up to 40%</th>
<th>up to 60%</th>
<th>up to 80%</th>
<th>up to 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student lab write-ups</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Projects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral talks</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Tests</td>
<td></td>
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<td></td>
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<tr>
<td>Attitude</td>
<td></td>
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<td></td>
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<td>Attendance</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
c) (Multiple Response Item)

How is the progress of your limited success students reported?

- formal letter grades (A, B, C, D, E) ...
- satisfactory/unsatisfactory ...........
- Pass/fail/incomplete .................
- Anecdotal ............................
- Other (please specify) ..............

Comments related to this portion of the questionnaire:

THANK YOU VERY MUCH FOR YOUR TIME AND COOPERATION

Please return this questionnaire in the self-addressed, pre-stamped envelope provided. The return of this questionnaire is requested by May 24, 1978.

For further information or inquiries please contact:

Mr. P.S. Healy (phone 228-4969)

or

Dr. R.W. Carlisle (phone 228-5056)

c/o Faculty of Education
Science Education Department
University of British Columbia
2075 Wesbrook Place
Vancouver, B.C. V6T 1W5

If you wish to receive a copy of the final report resulting from this survey please contact the people above or write your name and address in the space provided below.
APPENDIX B

Sampling Information
Description of Sampling Frame Used for Mr. Peter Healy

Phase I: Determining the eligible science teachers and assigning them to one of the categories of science teachers.

1. Categories: 1) Grade 8 Science teacher  
   2) Grade 9 Science teacher  
   3) Grade 10 Science teacher  

2. The September 30, 1977 Form J teacher information file, sorted by school code, was used to ensure a geographic representation in the final sample. All teacher records were examined to determine which secondary grade/subjects were taught by each teacher.

3. Teachers who had listed their teaching position (item 33) as:
   - Other School Instructional Staff (code 6)
   - Principal of More than One School (code 7)
   - District-wide Supervisor (code 8)
   - Other District-wide Instructional staff (code 9)
   were rejected from further consideration.

4. Remaining teachers were examined to determine the number of times they qualified as a teacher of one of the 3 categories. (A teacher may teach several classes of secondary science programs and may therefore qualify for several categories.) Secondary level grades and subjects were picked from items 46-59.

Example:
A teacher who has filled in items 46-59 with
   1 class Science 8
   2 classes Science 9
   1 class Science 10
qualifies 4 times (for the 4 science classes).

5. Teachers are systematically assigned to one of the categories in which they have qualified.

Example: In the above case the teacher qualified four times. He therefore has a 1/4th chance of being assigned to each of these categories. Teachers who qualify four times are systematically assigned as follows: the first
teacher is assigned to the first category where he qualifies, the second to the second, ...
the fourth teacher to the fourth, the fifth teacher to the first category, etc.

In the above example the teacher has the following probabilities of assignment:

- $\frac{1}{4}$ to Grade 8
- $\frac{2}{4}$ to Grade 9
- $\frac{1}{4}$ to Grade 10

6. Following the above procedure, teachers are assigned to one and only one category.
   (Note: if the teacher teaches none of the Secondary Level Science courses and grade combinations, he is rejected from consideration.)

The attached table shows the number of teachers assigned to each of these categories according to the Geographic Zone in which they teach and for the Province as a whole.

Phase II: Selecting the actual sample of teachers in each of the categories.

1. Because of the numbers of teachers assigned to each category, the following procedure was adopted in order to select an appropriate sample size:

   - The list of teachers was sorted into the appropriate categories and listed by zone (region) within category.

   - Picking a number at random between 1 and 3, this teacher was chosen from the first zone in each category.

   - Every 3rd teacher thereafter in each category was picked to arrive at a 33% sample, proportion to zones.

Codes Used in Items 46-59

<table>
<thead>
<tr>
<th>Code</th>
<th>Item Description</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>50300</td>
<td>Agriculture</td>
<td>All codes used for</td>
</tr>
<tr>
<td>14214</td>
<td>General Science</td>
<td></td>
</tr>
<tr>
<td>12700</td>
<td>Human Life Sciences</td>
<td>only these codes used for</td>
</tr>
<tr>
<td></td>
<td>(Health)</td>
<td>Senior categories.</td>
</tr>
<tr>
<td>50900</td>
<td>Biology</td>
<td></td>
</tr>
<tr>
<td>81500</td>
<td>Chemistry</td>
<td></td>
</tr>
<tr>
<td>83000</td>
<td>Physics</td>
<td></td>
</tr>
<tr>
<td>81800</td>
<td>Earth Sciences/Geology</td>
<td></td>
</tr>
</tbody>
</table>
Reasons for Excluding Teaching Position Codes 6-9

Special teachers such as music, library are code 6 and are generally not teaching any Science.

