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ABSTRACT

The purpose of this study was to develop, validate, and describe indicators of educational disadvantage to be used in Australia to identify schools and students most in need of assistance from the Disadvantaged Schools Program. Initially, a detailed review was prepared of the resource allocation responses which have been made in Australia to the changing concept of equality of educational opportunity. Next a theoretical model was developed which was designed to quantify the optimal level of precision with which these responses could be used to allocate resources. The data obtained from a national study conducted during 1975 of the educational achievements of Australian 10-year-old and 14-year-old students in the areas of reading, writing, and numeration were then used to develop criterion and validation measures for the construction of indicators of educational disadvantage. These data were combined with data from the 1971 Australian Census of Population and Housing which provided detailed descriptions of the students' neighborhoods. These combined data were divided according to age level and aggregated over schools. Following an analysis of indicator characteristics, the indicator with the best overall performance was examined with respect to the dimensions of residential differentiation associated with the Shevky-Bell model. It was demonstrated that neighborhoods associated with educationally disadvantaged schools were characterized by an overlapping network of social features associated with the socioeconomic status, ethnicity, and family living arrangements of the community. (RM)

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SOCIAL AREA INDICATORS OF EDUCATIONAL NEED

A Study of the Use of Census Descriptions of School Neighbourhoods in Guiding Decisions Concerning the Allocation of Resources to Educationally Disadvantaged Schools in Australia.

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CHAPTER 1

INTRODUCTION

Educational Means and Social Ends

In recent times the concept of 'equality' has become a central issue in debates concerning the provision and distribution of resources in education. However the goal of equality of educational opportunity has often not been treated as a goal in itself but as a means for obtaining certain long-range social goals. This instrumentalist interpretation appears to have emerged from the view that, in modern society, education has been seen as the 'social distributor of life chances' (Halsey, 1972:3).

Rather than taking direct action to rearrange 'life chances', governments in Western countries have generally opted to use the education system as an indirect and politically more defensible means of achieving social reforms. Confidence in this approach reached its zenith in the United States during the early 1960's when President Lyndon Johnson launched his 'War on Poverty' with the following statement:

> This is going to be an education programme. We are going to eliminate poverty by education, and I don't want anybody to mention income distribution. This is not going to be a handout, this is going to be something where people are going to <u>learn</u> their way out of poverty. (Quoted from Ashline, 1976)

The educational attack on poverty in the United States was most strongly related to the passing of the Elementary and Secondary Education Act in 1965. This legislation resulted in the commencement of the "Title I" programs which were aimed specifically at children who were disadvantaged because of 'poverty'.

The urge to seek educational solutions to social problems has also emerged in the United Kingdom and Australia, and programs have been developed which have overtly been designed to assist students living in 'deprived areas' or students attending 'disadvantaged schools'. Generally this has been expressed in a view of the school as a key agent for breaking the 'cycle of poverty'.

In the United Kingdom the Plowden Report recommended that the educational needs of students living in 'deprived areas' would best be satisfied by directing supplementary government funds to schools in 'Educational Priority Areas'. Schools in these areas were described as being both agents and victims in the 'vicious circle' of deprivation.

> Thus the vicious circle may turn from generation to generation and the schools play a central part in the process, both causing and suffering cumulative deprivation. (Plowden, 1967:50)

Similarly, the Karmel Report in Australia recommended that students who attended 'disadvantaged schools' should be assisted by providing supplementary government funds for schools nominated to participate in the 'Disadvantaged Schools Program'. In this program schools were preferred to students' families as a point of attack on the 'cycle of poverty'.

> The school provides a practical point of attack on the cycle of poverty, for it is a social institution more amenable to change than is the family, and an institution where deliberate social intervention is acceptable. (Karmel, 1973:94)

A report prepared by the Organization for Economic Co-operation and Development (OECD, 1979) has suggested that, at a very general level, the arguments supporting the use of educational systems as instruments of social reform have proceeded in three main steps:

1. Poverty and school achievement appear to be very closely linked;
2. Economic and social mobility as well as life chances appear to be rather closely related to educational attainment;
3. Thus, concentrated effort, by way of increased funding for improved and/or increased schooling for disadvantaged children, should break the poverty cycle. (OECD, 1979:11)

The validity of this line of argument has been strongly challenged by two major studies carried out in the United States by Coleman et al (1966a) and Jencks et al (1972). These reports presented analyses which have suggested that variations in school resources had a relatively small impact on variation in educational achievement and attainment. Similar findings have been reported by Little and Smith (1971) following a wide ranging review of educational programs for disadvantaged students in the United States, and also by the researchers involved in the cross-national studies of educational achievement carried out by the International Association for the Evaluation of Educational Achievement (for example, Comber and Keeves, 1973).

More recently, hopes for educational solutions to social problems were further damaged following the publication of the report describing a large scale evaluation of the 'Follow Through' compensatory education program in the United States (Stebbins et al, 1977). This evaluation followed 20,000 students over a four year period in order to examine the effectiveness of seventeen different models of compensatory action. The researchers concluded that 'none of the seventeen models in the evaluation demonstrated that it could compensate consistently for the academic consequences of poverty' and that the overall Follow Through strategy was 'not an effective tool for raising poor children's test scores' (Anderson et al, 1978:162).

All of these studies have been subjected to a great deal of discussion and criticism with respect to their methodologies (Mosteller and Moynihan, 1972; Levine and Bane, 1975; Hodges, 1978; House et al, 1978; Wisler et al, 1978). Much of this debate has been concentrated upon the technical problems in these studies which have occurred because they were carried out in 'naturalistic' settings rather than as true experiments, and also upon the assertion that the educational outcome measures which were employed focussed too narrowly on an academic view of the purposes of schooling. A further problem associated with these studies has been that they have concentrated on short term effects - whereas an assessment of educational effects on social reforms requires the development of longitudinal studies. These studies would be able to consider the long term influences of educational effects on the total 'life chances' of students in a more comprehensive fashion.

The Use of Indicators to Allocate Educational Resources

An important issue in the implementation of educational programs designed to achieve social goals has been the selection of procedures by which educational resources have been distributed among schools and students. The effectiveness of these programs would obviously be expected to have limited impact unless these procedures were able to identify accurately the schools and students which the programs were designed to assist.

The three educational programs in the United States, United Kingdom and Australia, described in the previous section, have all relied upon the use of indicators constructed from objective data to identify appropriate 'targets' for the allocation of supplementary government assistance. The target groups for each of these programs have been described in different ways. In the United States the program was concerned with children living in 'poverty', in the United Kingdom the aim was to assist students attending schools in 'deprived areas', while in Australia the focus was on students attending 'disadvantaged schools'.

The various definitions of target groups for these programs have been accompanied by a variety of approaches to the construction of indicators to assist with the objective identification of the target groups.

In the United States the allocation of Title I funds has been based on purely economic criteria in order to provide assistance for 'the special needs of children of low-income families and the impact that concentrations of low-income families have on the ability of local educational agencies to support adequate educational programmes' (United States House of Representatives, 1978). The indicator used to operationalize this definition has been based on a 'count' of poor children derived from census data according to the following categories (United States Department of Health, Education and Welfare, 1976):

1. Children aged 5 to 17 years from families designated as "poor" according to the Orshansky (1965) formula applied to the 1970 census.
2. Two-thirds of the children aged 5 to 17 years receiving payments under the Aid to Families with Dependent Children (AFDC) programs.
3. Children aged 5 to 17 years being supported by public funds who live in foster homes or in institutions for neglected or delinquent children.

> After 1980 the basic allocation formula will take account of 100 per cent of children from families receiving AFDC instead of only two-thirds, which has been the provision since 1965. Also, a further supplement will be made to the Title I basic funds according to the number of families in each State with incomes below the national median figure. (OECD, 1979)

This indicator has been used to allocate funds among States. Within States the allocations to school districts and then schools within school districts has been made by using a variety of indicators which have similarly been based on estimates of poverty 'counts' (Blackburn, 1979a).

The Plowden Report (Plowden, 1967) in the United Kingdom emphasized that the identification of schools in Educational Priority Areas should be based on objective data. The National Survey carried out for the Plowden Report had demonstrated that parental attitudes were of prime importance in explaining variation in the educational achievement of students. However, it was reasoned that there might be validity problems if a complete census of parental attitudes was undertaken when the purpose for collecting the data became public knowledge. Instead, the Plowden Report listed eight criteria which were assessed as being suitable for identifying 'those places where educational handicaps are reinforced by social handicaps': occupation, size of family, social welfare payments, overcrowded living conditions, poor school attendance rates, proportions of handicapped persons, incomplete families, and children unable to speak English (Plowden, 1967:57-59). The responsibility for the construction of an appropriate indicator was given to the Local Education Authorities.

Various attempts were made by Local Education Authorities to use these criteria to construct suitable indicators. However, anomalies arose between and within areas because of the types of criteria which were used and the weightings given to particular measures in the construction of the indicators (Halsey, 1972:46-47). The most widely accepted attempt at indicator construction was carried out for the Inner London Authority by Little and Mabey (1971). This index consisted of ten measures: occupation, children receiving free meals, overcrowded housing, lack of housing amenities, handicapped children, immigrant children, teacher turnover, pupil turnover, absenteeism, and family size. The measures were standardized according to a formula based on the range of each measure and then added together with equal weights to form the indicator (Halsey, 1972:50).

The measures used in the construction of this indicator were derived from various sources. The occupation, overcrowded housing, lack of house amenities, and family size measures were obtained from census data; the children receiving free meals, immigrant children, teacher turnover, pupil turnover, and absenteeism measures were derived from various government department records; and the handicapped children measure was based on the percentage of children of low ability at the 11+ transfer to secondary schools.

The Karmel Report in Australia examined several approaches to the identification of schools for participation in the Disadvantaged Schools Program: subjective assessment based on information obtained from informed persons within Australian school systems, and objective assessment based on the construction of indicators from census data. The former approach was rejected because there would have been a lack of inter-system comparability in the information obtained from each education system.

The initial 1973 national indicator, derived from a range of census data describing occupations, ethnicity, education, family characteristics, religion, and housing, was intended to identify 'schools drawing a high proportion of enrolments from neighbourhoods having certain characteristics known to be generally associated with a low capacity to take advantage of educational facilities' (Karmel, 1973:92). More recently the 1980 national indicator has only been used to divide funds between school systems who have then employed their own indicators to allocate funds to schools. The structure of the national and system-level indicators have been described in detail in a later chapter.

In the United States and the United Kingdom there has been criticism relating to the degree of precision with which resources allocated by the indicators used in the Title I and Educational Priority Areas programs have reached those students who were in most need of assistance. Glass (1970) and Fortune (1971) showed that an income dichotomy for family incomes, as was used in the Title I program indicator, was a very imprecise method for identifying students having reading and learning difficulties. Similar concerns have been expressed about the lack of precision of the Educational Priority Area indicators following research studies carried out by Acland (1971) and Barnes and Lucas (1974). In Australia there would appear to have been no research studies which have systematically examined the precision with which resources allocated by indicators used in the Disadvantaged Schools Program have reached students who were in most need of assistance.

The Purpose of This Study

The previous discussion has raised two important issues concerning the use of educational programs to achieve social goals: the magnitude of the 'effects' of these programs on participating students, and the precision with which supplementary resources have been allocated by the use of indicators to those students who were in most need of assistance. It was noted that the first issue has been subjected to considerable research and debate - mostly without satisfactory resolution at this point of time. The second issue has received relatively less attention by researchers - but the available findings in the United States and the United Kingdom have consistently suggested that the indicators used in the Title I and Educational Priority Areas programs have lacked precision in the delivery of resources to those students who were in most need of assistance.

In the absence of detailed research knowledge concerning the performance of indicators being used in Australia it was considered important to examine the implications of the second issue for the conduct of the Disadvantaged Schools Program. At present there are nine different indicators being used for this one program: one at the national level, and eight others being employed by various school systems. Not one of these indicators has ever been subjected to a detailed examination with respect to either the specific definition of 'disadvantaged' (Karmel, 1973:92) which they purport to measure, or the characteristics of the students which they identify as being educationally disadvantaged. Further, there would appear to be no published research available which would enable an assessment to be made of the precision with which they may be used to identify students who are in most need of assistance.

The main aim of this study was to develop, validate, and describe the properties of a national indicator of educational disadvantage which was in harmony with the definition of 'disadvantaged' provided for the conduct of the Disadvantaged Schools Program in Australia.

Initially, a detailed review was prepared of the resource allocation responses which have been made in Australia to the changing concept of equality of educational opportunity. This was followed by the development of a theoretical model which was designed to quantify the optimal level of precision with which these responses could be used to allocate resources.

By drawing upon the results of these two tasks a program of research was designed to prepare several indicators of educational disadvantage which would avoid the inadequacies of the currently available indicators, and would also provide a quantitative assessment of the capacity of these indicators to deliver resources to those students who were in most need of assistance.

There were three main phases associated with the development of these indicators. First, a list of items describing important properties of indicators was prepared and a three-stage strategy was devised to develop the indicators in a fashion which would optimize overall satisfaction among the demands of this list of properties. Second, the characteristics of the indicators were examined in a range of analyses which permitted the selection of an indicator with the best overall performance. Third, this 'preferred' indicator was compared with certain dimensions of residential differentiation in order to enable a meaningful social description to be made of the construct assessed by the indicator scores.

CHAPTER 2

RESOURCE ALLOCATION RESPONSES TO THE CHANGING CONCEPT OF EQUALITY

Introduction

Over the past two decades in Australia the concept of equality of educational opportunity has been subjected to a great deal of attention and review. The focus of this discussion has moved, since the publication of the first report of the Australian Schools Commission (Karmel, 1973), from what Dyer (1972) has described as a 'means' debate to an 'ends' debate.

The notion of equality of 'means' referred to the aim of establishing equality of educational resource provision across schools. This type of equality has often been measured by comparing schools with respect to their physical plants, staffing quality, location, etc. The 'means' approach has variously been described as a concern for equal treatments (Husén, 1972) or equal schools (Coleman, 1966b).

Alternatively, equality of 'ends' referred to equality in the end results of the educational process. This has commonly been assessed by comparing students, or certain subgroups of students, on school achievement test scores or on final educational attainments. The 'ends' interpretation has also been referred to as a commitment to equal final goals (Husén, 1972) or equal students (Coleman, 1966b).

In the following pages the changing nature of the concept of equality of educational opportunity in Australia has been discussed. The framework for this discussion has been drawn from the lucid analysis presented by Husén (1972, 1975). Husén examined the changing nature of the concept by incorporating the 'means'/'ends' distinction into developmental stages which corresponded to three distinct social philosophies: conservative, liberal, and redemptive.

Many other authors have employed a similar division of these developmental stages in their discussion of equality of educational opportunity. In Table 2.1 a list of authors and their terminology has been presented in a form which links the three-stage model proposed by Husén (1972, 1975) to approaches presented by the other authors. Most of these authors have used different styles of argument, and while the overlap of stages between authors was often large it was never exact. The examination of the concept of equality of educational opportunity by Crittenden (1978a, 1978b) and Keeves (1978) provided an Australian perspective several years after the publication of the first report of the Schools Commission (Karmel, 1973); Halsey (1972); Husén (1972, 1975), and Neave (1979) have described European developments; the other authors, Bell (1977), Coleman (1968), Gordon (1972), Jencks et al (1972), and Mosteller and Moynihan (1972), have centred their discussion mostly on developments in the United States.

Stages in the Development of the Concept of Equality of Educational Opportunity in Australia

1 Conservative

From the time of early settlement to around the end of the nineteenth century, the provision of education in Australia was mostly limited to schooling administered by religious or private organizations. The educational system was designed to provide educational opportunities which were appropriate to one's station in life. The private secondary schools and universities mostly catered for students from professional families who were 'destined' for professional occupations. The tuition fees for these institutions were substantial and only a limited number of scholarships were made available in order to assist exceptional students whose efforts would bring credit to the institutions.

By the early years of this century each of the Australian States had established public education systems, covering the elementary years of schooling, which were designed to be free, secular and compulsory. The elementary schools provided training in the basic skills of reading, writing, and arithmetic for those who were to form the mass of manual, semi-skilled and clerical workers. Limited numbers of public secondary schools were also set up in each State. These schools were highly selective and in many cases were not free.

The general structure of Australian education at this time was therefore centred around a vertically separated system in which educational provision was fairly clearly divided along class lines. Husén (1972) has suggested that one of the more conservative assumptions behind this type of approach had its origins in a religious view of the world:

> God had given each individual the aptitudes that corresponded to the caste or social class in which he was born... he had not only to make optimal use of his capacity but be content with it. (Husén, 1972:28)

Table 2.1 Terminology Used by Various Authors in their Discussion of the Changing Nature of the Concept of Equality of Educational Opportunity

Author	Equality of Educational Opportunity		
	Stage 1	Stage 2	Stage 3
Bell (1977)	Natural Aristocracy	Liberal Ethic	Socialist Ethic
Coleman (1968)	Differentiated Opportunity	[Equality of] Inputs	[Equality of] Results
Crittenden (1978a, 1978b)	—	Liberal	Egalitarian
Gordon (1972)	[The Dichotomy of the] Educable/Uneducable	[The Universality of the] Educable	[Equality of] Survival Skills
Halsey (1972)	—	[Equality of] Access	[Equality of] Achievement
Husén (1972, 1975)	Conservative	Liberal	Redemptive
Jencks et al (1972)	—	[Equality of] Opportunity	[Equality of] Results
Keeves (1978)	Conservative	Liberal	Needs Based
Mosteller and Moynihan (1972	—	[Equality of] School Inputs	[Equality of] School Outputs
Neave (1979)	Predestinative	Redemptive	Dissenting/Sectarian

Within this conservative framework Australian governments considered that the purpose of education was to nurture 'talent'. The concept of equality of educational opportunity for all students was consequently not really relevant. Rather, policies were explicitly designed to produce what Coleman (1968) has described as 'differentiated educational opportunity'.

2 Liberal

A gradual movement from a conservative to a more liberal view of equality of educational opportunity took place in Australia during this century. This change was accelerated with the massive growth in the secondary and tertiary education sectors after the Second World War. In public secondary schools fees were eliminated and distinctions between curricula for students preparing for professions and those preparing for sub-professional, commercial, and technical occupations had diminished. At both secondary and tertiary levels there was a great expansion of scholarships for the more able students. Within each State attempts were made to ensure that there was a uniformity in standards of staffing and essential equipment for all schools.

This emphasis on uniformity of educational provision appeared to be based on the assumption that individuals were born with certain, relatively constant, abilities or intelligence. Therefore the appropriate government response was to remove those external material obstacles which would prevent students making best use of their abilities. Schrag (1970) has described the liberal approach as 'social Darwinism' in which everyone in the 'jungle' had the same facilities and therefore success was decided by the student's capacity for resourcefulness, ambition, ability and strength. The move from a conservative to a liberal view carried the hope that the rewards of educational systems would pass from being based on socio-economic background and personal influence to being dependent upon both ability and industry.

A growing uncertainty about the validity of the expected outcomes from the liberal view began to be supported by a range of educational research studies which described the achievement and attainment levels of different social groups. By the late 1960's it had become common knowledge that 'the major determinants of educational attainment were not school-masters but social situations, not curriculum but motivation, not formal access to the school but support in the family and the community' (Halsey, 1972:8).

3 Redemptive

The publication of the report of the Interim Committee of the Australian Schools Commission (Karmel, 1973) moved discussion in Australia from a liberal to a redemptive view of equality of educational opportunity. This report was prepared at a time when a flood of research evidence was demonstrating that the liberal view had failed. Achievement and attainment levels in Australia, even under conditions of comparable access, uniform curricula and comparable material provision, still appeared to be firmly linked to the socioeconomic circumstances of the student's home environment.

The main sources of pressure for a review of the liberal approach stemmed from the large-scale investigations which had been carried out in the United Kingdom (Plowden, 1967) and the United States (Coleman et al, 1966a). The results of these reports provided the catalyst required to move the debate from a concern with equality of inputs, associated with access and material provision, to a concern with equality of outputs, associated with final student achievements and attainments.

Neave (1979) noted that the transition to a redemptive view was marked by the growth of the notion that the educational system should be able to adapt to the needs of individual students. According to this interpretation, 'failure on the part of the individual is as much evidence of the inability of the education system to adapt to the individual's need as it is of the individual's inability to meet the exigencies of the education system' (Neave, 1979:166).

Husén (1972) formulated the redemptive view of equality of educational opportunity in the following fashion:

> It is not enough to establish formal equality of access to education. One has also to provide equality in the pre-school institutions or in the regular school for children of various social backgrounds to acquire intelligence. (Husén, 1972:38)

Husén (1974) warned that a move to the redemptive view required a complete revision of basic pedagogical notions by the education system. The common element in action taken by schools would be 'individualization' of the entire system of instruction (Block, 1971). This type of learning environment would be a necessary step towards being able to 'provide equal opportunity for unequal treatment so far as socially relevant differences are concerned' (Husén, 1974:40).

The Australian Schools Commission's View of Equality of Educational Opportunity

1 Equality: As a 'Principal Value'.

In the second chapter of their report, under the heading of 'Values and Perspectives', the Interim Committee for the Australian Schools Commission listed the 'principal values from which its recommendations have been derived' (Karmel, 1973:10). The two values listed under the 'Equality' sub-heading were coupled with some general descriptions of the actions required to reinforce these values. These actions dealt with aspects of resource allocation which have come to be known as forms of 'positive discrimination' in which 'the schools must supply a compensating environment' (Plowden, 1967:57).

The first value was concerned with 'the principle that the standard of schooling a child receives should not depend on what his parents are able or willing to contribute directly to it, or whether he is enrolled in a government or non-government institution' (Karmel, 1973:11). This principle supported a liberal view of equality of educational opportunity. That is, it affirmed students' rights to have equal access to schools of equal standards. However the action with respect to this value which was recommended included the notion of compensation through schooling for unequal environmental conditions and therefore seemed to be taking a more redemptive view of equality of educational opportunity:

> [The Committee believes that] there are good reasons for attempting to compensate to some extent through schooling for unequal out-of-school situations in order to ensure that the child's overall condition of upbringing is as free of restriction due to the circumstances of his family as public action through the schools can make it. (Karmel, 1973:11)

The second value was associated with 'the right of every child, within practicable limits, to be prepared through schooling for full participation in society, both for his own and for society's benefit' (Karmel, 1973:11). This value moved beyond the outcomes of schooling to a form of equal opportunity in the life of adult society. It was a somewhat tangled mixture of liberal and redemptive views because the concept of 'full participation in society' could mean either participation up to a level governed by individual ability, or equal level of participation, or both of these at the same time. However the action required to reinforce this value again took a redemptive view by suggesting compensatory action through making 'special efforts' for a sub-group of students:

> [The Committee] accepts the obligation to make special efforts to assist those whose pace of learning is slow.
> (Karmel, 1973:11)

In the final paragraph dealing with 'Equality', a clearly redemptive view of equality of educational opportunity was emphasized through proposals concerning the allocation of funds required to support aspects of equality inherent in the two values described above. The report contained proposals that there should be 'greater than average public spending on education for children handicapped in various ways' and that there should be 'some altering of the balance of expenditure in favour of earlier stages of education to consolidate a more equal basic achievement between children' (Karmel, 1973:11). These two proposals formed the essential elements of a resource allocation program based on the redemptive view: greater resources were to be given to those students with handicaps which inhibited their learning, in order to obtain a degree of equalization in final achievement levels for certain valued areas of the education process.

2 Equality: As a 'Limited Goal'.

The Interim Committee report (Karmel, 1973) and a subsequent report (McKinnon, 1976) of the Schools Commission presented strong opposition to the pursuit of equal educational outcomes, whether the units being considered were individuals or groups.

The Interim Committee report, as part of a discussion of equality of outcomes for groups, presented the following quotation from Halsey (1972):

> ... the goal should not be the liberal one of equality of access but equality of outcome for the median member of each identifiable non-educationally defined group, i.e., the average woman or negro or proletarian or rural dweller should have the same level of educational attainment as the average male, white, white-collar suburbanite. (Karmel, 1973:22)

This view was rejected as unsatisfactory because the Interim Committee considered that it would not necessarily result in a more equal society, it might become excessively expensive, it could lead to retardation of the most able students in order to reduce the range of achievement, and it could lead to concentration on academic performance as the only criterion of excellence (Karmel, 1973:22-23).

The 1976 report of the Schools Commission was somewhat less generous in providing reasons for its rejection of the idea of equality of outcomes for individuals. The idea was dismissed, with limited discussion, in one sentence:

> The Commission has never spoken, nor does it now, in favour of promoting equal educational outcomes among individuals.
> (McKinnon, 1976:10)

In place of a policy of equal outcomes the Interim Committee report accepted a more 'limited' goal:

> The Committee believes that schools should attempt to provide a more equal opportunity for all children to participate more fully in the society as valued and respected members of it. (Karmel, 1973:23)

A close examination of this 'limited' goal revealed three main themes which have recurred throughout the Schools Commission Reports. The wording of the Interim Committee's definition has been broken into three pieces in the following paragraphs in order to highlight these themes:

(a) ... schools should attempt to provide ...

The report of the Interim Committee of the Australian Schools Commission was prepared at a time when several major reports (Coleman et al, 1966; Jencks et al, 1972) had emerged with a message that the contribution which schools made to explaining variation in school achievement or educational attainment was small after the contribution made by the home environments of students was taken into account. The findings of these studies were similar to findings obtained in Australia from two large-scale evaluation studies in the areas of Mathematics (Keeves, 1968) and Science (Rosier, 1973).

Also, at that time, several reports which reviewed the effectiveness of compensatory education programs (Little and Smith, 1971) and the effectiveness of various educational resources (Averch et al, 1971) were published. These reviews provided little encouragement for the previously popular idea that manipulation of learning environments through increased expenditure on education would greatly affect student achievement.

The discussion of 'Equality' in the Interim Committee's report acknowledged these findings by incorporating cautionary statements concerning the expected magnitude of 'school effects' in the pursuit of equality.

> Attempts to make the school more effective in its contribution to developed ability are favoured by the Committee in full awareness of the limitations of their potential power. (Karmel, 1973:22)

> It is almost certainly the case that schools alone cannot effect the degree of environmental change necessary to enable all groups of children to reach an equal average level of educational attainment. (Karmel, 1973:22)

Similar expressions of caution were given in a later Schools Commission report during a discussion of the influence of education on social stratification in society:

> Schools do not have the power to make society more equal. (McKinnon, 1976:7)

The power of education to change the relative position of social groups has proved small in all advanced societies.
(McKinnon, 1976:7)

The views expressed in the above quotations had important implications for the interpretation of the Schools Commission's 'limited' goal with respect to outcomes. Rather than expecting schools to contribute to equality they were asked to 'attempt to provide' a contribution. This hesitance in emphasis turned the 'limited' goal into something which resembled a hope for instead of an expectation of equal educational outcomes.

(b) <u>... a more equal opportunity for all children ...</u>

In a previous section a description of the Schools Commission's rejection of a strict interpretation of equality of outcomes was presented. This rejection applied to both the goal of equal average outcomes for social groups and the goal of equal outcomes for individuals.

By referring to 'all children' in the 'limited' goal, the Schools Commission concentrated on the outcomes for individuals rather than social groups. However, in place of a strict interpretation of equal outcomes, the Schools Commission supported a somewhat toned-down interpretation. Instead of 'equal' opportunity, the 'limited' goal called for 'more equal' opportunity.

Statements in support of a need for 'more equal' opportunity have appeared in a number of forms in the reports prepared for the Schools Commission:

The Interim Committee's report called for 'more equal basic achievement', 'more equal opportunities to partake in higher education', 'more equal outcomes from schooling', 'more equal performance', 'more equal opportunity' and 'more equal chances for educational success' (Karmel, 1973:11, 20, 22, 23, 93, 94).

Similarly, the first and second reports of the Schools Commission supported policies which emphasized 'more equal outcomes' (McKinnon, 1975:6) and 'more serious contributions to equalizing the opportunities of children' (McKinnon, 1976:11).

These cautious approaches to the concept of equality of educational opportunity were in close harmony with the use of the word 'limited' that had been employed to describe the Interim Committee's goal of equal educational outcomes.

(c) ... to participate more fully in the society as valued and respected members of it.

The final section of the Schools Commission's definition of the 'limited' goal of equal educational outcomes described the outcomes which the schools were expected to 'attempt' to make 'more equal' among students. This section provided little useful information about the specific activities or structures with which the schools might be concerned in order to achieve the 'limited' goal.

Some clues were given about the specific roles of the schools in the sentences which followed the definition. The schools were expected to provide:

(i) 'Basic skills' necessary to 'participate in the society', and to 're-enter formal education at a later stage'.

(ii) 'A comprehensive core curriculum'.

(iii) 'An introduction to a variety of leisure pursuits'.

(Karmel, 1973:23)

The second and third of these roles referred to the provision of certain curriculum content. The appropriate response by the schools would have been to ensure that students had access to these activities. No attempt was made to suggest that students were to reach particular levels of performance. In this sense, these two roles could be linked to a liberal view of equality of educational opportunity because the essential requirement was that schools should guarantee exposure to, rather than mastery of, the curriculum content.

In contrast the first role emphasized a redemptive view of equality because it implied that all students would be required to achieve competence in those 'basic skills' which were necessary to participate in society or to re-enter formal education at a later stage.

The responsibility of the schools for the development of 'basic skills' continued to be emphasized and presented in more detail in the first and second reports of the Schools Commission. These basic skills tended to fall into two broad categories: basic cognitive skills and basic personality and social skills.

The basic cognitive skills were described in a variety of ways: 'the basic threshold of schooling', 'certain threshold levels of education', 'reading ... the most basic tool', 'the basic plateau of competence in schooling' (McKinnon, 1975:6, 7, 8), 'basic learning skills', 'levels of competence', 'basic credentials', 'to read, use language and to figure to a level which secondary schooling assumes', 'access skills', 'reading and language competence' (McKinnon, 1976:8, 9, 10).

The basic personality and social skills were described in a somewhat more abstract fashion. The students were required to 'find an identity as social beings', 'become full citizens', develop 'the capacity and confidence to forge meaningful links with others', 'organize and take personal responsibility', 'shape the character of their own lives and participate in shaping the character of the society' (McKinnon, 1975:7), 'acquire a capacity for making choices through an understanding of the society', 'reflect on experience', 'act individually or in association with others to change arrangements they find unjust or humanely degrading' (McKinnon, 1976:9, 12).

A striking difference between the two types of basic skills was associated with the time scale upon which successful mastery might be judged. The basic cognitive skills were concerned with the need for mastery of the fundamental skills of literacy and numeracy. These skills could be assessed with criterion-referenced testing during or after the process of schooling. On the other hand, the basic personality and social skills referred to individual characteristics which would not be able to be assessed until later adult life.

3 Summary

The collation of quotations presented above would appear to indicate that the Schools Commission's perception of equality might be appropriately characterized as a 'limited liberal-redemptive hope'.

The word 'hope' emerged as a suitable summary of the Schools Commission's response to those research findings which had demonstrated that schools had relatively small effects in explaining variation in student achievement and attainment. This hope was expressed by asking the schools to 'attempt' to be more effective in 'full awareness of the limitations of their potential power' (Karmel, 1973:22).

The notion of 'limited' referred to a less-than-full commitment to equality of outcomes. The Schools Commission rejected a strict interpretation of equal outcomes for either groups or individuals. Instead a tentative version of 'more equal', rather than 'equal', outcomes was supported.

This limited approach, incorporated in an explicit definition of equality presented in the first Schools Commission report, expressed the need to aim for 'more equal' outcomes from schooling and to 'mitigate' social group disparities (McKinnon, 1975:6).

The 'liberal-redemptive' nature of the Schools Commission's 'limited hope' was expressed in the expected roles of the schools as agents for obtaining equality of educational opportunity. These roles combined liberal calls for uniformity of material provision: 'a comprehensive core curriculum' and 'an introduction to a wide variety of leisure pursuits' with redemptive views concerning the need for all students to master the basic skills necessary to 'participate in the society' and to 're-enter formal education at a later stage' (Karmel, 1973:23).

This liberal-redemptive mixture also surfaced in the Schools Commission's rationale for resource allocation. The liberal value that the standard of schooling received by a student 'should not depend on what his parents are able or willing to contribute directly to it, or whether he is enrolled in a government or non-government institution', was to be established by the redemptive response of taking public action 'to compensate for unequal out-of-school situations' in order to ensure that a child's development was 'free of restriction due to the circumstances of his family' (Karmel, 1973:11).

The Australian Schools Commission's Resource Allocation Strategy

The Australian Schools Commission pursued its 'limited liberal-redemptive hope' via a major review of the federal funding of Australian education. The focus of the range of funding programs which emerged from this review were described as falling along two main 'dimensions'. These dimensions, which were labelled 'inputs of resources to schools and school systems' and 'degree of disadvantage of groups of pupils in particular schools' (Karmel, 1973:50), have closely paralleled resource allocation responses which would be respectively appropriate to the liberal and redemptive views of equality of educational opportunity.

The first dimension involved a strictly liberal interpretation of the 'needs' of Australian schools and students. This dimension concentrated on inputs of material resources which, for example, were required to upgrade school buildings, expand library facilities, and improve the provision of teachers and buildings for special education. The largest single program in this area was concerned with equalizing recurrent expenditures across all Australian schools. A school's need for supplementary recurrent resources to cover the general 'running costs' of education was assessed by comparing the school's per pupil expenditure with the national average for government schools. The essential goal for the programs prepared for this dimension was to move towards uniformity of material resource provision, at an acceptable standard, across all schools in Australia.

No attempt was made in the initial planning of these programs to link expenditure with educational outcomes. It was conceded by the Schools Commission that 'there is no simple means-end relationship in education between resources employed and consequential outcomes, neither is there an optimum combination of resources which will achieve a desired objective in any circumstance' (Karmel, 1973:50).

The second dimension was redemptive in nature because it acknowledged that 'there are schools in Australia which require greater than average resources if they are to be effective with the children they serve' (Karmel, 1973:91). This dimension led to the development of positive discrimination in favour of 'disadvantaged schools'. The primary aim of the resulting funding program was concerned with facilitating variation in school programs in ways which would enable disadvantaged children to learn more successfully. Unlike the programs based on the first dimension, the Disadvantaged Schools Program was expected to have specific educational outcomes. The emphasis was to be placed on 'reducing differences in the educational performance of socially disadvantaged children and the rest of the school population over the traditional gamut of schooling' (Karmel, 1973:93).

The identification of schools and students to receive assistance under the programs developed for the first dimension was based on simple accountancy procedures which counted expenditures per pupil, accommodation space, library resources, etc. That is, the information required for this dimension consisted of quantifiable material resources which could be directly and accurately measured.

However, the identification of schools and students for the second dimension required the construction of an indicator which would form an appropriate measure of the construct of 'disadvantage'. That is, since the construct of disadvantage was not a physical entity which could be directly and accurately measured, there was a need for the development of an indicator which would provide a suitable surrogate for the construct.

The Australian Schools Commission's Disadvantaged Schools Program

The Disadvantaged Schools Program was introduced to implement the recommendations presented in the Report of the Interim Committee for the Australian Schools Commission (Karmel, 1973). This program was a landmark for federal intervention in Australian education because it represented the first large-scale attempt to foster a redemptive view of equality of educational opportunity. The redemptive spirit of the program was captured by a single sentence in an early section of the Karmel report:

> More equal outcomes from schooling require unequal treatment of children. (Karmel, 1973:22)

The 'unequal treatment' referred to the provision of 'greater than average resources' to disadvantaged schools; and the 'more equal outcomes' referred to an 'emphasis on reducing differences in the educational performance of socially disadvantaged children and the rest of the school population (Karmel, 1973:91, 93).

In acknowledgement of an earlier admission that there was uncertainty about the resource inputs - educational outputs nexus, the Karmel Report presented several liberal justifications as additional support for the resource allocation measures introduced as part of the Disadvantaged Schools Program. The supplementary assistance to Disadvantaged Schools was expected to ensure greater equality in terms of resource inputs for all schools because:

1. Disadvantaged schools were usually among the worst provided for in terms of buildings, playing space, and other facilities,
2. Students in Disadvantaged Schools enjoyed less overall public support for their education because they typically did not continue to the publicly-subsidized higher levels of schooling and tertiary education, and
3. Students in Disadvantaged Schools often were exposed to surroundings and a school community and program which prevented their schooling from being 'enjoyable and fruitful in itself'.

Choice of Indicator

The Australian Schools Commission examined two alternative approaches to the the establishment of a priority list of disadvantaged schools: subjective assessment based on information obtained from informed persons within the school systems, and objective assessment which required the construction of suitable objective indicators for schools.

The subjective assessment approach was rejected because there would have been a lack of inter-system comparability in the information obtained from each school system. Instead, a limited amount of subjective information was used as validation data for the objective procedures which were adopted (Karmel, 1973:166).

The use of objective assessments required that decisions be made as to whether the appropriate indicators would be concerned with educational achievement or social criteria. Blackburn (1979b) has presented several reasons why social criteria were favoured for the identification of disadvantaged schools. These reasons may be divided into three main areas.

First, there was a concern that indicators based on achievement measures concentrated too narrowly on one aspect of educational disadvantage:

> ... educational achievement criteria bypass the broader aspects of support and development with which we might expect the schools to be concerned. (Blackburn, 1979b:1)

Second, there was a fear that the use of achievement measures might have influenced the curricula of disadvantaged schools in ways which would have prevented attempts to adapt to the specific needs of the students. That is, excessive attention given to test scores may have caused the schools to resort to the 'intensive application of methods which have been unsuccessful in the past' (Blackburn, 1979b:2).

The third reason described the need to avoid certain 'educational dangers' in making achievement measures central to the selection of disadvantaged schools: the appearance of rewarding incompetence, and the diversion of attention from the 'fundamental school change' which was considered to be an important feature of the program.

The social criteria upon which the indicators of disadvantage were based were concerned with the characteristics of the neighbourhoods which surrounded schools:

> The Committee has chosen the term 'disadvantaged' in relation to schools drawing a high proportion of enrolments from neighbourhoods having certain characteristics known to be generally associated with a low capacity to take advantage of educational facilities. (Karmel, 1973:92)

Census data were used for the construction of the indicators rather than data obtained from the families having children attending the schools. These data were preferred because they were 'likely to be more accurate', and because they avoided the 'invasion of privacy involved in seeking out information which can be associated with particular families by the people using the data'. A further consideration was that the characteristics of the population surrounding the school were believed to be 'part of the total environment of the child' (Blackburn, 1979b:4).

Units of Identification and Funding

The Austra ian Schools Commission decided to use schools, rather than individual students, as the unit of identification and funding. That is, the indicators of disadvantage were used to rank schools in order of 'disadvantage' and then all students who were members of schools below a specified cut-off point on the distribution of schools were eligible to participate in the Disadvantaged Schools Program.

In the early stages of the program an Australia-wide list of schools was prepared by the Australian Schools Commission as a guide to assist detailed examination of these schools by school system authorities. More recently each school system has taken greater control of preparing its own list of disadvantaged schools. Within each of the school systems, the school has remained the basic unit of identification and funding.

The Disadvantaged Schools Program: Indicators at the National Level

The 1973 Indicator

The first lists of disadvantaged schools were developed at a national level by the Interim Committee of the Australian Schools Commission. The lists were presented to school systems throughout Australia for consideration during 1973 and were adopted for funding purposes after any major anomalies had been corrected.

The development of these lists employed a measure called the 'Socioeconomic Scale', which was derived from information obtained for the 1971 Census. The main components used in the scale were: socioeconomic status, ethnicity, extent of schooling, unemployment, residential mobility, certain aspects of the family, religious adherence, number of Aborigines and housing conditions. Details describing the 38 census-derived variables were briefly summarized in Appendix E of the Interim Committee's report (Karmel, 1973:167).

The "Socioeconomic Scale" was produced by using principal components analysis followed by factor rotation and then deletion of 'variables which did not assist in discriminating among districts' (Karmel, 1973:166). The weights obtained from these analyses were then applied to the component variables to obtain each school's measure on the Socioeconomic Scale.

The Interim Committee decided that 'because of the markedly different social composition of major urban areas as compared with non-major urban areas', a separate analysis would be conducted for each type of area (Karmel, 1973:165). The principal component analysis technique was applied to the correlation matrices which were developed separately for major urban and non-major urban areas. The principal component extracted for the major urban areas contained 18 variables, and the principal component extracted for the non-major urban areas contained 12 variables (Australia, Schools Commission, 1980a). The variables and their raw component weights from the principal component analyses have been reported in Appendix A.

The graphically defined pupil catchment area of each school was converted to a numeric code representing the Census Collector's Districts linked to each school. These codes were used to obtain average scores for each school on the census variables used in the analyses described above. The weights obtained from the principal component analyses were then combined with these average scores to obtain school scores on the 'Socioeconomic Scale'.

The schools were ranked in order of their scores on the 'Socioeconomic Scale' and, beginning from the most disadvantaged schools, enrolments were counted until 15 per cent of enrolments in major urban schools and 10 per cent of enrolments in non-major urban schools were reached. The schools on the lists below these cut-off points formed the first list of Disadvantaged Schools.

It was important to note that the principal component analyses and subsequent component rotations were carried out by using Collector's Districts as the units of analysis and <u>not</u> schools. Therefore, the properties of these techniques which the Schools Commission considered to be important: 'to ascertain which variables were the most efficient discriminators', to provide 'appropriate weighting for the variables which were ultimately retained', to present 'an objective basis for actually determining the extent to which a limited number of factors are latent in a given set of measurements', and to calculate one factor which was 'interpreted as relating to socioeconomic class' (Karmel, 1973:165, 166), were all properties which applied <u>only</u> to Collector's Districts. The fact that the schools were scored on the outcomes of these analyses according to their catchment area characteristics in no way guaranteed that the properties listed above were transferrable to statements about populations of schools.

One can only speculate about the logic of the Schools Commission's methodology in deriving the component scores. Since each school was identified in terms of the Collector's Districts associated with its catchment area it would seem to have required no greater degree of computational effort or resources to conduct the analyses by using the school as the unit of analysis. It is quite feasible that a totally different set of components would have emerged if schools had been used as the unit of analysis. This may then have resulted in a different rearrangement of the Socioeconomic Scale scores for schools.

The 1980 Indicator

In 1979 the Schools Commission decided to revise the 1973 'Socioeconomic Scale' by conducting a new set of analyses with the 1976 Census data. Due to time and resource constraints it was not possible to either update or repeat the school catchment mapping exercise which had taken place during 1973. Also, while the 1976 Census did contain information which would have permitted a link to be made between each school and its community, the Australian Bureau of Statistics considered that disclosure of data at the school aggregation level could lead to problems of confidentiality. These difficulties prevented the preparation of index scores associated with particular schools and consequently the Schools Commission was unable to prepare a revised priority list of schools for the Disadvantaged Schools Program. The 1980 Indicator provided scores only for Census Collector's Districts and was therefore restricted in its use to assisting with decisions concerning the division of funds between school systems. The nomination of particular schools for participation in the Disadvantaged Schools Program has subsequently become completely dependent on indicators developed within each school system.

The indicator developed in 1980, known as the 'Socioeconomic Index' was designed 'to determine the relative number of school children living in areas of concentrated disadvantage in each State' (Linacre et al, 1980:4). The 'areas' referred to the Collector's Districts used during the 1976 Population Census. A final list of 32 census-derived variables was selected for the construction of the indicator after consultation with the author of this report. These variables were selected because preliminary analyses conducted by the author showed that many of these variables were highly correlated with school mean scores on tests of educational achievement. The variables selected for the construction of the indicator covered similar topics to those used in the 1973 index: occupation, education, income, family structure, dwellings, and ethnicity. Details of the construction and selection of these variables have been described by Linacre et al (1980:55-58).

The principal components analysis technique used for the 1973 index was again used for the 1980 analyses. However, following an investigation of analyses carried out separately for major urban, other urban, rural locality and rural balance areas, it was demonstrated that a single Australia-overall principle component analysis would provide appropriate indicator scores for each of the four regional classifications (Linacre, et al, 1980: 9-10). The weights derived from the Australia-overall principal components analysis were applied to the 32 variables to obtain a score for each Collector's District on the 'Socioeconomic Index'. The variables and their standardized component weights from the principal component analyses have been reported in Appendix A.

In order to carry out the distribution of funds between school systems, the 'Socioeconomic Index' scores were transformed in a fashion which assumed that (1) the funds required to overcome disadvantage increased monotonically with scores on the transformed index, and (2) the marginal increase of funds required to cope with disadvantage was diminished as scores on the transformed index increased. These transformed scores were used to create 'weighted enrolment' figures which were used to make decisions concerning the division of funds between school systems. Details of the calculations required to prepare the transformed indicator scores, and the use of 'weighted enrolment' figures have been presented by Linacre et al (1980).

Following the preparation of the 1980 'Socioeconomic Index', the task of developing methods for the selection of lists of 'disadvantaged schools' became, by default, the responsibility of the school systems.

The Disadvantaged Schools Program: Indicators at the School System Level

In the years following the publication of the Report of the Interim Committee for the Australian Schools Commission (Karmel, 1973) the school systems in each Australian State/Territory began to take an interest in the development of their own lists of 'disadvantaged schools'. Initially this interest was associated with minor anomalies which had appeared on the first list of disadvantaged schools prepared by the Schools Commission. Interest later turned to necessity when the Schools Commission, through lack of resources and information, was unable either to revise or refine its methods for the identification of disadvantaged schools. The following discussion of the responses of the Australian school systems to this situation has been drawn from a collection of papers and seminar presentations prepared during 1979-80 for the Australian Schools Commission Working Party on Disadvantaged Schools (de Silva, 1980; New South Wales Department of Education, 1980; Ross, 1979a, 1980; South Australia Education Department, 1979; Tasmania Education Department, 1979; Western Australia Education Department, 1979).

The term "non-government" has been used in this chapter to refer to Catholic systemic schools. This usage was adopted in order to be consistent with technical reports on indicator construction prepared by the Australian Schools Commission. (See, for example, Australian Schools Commission (1980)).

Whereas all government school systems have developed their own indicators of educational disadvantage, only in the Victorian and South Australian non-government school systems have indicators been prepared. In other non-government school systems a wide range of variables were considered but no attempt has been made to combine these into indicators. The Queensland non-government system does not gather data on any variables.

The variables used for the construction of indicators by Australian school systems have been described in detail in Appendix A. A summary of the types of variables used by the school systems has been presented in Table 2.2. It is important to remember that only the types of variables have been described and therefore this table does not distinguish between either the different metrics which were used to measure these variables or the variable recoding techniques which were unique to each school system.

The 'most popular' variables across the systems were 'Occupational Status of Father/Breadwinner' and 'Migrancy'. These variables were used by six school systems. The occupational status variables were all based on the scaling procedures developed at the Australian National University (Broom et al, 1965, 1977). The variable describing the degree of migrancy was generally based on the percentage of students from non-English speaking homes. No attempt appeared to have been made to distinguish between different subsets of languages. The next 'most popular' variables were 'Aboriginal Students', 'Single Parents' and 'Student Turnover', each being used by three school systems. These three variables were each measured in a consistent fashion across the school systems.