Codes 7-9 are teachers with more than one school and therefore cannot properly answer the facility questions on the questionnaires.
<table>
<thead>
<tr>
<th>GROUP</th>
<th>NAME</th>
<th>ZONE 1</th>
<th>ZONE 2</th>
<th>ZONE 3</th>
<th>ZONE 4</th>
<th>ZONE 5</th>
<th>ZONE 6</th>
<th>PROV.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>0</td>
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<td>0</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>GRADE 2</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
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<td>0</td>
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APPENDIX C

Covering Letter to Superintendents
We are writing to you to obtain permission to survey some of the junior secondary science teachers of your district. By means of a mail questionnaire (Appendix 1), our intent is to develop an understanding of science teaching for limited success students in British Columbia. For the purpose of this study limited success students are defined as those students who achieve a consistent D or E average in science, or those students specially grouped for science instruction due to previous low achievement.

In addition to defining the 'state of the art' in B.C. it is our intent to outline particular needs of limited success students, relate the findings to practices worldwide, and suggest some lines of action which might enhance the teaching of science to these students.

In surveying the province the most effective methodology will be to use a sampling frame* whereby one-third to one-half of the junior secondary science teachers in any one school district would be involved. The sample will cover grades eight, nine and ten, and some twenty minutes will be needed to complete the questionnaire. We therefore request permission to mail this questionnaire to specific teachers in your school district. Once having gained your permission we will proceed to contact the principals and teachers involved. We anticipate that the questionnaire will be ready for mailing by May 1978.

Complete anonymity of teachers, schools and school district is guaranteed as we are only interested in group data.

Your cooperation is greatly appreciated. Should you require further information please contact us at the numbers listed below.

Yours sincerely,

Mr. P.S. Healy

Dr. R.W. Carlisle
Science Education Department
Appendix 1

The items of the questionnaire are designed to elicit the following information:

1. Teachers - undergraduate and graduate background.
   - teacher training relative to limited success students
   - total teaching experience
   - teaching experience with limited success students
   - subject areas and grades presently teaching

2. School - grade level range
   - population size
   - school timetable for science (e.g. full year/semester)

3. Students - size of limited success student population
   - science class size
   - number of hours of science per week
   - distribution of limited success students according to sex
   - achievement of limited success students
   - evaluation procedures

4. Science Program - text(s) and lab manual(s) used and appropriateness
   - course content determination
   - teaching methods used
   - program evaluation
APPENDIX D

Covering Letter to Principals
Dear Principal:

We are writing you to obtain your cooperation in a province-wide survey we are conducting. The district superintendent has been contacted and has agreed to permit us to survey in this district. We ask for your further assistance in the implementation of this study.

Certain junior secondary science teachers in your school have been selected to answer a questionnaire (Appendix I) related to science for limited success students. For the purpose of this study limited success students are defined as those students achieving a consistent D or E average in science, or those students specially grouped for science instruction due to previous low achievement.

In addition to defining the 'state of the art' in B.C. it is our intent to outline particular needs of limited success students, relate the findings to practices world-wide and suggest some lines of action which might enhance the teaching of science to these students.

The sample of teachers will cover grades eight, nine and ten, and some twenty minutes will be needed to complete the questionnaire. We anticipate that the questionnaire will be ready for mailing by May 1978.

Complete anonymity of teachers, school and school district is guaranteed as we are only interested in group data.

Since we are sampling a fraction of the total science teacher population it is important that we obtain a good response. Your school's participation will be greatly appreciated.

Thank you in advance for your cooperation.

Yours sincerely,

Mr. P.S. Healy

Dr. R.W. Carlisle
Science Education Department
Appendix 1

The items of the questionnaire are designed to elicit the following information.

1. Teachers - undergraduate and graduate background
   - teacher training relative to limited success students
   - total teaching experience
   - teaching experience with limited success students
   - subject areas and grades presently teaching.