The 'Isolation' variable was used by the Victorian and Queensland government school systems. In the Victorian government school system the degree of 'Isolation' was based on the distance in kilometres between the school and the next stage of education to which most students move. The Queensland government system assessment of isolation reflected a more detailed investigation of the concept of isolation. The measurement of the 'Isolation' variable was based on a 32-item scale developed by the Queensland Education Department. This scale focused on three main facets of the concept of isolation: cultural (with items concerning proximity of educational facilities, theatres, etc.), social (with items concerning proximity to health facilities, students using boarding facilities, etc.) and geographical (with items concerning the distance in kilometres from a range of major cities).

The 'Social Welfare' variable was used by the Western Australian and Tasmanian government school systems. The measure used in Western Australia was based on Department of Social Security records, whereas in Tasmania this information was obtained from the census data gathered by the Australian Bureau of Statistics.

The 'Income Measures' variable was also employed by two school systems. The Tasmanian government system measured this variable by using income levels obtained during the 1976 census. In New South Wales a detailed examination of the occupational structure of family breadwinners was used in conjunction with estimates of mean income levels for certain occupational classifications to obtain an estimate of average family income per child for each school.

Several variables were used only by individual school systems: 'Family Size', 'Achievement/IQ Tests', and 'Other Variables Based On Estimates Provided by Education Department Staff'.

Each of the school systems avoided the issue of indicator validation and the development of measurable external validation criteria. The inclusion of many variables was generally supported with appeals to face validity by suggesting that these variables were linked to concepts such as socioeconomic class, student needs, and student achievement. Other variables have been included following consultation with specialist committees and various specialist school system staff members.

The lack of widely accepted rules for the inclusion of variables was evidenced by the lack of uniformity with respect to the selection of types of variables and the numbers of variables which were used in the indicators. Consequently, an examination of the information in Table 2.2 revealed a range of anomalies which was difficult to reconcile with a school funding program which was supposedly aimed at a particular subgroup of Australian schools and students:

1 There was no single variable which was employed by all systems.
2 One State developed separate indicators for Primary and Secondary schools while the other systems prepared one indicator for all schools.
3 The numbers of variables used in the development of indicators varied between systems from a minimum of one to a maximum of six.
4 Whereas some systems used similar variables, the measurement of these variables was sometimes undertaken in different ways. These differences were centred around explicit differences in operational definitions, the application of a variety of recoding rules, or the use of different types of data to measure the same variables.
5 Achievement/IQ tests were incorporated into the indicators for one system. In the other systems these variables were not included in their indicators however, the selection of particular variables was often justified by reference to the high degree of interrelationships between these variables and the educational achievement of students.

The weighting schemes used to combine the variables into indicators have been described in Appendix A. In each school system the signs of the weights were adjusted so that a high score on the indicators referred to a high level of educational disadvantage.

No information was available from the school systems concerning the rationale employed in establishing the weights. However, from simple observation of the magnitudes of the variable weights for the government systems, it could be seen that only integer weights were used. This suggested that the weights were probably assigned on the basis of 'expert opinion' rather than by the application of quantitative statistical techniques. The South Australian non-government system was the only system to use non-integer weights. However, as for the other systems, no explanation was available to describe how these were selected.

The sources of the data which were used to measure each variable employed in the development of the indicators have been described in Appendix A. In Table 2.3 these sources have been summarized for each school system.

Table 2.2 The Variables Used by Australian School Systems During 1980 for the Preparation of Indicators of Educational Disadvantage

Variables	Government						Non-Government[b]	
	NSW	Vic	Qld	SA	WA	Tas[a]	Vic	SA
Occupational Status of Father/Breadwinner		*	*		*	*(P)	*	*
Migrancy		*	*	*	*		*	*
Aboriginal Students		*	*		*			
Isolation		*	*					
Social Welfare					*	*(S)		
Single Parents		*					*	*
Family Size						*(S)		
Free Book Recipients				*				*
Income Measures	*					*(S)		
Student Turnover		*					*	*
Working Parents								*
Achievement/IQ Tests						*(P/S)		
Other Variables Based On Estimates Provided by Education Department Staff						*(P)		

a In Tasmania separate indices were prepared for Primary (P) and Secondary (S) Schools.

b Variables used by New South Wales, Western Australian and Tasmanian non-government systems have not been used to construct indicators. These variables have been listed in Appendix A. The Queensland non-government system does not gather data on any variables.

Source: Ross (1980).

Table 2.3 The Sources of the Data Used to Construct Indicators for Australian School Systems During 1980

Data Source	Government						Non-Government	
	NSW	Vic	Qld	SA	WA	Tas	Vic	SA
School	*	*	*	*	*	*	*	*
Education Department		*		*				
Australian Bureau of Statistics					*	*		
Department of Social Security					*			

The number of data sources ranged from a maximum of three in the Western Australian government system to a minimum of one in the New South Wales and Queensland government systems, and the Victorian and South Australian non-government systems.

The Western Australian and Tasmanian government systems were the only systems to obtain information from outside agencies. Both of these systems used information obtained from the Australian Bureau of Statistics. The Western Australian government system supplemented these data with information obtained from the Department of Social Security.

The importance of the indicators in the final selection of schools varied markedly across the school systems. At one extreme, the Victorian government system placed almost complete dependence on the rank order of schools developed from its indicator. A cutting score on the indicator was selected by cumulating the student enrolments of the schools which were most disadvantaged until the cumulative tally of enrolments reached the total number of students which were permitted by the Schools Commission to participate in the Victorian Disadvantaged School Program. All schools above this cutting score were then included in the Program with the exception of schools either slightly above or slightly below the cutting score. The decision to include these schools was taken following a review of their characteristics by a committee that was responsible for the administration of the Program in Victoria. There was no attempt to rearrange the balance of participating schools between, for example, primary and secondary schools, or metropolitan and non-metropolitan schools.

In contrast, the Queensland government school system determined a list of disadvantaged schools through a series of reviews carried out by the members of a special task force who possessed a detailed knowledge of Queensland government schools. A list of schools was initially constructed by making use of information obtained from regional directors of education, inspectors and school principals. Whenever some doubt arose concerning a particular school, the indicator score of that school was consulted only as a supplementary piece of information. This list was then repeatedly refined by the task force by obtaining further information from informed persons, or by the members of the task force making visits to the schools. This review continued until the cumulative tally of enrolments of the remaining schools reached the total number of students that were permitted to participate in the Queensland program.

Summary

In this chapter a review has been presented of the resource allocation responses which have been made in Australia to the changing concept of equality of educational opportunity.

The changing nature of the concept of equality was discussed within a framework, developed by Husen (1972, 1975), that was linked to three distinct social philosophies: conservative, liberal, and redemptive. A detailed examination of the interpretation of the concept of equality presented in reports prepared for the Australian Schools Commission showed that federal assistance provided to educationally disadvantaged schools in Australia has been guided by a mixture of liberal and redemptive philosophies.

The federal assistance to educationally disadvantaged schools has been channelled through the Disadvantaged Schools Program since 1974. Initially, schools were selected to participate in this program by means of a national indicator of educational disadvantage based on census data. However, in recent years, responsibility for the identification of disadvantaged schools has been assumed by the school systems.

In 1980 there were eight different indicators being used to identify disadvantaged schools in Australia: one for each of the six State government school systems, and one each for the non-government (Catholic) school systems in Victoria and South Australia. In most of the other non-government school systems a wide range of objective data has been gathered but no attempts have been made to combine these into indicators.

A review of the techniques which had been used by Australian school systems to construct indicators of educational disadvantage showed that there was little consistency across school systems with respect to the types of data used to construct these indicators. Further, the school systems had generally ignored the issues of indicator validation and the development of measurable external validation criteria. The construction of the school system indicators had mostly been based on appeals to face validity and had been guided by the opinions of committees of 'experts'.

CHAPTER 3

THE ACCURACY OF RESOURCE ALLOCATION STRATEGIES AIMED AT ALLEVIATING EDUCATIONAL DISADVANTAGE

Introduction

The history of programs aimed at alleviating educational disadvantage has featured a common concern with respect to the accuracy associated with the delivery of supplementary educational resources and services to those students who were most in need of assistance.

In the United Kingdom the precision of the procedures employed to identify disadvantaged Educational Priority Area schools was subjected to heavy criticism by Acland (1971) following a reanalysis of the data collected for the Plowden Committee. Acland concluded that 'there is <u>some</u> concentration of 'slower' children in the E.P.A. [Educational Priority Area] schools. But the difference is not educationally exceptional' ~~(Acland, 1971:450). A later~~ study by Barnes and Lucas (1974) conducted in London schools presented a similar conclusion:

> It seems likely that the majority of disadvantaged children are not in disadvantaged areas and the majority of children in disadvantaged areas are not disadvantaged.
>
> (Barnes and Lucas, 1974:56)

Criticism of the accuracy of resource distribution has also been directed at the selection procedure for disadvantaged Title I schools in the United States. Glass (1970) and Fortune (1971) showed that an income dichotomy for family incomes, as was used in the Title I program, was a very imprecise method for identifying students having reading and learning difficulties. Later research and criticism led to attempts to change the distribution of resources from the selection of schools on the basis of social criteria to the selection on the basis of performance on criterion-referenced tests (Emrick, 1974; Quie, 1974). Feldmesser (1975) has presented a comprehensive review of the dangers associated with the use of test scores to guide resource allocation strategies for programs designed to assist educationally disadvantaged students. In particular he emphasized the problems of a 'disincentive effect' - in which schools may be tempted to manipulate student test scores to give the appearance of low performance and thereby guarantee continuity of supplementary assistance.

The problem of obtaining accuracy in the delivery of resources to those students attending educationally disadvantaged schools who are in most need of assistance is not solely a question of choosing the 'correct' indicator. Consideration must also be given to the approach of selecting schools, rather than individual students, as the units of funding.

Since there will generally be some degree of variation in student characteristics (abilities, home environments, etc.) both between schools and between students within schools, the nomination of certain schools or groups of schools to be the recipients of supplementary resources will always lead to some needy students being unable to receive assistance because their school or group of schools was not selected to participate in the program. For example, if the distribution of the criterion measure of disadvantage was associated only with variation between students within schools then all schools would contain approximately the same proportion of disadvantaged students. In this situation resource allocation based on the selection of schools or groups of schools would be extremely inaccurate. Conversely, if the distribution of the criterion measure was associated only with variation between schools then the selection of schools or groups of schools with the lowest mean scores on the criterion would result in completely accurate resource allocation.

The two extreme examples described above specify the boundaries for a consideration of the accuracy of resource allocation programs associated with the funding of disadvantaged schools in Australia. The unit of identification and funding for all Australian school systems has been the school because the definition of 'disadvantaged' prepared by the Australian Schools Commission at the commencement of the Disadvantaged Schools Program incorporated this notion.

In the following sections of this chapter the implications of the choice of the school as the unit of identification and funding have been examined. In particular, consideration has been given to developing quantitative estimates of the accuracy with which resources may be delivered to individual students when a 'school-based' funding program is adopted in order to assist educationally disadvantaged students.

Definition of Terminology: Accuracy and Leakage

In the following discussion the precision with which educational resources may be delivered through a school-based procedure to those students who most need them has been described in terms of two statistics: Accuracy and Leakage. The term 'school-based' has been used as a summary description of the procedure used both by the Australian Schools Commission in its initial 1973 allocation of resources to disadvantaged schools, and by Australian school systems in the years following this initial allocation. In brief, this procedure has been based on the development of an ordered list of schools according to school mean scores on an indicator of disadvantage followed by the allocation of resources to a group of schools who are lowest on this list. The cutoff points for selecting the lowest group of schools have been obtained by limiting the number of participating students to a percentage within the range of 10 to 20 per cent of total enrolments.

The Accuracy coefficient for an individual school describes the degree to which a school at a given percentile on the distribution of school indicator scores contains students with characteristics which are associated with educational disadvantage.

For example, consider a school at the 20th percentile on the cumulative distribution of indicator scores for schools. The Accuracy coefficient for this school, A(10, 20), with respect to student scores on a measure known to be associated with educational disadvantage refers to the percentage of students in this school who are below the 10th percentile for the overall cumulative distribution of student scores on this measure.

The Leakage coefficient borrows its name from the concept of 'resource leakage' used by Benson et al (1974:85) to describe a situation when 'too much money leaks to students who are doing well enough by ordinary standards'.

In this chapter, students have been considered to be doing 'well enough by ordinary standards' when they have obtained scores on a measure known to be associated with educational disadvantage which are above the median (50th percentile) for the overall cumulative distribution of student scores on this measure.

For example, consider a school at the 20th percentile on the cumulative distribution of indicator scores for schools. The Leakage coefficient, L(20), with respect to student scores on a measure known to be associated with educational disadvantage refers to the percentage of students in this school who are above the median for the overall cumulative distribution of student scores on this measure.

Factors Influencing Precision in Resource Allocation

The values of the Accuracy and Leakage coefficients for particular schools depend on the nature of the allocation of students among schools. This may be demonstrated by considering the following simple hypothetical example in which two different arrangements of the same population of students among ten schools have been compared. These two arrangements have been presented in diagrammatic form in Figure 3.1.

The ranges of student scores within each school for each arrangement have been represented by vertical lines in Figure 3.1. The school mean scores were represented by dots in the middle of each of these vertical lines. The ranges of school mean scores for each arrangement may be examined by considering the distance between the highest and lowest school mean scores within each arrangement.

In order to facilitate comparisons between the arrangements the following simplifying assumptions have been made:

1 Assume that the overall distribution of student scores, the distributions of student scores within schools, and the distributions of school mean scores are all normal distributions.

2 Assume that, within each arrangement, the distributions of student scores within schools are identical.

The total variance of student scores was the same for both arrangements because the same population of students was being considered in each arrangement. However the variance of school means and the variance of students within schools differed widely between arrangements.

In arrangement I there was a large degree of variation between school means and a small degree of variation between students within schools. In arrangement II the relative magnitudes of these two sources of variation have been reversed. To summarize these characteristics we could say that arrangement I showed a high level of student homogeneity within schools, and arrangement II showed a high level of student heterogeneity within schools.

Since the same population of students was being considered in each arrangement, the raw score equivalents of student percentile ranks was the same for both arrangements. An inspection of Figure 3.1 showed that this was not the case when school mean percentile ranks were compared across arrangements. For example, the raw score equivalent of the 20th percentile for school means was much lower in arrangement I than it was in arrangement II.

The Xth percentile for students, which had the same raw score equivalent in both arrangements, has been shown in Figure 3.1. The 'school locations' of students below this percentile differed markedly across the two arrangements. In arrangement I the students below the Xth percentile for students were located in the lowest three schools, whereas in arrangement II these same students were located in all schools. From Figure 3.1 it could therefore be seen that in arrangements where there was a high level of homogeneity of students within schools, the students below a particular percentile value for students would generally be located in fewer schools than for arrangements where there was a high level of heterogeneity of students within schools.

The above discussion may be used to examine the implications for precision in resource allocation programs when school mean scores are used to select students who are to benefit from these programs.

Consider a resource allocation program in which the selection of students to receive the benefits of supplementary funding was based on the school mean scores of a student derived measure. The student derived measure could, for example, be test scores on an instrument designed to measure basic literacy skills, or it could be a composite measure of indicators which were designed to assess the educational environment of each student's home circumstances. Also consider that the student derived measure was an adequate measure of educational disadvantage for individual students, and that a low score indicated high disadvantage.

If there was a high level of homogeneity of students within schools, as for arrangement I, then the lowest scoring students would be located within a relatively small number of schools. The schools whose mean scores fell below the given percentile cutoff, for example the 20th percentile for schools, would generally have relatively high values for the Accuracy coefficient and relatively low values for the Leakage coefficient. Conversely, where there was a high level of heterogeneity of students within schools, as for arrangement II, then the schools below the given percentile cutoff would generally have relatively low values for the Accuracy coefficient and relatively high values for the Leakage coefficient.

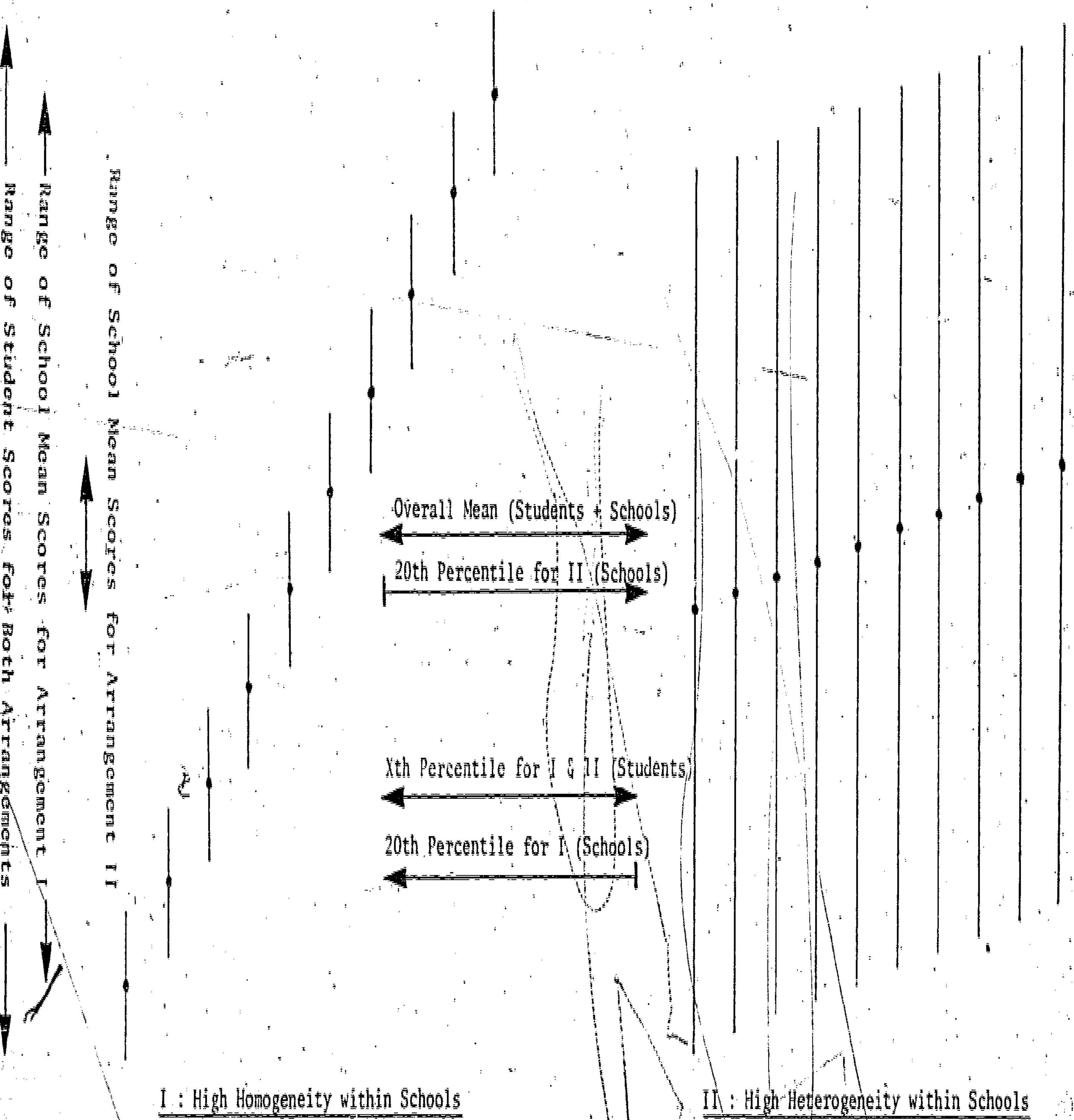

Figure 3.1 Two Possible Arrangements of the Same Population of Students Among Ten Schools

These results indicated that, where the school was used as the unit of funding, the precision with which the benefits of a program of supplementary funding for educational disadvantage reached those students who were in most need of assistance depended upon the nature of the variation in student characteristics within and between schools.

Relationships between Accuracy, Leakage, and Student Variation Within and Between Schools.

In the following sections of this chapter a quantitative measure, the coefficient of intraclass correlation, has been employed as a means of examining the components of student variation within and between schools. This statistic provides a measure of the 'homogeneity' of student scores within schools.

This statistic has been initially defined in terms of the data available for this study and then examined with respect to certain limiting cases. Relationships between the coefficient of intraclass correlation and the Accuracy and Leakage coefficients have subsequently been developed.

Notation

The following discussion describes the notation used in later sections of this chapter. The arguments which have been presented have drawn upon the theoretical analysis of intraclass correlation given by Kish (1965:166-178).

Consider a population of A schools each having B students. Also consider a student measure $Y_{\alpha\beta}$ obtained for student β in school α of this population. Let the mean score for school α be $\overline{Y}_\alpha$ and the overall population mean score be $\overline{Y}$. The variance of student scores for the population (σ^2) may be broken down into the sum of two components: the variance of the school means around the population mean ($\sigma_a{}^2$), and the mean of the variances of student scores around their own school means ($\sigma_b{}^2$).

In Y notation this summation of variance components ($\sigma^2 = \sigma_a{}^2 + \sigma_b{}^2$) may be written as:

$$\frac{1}{AB}\sum_{\alpha\beta}^{AB}\sum(Y_{\alpha\beta}-\overline{Y})^2 = \frac{1}{A}\sum_{\alpha}^{A}(\overline{Y}_\alpha - \overline{Y})^2 + \frac{1}{A}\sum_{\alpha}^{A}\frac{1}{B}\sum_{\beta}^{B}(Y_{\alpha\beta} - \overline{Y}_\alpha)^2$$

The coefficient of intraclass correlation, Rho, which measures the homogeneity of student scores within schools is defined as the product-moment correlation between each of the $\frac{B(B-1)}{2}$ different pairs of student scores within each of the A schools:

$$\text{Rho} = \frac{1}{\sigma^2}\left[\frac{1}{A}\sum_{\alpha}^{A}\frac{2}{B(B-1)}\sum_{\beta<\gamma}^{B}(Y_{\alpha\beta}-\bar{Y})(Y_{\alpha\gamma}-\bar{Y})\right]$$

When student scores within the same school tend, on the average, to deviate in the same direction from the population mean, the average of the products and hence Rho, tend to be positive.

It may be shown (Kish, 1965:171) that the above expression for Rho is equivalent to:

$$\text{Rho} = \frac{\sigma_a^2 - \sigma_b^2 / (B-1)}{\sigma^2}$$

There are three special cases of Rho which describe particular arrangements of students among schools:

1 Complete homogeneity of student scores within schools occurs when $\sigma_b^2 = 0$ and $\sigma_a^2 = \sigma^2$. In this case Rho = 1.

2 Extreme heterogeneity of student scores within schools occurs when $\sigma_a^2 = 0$ and $\sigma_\beta^2 = \sigma^2$. In this case Rho = $\frac{-1}{(B-1)}$.

3 Random sorting of student scores among schools occurs when the relationship between σ_a^2 and σ_b^2 is as if each school was composed of a random selection of B students. In this instance the relationship between σ_a^2 and σ_b^2 is obtained from the expression for the variance of the sample mean under the assumptions of simple random sampling (Kish, 1965:63, 167):

$$\sigma_a^2 = (1 - \frac{B}{AB})\,(\frac{B\,\sigma_\beta^2}{B-1})\ \frac{1}{B}$$

The resulting value of Rho is $\frac{-1}{AB-1}$. This value tends to zero for large populations.

Within-School Deviation Scores and Percentile Ranks

By using the assumptions described in a previous section concerning a population of students and schools, the relationship between a student's within-school deviation score or percentile may be linked to his/her overall deviation score or percentile in a functional form which depends on the coefficient of intraclass correlation.

In the following discussion the overall distribution of student scores has been assumed to be scaled so that the overall mean, $\bar{Y}$, is equal to zero. From the previous assumptions concerning the distributions of student and

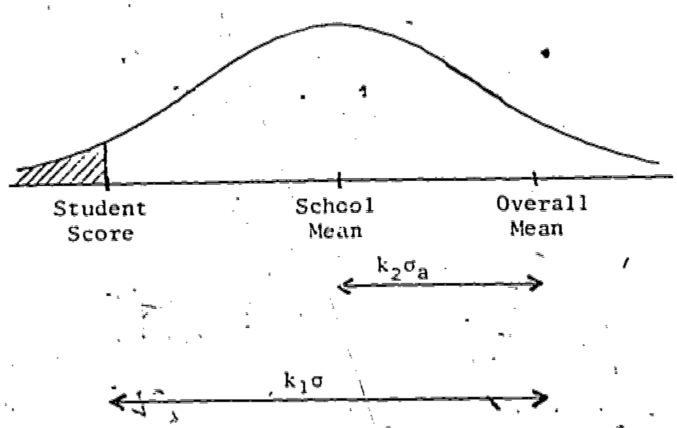

Figure 3.2 A Possible Arrangement of Student, School Mean, and Overall Mean Scores.

school scores, the mean of the school scores will also be zero and the variances of student scores within schools will be equal (σ_b^2) for all schools.

Consider a student with a score of $k_1 \sigma$ units, where k_1 is a constant. This student's score would be situated at k_1 student standard deviation units from the overall mean of student (and school) scores.

Let the mean score of the school which this student attends be $k_2\sigma_a$ units, where k_2 is a constant. This school's mean score would be k_2 school mean standard deviation units from the overall mean of student (and school) scores.

Figure 3.2 shows one possible arrangement of the distribution of scores within a particular school. In this example the school mean score is below the overall mean. Also, the particular student's score is below both of these scores.

The deviation score, y, of this student with respect to his own school mean is:

$$y = \text{Student Score} - \text{School Mean Score}$$

$$= k_1\sigma - k_2\sigma_a$$

The standard score, z, of this student with respect to the distribution of student scores within his own school is:

$$z = \frac{\text{Student Score - School Mean Score}}{\text{Standard Deviation of Scores Within School}}$$

$$= \text{Student Score in Within-School Standard Deviation Units} - \text{School Mean Score in Within-School Standard Deviation Units}$$

$$= \frac{k_1\sigma}{\sigma_b} - \frac{k_2\sigma_a}{\sigma_b}$$

Since the distribution of student scores within schools is assumed to be normal, the proportion of students in this school who score at or below the score of this particular student is:

$$\text{Proportion of students at or below } z \text{ in this school} = \int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}} e^{\frac{-z^2}{2}} dz$$

= Area of the shaded region in Figure 3.2.

From previous discussion of the equations which relate σ^2, σ_a^2, σ_b^2 and Rho, the values of σ^2 and σ_a^2 may be expressed in terms of σ_b^2 and Rho:

$$\sigma^2 = \frac{B\sigma_b^2}{(B-1)(1-Rho)} \quad \text{and} \quad \sigma_a^2 = \frac{[1+Rho(B-1)]\sigma_b^2}{(B-1)(1-Rho)}$$

Further substitution of these expressions into the equation which defines z gives an expression for z which eliminates the variance terms:

$$z = k_1\left[\frac{B}{(B-1)(1-Rho)}\right]^{\frac{1}{2}} - k_2\left[\frac{1 + Rho(B-1)}{(B-1)(1-Rho)}\right]^{\frac{1}{2}}$$

When this value of z is used as an upper limit in the above integral of the normal distribution, the value of the 'proportion of students at or below z in this school' becomes a function of k_1, k_2, B and Rho. Further, by multiplying both sides of the integral by 100 it is possible to restate the expression in terms of percentiles:

Within-school percentile rank corresponding to a within-school standard score of z = 100f (k_1, k_2, B, Rho)

where f = the area under the unit normal curve between the limits of $-\infty$ and the value of z described above.

Accuracy Coefficient for Individual Schools

Consider a student whose score is at the p_1th percentile in the overall distribution of students scores. Let this student be a member of a school with mean score at the p_2th percentile in the distribution of school mean scores.

The value of the Accuracy coefficient, $A(p_1,p_2)$, for a school with mean score at the p_2th percentile for schools is the percentage of students in this school whose scores are below the p_1th percentile for student scores.

From previous discussion the Accuracy coefficient may be expressed as:

$A(p_1,p_2)$ = 100f (k_1,k_2,B,Rho)

where k_1 = the standard score equivalent of p_1.

where k_2 = the standard score equivalent of p_2.

For example, A(10,20) is the percentage of students in a school, with mean score at the 20th percentile for schools, whose scores are below the 10th percentile for students.

Assume a Rho value of 0.2 and a value of B equal to 23.6. This value of B was selected for this example because it was equal to the number of students per school in the samples which were employed in later chapters of this study.

Use of these values and substitution in the formulae presented in previous discussion gives the following:

Student Score in Within-School Standard Deviation Units at 10th Percentile $= k_1 \left[\frac{B}{(B-1)(1-Rho)}\right]^{\frac{1}{2}}$

$= -1.28 \left[\frac{23.6}{(23.6-1)(1-0.2)}\right]^{\frac{1}{2}}$

$= -1.46$

School Mean Score in Within-School Standard Deviation Units at 20th Percentile $= k_2 \left[\frac{1+Rho(B-1)}{(B-1)(1-Rho)}\right]^{\frac{1}{2}}$

$= -0.84 \left[\frac{1+0.2(23.6-1)}{(23.6-1)(1-0.2)}\right]^{\frac{1}{2}}$

$= -0.46$

Within-School Standard Score $= -1.00$

and $A(p_1,p_2) = 100f\,(k_1,k_2,B,Rho)$

$$\therefore A(10,20) = 100 \int_{-\infty}^{-1.00} \frac{1}{\sqrt{2\pi}}\, e^{\frac{-z^2}{2}}\, dz$$

$= 15.9.$

That is, given the values of B and Rho described above, there are 15.9 per cent of students below the 10th percentile for students in a school with a mean score at the 20th percentile for schools.

The above set of calculations was repeated for the four possible Accuracy coefficients which arise when p_1 and p_2 take values equal to either the 10th or 20th percentiles. The results of these calculations have been summarized in Table 3.1. For each value of Rho, student scores and school mean scores in within-school standard deviation units have been presented for the 10th and 20th percentiles.

In Table 3.1 values of the four Accuracy coefficients have been listed according to Rho values which range from 'extreme heterogeneity' to 'complete homogeneity'.

Table 3.1 Accuracy Coefficients for Individual Schools at the 10th/20th Percentiles for Schools, and Students Below the 10th/20th Percentiles for Students

Rho	Student Score (σ_b units)		School Mean Score (σ_b units)		Accuracy Coefficient $A(p_1,p_2)$			
	10th Percentile for Students	20th Percentile for Students	10th Percentile for Schools	20th Percentile for Schools	A(10,10)	A(10,20)	A(20,10)	A(20,20)
-1/22.6[a]	-1.28	-0.84	0.0	0.0	10.0	10.0	20.0	20.0
0.0[a]	-1.31	-0.86	-0.27	-0.18	14.9	12.9	27.7	24.7
0.1	-1.38	-0.91	-0.51	-0.34	19.3	14.8	34.7	28.4
0.2	-1.46	-0.96	-0.71	-0.47	22.5	15.9	40.0	31.0
0.3	-1.57	-1.03	-0.90	-0.59	25.2	16.5	44.9	33.1
0.4	-1.69	-1.11	-1.10	-0.73	27.8	16.7	49.7	35.0
0.5	-1.85	-1.22	-1.34	-0.88	30.3	16.5	54.8	36.8
0.6	-2.07	-1.36	-1.63	-1.07	32.8	15.8	60.5	38.5
0.7	-2.39	-1.57	-2.02	-1.33	35.5	14.3	67.3	40.3
0.8	-2.93	-1.92	-2.63	-1.73	38.4	11.5	76.1	42.3
0.9	-4.14	-2.72	-3.94	-2.59	41.9	6.0	88.8	44.7
1.0[a]	b	b	b	b	50.0	0.0	100.0	50.0

Note: a The value of the coefficient of intraclass correlation (Rho) for 'extreme heterogeneity' of student scores within schools is -1/22.6; for 'random sorting' of student scores among schools it is 0.00; and for 'complete homogeneity' of student scores within schools it is 1.0 (for infinitely large populations of schools). Note that the values of Rho for 'extreme heterogeneity' and 'complete homogeneity' are limiting cases.

b The limiting values for these scores have been discussed in Appendix B.

c The Accuracy values were calculated by using PROGRAM NORMAL. (See Appendices C and D).

For example, when Rho = 0.2, the coefficients A(10,10), A(10,20), A(20,10), and A(20,20) took the values 22.5, 15.9, 40.0, and 31.0 respectively. These values may be interpreted in the following fashion: A school with mean score at the 10th percentile for schools has 22.5 per cent of its students below the 10th percentile for students and 40.0 per cent of its students below the 20th percentile for students; whereas a school with mean score at the 20th percentile for schools has 15.9 per cent of its students below the 10th percentile for students and 31 per cent of its students below the 20th percentile for students.

The values of Rho which represent 'extreme heterogeneity' and 'complete homogeneity' are limiting cases. In fact it would be impossible to calculate values of Accuracy or Leakage coefficients if Rho took either of these values. 'Extreme heterogeneity' would result in all schools having the same mean score which would prevent the calculation of percentiles for schools; 'complete homogeneity' would result in all students within a particular school having the same score which would prevent the calculation of within-school percentiles. These limiting values of Rho and the resulting values of the Accuracy and Leakage coefficients have been discussed in detail in Appendix B.

A computer program, PROGRAM NORMAL, was prepared to calculate Accuracy and Leakage values for schools at each percentile from the 0th to the 20th percentiles. This program has been listed in Appendix C. Some examples demonstrating the output from this program for a range of Rho values have been presented in Appendix D.

The Leakage Coefficient for Individual Schools

The Leakage coefficient may be considered as a special case of the Accuracy coefficient.

Consider a student whose score is equal to the median of the overall distribution of student scores. From previous assumptions, this student's score would also be equal to the mean of the distribution of school mean scores. Let this student be a member of a school with mean score at the p_2th percentile in the distribution of school mean scores.

The value of the Leakage coefficient, $L(p_2)$, for a school with a mean score at the p_2th percentile for schools is the percentage of students in this school with scores above the overall median for student scores.

The Leakage coefficient is related to the Accuracy coefficient by the following expression:

$L(p_2) = 100 - A(50,p_2)$

The value of p_1 in the Accuracy coefficient is fixed at 50 because this is the percentile equivalent of the median of student scores.

Then, from previous discussion

$L(p_2) = 100(1-f(o,k_2,B,Rho))$

The value of k_1 in the function f has been fixed at zero because, from earlier assumptions, this is the standard score equivalent of the 50th percentile.

For example, L(20) is the percentage of students in a school, with mean score at the 20th percentile for schools, whose scores are above the 50th percentile for students. Assume a Rho value of 0.2 and a value of B equal to 23.6. This value of B was selected for this example because it was equal to the number of students per school in the samples which were employed in later chapters of this study.

Using these values and substituting in the formulae presented in previous discussion gives the following:

Student score in Within-School Standard Deviation Units at 50th Percentile $= k_1 \left[\frac{B}{(B-1)(1-Rho)}\right]^{\frac{1}{2}}$

$= 0$ for all values of B and Rho because $k_1=0$ for the 50th percentile,

School Mean Score in Within-School Standard Deviation Units at the 20th Percentile $= k_2 \left[\frac{1+Rho(B-1)}{(B-1)(1-Rho)}\right]^{\frac{1}{2}}$

$= -0.84 \left[\frac{1+0.2(23.6-1)}{(23.6-1)(1-0.2)}\right]^{\frac{1}{2}}$

$= -0.46$

60

Within-School Standard Score $= 0-(-0.46)$

$= 0.46$

and $L(p_2) = 100(1-f(o,k_2,B,Rho)$

$$\therefore L(20) = 100(1-\int_{-\infty}^{0.46} \frac{1}{\sqrt{2\pi}} e^{-\frac{z^2}{2}} dz)$$

$= 100(1-0.6791)$

$= 32.1$

That is, given the values of B and Rho described above, there are ~~32.1 per~~ cent of students above the 50th percentile for students in a school with a mean score at the 20th percentile for schools.

The above set of calculations was repeated for Leakage coefficients at the 10th percentile and the 20th percentile. For each value of Rho, the school mean scores in within-school standard deviation units have been presented for the 10th and 20th percentiles in Table 3.2. The two Leakage coefficients have been listed according to Rho values which range from 'extreme heterogeneity' to 'complete homogeneity'.

For example, when Rho = 0.2, the coefficients L(10) and L(20) were 23.9 and 32.1 respectively. These values may be interpreted in the following fashion: A school with mean score at the 10th percentile for schools has 23.9 per cent of its students above the 50th percentile for students; whereas a school with mean score at the 20th percentile for schools has 32.1 per cent of its students above the 50th percentile for students.

Average Accuracy and Leakage for Groups of Schools

The previous discussion was concerned with the calculation of Accuracy and Leakage coefficients for individual schools. The average of the Accuracy and Leakage coefficients over groups of schools may be used to provide information about the precision with which indicators may be employed to identify groups of schools having students with certain ranges of educational achievement.

Table 3.2 Leakage Coefficients for Individual Schools At the 10th/20th Percentiles for Schools

Rho	Student Score at 50th Percentile for Students (σ_b units)	School Mean Score ($\bar{\sigma}_b$ units)		Leakage Coefficient $L(p_2)$	
		10th Percentile for Schools	20th Percentile for Schools	L(10)	L(20)
-1/22.6[a]	0.00	0.00	0.00	50.0	50.0
0.0[a]	0.00	-0.27	-0.18	39.4	43.0
0.1	0.00	-0.51	-0.34	30.4	36.8
0.2	0.00	-0.71	-0.47	23.9	32.1
0.3	0.00	-0.90	-0.59	18.4	27.7
0.4	0.00	-1.10	-0.73	13.5	23.4
0.5	0.00	-1.34	-0.88	9.1	19.0
0.6	0.00	-1.63	-1.07	5.2	14.3
0.7	0.00	-2.02	-1.33	2.2	9.2
0.8	0.00	-2.63	-1.73	0.4	4.2
0.9	0.00	-3.94	-2.59	0.0	0.5
1.0[a]	b	b	b	0.0	0.0

Note: a The value of the coefficient of intraclass correlation (Rho) for 'extreme heterogeneity' of student scores within schools is -1/22.6; for 'random sorting' of student scores among schools it is 0.00; and for 'complete homogeneity' of student scores within schools it is 1.0 (for infinitely large populations of schools). Note that the values of Rho for 'extreme heterogeneity' and 'complete homogeneity' are limiting cases.

b The limiting values for these scores have been discussed in Appendix B.

c The Leakage values were calculated by using PROGRAM NORMAL. (See Appendices C and D).

For example, consider the average value of $A(20, p_2)$ over the group of schools from the school at the 20th percentile down to the lowest school. This statistic estimates the average school percentage of all students who are in schools below the 20th percentile for schools and who are also below the 20th percentile for students overall.

Similarly, consider the average value of $L(p_2)$ over the group of schools from the school at the 20th percentile down to the lowest school. This statistic estimates the average school percentage of all students who are in schools below the 20th percentile for schools and who are also above the 50th percentile for students overall.

Estimates of the average Accuracy and average Leakage coefficients have been presented in Table 3.3 according to a range of values for the coefficient of intraclass correlation. These values were obtained by taking the mean of the relevant Accuracy and Leakage coefficients for schools situated at one percentile intervals. That is, the estimate of the average value of $A(20, p_2)$ for schools below the 20th percentile was obtained by evaluating the Accuracy coefficient for an individual school at the 20th percentile, 19th percentile, 18th percentile, and so on. A similar approach was employed to estimate the average values of the Leakage coefficient. The 10th and 20th percentiles for schools were chosen as appropriate 'cut-off' points for calculating the average coefficients because these percentiles represented approximate upper and lower bounds for the percentages of students who have participated in the Disadvantaged Schools Program in Australia.

The average coefficients in Table 3.3 may be used to examine the precision in resource allocation which would be associated with programs which use schools as the unit of funding.

For example, consider a school system in which Rho = 0.8 for a measure derived from students which was designed to assess educational disadvantage. This school system would be described as having a high level of student homogeneity within schools. Now consider a funding program which was directed at the lowest 10 per cent of schools with respect to the school mean scores on the same measure of educational disadvantage. From Table 3.3 it can be seen that, for this resource allocation program, there would be about 90 per cent of students within funded schools who would be below the 20th percentile for students. Also, about 70 per cent of the students within funded schools would be below the 10th percentile, and less than one per cent would be above the median score for the whole population of

Table 3.3 Average Accuracy and Leakage Coefficients for Schools At or Below the 10th/20th Percentile for Schools, and Students Below the 10th/20th Percentiles for Students

Rho	Average Coefficients for Schools At or Below 10th Percentile			Average Coefficients for Schools At or Below 20th Percentile		
	A(10,p2)	A(20,p2)	L(p2)	A(10,p2)	A(20,p2)	L(p2)
-1/22.6[a]	10.0	20.0	50.0	10.0	20.0	50.0
0.0[a]	24.5	36.9	33.0	19.4	31.7	37.0
0.1	30.9	46.1	23.0	24.1	38.9	28.3
0.2	36.1	53.2	16.5	27.7	44.3	22.3
0.3	40.9	59.6	11.5	30.9	49.2	17.3
0.4	45.7	65.7	7.5	33.9	53.9	13.0
0.5	50.7	71.9	4.4	36.9	58.6	9.2
0.6	56.0	78.1	2.1	39.9	63.5	5.9
0.7	61.9	84.4	0.7	43.0	68.8	3.1
0.8	68.7	90.9	0.1	46.1	74.7	1.0
0.9	77.4	97.1	0.0	48.9	82.0	0.1
1.0[a]	100.0	100.0	0.0	50.0	100.0	0.0

Note: a The value of the coefficient of intraclass correlation (Rho) for 'extreme heterogeneity' of student scores within schools is -1/22.6; for 'random sorting' of student scores among schools it is 0.00; and for 'complete homogeneity' of student scores within schools it is 1.0 (for infinitely large populations of schools). Note that the values of Rho for 'extreme heterogeneity' and 'complete homogeneity' are limiting cases.

b The limiting values for these scores have been discussed in Appendix B.

c The Leakage values were calculated by using PROGRAM NORMAL. (See Appendices C and D).

students. These results could be summarized by saying that the use of schools as the unit of funding for this population of students and schools would provide a relatively accurate delivery of resources to those students who were in most need of assistance.

If the population described above was compared with another population in which Rho is equal to 0.1, then the use of schools as funding units leads to a much less accurate delivery of resources to the individuals who would be in most need of assistance. In this population there would be a high level of student heterogeneity within schools. If resources were directed to the lowest 10 per cent of schools in this population, then less than one half of the students in funded schools would be below the 20th percentile for students. Further, less than one third of the students within funded schools would be below the 10th percentile, and almost one quarter would be above the median score for the population.

Application of the Model: An International Example

In the following discussion the theoretical model described above has been applied to an international example in order to compare the precision of a hypothetical resource allocation scheme based on the funding of schools with low mean test scores. Test scores on a test of Word Knowledge have been used in this example because their statistical characteristics were readily available for a group of countries from the reports of studies carried out by the International Association for the Evaluation of Educational Achievement (Thorndike, 1973; Peaker, 1975). If data had been readily available to permit the calculation of the coefficient of intraclass correlation for some other variable, for example, a measure of the socio-economic level of a student's home environment, then the same principles outlined in earlier sections could have been applied to compare different countries. The procedures employed to calculate estimates of the coefficient of intraclass correlation from sample data have been described in Appendix F.

The comparison of average Accuracy and Leakage coefficients for the ten countries examined in this example assumed that the aim of the 'school-based' funding program would be to assist those students in most need of assistance as measured by their Word Knowledge test scores. For example, if the lowest 10 per cent of schools were funded then the 'optimal' level of precision would require average Accuracy and Leakage coefficients of 100 and zero, respectively. This situation would occur when all students in the lowest 10 per cent of schools were also in the lowest 10 per cent of students and none of these students were performing above the national median score. From previous discussion we would only expect this situation when the coefficient of intraclass correlation was equal to unity - signifying complete homogeneity of students within schools.

From information presented by Thorndike (1973:142) it was possible to calculate estimates of the coefficient of intraclass correlation associated with the same test of Word Knowledge applied to nine countries at the 10-year-old level and the 14-year-old level. The tests which were used in the study described by Thorndike consisted of the same tests at each age level after having been translated into mother-tongue languages for each country.

The information for Australia was obtained from a study of Literacy and Numeracy carried out in Australian schools in 1975 (Keeves and Bourke, 1976). In all ten countries similar target population definitions were used at each age level. The values of the estimates of the coefficients of intraclass correlation have been reported in Table 3.4. Values of the Accuracy and Leakage coefficients have also been listed in this table.

For Australia, the coefficient of intraclass correlation was 0.14 at both age levels. Since the value of roh was the same at each age level, the corresponding average Accuracy and Leakage coefficients were also the same. For Australia, in the lowest 10 per cent of schools the average Accuracy estimate showed that 33.1 per cent of these students would be in the lowest 10 per cent of students overall. The average Leakage estimate showed that 20.2 per cent of students in the lowest 10 per cent of schools would have scores above the national median score.

The values of the coefficients of intraclass correlation were low for both age levels in only three countries: Australia, Hungary and Sweden. Consequently each of these countries also had relatively low average Accuracy coefficients and relatively high average Leakage coefficients. These results demonstrate that, compared to the other countries listed in Table 3.4, these three countries would have comparatively low precision in resource allocation schemes which used schools as the unit of funding.

In comparison Italy, Scotland and the United States had relatively high values of roh at both age levels and therefore had high values for the average Accuracy coefficient and low values for the average Leakage coefficient. These three countries would therefore be more appropriate settings for funding programs based on the selection of schools with low mean scores.

Some anomalies appeared between age levels for England, Finland, Israel and the Netherlands. In these countries the values of roh were substantially higher for the 14-year-old level than for the 10-year-old level. These results implied that, for these countries, a resource allocation program which used schools as the unit of funding would be more appropriate at the secondary school level than at the primary school level.

Table 3.4 Coefficients of Intraclass Correlation and Average Accuracy/Leakage Coefficients Over the Lowest 10 Per Cent of Schools for Ten Countries

Country	10-year-old					14-year-old				
	$\frac{s_a^2}{s^2}$	b	roh	Average Coefficient $A(10,p_2)$	Average Coefficient $L(p_2)$	$\frac{s_a^2}{s^2}$	b	roh	Average Coefficient $A(10,p_2)$	Average Coefficient $L(p_2)$
Australia[b]	0.17	24	0.14	33.1	20.2	0.18	24	0.14	33.1	20.2
England	0.20	22	0.16	34.1	18.9	0.30	22	0.27	39.5	12.9
Finland	0.20	13	0.13	32.5	20.9	0.29	30	0.27	39.5	12.9
Hungary	0.19	32	0.16	34.1	18.9	0.16	33	0.13	32.5	20.9
Israel	0.22	17	0.17	34.6	18.3	0.36	16	0.32	41.9	10.6
Italy	0.40	15	0.36	43.8	9.0	0.47	22	0.44	47.7	6.1
Netherlands	0.16	27	0.13	32.5	20.9	0.40	25	0.38	44.7	8.2
Scotland	0.24	21	0.20	36.1	16.5	0.34	28	0.32	41.9	10.6
Sweden	0.14	21	0.10	30.9	23.0	0.07	26	0.03	26.7	29.3
United States	0.27	21	0.23	37.6	14.9	0.28	24	0.25	38.5	13.8
Mean	0.22	21	0.18	34.9	18.2	0.29	25	0.26	38.6	14.6

Note: a The ratios of the variance of school means to the total student variance $(\frac{s_a^2}{s^2})$ were reported by Thorndike (1973:142) for the Word Knowledge Test which was employed cross-nationally as part of a series of studies carried out by the International Association for the Evaluation of Educational Achievement. The average cluster sizes (b) were reported for the same study by Peaker (1975:120).

b The calculations for Australia were based on the Word Knowledge Test scores gathered for this study.

c The average Accuracy and Leakage values were calculated by using PROGRAM NORMAL. (See Appendices C and D).

d The statistic 'roh' is a sample estimate of the population value of 'Rho'. (See Appendix F.)