2. School - grade level range
   - population of school
   - school timetable for science (e.g. full year/semester)

3. Students - size of the limited success student population
   - science class size
   - number of hours of science per week
   - distribution of limited success students according to sex
   - achievement of limited success students
   - evaluation procedures

4. Science Programs - text(s) and lab manual(s) used and appropriateness
   - course content determination
   - teaching methods used
   - program evaluation
APPENDIX E

Covering Letter to Teachers
Dear Colleague:

In the interest of improving junior science for what we call limited success students we ask for help in completing the enclosed questionnaire. For the purpose of this survey we define limited success students as those students achieving a consistent D or E average in science or those students specially grouped for science instruction due to previous low achievement.

In addition to defining the 'state of the art' in B.C. it is our intent to outline particular needs of limited success students, relate the findings to practices worldwide and suggest some lines of action which might enhance the teaching of science to these students.

Your response to this questionnaire is confidential and will be used strictly for research purposes. The number on the questionnaire is for follow-up purposes only.

As we are sampling a fraction of the total junior science teacher population it is important that we obtain a good response. Your participation will be greatly appreciated. The district superintendent and your principal have been contacted regarding this questionnaire and have agreed to your participation.

Please return the completed questionnaire by May 24, 1978 in the self-stamped, pre-addressed envelope provided.

Your cooperation is greatly appreciated.

Yours sincerely,

Mr. P.S. Healy

Dr. R.W. Carlisle

Science Education Department
APPENDIX F

Covering Letter for Follow-up
Dear Colleague:

Approximately two weeks ago a letter and a questionnaire were mailed to you. We have not, as yet, received your reply. In the event you have not received or misplaced the previous questionnaire we have included a second copy with this letter.

In the interest of improving junior science for what we call limited success students we ask for help in completing the enclosed questionnaire. For the purpose of this survey we define limited success students as those students achieving a consistent D or E average in science or those students specially grouped for science instruction due to previous low achievement.

In addition to defining the 'state of the art' in B.C. it is our intent to outline particular needs of limited success students, relate the findings to practices worldwide and suggest some lines of action which might enhance the teaching of science to these students.

Your response to this questionnaire is confidential and will be used strictly for research purposes. The number on the questionnaire is for follow-up purposes only.

As we are sampling a fraction of the total junior science teacher population it is important that we obtain a good response. Your participation will be greatly appreciated. The district superintendent and your principal have been contacted regarding this questionnaire and have agreed to your participation.

Please return the completed questionnaire by May 31, 1978 in the self-stamped, pre-addressed envelope provided.

Your cooperation is greatly appreciated.

Yours sincerely,

Mr. P.S. Healy

PSH/had
Enclosure

Dr. R.W. Carlisle
Science Education Department
APPENDIX G

Further Teacher Comments
Further teacher comments

Teachers responding to the questionnaire often provided extended comment at the end of the three major sections. The comments of these teachers are included to furnish additional information regarding junior science practices and programs for limited success students in B.C. These comments may also be used to help indicate teacher opinion and attitude. While many of the following comments help to elaborate on the results presented other comments are speculative and opinion-oriented and should not be considered as province-wide information.

Causes and continuation of limited success

- the current program frustrates limited success students leading to discipline problems
- failure in this school is due to non-performance or unwillingness to participate (streaming does not change this situation)
- limited success in science is based on limited success in english and mathematics (need some form of integration)
Selection and grouping of limited success students

- limited success students are given a choice in courses given certain prerequisites (limited success students actually have more choice than other students)
- special classes timetabled for limited success students start out as small groups but mushroom in size
- students are grouped by counsellors and the science department head
- smaller classes are needed to teach limited success students - they are basically a chore to teach - grouping seems to lower these students' self-concept resulting in poor behaviour
- a three level system used in this school: best students - top 20 percent; average students - middle 55 percent and limited success students - bottom 25 percent.
- students and parents chose the limited success class with counsellor and teacher recommendation
- limited success student classes are composed of many types of students (some slow, previous failures, "free loaders", class disturbers, "sleepers") - the main cause of limited success is slow reading
- an option for non-academic science exists after grade eight
- limited success students seem to benefit and learn from their presence in heterogeneous classes
- smaller class sizes are needed to give limited success students the necessary attention, if classes are too big then these students will lose interest and the will to succeed.
- separate classes are deadening for the teacher.