Summary

In this chapter the problems associated with obtaining precision in the delivery of resources to students attending educationally disadvantaged schools were examined. It was demonstrated that the approach of using schools as the unit of funding required acknowledgement of the influence of student variation within and between schools on the precision with which educational resources could be delivered to those students who were in most need of assistance.

A theoretical model was introduced for the purposes of estimating the precision in the delivery of educational resources to students when schools were used as the unit of funding. This model quantified the degree of precision in terms of Accuracy and Leakage coefficients. A test of this model against empirical data has been presented in Appendix E.

This theoretical model was applied to an international example in order to show that the use of schools as the unit of funding may result in substantial differences in the precision of resource allocation across different types of school systems. For example, Scotland, Italy, and the United States appeared to be more appropriate settings for school-based funding than were the seven other countries which were considered. This occurred because the homogeneity of students within schools was relatively high for these three countries at both the primary and secondary levels of schooling.

CHAPTER 4

THE DESIGN OF THE STUDY

Introduction

The previous chapters have examined educational resource allocation responses in Australia to the changing concept of equality of educational opportunity, and also the implications of using schools as the units of identification and funding when these responses have been aimed at assisting students who attend educationally disadvantaged schools. This discussion has shown that the quest for accuracy in the delivery of resources to those students who are most in need of assistance must take into consideration that the performance of an indicator of educational disadvantage may be strongly influenced by the nature of the school population to which it is applied.

In Australia, the many indicators of educational disadvantage which have been used to distribute resources worth millions of dollars as part of the Disadvantaged Schools Program have not been examined in terms of the accuracy with which they deliver resources to those students who are most in need of assistance. These indicators have been developed on the basis of the 'expert' opinions of school system committees without ever having been subjected to a comprehensive assessment with respect to either the construct which they purport to measure or the characteristics of the schools and students which they identify as being educationally disadvantaged.

In this chapter a program of research has been outlined which aimed to overcome the deficiencies of the available indicators of educational disadvantage in Australia. This program involved a review of the features of the indicators of educational disadvantage currently being used by Australian school systems followed by a plan for the development, validation, and intensive examination of the properties of a national indicator which was designed to be consistent with the definition of 'disadvantaged' employed by the Australian Schools Commission to establish the Disadvantaged Schools Program.

The Definition of 'Disadvantaged'

The emergence of a redemptive interpretation of equality in Australia was most strongly marked by the proposal put forward by the Interim Committee for the Australian Schools Commission to establish the Disadvantaged Schools Program (Karmel, 1973). This program aimed to provide 'greater than average resources' to disadvantaged schools with the intention of 'reducing differences in the educational performances of socially disadvantaged children and the rest of the school population' (Karmel, 1973:91, 93).

At the beginning of the Disadvantaged Schools Program the Australian Schools Commission provided a definition of the concept of 'disadvantaged' in the following terms:

> The Committee has chosen the term 'disadvantaged' in relation to schools drawing a high proportion of enrolments from neighbourhoods having certain characteristics known to be generally associated with a low capacity to take advantage of educational facilities. (Karmel, 1973:92)

The first key idea in this definition was that the term 'disadvantaged' was to be associated with 'schools' and not individual students. Thus, a disadvantaged student was defined by being a student at a disadvantaged school. The second idea was that the definition was not concerned with the characteristics of the families of students - but rather the 'neighbourhoods' from which schools obtained their students. The third key idea was that these neighbourhoods should display characteristics which were 'associated with' conditions which were adverse to making the best use of educational facilities.

The Proliferation of Indicators of Educational Disadvantage in Australia

The initial lists of disadvantaged schools were developed by the Australian Schools Commission at a national level in 1973 by employing a single indicator called the 'Socioeconomic Scale'. These lists were presented to the school system in [illegible] for comment and then adoption following the correction of any [illegible]. Since that time great efforts have been expended both b[illegible]ools Commission and the school systems to update, m[illegible]ct a wide range of indicators of educational disadvant[illegible]

By 1980 there were nine separate indicators of educational disadvantage being used in Australia: one at the national level, one each for the six State Government school systems, and one each for the Non-Government school systems in Victoria and South Australia. Further, data describing a range of socioeconomic variables were being collected to assist with decisions concerning the identification of disadvantaged schools by the New South Wales, Western Australian, and Tasmanian Non-Government school systems.

There appears to have been no published evidence to explain in detail why the school systems rejected the notion of a national index of educational disadvantage and instead set about the expensive and time-consuming task of developing their own indicators. The reasons which have been expressed in official documentation have, in a tangential fashion, suggested that there was a need for a 'local' indicator because the original national indicator was not able to identify disadvantaged schools with sufficient precision (see references listed in Ross (1980)). This reason was the most enthusiastically endorsed explanation presented during the author's attendance at a series of conferences on educational disadvantage attended by representatives of all school systems (Australian Schools Commission, 1980b).

The Inadequacies of the Currently Available Indicators of Educational Disadvantage

The proliferation of a diversity of indicators of educational disadvantage in Australia has not been accompanied by substantial efforts to assess the validity of the information provided by the indicator scores. There appears to have been no systematic studies which have examined the 'meaning' of the rank order of schools which these indicators have provided. In general, the validity of the indicators developed by school systems has depended solely upon opinions, provided by expert committees, concerning the face validity of the component variables employed in the construction of the indicators (Ross, 1980).

The consequences of a reliance on opinion, rather than objective procedures, has been that many indicators developed by the school systems have both departed substantially from the definition of 'disadvantaged' which was central to the Disadvantaged Schools Program, and also have no known relationships with other measures which could be considered to be symptomatic of educationally disadvantaged schools:

1 An inspection of the review of the indicators used by school systems presented in a previous chapter and in Appendix A showed that none of the indicators developed by the school systems closely satisfied the definition of 'disadvantaged', quoted in an earlier section, which was central to the Disadvantaged Schools Program. The major point of departure between this definition and the school system indicators was that the definition emphasized that degrees of disadvantage were to be assessed through an examination of the neighbourhood of the school whereas the school systems developed indicators which were mostly based on the characteristics of the families associated with children attending the school. The latter approach to the identification of disadvantaged schools was considered to be less desirable by the Australian Schools Commission because it would 'ignore the importance of the neighbourhoods, as an extension of the family, on children' (Karmel, 1973:98).

2 A second important point of departure between the definition and the school system indicators was concerned with the requirement that the information used to assess disadvantage should be restricted to characteristics associated with 'a low capacity to take advantage of educational facilities'. The construction procedures for all of these indicators were devoid of either the use of criterion variables or other information suitable for checking that the indicator components had been selected and combined according to this restriction.

An excellent example of the dangers of expert opinion was evident in the construction of the Victorian Government system's indicator of educational disadvantage. In this indicator the variable measuring 'isolation' was included with the intention that a high level of isolation was to be considered as evidence of a high degree of educational disadvantage. However, in a later investigation of the properties of this indicator, this variable was shown to have a correlation with the indicator scores which was opposite in sign to the direction which had been expected (Ross, 1979a).

3 The construction of the school system indicators has not been accompanied by any evaluations of the properties of the indicator scores. For example, there appeared to be no published evidence concerning the capacity of these indicators to identify schools which have high concentrations of students who had either a low capacity to master the basic skills of literacy and numeracy, or a low capacity to overcome behavioural and social handicaps which would inhibit personal development and

opportunities for further learning. The lack of this type of information made it impossible to know exactly what the indicators were measuring - or if the approach of using the same indicator at both primary and secondary levels of schooling, which had been adopted by most school systems, was appropriate. Further, since there was no information available with respect to the capacity of these indicators to identify students who were in most need of assistance, it was not possible to assess the precision with which the indicators could be used to allocate resources aimed at alleviating educational disadvantage.

4 In addition to problems associated with the lack of congruence between the school systems' indicators and the Disadvantaged Schools Program's definition of 'disadvantaged', and problems concerning the lack of validity information about the nature of the indicator scores, there were certain questions of administrative efficiency, public accountability, and invasion of personal privacy which surrounded the use of separate indicators by the school systems.

(a) The development of separate indicators has required that considerable amounts of money, time, and research expertise be expended by each school system on the development of their indicators. These replications of effort across Australia have to date been totally independent activities with little or no sharing of experience, facilities and resources - even between government and non-government systems within the same state. Several non-government school systems were not able to develop their own indicators because they lacked access to the research expertise required to gather and process the required data.

The independence of these activities has been reflected in the variety of approaches to indicator construction. For example, there was no single variable employed by all school systems in the construction of their indicators. While this characteristic may be seen by some as an interesting feature of the diversity of the Australian education scene, it also exhibited a questionable approach to a program funded from federal sources and having a national set of aims covering all school systems.

(b) The use of separate indicators by the school systems has raised questions of public accountability for the conduct of the Disadvantaged Schools Program. The program was funded from federal sources with the specific intention of assisting the most disadvantaged Australian schools - irrespective of the State or school system to which they belonged.

After 1980, the lack of a national indicator has made it impossible to compare degrees of educational disadvantage for schools in different systems even if they are in the same State. The Schools Commission has made an attempt to overcome this difficulty by estimating degrees of educational disadvantage at the school system level and then allocating funds according to differences between systems. However, it appears that this approach has simply moved more closely toward a per capita division of funds between school systems (Schools Commission, 1980b:14).

The indicators which have been developed by the school systems have generally drawn upon data from individual students, school records, and education department files. These data have then been subjected to an extensive series of calculations involving recoding, aggregation, and weighting, before they have entered the appropriate indicator. The complexity of the data gathering and data manipulation activities required to build these indicators have made it virtually impossible for persons outside the data processing sections in education departments to check or compare or comment upon the indicator scores associated with even a few schools.

This approach to indicator construction has automatically removed any possibility of public discussion concerning the suitability of the data collection and indicator construction procedures. However, in future, the pressures which are increasingly being exerted on the public funding of education will inevitably result in calls for indicators which are based on readily available data, and which are combined into indicators in a fashion that will permit members of the public to check calculations and discuss the appropriateness of various types of indicators.

(c) The data used by school systems to construct their indicators has often relied heavily on the use of personal information gathered from students. This information has usually been obtained directly from students or from personal files and records kept by schools and school systems. In some cases the information has covered such extremely sensitive areas as the marital circumstances of a student's parents, the student's race or ethnic origins, and the employment status of a student's father.

In Australia there is currently a great deal of concern being expressed about the potential for invasion of personal privacy through the storage and manipulation of personal data with sophisticated computer equipment. These concerns may in future prevent the school systems from using data describing students and their families in the construction of indicators of educational disadvantage. One solution to the problem of personal privacy would appear to involve the use of census data because these data are widely available, provide a complete coverage of all Australian school neighbourhoods, and yet are aggregated to a level which is sufficient to prevent disclosure of personal information about individuals.

The General and Specific Aims of the Study

The general aim of this study was to develop, validate, and describe the properties of a national indicator of educational disadvantage which was in harmony with the definition of 'disadvantaged' provided for the conduct of the Disadvantaged Schools Program in Australia.

In order to develop this indicator several decisions were initially made with respect to the quantification of concepts contained in this definition:

1 The definition was constructed in terms of schools and not students. Therefore schools were used as the unit of analysis in the construction of the indicator.

2 The definition emphasized that neighbourhoods were to be used to describe the characteristics of disadvantaged schools rather than the families of students which attended disadvantaged schools. Therefore only information describing the neighbourhoods from which schools obtained their students was used to describe the schools. The description of school neighbourhoods was undertaken by obtaining school average profiles from the census characteristics of the neighbourhoods in which students lived. No information derived from the characteristics of individual students or their families was permitted to enter the indicator.

3 The definition required that only school neighbourhood information which was associated with a low capacity to take advantage of educational facilities should be included in the indicator. Therefore a criterion measure was required to be selected which would enable the selection of appropriate census descriptions of school neighbourhoods. The criterion variable which was selected was the school mean score on a test of Word Knowledge which had been developed by the International Association for the Evaluation of Educational Achievement (Thorndike, 1973). This measure was considered appropriate because it assessed the most central skill

required to take advantage of educational facilities - the ability to understand the meaning of words used as part of the language of instruction in Australian educational institutions.

The incorporation of these decisions into the general aim described above enabled the following more specific statement to be made with respect to the major concern of this study:

> To develop, validate and describe the properties of a national indicator to be used for listing schools according to a measure of their school neighbourhood characteristics (based on census descriptions of school catchment areas) which is optimally correlated with a measure of the capacity to take advantage of educational facilities (based on school mean scores on a test of Word Knowledge).

The planning of the development of this indicator had to take account of the previous discussion of the inadequacies of currently available indicators in Australia. In particular it was considered important that: (1) the indicator should be able to be used nationally in order to identify the most disadvantaged schools in Australia, (2) the indicator should have known properties in terms of its correlates with other measures considered to be symptomatic of educationally disadvantaged schools, (3) the indicator should be checked in terms of the precision with which it can be used to allocate resources to those students who are in most need of assistance, (4) the indicator should be constructed from data in a fashion which ensured the maintenance of personal privacy, and which avoided the lack of public discussion associated with the widely used 'black-box' approach to indicator construction, (5) the indicator should be constructed separately for primary/secondary schools in order to take into consideration the possibility that the performance of an indicator may be influenced by the nature of the population to which it is applied.

The Units of Sampling and Analysis

The data employed in this study were partially drawn from a national study conducted during 1975 of the educational achievements of Australian 10-year-old and 14-year-old students in the areas of reading, writing, and numeration (Keeves and Bourke, 1976). The author was responsible for the design of the student questionnaire, data preparation and analysis, and the sample design evaluation for this study. The information obtained from this national study was used to develop criterion and validation measures with which to guide the construction of indicators of educational disadvantage.

Data were also obtained from the 1971 Australian Census of Population and Housing (CBCS, 1971). These data permitted the development of detailed descriptions of the neighbourhoods surrounding Australian schools and were therefore used as the basic components in the construction of the indicators.

The two bodies of data were combined together by linking each student's data to the data associated with the census Collector's District in which the student lived. These combined data were divided according to age level and then aggregated over schools to obtain data files which would be appropriate for the between-school level of analysis. Detailed descriptions of the sample of schools and students, and the procedures involved in the preparation of the data files prior to the construction of the indicators have been presented in Chapters 5 and 6.

The appropriate unit of analysis for the development of the indicator was the school, because this unit had been employed within the definition of 'disadvantaged'. Therefore, discussion and interpretation of the results of these analyses has also remained at the between-school level.

In order to avoid problems associated with the 'ecological fallacy' (Robinson, 1950) it was not possible to infer that relationships between variables established at the between-school level would also apply at the between-student level. However, the impact of the development of the indicators at the between-school level on the precision with which they could be used to allocate resources to individual students was examined in detail.

The Three Phases of Indicator Preparation

There were three main phases associated with the preparation of the indicators of educational disadvantage: the development of the indicators, the investigation of indicator characteristics, and the investigation of the 'meaning' of the indicators. These three phases have been summarized in the following paragraphs.

The Development of the Indicators

In order to guide decisions concerning the development of the indicators, a list of items describing important properties of the indicators was prepared: unit of analysis, nature of the criterion variables, statistical constraints, stability, parsimony, and face validity. Following an examination of these properties a three-stage strategy was designed which aimed to optimize satisfaction among the often competing requirements of the list of important properties of indicators. The three-stage strategy involved the preparation of 22 groups of census percentage variables which described various aspects of the school neighbourhood environment, the use of stepwise regression analysis within each of these groups to form 22 linear composites of census percentage variables which were optimally correlated with the criterion variable, the use of stepwise regression and principal components analysis to combine the linear composites into the indicators, and the validation of the final set of indicators. The results of these analyses have been reported in Chapter 7.

The Investigation of Indicator Characteristics

Following the development of the indicators, they were employed in a range of analyses which were designed to provide a detailed investigation of their properties. These analyses examined the nature of the dimensions assessed by the indicators, the predictive power of the indi ith respect to school mean achievement scores and school behaviour imate, the precision with which the indicators could be used for resource allocation, the properties of school mean achievement scores following residualization by the indicators, and the theoretical and 'cross-age' stability of the indicators. From the results of these analyses a 'preferred' indicator was selected for each age level. The results of these analyses have been reported in Chapter 8.

The Investigation of the 'Meaning' of the Indicators

The development of the indicators was primarily guided by the aim to optimize the predictive power of the indicator scores with respect to school mean achievement scores on the tests of Word Knowledge. The 'preferred' indicator was therefore based on a wide range of school neighbourhood characteristics. This wide spectrum made it difficult, if not impossible, to readily deduce a descriptive name for this indicator by inspection of its census percentage variable correlates. In order to clarify the nature of the social dimension assessed by the preferred indicator, the 'meaning' of the indicator was investigated with respect to the Shevky-Bell model of residential differentiation. This model enabled a description of the indicator to be made in a more parsimonious and more readily interpretable form based on three dimensions of school neighbourhood residential differentiation. The results of these analyses have been described in detail in Chapters 9 and 10.

CHAPTER 5

THE DESIGN OF THE SAMPLES

Introduction

The target populations in this study were designed for a national study of the educational achievements of Australian students in the areas of reading, writing and numeration. Prior to the execution of this study there had been no other investigations at the national level which had attempted to examine the educational performance of students in both primary and secondary schools. Previous studies (Radford (1950), Keeves (1968), Rosier (1973)), had undertaken large-scale evaluations of Australian education - however, these studies did not attempt to cover both levels of schooling, nor did they consider a coverage of all Australian States and Territories.

An initial decision was concerned with whether to focus the target population definitions on age or grade samples. Sampling by grade was known to be considerably less complex than sampling by age since grade statistics for Australian schools were more readily available, and also the conduct of studies based on intact classes would subject the participating schools to less disruption during the data gathering operations. However, because of the different school entry and grade promotion policies in different parts of Australia and in different school systems, it was therefore considered that grade-based information would not be meaningful when attempting to obtain an overall picture of the performance of Australian students.

It was further considered important that the use of sampling by age should represent, as accurately as possible, the total age cohort involved in normal schooling. At the primary school level this was not a major problem because the whole of primary schooling in Australia falls within the years of compulsory schooling. However, at the secondary school level, the age cohort was selected to be as close as possible to the end of the period of compulsory schooling.

The selection of the age cohort at the primary school level was governed by the researchers' aim to focus on an age group in primary schooling which could be expected to have at least mastered the fundamental skills which were to be assessed. The selection of this age cohort also had to take ~~into consideration that the~~ testing environment for the study would be centred around group testing sessions rather than individualized testing. The type of testing environment which was to be used therefore precluded the use of age cohorts in the early years of primary schooling.

The age levels selected for study were:

> Age 10:00 to 10:11 years, during the middle primary school period where the basic skills of literacy and numeracy, which influence to a major extent all further learning, should have been acquired; and
>
> Age 14:00 to 14:11 years, during the middle secondary school period at a level immediately prior to the end of the period of compulsory schooling, where all students were still at school. (Keeves and Bourke, 1976:13)

The above two descriptions represented the desired target population definitions for the study. Some further refinement of these descriptions was undertaken to obtain the defined target population definitions. These defined target population definitions were then later used to assemble the sampling frames for the study.

The excluded populations for the study were those students who were attending special schools which operated independently of the normal schooling system in each State and Territory. These schools were generally designed to cater for the deaf, blind and educationally sub-normal. A detailed description of the excluded population has been presented by Keeves (1977). At the 10-year-old level the excluded population represented 1.1 per cent of the desired target population and at the 14-year-old level the excluded population represented 1.0 per cent of the desired target population.

It was important to remember that the defined target populations were concerned with those students attending normal schools. Therefore, those students who attended special classes which were held within normal schools were also included in the defined target population.

The Sampling Frame

After having decided upon specific definitions of the defined target populations, the next stage in the sample design procedure was to construct sampling frames for each of the populations. The first step was to compile a list of primary and secondary schools for each school system together with the numbers of 10-year-old and 14-year-old students in each school on 1 August 1974.

These lists were then stratified within each State and Territory according to the following nine classifications:

1 Government metropolitan schools
2 Government non-metropolitan composite primary/secondary schools
3 Government non-metropolitan schools
4 Catholic Systemic metropolitan schools
5 Catholic Systemic non-metropolitan schools
6 Independent Catholic metropolitan schools
7 Independent Non-Catholic metropolitan schools
8 Independent Catholic non-metropolitan schools
9 Independent Non-Catholic non-metropolitan schools

Within each stratum of the two sampling frames the schools were listed in postcode order. The use of this extra element of implicit stratification ensured that when a systematic sampling technique was used across each stratum, schools which were geographically adjacent would not be drawn. The resulting samples would therefore represent a balanced geographic coverage of each stratum - without disturbing the basic probabilities of school and student selection.

The reference date for the sampling frame was set at 1 August 1974 since this was the date of the most recent school census. The reference date for identifying students within schools for testing purposes was defined to be 1 October 1975, since testing was planned to take place during the week of 6-10 October 1975. This discrepancy in dates meant that the estimates of the numbers of students in each school falling within the target population definitions were approximately a year out of date.

In a study of this magnitude it would never be possible to obtain exact figures for each school in the country for the precise time of testing. The decision was therefore taken to employ 'measure of size' figures (Kish, 1965:222) as exact sizes. This assumption was made quite confidently because it was known that large variations in cohort enrolment figures were unlikely to occur in the space of one year. Further, if proportionately large (or small) enrolments occurred across all schools then this would in no way alter the basic probabilities of selection for schools and students.

The Sample Design

The sample design for this study followed the procedures employed in Australia during 1970 for the IEA Science Project (Rosier and Williams, 1973). This sample design employed a two-stage stratified design, selecting schools at the first stage and then students from the selected schools.

The schools were sampled with a probability proportional to the number of students in each school within the target population. The selection of schools was undertaken separately within each State and Territory. A sample of 25 students from each selected school was then randomly drawn from the students within the target population description.

The decision to sample clusters of 25 students from schools was undertaken to maximize the validity of the data. It was reasoned that a group of this size could be tested in one testing session in a single classroom. This would minimize the possibility of the contamination of results when, for example, larger numbers of students tested in schools may have required testing sessions at different times or days. A further consideration, which was also aimed at maximizing the validity of the results, was that the schools would be more co-operative in terms of the standardized conditions required for testing if the testing program was not overly disruptive of the daily school program.

The level of sampling precision followed the constraints employed in the IEA Science Project: that the standard error of a mean for each State should be approximately six per cent of a student standard deviation.

If we were to select a simple random sample of n^* students from a State then the standard error of the sample mean could be written as (Ross, 1978:113):

$$SE(\bar{x}) = \sqrt{\left[\frac{N-n^*}{N} \cdot \frac{S^2}{n^*}\right]}$$

where $SE(\bar{x})$ is the standard error of the sample mean,
N is the population size,
n^* is the size of the simple random sample,
and S is the standard deviation of student scores.

When N is large compared to n^* (as it is in this study for the State samples), we may write:

$$SE(\bar{x}) = \frac{S}{\sqrt{n^*}}$$

since the term $\frac{N - n^*}{N}$ tends to unity.

If we require the value of $SE(\bar{x})$ to be approximately six per cent of the standard deviation of student scores, then we have:

$$\frac{6S}{100} = \frac{S}{\sqrt{n^*}}$$

$$\text{or,} \quad n^* = \left(\frac{100}{6}\right)^2$$

$$= 277.8$$

That is, in order to satisfy the error requirement a simple random sample of at least 278 students was required.

Unfortunately, the use of a simple random sample of this size may have required testing in as many as 278 schools in each State. This would have been beyond the resources of the study.

Further, since some between-schools analyses were planned for the study, such a sample design would not have provided sufficiently stable estimates of school mean scores.

The decision to sample clusters of 25 students per selected school which was described above required an appropriate decision concerning the number of schools which must be selected at the first stage in order to obtain an equivalent degree of precision as for a simple random sample of 278 students. Recent research (Ross, 1976) has shown that an equivalent degree of precision cannot simply be obtained by sampling $\frac{278}{25} \doteq 11$ schools followed by the selection of 25 students per school.

Instead, we must appeal to the 'planning equation' described by Ross (1978:159) which presents a functional relationship between the number of schools required in a two-stage sample design and the size of the simple random sample which has equivalent precision:

$$m = \frac{n^*}{\bar{n}} \left[1 + (\bar{n} - 1)\,roh\right]$$

where m = the number of schools in the two-stage sample,

$\bar{n}$ = the number of students to be selected from each of the schools (25 in this study),

and roh = the sample estimate of the population coefficient of intraclass correlation. (See Appendix F.)

In previous studies (Husén, 1967; Peaker, 1975) it was shown that an estimate of roh = 0.1 was a suitable figure for Australian secondary schools. No similar evidence was available for an estimate of roh to be made for Australian primary schools and consequently the same value for this population was assumed.

By substituting n = 25, n* = 278 and roh = 0.1 into the above equation we obtain:

$$m = \frac{278}{25}\left[1 + (25 - 1)\ 0.1\right]$$

$$= \frac{278 \times 3.4}{25}$$

$$= 37.8$$

That is, we would require at least 38 schools at the first stage of sampling in order to satisfy the error constraint that the standard error of the mean should be no more than six per cent of the standard deviation of student scores.

For the purposes of this study it was decided that a sample of 40 schools per State would provide a suitable degree of precision.

In the Australian Capital Territory and the Northern Territory a similar sampling procedure was followed except that only 20 schools were selected at the first stage of sampling. The errors for the estimates of means were expected to be slightly higher than for the States (approximately ten per cent (Keeves and Bourke, 1976:17)). However, in the overall Australian estimates these increases would be expected to have only a small effect due to the weighting adjustments which were used to correct for the disproportionate sampling from the States and Territories.

For the Australia overall estimates the samples were designed to obtain a maximum of 7000 students at each age level. With samples of this size it was expected that the errors of estimates for means would be between three per cent and six per cent of the standard deviation of student scores (Keeves and Bourke, 1976:17).

The Sampling of Students within Schools

The sample design required the selection at random of 25 students from each selected school. In order to achieve this, each selected school was asked to submit a list of all students falling within the defined target population. These lists were checked to ensure that they contained no students whose date of birth placed them outside the defined target population.

When the school lists had been checked, 30 students - 25 students for the sample and five reserves - were selected using the following procedures:

1 Choose all students with birth dates on the 10th day of any valid month (within the defined age bands for the 10-year-old and 14-year-old population).

2 Choose all students born on the 11th, 12th etc. days of any month until the 25 students required have been selected.

3 If there are more than the required number of students with birthdays on the 11th, 12th etc. day of the month than are needed to yield a group of 25 students, choose the students required to complete the sample of size 25 at random from those students with birthdays on the terminal day.

4 Five additional students were chosen by continuing to apply the above method. Those students were the reserves. The reserve students were used to replace students who had been selected for the study but were missing on the day of testing for reasons such as: transfer to other schools between the selection and testing dates, illness on the day of testing, etc.

The Designed and Achieved Samples

From the previous discussion it was demonstrated that, in order to obtain the required levels of sampling precision, it would be necessary to select samples of 40 schools followed by the selection of 25 students per school in each State, and to select 20 schools followed by the selection of 25 students per school in each Territory.

If it was possible to have full participation of all selected schools and to obtain complete data for all selected students then we would refer to these samples as the 'designed samples'. In practice, for studies of this magnitude, there has often been some loss of data due to reasons such as: the refusal of some selected schools to participate, and the absence of some selected students on the day of testing. The resulting body of data which eventually was available for analysis was referred to as the 'achieved samples'.

In Table 5.1 the information summarizing the execution of the sample design for each State or Territory, and for each age group has been presented.

Table 5.1 Summary of Sample Designs for Australian 10-Year-Old and 14-Year-Old Samples

State/Territory	Population Schools	Population Students	Designed Sample Schools	Designed Sample Students	Achieved Sample Schools	Achieved Sample Students	Ratio = Achieved/Designed Schools	Ratio = Achieved/Designed Students
10-Year-Old Sample								
New South Wales	2115	85656	40	1000	40	967	100	97
Victoria	2152	68187	40	1000	40	938	100	94
Queensland	1496	38729	40	1000	39	942	98	94
South Australia	688	23558	40	1000	40	958	100	96
Western Australia	637	21518	40	1000	40	937	100	94
Tasmania	336	8136	40	1000	39	898	98	90
Australian Capital Territory	66	3695	20	500	18	407	90	81
Northern Territory	34	1985	20	500	16	369	80	74
Total	7524	251464	280	7000	272	6416	97	92
14-Year-Old Sample								
New South Wales	594	84894	40	1000	38	918	95	92
Victoria	580	66550	40	1000	39	915	98	92
Queensland	286	38106	40	1000	37	884	93	88
South Australia	182	24152	40	1000	37	916	93	92
Western Australia	184	20842	40	1000	39	917	98	92
Tasmania	91	8290	40	1000	39	921	98	92
Australian Capital Territory	22	3309	20	500	17	387	85	77
Northern Territory	11	1275	20	500	10	187	50	37
Total	1950	247418	280	7000	256	6045	91	86

The response rates for each of the States were highly satisfactory, generally being in excess of 90 per cent. However, for each of the Territories, the response rates were below this desired value. In particular, there were considerable data losses in the Northern Territory - especially at the 14-year-old level. This low response rate in the Northern Territory was considered to be associated with problems of remoteness and postal difficulties, and because of the disruption that had occurred to the educational system of the Northern Territory due to the cyclone in late 1974.

Weighting the Sample Design

The sample designs in this study employed disproportionate sample allocation among the explicit strata. This technique was employed in order to permit the calculation of State/Territory estimates with approximately equal sampling error. In order to compensate for this disproportionate allocation it was necessary to calculate weighting factors, both at the between-students and between-schools level of analysis, before estimates of Australia-overall parameters could be made.

The weighting factors had to take into account the possibility of data loss due to non-response from both students and schools. This required that certain assumptions be made about the nature of the non-response. These assumptions, which have been described in detail in Appendix G, may be summarized as:

1 The sampling frames prepared for the study were accurate representations of the defined target population.

2 The achieved numbers of schools and students within schools for each stratum were planned constants. That is, any data loss from schools or students could be considered to be 'missing at random'.

Since the sampling frames had been prepared from official school census information, and since (with the exception of the Northern Territory) the response rates had been extremely high for a study of this kind, it was considered that these two key assumptions would form an acceptable basis for the use of weighting factors to adjust for non-response. The low response rate in the Northern Territory did not present a challenge to these assumptions because it was known that the Northern Territory results would have little influence on Australia overall estimates after adjustment for the disproportionate allocation of the sample between strata had been made.

In Appendix G a theoretical discussion has been presented which describes the preparation of the weighting factors.

At the between-students level of analysis the weighting factor (wf) for student i in school j of stratum k was:

$$wf\ (students) = \frac{B \times n'}{a' \times c' \times N}$$

where B = total number of students in stratum k,

n' = achieved total sample size (students),

a' = achieved total number of schools selected from stratum k,

c' = achieved total number of students selected from school j,

and N = total number of students in the population.

At the between-school level of analysis the weighting factor for school j in stratum k was:

$$wf\ (schools) = \frac{[illegible] \times \sum_k a'}{[illegible] \times a'}$$

where $\sum_k a'$ = achieved number of schools in the total sample.

The use of these weighting factors for the between-student and between-school analyses had the following effects:

1 The weighted number of students per school within each stratum was a constant. For example, in Victoria at the 10-year-old level the weighted number of students per school was 43.5 for all schools in Victoria. The figures for other States/Territories at both age levels have been listed in the second column of Table 5.2.

The equality of the weighted number of students per school within strata occurred because, where data loss occurred for a particular student within a particular school, the loss of data for that student was compensated for by increasing the weight for the other students in that school. It is important to note that this effect was produced by having unequal weighting factors for schools within each stratum. For example, in Victoria at the 10-year-old level the response rates for schools of 25, 24, 23, and 22 were associated with weighting factors of 1.74, 1.81, 1.89, and 1.98 respectively. The figures for other States or Territories at both age levels have been listed in Table G.2 of Appendix G.

Table 5.1 The Weighted Numbers of Students and Schools, and the Numbers of Students and Schools Which Would Have Occurred for Proportionate Sampling

	Weighted Samples			Proportionate Distribution of Samples		
	Student Level		School Level	Student Level		School Level
	Students	Students per School		Students	Students per School	
10-Year-Old Sample						
New South Wales	2189.3	54.6	92.8	2185.5	54.6	92.7
Victoria	1739.7	43.5	73.6	1739.8	43.5	73.8
Queensland	985.9	25.3	41.7	988.2	25.3	41.9
South Australia	600.1	15.0	25.6	601.2	15.0	25.5
Western Australia	549.5	13.7	23.2	549.0	13.7	23.3
Tasmania	205.5	5.3	9.0	207.6	5.3	8.8
Australian Capital Territory	94.8	5.2	4.0	94.3	5.2	4.0
Northern Territory	51.5	3.2	2.1	50.6	3.2	2.1
Total	6416.3	-	271.9	6416.0	-	272.0
14-Year-Old Sample						
New South Wales	2017.2	54.6	87.8	2074.2	54.6	87.8
Victoria	1627.5	41.7	69.0	1626.0	41.7	68.9
Queensland	932.6	25.2	39.6	931.0	25.2	39.4
South Australia	590.8	15.9	25.2	590.1	15.9	25.0
Western Australia	507.4	13.1	21.5	509.2	13.1	21.6
Tasmania	204.9	5.2	8.6	202.5	5.2	8.6
Australian Capital Territory	81.5	4.8	3.4	80.8	4.8	3.4
Northern Territory	31.0	3.1	1.3	31.2	3.1	1.3
Total	6046.8	-	256.3	6045.0	-	256.0

Note: A detailed description of the calculation of weighting factors has been presented in Appendix G.

2 The weighted number of students for each stratum was equal (except for rounding error) to the number of students which would have been selected from each stratum if a true proportionate sample design had been used. For example, a proportionate allocation of the total achieved sample of 6416 10-year-old students would have resulted in the selection of 1740 (actually 1739.8) students from Victoria. The weighted number of students in Victoria at this age level was 1739.7 which was equal (except for rounding error) to the proportionate allocation sample size. The weighted numbers of students for each State/Territory and the proportionate allocation numbers have been presented in columns one and four of Table 5.2.

In columns two and five of Table 5.2 the weighted numbers of students per school and the numbers per school which would have been selected by using proportionate sampling have been presented. At both age levels these sets of figures were equal for each State/Territory.

3 The weighted number of schools for each stratum was equal (except for rounding error) to the number of schools which would have been selected from each stratum if a true proportionate sample design had been used. For example, a proportionate allocation of the total achieved sample of 272 primary schools would have resulted in the selection of 74 (actually 73.8) schools from Victoria. The weighted number of schools in Victoria at this age level was 73.6 which was equal (except for rounding error) to the proportionate allocation sample size. The weighted numbers of schools for each State/Territory and the proportionate allocation numbers have been listed in columns three and six of Table 5.2. The weighting factors for the between-school analyses have been listed in Table G.3 of Appendix G.

The Estimation of Sampling Error

The sample designs used in this study were not based on the well-known model of 'simple random sampling'. Instead they incorporated the complexities of stratification, the selection of students in clusters, and also the use of unequal probabilities of selection which required the use of weighting in order to minimize bias in the sample estimates. When these complexities have been introduced into a sample design it is not possible to use established formulae. The computational formulae required for estimating the standard errors of complex statistics (such as correlation coefficients) from complex sample designs are either enormously complicated or, ultimately, they prove resistant to mathematical analysis (Frankel, 1971).

In this study the technique of 'Jackknifing' (Quenouille, 1956; Tukey, 1958) was used to calculate sampling errors. A review of this technique has been presented in Appendix G. The calculations required to apply the Jackknife have been described in Appendix G and Tables G4 to G13.

From the Jackknife calculations two statistics were obtained for means and correlations: the average of the square root of the 'design effect' and the 'effective sample size' (Kish, 1965:162). These statistics have been presented for the between-student and between-school levels of analysis in Table 5.3. These statistics were not calculated for correlation coefficients at the between-student level of analysis because no correlational analyses were carried out by using students as the units of analysis.

A detailed description of the 'design effect' and the 'effective sample size' has been given in Appendix G.

The values of the average of the square root of the design effect, average $\sqrt{Deff}$, may be used to estimate sampling errors in the following fashion (Ross, 1979b:139):

$$se(v_c) = \text{average } \sqrt{Deff} \, . \, se(v_{srs})$$

Where v = the statistic being examined,

$se(v_c)$ = the standard error of the statistic for the complex sample design,

and $se(v_{srs})$ = the standard error of the statistic under the assumption of simple random sampling.

The values of the effective sample size described the size of a simple random sample which would give the same sampling error for the statistic as for the complex design (Ross, 1978:138).

Summary

In this chapter the sample designs which were used to gather data from Australian students and schools have been described. At the 10-year-old level the sample consisted of 6416 students in 272 schools, and at the 14-year-old level the sample consisted of 6045 students in 256 schools.

Table 5.3 Values of Average $\sqrt{Deff}$ and the Effective Sample Size for Means and Correlations

Statistic	Level of Analysis			
	Between-Student		Between-School	
	10	14	10	14
Average $\sqrt{Deff}$				
Means	2.04	2.15	1.04	1.19
Correlations	a	a	0.76	0.89
Effective Sample Size Values				
Means	1542	1308	251	181
Correlations	a	a	471	323
Total Sample Size	6416	6045	272	256

Note: a Values of average $\sqrt{Deff}$ and the effective sample size were not calculated for the between-student level of analyses because no correlational analyses were conducted by using students as the unit of analysis.

A weighting scheme was devised in order to simultaneously adjust for (1) disproportionate sampling among the explicit strata of the sampling frame and (2) loss of student data within schools selected into the sample. This weighting scheme ensured that the weighted number of students per school was constant within each stratum, and that the weighted number of students and schools across strata was equivalent to a proportionate allocation of the sample.

The Jackknife technique was used to calculate the sampling errors of means and correlation coefficients for the between-school level of analysis, and for means at the between-student level of analysis. At the between-school level, the 'design effects' for means were close to unity whereas for correlations they were slightly less than unity. At the between-student level the design effects for means were substantially greater than unity.

CHAPTER 6

THE STAGES OF DATA PREPARATION

Introduction

The data employed in this study were derived from two sources: data gathered for the Australian Council for Educational Research (ACER) study concerning the literacy and numeracy skills of Australian 10-year-olds and 14-year-olds (Keeves and Bourke, 1976), and data gathered for the 1971 Australian Census of Population and Housing (CBCS, 1971). The ACER study, known as the Australian Studies in School Performance (ASSP) project, carried out its data collection during October 1975. Data were collected for a national sample of 10-year-olds in 272 schools, and a national sample of 14-year-olds in 256 schools. As part of the testing program for this study, each student was required to provide a full home address. With the assistance of maps, street and telephone directories and the official Australian census maps, these addresses were transformed into Census Collector's District numbers. The Collector's District numbers were then used to link the computer stored ASSP data with the 1971 Australian census data.

In the following discussion the preparation of the computer-stored data files which were appropriate for the between-student level of analysis has been described in detail. These data files were subsequently aggregated to obtain data files appropriate for the between-school level of analysis.

The Australian Studies in School Performance (ASSP) Project Data

The data gathered for the ASSP project focussed on Australian 10-year-old and 14-year-old students. The students provided information by means of specially designed mastery tests in reading, writing and numeration. They also completed a test of word knowledge and a questionnaire which was concerned with detailed information about the students and their home backgrounds. Further information was gathered from teachers describing the incidence of any physical, physiological and behavioural handicaps which the students may have exhibited.

The Reading, Writing and Numeration Tests

The procedures involved in the development of the ASSP tests of reading, writing and numeration have been described in detail by Keeves and Bourke (1976). In brief, the development of these tests consisted of four separate stages. First, the objectives of testing in each area were specified. Secondly, a list of tasks and subtasks regarded as essential learning in each area was prepared. Thirdly, items were constructed which were consistent with the stated objectives and which assessed performance on the defined subtasks. Finally, items were selected according to their validity in assessing student performance on the subtasks, and according to an appropriate difficulty level for the two age groups.

All students in the study were required to complete the tests of reading and numeration. However, the Writing Test was designed as three different forms in order to completely cover the specified objectives and was used as a rotated forms test. Three forms were randomly rotated among the members of the samples and consequently only a third of the sample at each age level completed the same form of the test. The resultant reduction in the sample size which occurred for each form of the Writing Test led to a greatly reduced level of sampling accuracy (Ross, 1976) and therefore performance levels on these writing tests were not included in this study.

The Reading Tests at each age level covered four areas of ability: to apply word attack skills, to use conventions employed in written language as an aid to understanding, to comprehend what is read, and using a variety of approaches to obtain information (ACER, 1976a). The test for 10-year-olds (referred to as test 10R) consisted of 29 items and the test for 14-year-olds (referred to as test 14R) consisted of 33 items. The time limit allowed for completion of the tests was 30 minutes at both age levels.

The Numeration Tests at each age level were initially included to cover four main areas of ability: to recall definitions and notations, to manipulate and calculate rapidly and accurately, to interpret symbolic data, and to apply mathematical concepts. These four areas were later collapsed into two broad areas of ability: recall/manipulation, and interpretation/application (ACER, 1976b). The tests for 10-year-olds (referred to as test 10N) and 14-year-olds (referred to as test 14N) each consisted of 33 items. The time limit allowed for the completion of the tests was 30 minutes at both age levels.

The Word Knowledge Test

The Word Knowledge Test for each level consisted of 40 word-pairs. The students were required to choose whether the words in each pair had similar or opposite meanings. Both of these tests were developed by R.L. Thorndike for studies carried out by the International Association for Educational Achievement. Thorndike (1973) has indicated that these tests were designed as brief tests of verbal ability rather than as instruments for the measurement of reading comprehension.

The Student Questionnaire

This questionnaire was designed to obtain general information about the student and also some information about the student's home environment. The questions concerned with general information included questions about the student's home address, age, sex, the number of schools attended and the number of years the student had lived in Australia. The questions concerned with the student's home environment included questions about the ethnic background of members of the student's family, languages spoken in the home, family size, and whether newspapers were read in the home.

The Teacher Questionnaire

A teacher who knew each student well was asked to complete a questionnaire which described the incidence of any physical, physiological and behavioural handicaps which the student may have exhibited.

The questions associated with physical and physiological handicaps included questions covering visual impairment, hearing impairment, speech impairment, dexterity, lethargy, hyperactivity and health condition (for example, diabetic, epileptic, asthmatic). The questions associated with behavioural handicaps included questions covering attention seeking, inability to co-operate with peers, self-isolation, timidity, and marked rejection by other students.

The Merging of the Data Files

During the testing program carried out for the ASSP project, the sample members were required to provide their complete home addresses. With the assistance of maps, street and telephone directories and the official Australian census maps, these addresses were coded into Collector's District (CD) numbers.

A set of punched cards was then prepared. These cards contained each student's identification number from the ASSP study and the appropriate CD number associated with the student's home address. A computer-stored data file was constructed from these cards and then this file was merged with the ASSP data file.

This file was then sorted on the CD numbers in preparation for merging with the census data. This sorting process was carried out on the combined 10-year-old and 14-year-old ASSP data files.

The combination of the originally separate ASSP data files was undertaken in order to minimize the number of merge runs which would be required. That is, a single Australia-overall ASSP data file containing all data from both age groups was employed in the merging operation. This was not possible for the census data file because the magnitude of an Australia-overall census data file would have led to difficulties for individual computer runs with respect to the large amount of data storage space and computer time which would be required. Since the computing work for this study had to fit in with the daily operations of a commercial computing installation, it was necessary to conduct the computer merging separately for each State and Territory.

The Census Data

The census data employed in this study was derived from the 1971 Australian Census of Population and Housing (CBCS, 1971). The data from this census was gathered about four years prior to the ASSP data. In Australia, a census is now normally conducted every five years, and therefore the 1976 Census of Population and Housing (ABS, 1976) would have provided census data which was nearer in time to the ASSP data collection. The decision to employ 1971 census data rather than 1976 census data was based on the following reasons:

1. At the time of the commencement of data preparation for this study, complete 1976 census data for all Australian States and Territories were not available. This constraint, in addition to the uncertainty associated with the date when complete 1976 data would become available, limited the choice of census data to the 1971 Census.

2. Due to unusual economic circumstances in Australia at the time of the 1976 census it was decided by the Australian Government that only 50 per cent of census schedules would be processed from private dwellings in all States and the Australian Capital Territory. This sample was selected at the CD level by randomly selecting either the first or second private dwelling in each CD and then systematically taking every second private dwelling after that. The use of a sample of private dwellings in the 1976 census rather than the usual complete

coverage resulted in the introduction of sampling errors into the census data. While these errors may have been small for estimates derived at the national level, the possibility of large errors for rarely occurring population characteristics at the CD level was greatly increased. Since this study was concerned with the linkage of students' characteristics to the characteristics of their communities it was decided that these sampling errors might lead to the overlooking of important relationships between student characteristics and certain rarely occurring population characteristics.

3 The preparation of census data by the Australian Bureau of Statistics required a great deal of time. The time gap between the data collection and the release of complete and detailed national data for general use may often take from one to two years. Therefore it was unrealistic to expect that the use of census data to make large-scale administrative decisions about education could be undertaken prior to periods of up to two years following the actual collection of the data. Inevitably, because of this time lapse, questions may be raised about the suitability of using 'old' data to make 'current' decisions.

It was considered important in this study to use the census data in a realistic fashion and consequently it was decided to choose census data which provided the largest possible time gap between data collections. Any generalizations which could be made concerning the interrelations between the two sets of data would therefore be strengthened because after four years the census data was in its most 'out-of-date' condition.

The Preparation of the Census Data

The 1971 census data was distributed by the Australian Bureau of Statistics in a form which was not appropriate for immediate use in the file preparation stage of the study. A major re-organization of the original census data was required in the following areas:

1 For this study only census information at the lowest level of aggregation, the Collector's District, was required. However, the census data tapes distributed by the Australian Bureau of Statistics contained a range of different types of data records which represented four different levels of data aggregation: CD (Collector's District) records containing data for individual CD's; LGA Part (Local Government Area Part) records with data totalled over all CD's in each LGA Part; LGA records with data totalled over the LGA Parts comprising the LGA;

and a State total record containing data totalled over all CD's forming the State or Territory. As a first step in preparing the census data files it was necessary to rewrite the census data tapes to ensure that they contained only CD records.

2 The original census data tapes were produced on computers with technical specifications which differed from the computer equipment which was to be used for the study. It was therefore necessary to rewrite the tapes in a suitable technical format.