Curriculum
- lower reading level and simple experiments seem to be successful with grouped limited success students (little transfer between levels occurs)
- students take four half courses of their own choice (they tend to avoid academics such as physics and chemistry in favour of space science and conservation).
- in grade eight limited success students learn core material in a demonstration-oriented class. If they pass this course then they may take academic science mix
- students must take three of four semesters of science
- provision for limited success students when harder units occur (e.g. Chemistry becomes Household Chemistry)
- lower level non-compulsory courses are available to all students
- students must take six quarters in science nine and ten (chemistry, biology, physics and earth
science are compulsory plus two options) - non-academic science is possible by student choice
- if grouping occurred a special course such as IIS would be useful
- a more process-oriented than content-oriented course provides more success for limited success students
- the present science program is to academically oriented - need a job or life-oriented program.

Evaluation and reporting of limited success students' progress
- limited success students are not dumb but are too lazy to hand in laboratory reports which make up most of their grade
- limited success students are treated and marked differently but need to be in a mixed group

Other comments
- separate classes of limited success students take tremendous teacher time - only one class at a time per teacher to ensure a good job
- the Ministry of Education should recognize the existence of limited success students and provide special materials and programs
APPENDIX H

Summary of Survey Results
Summary of survey results

The following lists summarize the more striking results reported in this survey. It must be emphasized that findings reported are based on teacher perceptions and not validated observation. Some results may have reinforced validity upon publication of other results such as the 1978 Learning Assessment Survey. The results listed below have implications for science teaching, school organization, school administration, teacher training and further research. For cross-reference purposes each stated result is followed by the number of the associated table in parantheses.

Demographic data

- 9% of respondents reported no undergraduate science experience (1.1)
- less than 20% of all respondents reported graduate degrees (1.2)
- 77% of respondents reported four years or more teaching experience (2.1)
- 51% of respondents who had taught science to separate groups of limited success students said they did so for their first time in their first or second year of teaching (2.3)
Extent and composition of the limited success student population in B.C.

- 47% of respondents reported the limited success student population to be 20% or more of the school population sampled (4.3)
- 25% of respondents reported that more than 50% of their limited success students were boys while only 4% reported that well over half were girls (5.1)

Teaching methods presently in use for limited success science students

Grouping
- 42% of respondents reported the use of ability grouping in their science classes (6.1)
- 80% of teachers of homogeneously grouped science classes reported class sizes of twenty-five or less students (6.4)
- 59% of teachers of heterogeneously grouped science classes reported class sizes in excess of twenty-six students (6.6)

Curriculum
- 25% of respondents reported that they offered special science programs for their limited success students (7.1)
- 74% of respondents reported that the texts and laboratory manuals they were using were only somewhat suitable to unsuitable for teaching science to limited success students (7.5)
- 65% of respondents reported that they used student interest to some extent in order to determine their science course content (7.7)
- 29% of respondents reported that they used student choice to some extent in order to determine their science course content (7.7)
- 33% of respondents reported the use of alternative curricula to teach their limited success students (7.4)
- 46% of respondents reported that they based at least half their science course for limited success students on reduced content compared to other students (7.7)
- 48% of respondents reported that they based at least half their science course for limited success students on reduced complexity compared to other students (7.7)
- 71% of respondents reported basing one half of their science course for limited success students on the present B.C. core curriculum while only 21% reported the use of an alternative structured sequential curriculum (7.7)
Approaches to Learning

- 76% of respondents reported using teacher arranged laboratory work to instruct limited success students at least once or twice a week while only 35% said they used the discovery method to the same extent (8.1)

- 60% of all respondents reported that they never or rarely (once or twice a term) used a small group or individualized approach with their limited success students while 15% said they used this approach at least once a week (8.1)

- 26% of respondents reported that they did not involve their limited success students in project work (8.1)

- 53% of respondents reported that they used the lecture and notes approach at least once a week with their limited success students (8.1)

- 70% of respondents reported the use of worksheets to instruct their limited success students once or twice a month or less (8.1)

- 40% of respondents reported that they did not involve their limited success students in field trips (8.1)

- 57% of respondents reported that they did not involve their limited success students in oral presentations (8.1)
- 60% of respondents reported that they never used programmed learning to instruct their limited success students (8.1)