3 The OSIRIS software package (developed at the Institute for Social Research, University of Michigan) which was to be used in the data management phase of the study led to a further constraint on the rewriting of the census tapes. The version of the OSIRIS software package which was available for the study would only accept data records which were less than or equal to 3,600 characters in length (ISR, 1973:171). After some investigation of the available CD information it was possible to reduce the original CD records from 1,068 count variables to 710 count variables. The reduced list of variables were reformatted so as to require a field width of five characters per count variable. The resulting CD records were thereby reduced to 3,500 characters which satisfied the record length constraints of the software. The final list of census count variables used in this study has been described in Table 6.1.

4 The CD records were originally stored on tape in order of the CD Serial Number. These serial numbers were assigned to CD's beginning at 1 in New South Wales and ending at 21,536 in the Australian Capital Territory (CBCS, 1971:2). However, from the census maps, it was only possible to link each student's address with a CD identification number based on the LGA code, LGA Part code, and CD number within LGA Part code. Therefore a new CD identification number was required to be constructed from these three elements before the merging operation could begin.

The three elements required to construct this merge number were:

(a) <u>LGA code</u>: This was the major tabulation unit code used in the publication of census results. This code corresponded in all but a few cases to legal local government areas and ranged from 1 to 400 <u>within each State</u>.

Table 6.1 Census Count Variables Derived from the 1971 Census of Population and Housing

Census Table Number	Number of Variables	Table Description
0	13	Indicative information
1	2	Total pop x sex
2	3	Total dwell x status
4	1	Total usual residents (persons)
5	1	Total born overseas (persons)
7	70	Sex x Age (total pop)
10	12	Sex x Marital status (total pop)
11	6	Sex x Marital status (labour force)
14	40	Sex x Birth place (overseas born)
17	18	Sex x Period of residence (residents)
18	12	Sex x Usual major activity (total pop)
20	18	Sex x Qualifications (studying)
21	18	Sex x Qualifications (obtained)
22	44	Sex x Religion (total pop)
24	28	Sex x Highest level school (total pop)
25	16	Sex x 1966 Residence (usual residents)
26	14	Sex x Occupational status (total pop)
27	26	Sex x Industry (employed)
28	146	Sex x Occupation (employed)
30	10	Household class x (population, dwellings)
31	10	Dwelling class x No. dwellings (occupied)
32	3	Dwelling class x Population (occupied)
33	24	Dwelling class x Inmates (occupied)
34	21	Dwelling class x Rooms (occupied)
35	21	Dwelling class x Bedrooms (occupied)
37	24	Dwelling class x Date built (occupied)
38	48	Dwelling class x Kitchen/Bathroom (occupied)
39	18	Dwelling class x Facil/TV (occupied)
40	12	Dwelling class x Sewer (occupied)
41	15	Dwelling class x No. vehicles (occupied)
42	12	Dwelling class x Nature of occupancy
45	4	Size of block x pop., flats (flats)
Total number of variables	710	

Source: CBCS (1971)

(b) LGA Part code: This was a physical partition of an LGA such that each LGA Part contained about 10 CD's. This partition facilitated the LGA Parts being supervised with roughly the same workload per supervisor. This code could take values from 1 to 33 within LGA's.

(c) CD code: This code referred to the basic element of the census data collection. There are 21,536 CD's in Australia. The CD code had values ranging from 1 to 25 within LGA Parts.

On the revised census data files the LGA code was stored in a five character width field, and the LGA Part and CD codes were stored as a composite also in a five character width field. These two fields were combined to form a single ten-digit merge number. It was not necessary to include a State code within the merge number because the merging process was carried out separately for each State. Prior to the merging of data the census data was sorted separately by State and Territory on this ten-digit number.

5 The census data tapes provided variables in the form of 'count' data (for example, the number of 20-year-old males in the particular CD). Although many CD's were designed to contain the same number of dwellings (approximately 300 dwellings), they generally contained variable population numbers. Therefore, in order to adjust for variations in population size, dwelling numbers, etc. between CD's, it was necessary to create percentages from the count variables (for example, the percentage of the total population in the CD who were 20-year-old males).

The Preparation of Census Percentage Variables

The census-derived variables used in this study were percentages which employed direct count variables as denominators. For example, when the percentage variables which described the workforce characteristics of the male and female population were prepared, the denominators employed were the total numbers of males and females who were participating in the workforce.

In the following discussion the calculation of the percentage variables from the data in the census tables listed in Table 6.1 has been described. These percentage variables provided information covering ten main areas: workforce characteristics, industry type, marital status, religion, educational qualifications, nature of dwellings, ethnic composition, age distribution, general facilities, and living arrangements. A detailed listing of each of the 148 percentage variables which were prepared has been given in Tables H.1 to H.22 in Appendix H.

Workforce Characteristics

The workforce characteristics percentage variables were derived from Census Tables 26 and 28 (CBCS, 1971:13). These two tables described the occupational status of the workforce and the type of occupation in which members of the workforce were employed.

1 Workforce Characteristics: Occupational Status. The census table describing the occupational status of the workforce used the categories: employer, self-employed, wage-earner and unemployed. This information was presented separately for males and females. The denominators used to calculate the percentage variables were the total number of males in the workforce and the total number of females in the workforce. In Table H.1 the percentage variables for the members of the workforce in the four occupational status groups have been listed separately for males and females.

2 Workforce Characteristics: Occupational Type. The census table concerned with the occupational type of the workforce in terms of the numbers of employed males and females used 73 occupational categories (CBCS, undated b). These 73 categories were recoded separately for males and females into the 12 broad groupings employed by the Australian Bureau of Statistics (ABS, 1976:34). The 12 percentage variables derived from the occupation groupings have been listed in Table H.2. The occupations were grouped into the headings professional, administrative/executive/managerial, clerical, sales, farming/fishing/hunting, miners, transport/communication, process/manual/labour, trade/building, service/sport/recreation, armed services, and not adequately described. The denominators employed in the calculation of percentages for males/females were the total number of males/females in occupation categories 1-73.

Industry Type

The industry type percentage variables were derived from Census Table 27 (CBCS, 1971:13). This table described the type of industry in which the workforce was employed. The classification of industries was based on a 13 group classification scheme. The 13 percentage variables obtained from the classification of industries have been listed in Table H.3.

This classification scheme allocated members of the workforce to industries which had similar productive activities: agriculture (including forestry and fishing), mining, manufacturing, etc. The denominator used to calculate the percentage variables was the total number of persons in occupation categories 1-73 for Census Table 28.

Marital Status

The marital status percentage variables were derived from Census Table 10 (CBCS, 1971:9). This table described the marital status of males and females who were ever married. The marital status of the population was reported in terms of the number of persons who were married, separated, divorced or widowed. The percentage variables calculated from this census table have been listed in Table H.4. The denominators for males/females were the total number of ever married males/females who were 15 years of age or older.

Religion

The religion percentage variables were derived from Census Table 22 (CBCS, 1971:11). The original ABS classification of religions employed 22 categories. This detailed list was reclassified into six main groups: Atheist, Hebrew, Protestant, Church of England, Catholic, and Other Religion. This reclassification attempted to sort the detailed list of religions in the census data files into groups which were homogeneous with respect to the educational background of the adherents.

The information concerning the educational background of the adherents was based on data prepared by Mol (1971). In Table H.5, which was derived from Mol's data, the main Australian religious groups and the number of graduates per religion for each 1,000 male adherents have been listed. The revised six-group classification is given in the final column of the table.

Following the reclassification of religions into six broad groups, the groups were converted into percentage variables according to the descriptions in Table H.6. The denominator used to obtain these percentage variables was the total population.

Educational Qualifications

The educational qualifications percentage variables were derived from three separate census tables: Census Tables 20, 21 and 24 (CBCS, 1971: 10, 12).

These three tables described the total numbers of persons in the population who had obtained, or who were studying for certain levels of qualifications, and the levels of schooling which had been completed by the population.

(a) Educational Qualifications: Qualifications (Obtained and Studying)

The census tables which examined the qualifications of the population were centred around educational qualifications which would be undertaken after leaving secondary school. There were four categories of qualification: trade or technician study, tertiary non-degree study, and two categories of degree study: bachelors and higher degree study. The denominator used to calculate the percentage variables was the total population who were 15 years of age or older. In Tables H.7 and H.8 the percentage variables for persons who had obtained, or who were studying for, the stated level of qualifications have been listed.

(b) Educational Qualifications: Qualifications (Level of Schooling)

The census table concerned with level of schooling presented the numbers of persons in the population who had completed levels of education which ranged from never having attended school to having completed level 10 of schooling. In this study two classifications were selected for examination: never having attended school, and having completed level 9 of schooling or higher (CBCS, undated a). The denominator used to calculate the percentage variables was the total population who had completed their schooling. These variables have been listed in Table H.9.

Nature of Dwellings

The nature of dwellings percentage variables were based on three separate census tables: Census Tables 31, 34 and 37 (CBCS, 1971:10, 16). These three tables described the nature of the dwellings in which the population lived. Table 31 described the type of dwelling: separate house, semi-detached house, etc. Table 34 provided information about the size of these dwellings in terms of the number of rooms per dwelling, while Table 37 provided information about the age of these dwellings.

(a) Nature of Dwellings: Type of Dwelling. The census categorization of the type of dwellings in which the population lived covered four main dwelling types: houses, flats/units, non-permanent dwellings, and non-private dwellings. The houses subgroup was further broken into four types of house: separate, semi-detached, attached, and terrace houses. The flats/units subgroup was divided into villa units, self-contained flats and non-self-contained flats. Non-permanent dwellings were categorized as either improvised dwellings or caravans. The percentage variables obtained from this census information have been listed in Table H.10. The denominator used to calculate the percentage variables was the number of occupied dwellings.

(b) Nature of Dwellings: Size of Dwelling. The census description of the size of dwellings was presented by describing the number of rooms per dwelling. The categorization of dwellings ranged from dwellings having only one room to dwellings with seven or more rooms. The denominator used to calculate the percentage variables was the total number of occupied dwellings. These variables have been described in Table H.11.

(c) Nature of Dwellings: Age of Dwelling. The census classification of the age of dwellings was linked to the time of the collection of the census data in 1971. The classification ranged from newer dwellings built during 1971 to older dwellings built prior to 1966. This range of five years was designed by the ABS because information has been gathered at five-year intervals for each population and housing census. The detailed information concerning dwellings built prior to 1966 was therefore only available from the data gathered during earlier censuses. The denominator used to calculate the percentage variables was the total number of occupied dwellings. These variables have been described in Table H.12.

Ethnic Composition

The ethnic composition percentage variables were based on Census Tables 14 and 17 (CBCS, 1971:9, 10). These two tables described the country of birth and the period of residence for overseas-born residents.

(a) Ethnic Composition: Country of Birth. The census table describing the country of birth of the overseas-born population consisted of a 19-country and continent classification scheme with an extra classification denoted 'other' which referred to categories other than those listed. The denominator used to calculate the percentage variables was the total population. The percentage variables derived from the country of birth classification have been listed in Table H.13.

(b) Ethnic Composition: Period of Residence. The census table describing the period of residence of the overseas-born population consisted of eight categories describing the number of years of residence. There were five categories which covered from one to five years of residence; the other categories described the ranges 5-9 years, 10-16 years and 17 or more years of residence. Since this table focused on residents who were born overseas, the denominator used to calculate the percentage variables was the total population of overseas-born residents. This denominator excluded those overseas-born persons who were not permanent residents of Australia. The percentage variables describing period of residence have been listed in Table H.14.

Age Distribution

The age distribution percentage variables were obtained from information in Census Table 7 (CBCS, 1971:8). The information presented in the census table describes the age distribution of the population in one-year increments from 0 to 24 years, and then five-year increments from 25 to 69. The final census classification was denoted 70 years of age or older. These 35 categories were recoded into eight categories as described in Table H.15. The denominator used to calculate the percentage variables was the total population.

General Facilities

The general facilities percentage variables were based on Census Tables 38, 39, 40 and 41 (CBCS, 1971:17). These four tables presented information about certain facilities and services which were available in dwellings. Table 38 gave a detailed analysis of the availability of bathroom and kitchen facilities in each dwelling. Tables 39 and 40 described the numbers of dwellings which had access to the services of sewerage, electricity and television. Table 41 was concerned with the numbers of vehicles which were associated with dwellings.

(a) General facilities: Bathroom and kitchen. The information in the census table describing bathroom and kitchen facilities was in the form of a highly detailed classification scheme. For each facility a dwelling was classified as having sole use, shared use, not shared use, and none available. These four classifications were combined for bathroom and kitchen facilities into a 16-point classification scheme. This detailed list was reclassified into six new categories according to the recoding scheme presented in Table H.16. The six new categories, which were labelled 1 to 6, have been described in the Note at the bottom of this figure.

Following the reclassification of access to bathroom and kitchen facilities, the resulting six classifications were converted into percentage variables according to the descriptions presented in Table H.17.

The denominator used to obtain these percentage variables was the total number of occupied private dwellings.

(b) General Facilities: Sewerage, Electricity and Television.

Three percentage variables associated with the services of sewerage, electricity and television were prepared from the census information. The electricity and television facilities were assessed by a simple counting of dwellings which had these services in use at the time of the census. The sewerage facility was defined as dwellings with a flush toilet connected to a public sewer. Dwellings in which other forms of flush toilet were operating (for example, a flush toilet connected to a septic system) were not considered to have access to the sewerage facility. The denominator which was used to calculate the percentage variables was the total number of occupied private dwellings. The percentage variables describing these three facilities have been listed in Table H.18.

(c) General Facilities: Vehicles. The percentage variables associated with the vehicles facility were derived from a census classification scheme which gave the number of vehicles per dwelling from none to three or more vehicles. The percentage variables which have been calculated from this information have been listed in Table H.19. The denominator used in these calculations was the number of private dwellings.

Living Arrangements

The living arrangements percentage variables were based on Census Tables 30, 33 and 42 (CBCS, 1971:15, 17). These three tables presented information describing certain living arrangements of the population. Table 30 provided a classification of households into living arrangements associated with family structure. Table 33 described the living 'density' of persons per dwelling. The nature of dwelling occupancy was summarised in Table 42.

(a) Living Arrangements: Household Class. The census table describing household class provided a detailed classification of the types of households in dwellings. The census definition of a household was a 'person or group of persons living and eating together'. The first major class of household was classified as 'single-family households'. Other types of households were 'separate family units' such as 'primary family units' in which the head of the family is also the head of the household, and 'secondary family units' which consisted of all other family units within the household. In this study, only the major classification of single-family households was used to create the percentage variable.

The denominator used in this calculation was the total population. The percentage variables describing household class have been listed in Table H.20.

(b) Living Arrangements: Density. The census table describing the density of living arrangements classified dwellings in terms of the number of inmates residing in these dwellings. The classification scheme ranged from one inmate per dwelling to six or more inmates per dwelling. The denominator used to calculate the percentage variables was the total number of occupied private dwellings. These percentage variables have been listed in Table H.21.

(c) Living Arrangements: Occupancy. The census table describing dwelling occupancy classified occupied private dwellings into 'owner occupied', which included purchaser occupied, and 'tenant occupied', which was broken into two categories of tenancy: state authority and other. In this study the two subgroups of tenancy were combined to form one classification called tenant-occupied dwellings. The reclassification provided two percentage variables listed in Table H.22. The denominator used to calculate these variables was the total number of occupied private dwellings.

Between-Student and Between-School Data Files

The data file merging procedures and the percentage variable preparation methods described above were carried out at the between-student level of analysis. After these tasks had been completed, the between-student data files were aggregated to obtain files appropriate for the between-school level of analysis.

The weighting factor information derived in Chapter 5 and the filter variables employed to create subsamples for the Jackknife error estimation technique (see Appendix G) were then added to the data files at the appropriate levels of analysis.

In total there were four computer-stored data files prepared for later analyses. At the 10-year-old level the between-student file was based on 6416 students, and the between-school file was based on 272 schools. At the 14-year-old level the between-student file was based on 6045 students, and the between-school file was based on 256 schools.

Summary

This chapter has described the stages associated with the preparation of the computer-stored data files used in this study.

The data were derived from two sources: data gathered for the Australian Studies in School Performance (ASSP) project (Keeves and Bourke, 1976), and data gathered for the Australian Census of Population and Housing (CBCS, 1971). The data from these sources were linked together for each student by matching student home addresses obtained in the ASSP project with the appropriate Collector's District numbers associated with the 1971 Australian census.

The raw census data provided information in the form of 'count' data. These data were transformed into percentage variables in order to adjust for variations in population size, numbers of dwellings, etc. between Collector's Districts. The percentage variables provided information covering ten main areas: workforce characteristics, industry type, marital status, religion, educational qualifications, nature of dwellings, ethnic composition, age distribution, general facilities, and living arrangements.

Four separate computer-stored data files were prepared for later analyses. The two files prepared for the between-student level of analysis described national samples of 6416 10-year-old students and 6045 14-year-old students. The between-student data files were aggregated to obtain between-school data files which described national samples of 272 10-year-old schools and 256 14-year-old schools.

CHAPTER 7

THE DEVELOPMENT OF THE INDICATORS

Introduction

The aim in preparing the indicators was to produce useful tools for the identification of educationally disadvantaged schools and students. While some efforts were made to design the indicators to have an 'appearance of reasonableness', there was no attempt during the development of the indicators to derive constructs which had well researched origins in the education or social science literature. The highest priority was placed on the development of indicators which would maximize the precision with which resources allocated on the basis of these indicators reached the students who were in most need of assistance.

Separate analyses were conducted to prepare the indicators at each age level because it was expected that variations in the arrangement of school catchment areas between age levels would be reflected in the interrelationships between the pieces of census information which described the communities surrounding sample schools.

Important Properties of the Indicators

In order to guide decisions about the development of the indicators, a list of six items describing important properties of the indicators was prepared: unit of analysis, nature of the criterion variable, statistical constraints, stability, parsimony and face validity. Following an examination of these items, a three-stage strategy was developed for the construction of the indicators.

1 Unit of Analysis. In Australia the units which have been employed by the National and State Governments to identify and assist educationally disadvantaged students have been schools. The identification of particular schools, rather than particular students, for participation in the Disadvantaged Schools Program was adopted as a funding strategy for three main reasons. First, the identification of disadvantaged schools prevented the possibility of 'streaming' which may have occurred if only certain students within schools received supplementary assistance. Second, it was decided that the best way to combat the non-supportive home environment of educationally disadvantaged students was to change the total school

environment. In order to achieve this change it was considered essential that all students within disadvantaged schools should participate with parents, teachers, and school administration in the design and implementation of appropriate school programs. Third, there was a belief that the 'concentration' in schools of students who came from non-supportive home environments resulted in handicaps which were 'additional' to those associated with the backgrounds of individual students (Blackburn, 1979b:3).

Since the school has been used both as the unit of identification and funding of educational disadvantage in Australia, the unit of analysis for the development of the indicators in this study was also taken to be the school. That is, the multivariate analyses required to construct the indicators from census information were based on school mean scores which were prepared by aggregating student information over schools.

2. Nature of the Criterion Variable. In this study various pieces of census information were combined in order to form single constructs which were highly correlated with educational achievement. The combination of a number of measures, each of which may be an imperfect measure of the construct, into a more reliable combination is generally known as 'scaling' (Lansing and Morgan, 1971:279).

In order to conduct the scaling procedure in an objective fashion it was necessary to select a criterion variable which had suitable characteristics with respect to reliability and validity. At both age levels data were available for a test of verbal ability, called the Word Knowledge Test, which had been designed for large scale surveys conducted by the International Association for the Evaluation of Educational Achievement (Thorndike, 1973).

The development of basic verbal ability has long been considered to be a prerequisite for successful learning in the classroom:

> It has always been clear that ability to read with understanding depends upon knowledge of the meanings of the words in which a message is expressed. (Thorndike, 1973:61)

An important recurring feature of measures of verbal ability has been their strong intercorrelation with other measures of school achievement. This property has often led researchers to employ verbal ability measures as useful surrogates for the assessment of other types of learning:

> ... verbal ability is basic to most forms of achievement in school and in a symbol-oriented society like ours. It is paramount among the so called basic skills; and it correlates so highly with measures of achievement in reading, mathematics, and factual information that it serves as a useful surrogate for the measurement of these other forms of learning.
> (Dyer, 1972:516)

The Word Knowledge Tests used in this study were found to have reasonably high correlation with school achievement in the subject areas examined by the International Association for the Evaluation of Educational Achievement (IEA). For example, in the English-speaking countries which participated in the IEA studies of Reading Comprehension and Science, the mean correlations between the Word Knowledge Test and Reading were 0.73 and 0.70 at the 10-year-old and 14-year-old levels respectively (Thorndike, 1973:62). In addition the mean correlations between the Word Knowledge Test and Science were 0.76 and 0.60 at the 10-year-old and 14-year-old levels respectively (Comber and Keeves, 1973:249, 259).

The mean reliability coefficients across the English speaking countries were 0.85 and 0.80 for the 10-year-old and 14-year-old levels respectively (Thorndike, 1973:58).

The relationship of the Word Knowledge Tests to a range of school achievement scores and also the satisfactory reliability coefficients for each age level which were established by the IEA studies provided support for the use of these tests as criterion variables for the scaling procedures required in the building of the indicators from census information.

3 Statistical Constraints. The units of analysis for the construction of the indicators were schools. Data were available for 272 schools at the 10-year-old level and 256 schools at the 14-year-old level. Therefore, in terms of the between-school analyses, any correlational analytic techniques which were employed had to acknowledge that there were limitations on the numbers of variables which could be used in order to avoid problems of instability which often occur when large numbers of variables are employed compared with the number of observations.

There are no commonly accepted precise rules which describe the ratio of the numbers of observations to numbers of variables for multivariate analyses. However, several authors have suggested rules for particular analytic techniques which have been intended to provide approximations to a lower bound for the ratio. Cattell (1952) recommended at least four cases for each variable when using factor analytic methods; Kerlinger and

Pedhazur (1973) suggested that between 100 and 200 cases were required for regression analyses which did not involve large numbers of variables. Tatsuoka (1970) stated that the sample size should preferably be at least three times the number of variables used in discriminant function analyses.

Thorndike (1978) has presented a method for estimating the 'lower limit' for the ratio of numbers of observations to numbers of variables for a range of correlational procedures in social science research. This rule generally leads to more stringent requirements for the numbers of observations by comparison with the suggestions provided by the authors listed above. Thorndike's rule, which was accepted as a guiding principle for this study, described the ratio in terms of an inequality statement:

$$N \geq 10(P+C) + 50$$

where N = the number of observations,

P = the number of predictor variables,

and C = the number of criterion variables.

Applying the inequality statement to the numbers of observations available for the between-school analyses gave upper limits of around 21 to 22 for the combined number of predictor and criterion variables.

4 Stability. The indicators in this study were built from census data. Since the Australian Census of Population and Housing has been conducted only once every five years, the preparation of the indicators had to ensure that the possibility of fluctuations in particular pieces of census information over this time period would have minimal impact on the stability of indicator scores.

For example, if the indicators were based solely on the workforce characteristics of the population then changes in industrial activity for particular communities between each census might lead to erroneous measures on the indicator scores. Similarly, if only information concerning the ethnic composition of communities was used then an influx of migrants in particular communities would also result in inaccurate scores.

In order to avoid these problems it was decided that the indicators should incorporate a wide range of different types of census information. The use of information across a broad spectrum of population characteristics would then minimize the opportunity for changes in a small number of areas to influence the stability of the indicators between each census.

5 Parsimony. A key aim for the development of the indicators was to seek a parsimonious solution without loss of accuracy. That is, while being simple with respect to structure and application, the indicators were required to provide scores which accurately identified disadvantaged schools and students.