**Evaluation and Reporting**
- 86% of respondents who reported on the evaluation of student progress stated that this evaluation was based solely on teacher judgment (9.1)
- the major components of student evaluation as reported by respondents were student laboratory write-ups, tests; attitude and projects (9.2)
- 75% of respondents reported the testing of limited success students at least once a month (9.3)
- 50% of respondents reported the use of formal letter grades (A,B,C,D,E) to report limited success student progress (9.4)

**Teacher attitudes and training**
- 49% of heterogeneous class science teachers reported being in favour of ability grouping of limited success students (10.2)
- 36% of respondents reported that they would be willing to teach limited success students under any grouping situation (10.6)
- 15% of respondents reported that they would not be willing to teach limited success students in any grouping situation (10.6)
- 68% of teachers of homogeneously grouped limited success science students reported being assigned by a principal or department head to teach these classes while only 28% of these teachers chose to teach these classes (10.7)
- 11% of respondents reported no spare time (10.8)
- 78% of respondents reported no pre-service training related to limited success students (10.9)
- 70% of respondents with some pre-service training reported that this training was at least of some use to their teaching of limited success students (10.11)
- 81% of respondents reported no in-service training related to limited success students (10.12)
- 77% of respondents who did receive some in-service training reported that this training to be of at least some use (10.13)
APPENDIX I

Summary of Conclusions and Recommendations
Summary of conclusions and recommendations

Conclusions

Based on the data collected three major conclusions can be drawn:

1. A significantly large population of limited success students exist in B.C. junior secondary schools
2. A general awareness of the existence of a population of limited success students in B.C. is evident
3. Few special science programs have been developed for limited success students in B.C.

Most junior secondary science teachers perceive the present recommended curriculum to be largely inappropriate for instructing limited success students

Recommendations

1. It is recommended that steps be taken towards the development of a new science curriculum which reflects the wide ability range of B.C. junior secondary students in general and limited success students in particular
2. It is recommended that teachers with science background be chosen to teach science at the junior secondary level

3. It is recommended that teachers with some teaching experience be assigned to teach special science classes for limited success students

4. It is recommended that the assignment of teachers to homogeneously grouped science classes of limited success students be done only if the teacher holds a commitment to teaching these students. It is further recommended that assignment of teachers to heterogeneously grouped science classes be done only if the teacher holds a commitment to teaching students of a wide ability range

5. It is recommended that teachers be given some choice in the classes they teach and adequate spare time for preparation

6. It is recommended that all science classes, regardless of student grouping, be reduced to a maximum of twenty-five students

7. It is recommended that teachers increase the number of components they use to evaluate the progress of their limited success students.

8. It is recommended that a required course or portion of a course, related to limited success students, be included in the pre-service training of science teachers.
9. It is recommended that the amount of in-service training related to limited success students be increased.

10. It is recommended that pre-service and in-service training include instruction in the methods necessary to facilitate student involvement in: small group and individualized learning; project work; oral presentations, and review. This training should encourage teachers to use and/or produce appropriate audio-visual aids, worksheets and programmed learning.

11. It is recommended that debate and discussion be stimulated on the current status of research and educational thinking on ability grouping.

12. It is recommended that pre-service and in-service training provide instruction which includes appropriate methods of grouping within heterogeneous classes.

13. It is recommended that research be carried out to help identify some of the causal factors underlying the higher proportion of male limited success students.

14. It is recommended that further research be conducted to determine the causal factors underlying the tendency for limited success students to remain in special science classes.
15. It is recommended that further investigation be initiated to determine the causal factors underlying the reported increase of limited success science students with increasing grade level.

16. It is recommended that further investigation be conducted to determine why there is a high incidence of limited success student identification in homogeneously grouped science classes compared to heterogeneously grouped science classes.
SELECTED BIBLIOGRAPHY

Bibliographic references are listed under the following headings: books; research reports; theses and dissertations; journals and other references. Those references marked with an asterisk (*) denote empirically based studies.

Books


The Pros and Cons of Ability Grouping.


Journals


Bingham, N. Eldrid. "A Demonstration of the Role of Science in Programs of Educationally Deprived Children in Grades Seven to Nine." Science Education 52 (April 1968): 246-255. (*)


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Karnes, Merle B. "The Slow Learner... What Are His Characteristics and Needs?" Todays Education 59 (March 1970): 42-44.


Shadrach, John P. and Henson, C. M. "Science for the Low Achiever." School and Community 56 (March 1970): 347-.


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Other references


Wong, Harry K. Director IIS project, Redwood City, California. Personal correspondence, February 1978.