Simplicity in structure and application was considered to be important because it would minimize the errors, effort, and resources required to prepare indicator scores. The indicators which have previously been developed at National and State level in Australia have remained a mystery to all but those who have constructed them. This has occurred because the techniques for the construction of these indicators have rarely been published, or because the data required for the calculations have not been made freely available to the public, or because the complexity of the construction (for example, the use of various variable recoding schemes) has been too difficult to duplicate without access to sophisticated research knowledge and computing equipment.

In order to obtain the most accurate indicators with the simplest structure it was decided to employ the technique of forward stepwise linear regression (Kerlinger and Pedhazur, 1973). The forward stepwise linear regression technique is generally employed when the researcher's primary interest is to obtain the most accurate degree of prediction possible with the smallest set of predictor variables. The technique proceeds in the following manner: the predictor variable with the highest zero-order correlation is entered into the analysis; the next variable to enter is the predictor variable that produces the greatest increment to the squared multiple correlation coefficient; this procedure is continued until the criterion for termination of the analysis has been satisfied.

The termination criterion may consist of a statistical significance test or a 'criterion of meaningfulness' (Kerlinger and Pedhazur, 1973: 286). The use of a criterion of meaningfulness involves a decision by the researcher as to whether an increment in explanatory power is substantively meaningful in the context of the research application. In this study the criterion of meaningfulness adopted was linked to the amount of additional variance required to be explained before a variable was added to the indicator being constructed. The details of this decision have been described in a later section.

6 Face Validity. A desirable feature of all types of indicators is that they should appear to be reasonable in terms of the construct which is measured by the indicator scores. Thorndike and Hagen (1977:60) have described this 'appearance of reasonableness' as 'face validity'.

It was extremely difficult to ensure that the indicators developed in this study had a high degree of face validity because of the units of analysis which were used. Theories and research which support relationships between environments and educational achievement at the between-student level of analysis have been widely established. However, these theories and relationships may not apply when data are aggregated to the between-school level of analysis.

For example, the well established correlation between the socio-economic status of a student's home and his/her performance on tests of educational achievement may, or may not, be applicable at the between-school level. This may occur because the relationship at the between-school level will be influenced by the allocation of students to schools. If students were allocated to schools in such a way as to ensure that the school mean scores on the achievement variable were exactly equal, then the correlation between the two variables would be zero when examined at the between-school level because of a lack of variance between schools with respect to school mean scores on the achievement variable.

A further difficulty in establishing face validity occurred because the indicators were constructed from census information which described the communities surrounding each school. This information did not describe the characteristics of the families of students attending the sample schools except in so far as they represented a small part of the neighbourhood. Thus there may be certain census information which provided very useful predictors of school mean scores - however at the between-student level of analysis there might be neither correlational nor causal connection between these variables if they were derived from the particular family and school environments of the students.

The above problems are central to a set of methodological issues which have generally been placed under the heading of 'ecological effects' (Robinson, 1950; Dogan and Rokkan, 1969). These effects pose few problems in the analysis of data. However, difficulties may arise when relationships established at one level of analysis are assumed to apply at another level of analysis.

The accuracy of the indicators as predictors of educational disadvantage was of paramount concern. That is, the performance of the indicators as tools for precise allocation of resources was given a higher priority than was a concern for the face validity of the pieces of census information which were combined to form the indicators.

The actions which were taken to improve face validity were restricted to a careful watch for technical inconsistencies such as suppressor relationships in the multiple regression analyses and certain checks which were carried out during the data analyses in order to examine any results which were dramatically different between age levels.

The Three-Stage Strategy Used to Develop the Indicators

The six areas listed above were used to guide the formation of a four-stage strategy for the development of the indicators. The strategy which evolved had to recognize that desirable solutions for the six areas were interrelated and, in some instances, contradictory. For example, the 'stability' requirement demanded that the indicators should be based on as many types of census information as possible, while 'parsimony' inferred that only a small subset of the large body of census information should be used.

Because of the impossibility of satisfying the needs of all six areas simultaneously with any one indicator, it was decided to develop four indicators at each age level. These four indicators were developed to present a range of possible solutions to the problem of attempting to optimize performance across the often competing requirements of the seven areas.

The three stages in the strategy have been presented diagrammatically in Figure 7.1. The following discussion has presented a detailed account of each stage.

The first stage in the development of the indicators commenced with the reduction of the 710 census direct-count variables to 148 percentage variables. This process was described in detail in the previous chapter. The percentage variables were then arranged into 22 groups which closely followed the structure and names of the source census tables from which the percentage variables were derived.

The second stage involved the application of stepwise regression analysis to select a subset of percentage variables from within each of

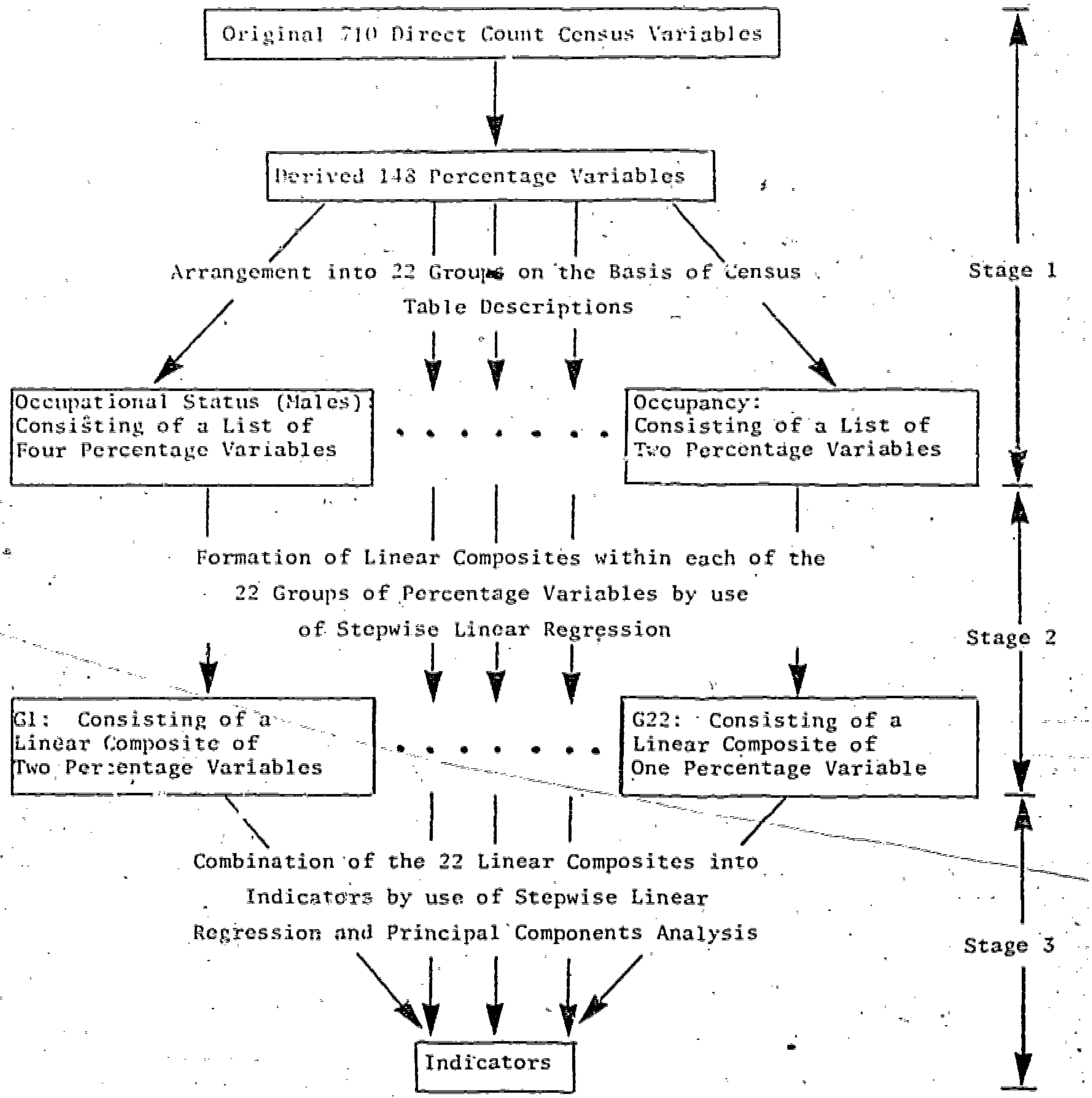

Figure 7.1 The Three-Stage Strategy Used to Develop the Indicators

the groups. The information contained within the groups was then replaced by 22 'new variables' which were based on linear composites of subsets of percentage variables in each group.

The third stage required the combination of the 22 linear composites into the indicators. This stage employed stepwise regression analysis and principal components analysis to combine the linear composites.

Stage 1: The Construction and Grouping of the Percentage Variables

The original census information which was available for the study consisted of 710 direct-count census variables. In order to adjust for variation in community size, and to re-organize the highly detailed information available for some variables into a more manageable form, a list of 148 percentage variables was constructed. The preparation of these percentage variables has been described in Chapter 6.

The total list of 148 percentage variables consisted of 22 groups of variables, each of which could be grouped and named in a fashion which closely followed the original table names and structure of the source census tabulations. These 22 groups have been listed in Table 7.1. The table has also listed the number of the source census table from which the percentage variables were derived, the number of the table in Appendix H which described the direct count variables which were used as denominators and numerators in the construction of percentages, and the number of percentage variables in each group.

The 22 groups of percentage variables have been listed under two broad headings: Social Environment and Built Environment. The groups of percentage variables associated with the Social Environment were based on descriptions of the characteristics of persons (for example, Occupational Type, Country of Birth and Marital Status). The groups of percentage variables associated with the Built Environment are based on descriptions of dwellings and the population interaction with dwellings (for example, Type of Dwelling, Bathroom/Kitchen Facilities and Density). For each of these two broad headings, the groups of percentage variables have been listed under sub-headings which describe particular aspects of either the Social or Built Environments with which the groups of percentage variables were associated.

Table 7.1 The Grouping of Census Percentage Variables

Group	Source Census Table Number	Percentage Variable Table Number in Appendix H	Number of Percentage Variables
Social Environment:	Workforce Characteristics		
1 Occupational Status (M)	26	H.1	4
2 Occupational Status (F)	26	H.1	4
3 Occupational Type (M)	28	H.2	12
4 Occupational Type (F)	28	H.2	12
	Industry Type		
5 Industry Type	27	H.3	13
	Marital Status		
6 Marital Status	11	H.4	6
	Religion		
7 Religion	22	H.6	6
	Educational Qualifications		
8 Qualifications (Obtained)	21	H.7	4
9 Qualifications (Studying)	20	H.8	4
10 Qualifications (School)	24	H.9	2
	Ethnic Composition		
11 Country of Birth	14	H.13	19
12 Period of Residence	17	H.14	8
	Age Distribution		
13 Age	7	H.15	8
Built Environment:	Nature of Dwellings		
14 Type of Dwelling	31	H.10	10
15 Size of Dwelling	34	H.11	7
16 Age of Dwelling	37	H.12	7
	General Facilities		
17 Bathroom & Kitchen	38	H.17	6
18 Facilities (Sewerage, etc.)	39/40	H.18	3
19 Vehicles	41	H.19	4
	Living Arrangements		
20 Household Class	30	H.20	1
21 Density	33	H.21	6
22 Occupancy	42	H.22	2
Total Number of Percentage Variables			148

Stage 2: The Development of Linear Composites Within the Groups of Percentage Variables

After Stage 1 had been completed the original 710 direct count census variables had been formed into 148 percentage variables, and these percentage variables had been grouped into sets which followed the names and structure of the original source census tables.

The next task was to combine these percentage variables into indicators of educational disadvantage. The census information which was to be used to form the indicators was available at the individual level. That is, each of the sample members had been linked to a set of percentage variables which described the Collector's District in which the sample member lived. Since the 'unit of analysis' was required to be the school, the percentage variable data and the associated data for each sample member drawn from the ASSP study were aggregated over schools to obtain files of data covering 272 schools at the 10-year-old level and 256 schools at the 14-year-old level.

One method of producing the indicators would have been to conduct regression analyses to combine the whole 148 percentage variables into a linear composite which was optimally correlated with a suitable criterion variable. However, the use of the whole 148 percentage variables would have violated the 'statistical constraints' which required that a maximum of 22 variables be used in any one correlational analysis.

An alternative method would have been to initially select a subset of the percentage variables which was small enough to satisfy the 'statistical constraints'. These variables could then have been used as independent variables in the regression analyses. This procedure would have presented difficulties in making decisions about which percentage variables to include in the analyses. For example, 'parsimony' required that the variables be selected so as to produce the most accurate indicators; and the need for 'stability' encouraged the use of as wide as possible range of different types of census information.

The method employed in this study was to draw information initially from as many groups of percentage variables as possible so as to maximize the 'stability' of the derived indicators. Also, it was decided that the stability of the indicators would be enhanced by using as many variables from within these groups as possible. The 'statistical constraints' on the use of correlational procedures required that no more than 22 variables be used in any one analysis, therefore this constraint could be satisfied by creating linear composites from each of the 22 groups and then using these linear composites as individual variables in further correlational analyses to create the indicators. The 'parsimony' characteristic could be satisfied by employing stepwise regression analyses within each group to create linear composites which were optimally correlated with the criterion variable. Those percentage variables which did not add substantially to the explanatory power of the linear composites would then be discarded.

Stepwise linear regression rather than simple linear regression was employed to create the linear composites of percentage variables within each group. This technique was used because of the need to extract a high degree of explanatory power from the information available within each group of percentage variables without including percentage variables which did not substantially add to this explanatory power. Within each group of percentage variables there was often a high degree of inter-correlation. For example, there were correlations of 0.74 and 0.83, between the percentages of male occupations which were 'professional' and the percentages of male occupations which were 'administrative/executive/managerial', for the 10-year-old and 14-year-old schools respectively. Because of this high degree of correlation between percentage variables within groups it was likely that the use of many variables from any one group would not add to the predictive power of the indicators.

When stepwise regression is being used the researcher is required to make a decision concerning how many predictor variables will be allowed to enter the analyses before the procedure is terminated. The termination decision for these analyses was associated with the increments to explained variance in the criterion variable at each step of the analyses. The formation of the linear composites was terminated when the increment in the amount of variance explained did not exceed one per cent. That is, when the change in the squared multiple correlation coefficient, R^2, after adding an additional percentage variable did not reach one per cent then the linear composite at that stage was accepted.

For certain analyses the restriction on the contribution to R^2 was relaxed to 0.25 per cent. This occurred for particular groups where only one or two percentage variables were permitted to be included in the analyses. It was considered that relaxation of the restriction would not contravene the desirable characteristic of 'parsimony' when such small numbers of variables were involved in any one stepwise regression analysis. During the construction of the linear composites this alternative restriction occurred only at the 14-year-old level for two groups of percentage variables: Occupational Status (Females) and Period of Residence.

Prior to the percentage variables being permitted to enter the stepwise regression analyses an initial 'sifting' of the percentage variables was carried out. This sifting procedure was employed to minimize the opportunity for suppressor relationships to arise by removing percentage variables exhibiting correlation coefficients with the criterion variable where the magnitudes of these coefficients were within the bounds of sampling error at both age levels.

An approximation to the standard error of a zero-order correlation coefficient was employed to estimate the magnitude of two standard errors (Guilford and Fruchter, 1973:145):

$$se(r) = 1/\sqrt{n}$$

where se(r) is the standard error of the zero-order correlation coefficient, and n is the sample size under the assumptions of simple random sampling.

The sample design for schools in this study was a disproportionate systematic stratified sample design. However, since the sifting procedure was to be used as a rough sorting device, it was considered that the approximation provided by the above formula would be sufficiently accurate. Therefore, in order to enter the stepwise regression analyses, a percentage variable had to exhibit a zero-order correlation coefficient with the criterion variable which exceeded two standard errors in magnitude.

Results of Stage 2

The second stage of the strategy required the combination of the percentage variables within each of the 22 groups of percentage variable groups to form linear composites. Since there were 22 groups of percentage variables for each of the two age levels, there were 44 separate stepwise regression analyses required to create the linear composites. A detailed description of each of these has been reported in Appendix I.

A summary of these 44 stepwise regression analyses has been reported in Table 7.2. For each group of percentage variables the number of percentage variables which entered the linear composites has been presented.

Overall there was a total of 50 percentage variables required to create the linear composites at the 10-year-old level and 49 at the 14-year-old level. The reduction, from an original list of 148 percentage variables, represented a considerable gain in 'parsimony' without loss in 'stability' because 21 of the total 22 groups were represented. The omitted group, 'Age of Dwelling', was not used to create linear composites because all percentage variables in this group failed to pass the 'sifting' process at both age levels. That is, all percentage variables in this group did not have correlations with the criterion variables which were in excess of that expected for normal sampling fluctuations.

There was a total of 63 different percentage variables employed in the analyses. Of the 63 there were 36 percentage variables employed at both age levels, and 14 which were unique to the 10-year-old level, while 13 were unique to the 14-year-old level.

In the final four columns of Table 7.2 the percentage of the criterion variable variance explained by the 'stepwise solution' and the 'full solution' have been presented. The percentage of criterion variable variance explained by the stepwise solution referred to the variance explained by the linear composite which was accepted to represent the appropriate group of percentage variables. The percentage of criterion variable variance explained by the 'full solution' referred to the variance explained by allowing all eligible variables within a group to enter the analyses without making use of the termination decision described in the previous section. In many cases the full solution contained suppressor relationships - with percentage variables having differences in sign between correlation coefficients and regression coefficients. An inspection of the percentage of variance explained by each solution showed that generally the reduction in the number of variables included in a regression equation by the use of stepwise regression analysis caused little loss in explanatory power while gaining greatly in terms of 'face validity' and also 'parsimony'.

Stage 3: The Development of the Indicators from the Linear Composites

The third stage in the strategy was the combination of the linear composites which had been formed at the second stage into indicators. After the second stage had been completed there were 21 linear composites available from the total of 22 percentage variable groups. Since this number was within the

Table 7.2 The Results of the Stepwise Regression Analyses which were Used to Develop Linear Composites from the Groups of Percentage Variables

Group Source of Linear Composite	Number of Variables in Linear Composite from Stepwise Solution		Percentage of Criterion Variance Explained			
			Stepwise Solution (100 r²)		Full Solution (100 R²)	
	10-Y-O	14-Y-O	10-Y-O	14-Y-O	10-Y-O	14-Y-O
1 Occupational Status (M)	2	2	12	19	12	19
2 Occupational Status (F)	2	2	5	4	5	4
3 Occupational Type (M)	4	2	42	33	43	36
4 Occupational Type (F)	4	4	38	36	40	38
5 Industry Type	4	3	37	26	39	29
6 Marital Status	2	1	7	15	8	19
7 Religion	3	4	17	18	18	18
8 Qualifications (Obtained)	3	3	36	29	36	29
9 Qualifications (Studying)	2	2	10	19	11	20
10 Qualifications (School)	2	2	18	23	18	23
11 Country of Birth	4	3	20	22	22	23
12 Period of Residence	2	2	9	4	9	4
13 Age	2	2	10	13	15	15
14 Type of Dwelling	4	5	11	21	15	23
15 Size of Dwelling	2	3	20	31	25	32
16 Age of Dwelling[a]	*	*	*	*	*	*
17 Bathroom & Kitchen	2	3	10	27	11	27
18 Facilities (Sewerage,etc)	2	2	4	15	4	15
19 Vehicles	1	1	16	24	18	24
20 Household Class	1	1	6	16	6	16
21 Density	1	1	17	13	18	14
22 Occupancy	1	1	6	17	8	19
Total Number of Percentage Variables in Analyses			50	49	98	98
Number of Schools (Weighted)			271	256	271	256

a. A linear composite was not extracted from the 'Age of Dwelling' group because all percentage variables in this group failed to have sufficiently large zero-order correlations with the criterion variable.

limit set by the statistical constraints' it was possible to employ correlational procedures on the whole set of linear composites in order to form the Indicators. Two correlational procedures were selected to be used in the task of combining the linear composites: regression analysis and principal components analysis.

The use of regression analysis for the total set of 21 linear composites was considered desirable because it would permit the construction of a linear combination of the composites which had optimal correlation with the criterion variable. However, initial regression analyses at each age level using the full set of 21 linear composites showed that the resulting Indicators displayed suppressor relationships for some of the linear composites. That is, although all 21 linear composites had been constructed to have positive zero-order correlations with the criterion (see Appendix I), several linear composites in the full regression equation had negative regression weights. These regression weights had occurred as a result of the high degree of collinearity between certain pairs of linear composites. Since this occurrence would have been incongruent with the need for 'face validity' it was necessary to abandon the use of a full regression solution.

Therefore, instead of employing all 21 linear composites in a regression analysis it was decided to use stepwise regression to select a subset of the linear composites which would avoid the difficulties of suppressor relationships. The termination decision for the entry of linear composites into the analyses was to end the stepwise procedure before any suppressor relationships emerged. That is, the linear composites would be allowed to enter the stepwise regression until the addition of an extra composite resulted in one or more linear composites receiving negative regression weights. This termination decision aimed to achieve maximum 'stability' (by including as many linear composites as possible) without loss of 'face validity' (by not allowing suppressor relationships to emerge in the indicators). A comparison of the proportion of variance explained by the full set of linear composites, R_o^2 (full model), with the proportion of variance explained by the subset of linear composites from the stepwise regression analyses, R^2, demonstrated that there was little loss in predictive accuracy by using the stepwise solution.

In addition to selecting a subset of linear composites from the total 21 linear composites, similar analyses were carried out after initially dividing them into two groups associated with the Social Environment and the Built environment.

The use of the Social Environment group of linear composites was more likely to result in indicators with higher 'face validity' because this group contained variables with well researched relationships to educational achievement at both between-student and between-school levels of analysis. For example, the Occupational Status, Occupational Type, Country of Birth, and Qualifications linear composites all have well established correlational links with educational achievement.

The Built Environment group of linear composites was less likely to contribute to 'face validity' because linear composites such as Bathroom and Kitchen Facilities, Vehicles, etc. do not in themselves appear to have well researched links with student educational performance. Where the Built Environment types of measures have entered the research literature they have been used as indicators of unmeasured constructs such as 'socio-economic class'. However, this group of linear composites might be considered more likely to add to 'stability' because changes in the percentage variables associated with the Built Environment would be less likely to occur between census data collections than for the percentage variables describing the Social Environment. That is, during the five year period separating the Australian Census of Population and Housing, variations in percentage variables such as Size of Dwelling, Type of Dwelling, etc. would be less likely to be large even if changes in the nature of population characteristics such as Occupational Status, Country of Birth, etc. did occur. Further, since the Census was carried out at one point of time, the variables associated with the Built Environment would be less likely to be subject to time-related variations in the social structure of communities which occur due to seasonal variations in work patterns, or social variations which may arise in communities which depend upon the travel/leisure industry.

The other correlational technique which was employed to combine linear composites into the indicators was principal components analysis. This technique was adopted because it provided a means of obtaining high 'stability' (by including all linear composites) and a high level of 'face validity' (by avoiding suppressor relationships). The principal components technique was used to extract a linear combination from all 21 linear composites which had maximum variation between the units of analysis on the derived indicators. This analytic procedure does not search for a linear combination with maximum predictive power as does the stepwise regression technique. Therefore it was expected that the correlation between the indicators derived from principal components analysis and the criterion variable would be somewhat less than that obtained from full regression analyses using the same set of linear composites. However, since the linear composites were constructed to have a high correlation with the criterion variable, it was expected that the first principal component (which extracts the strongest single dimension from the relationships among all the linear composites) would have a reasonably high degree of predictive power.

Results for Stage 3

The third stage of the strategy was concerned with the combination of the linear composites to form the indicators. Three sets of stepwise regression analyses were carried out at each age level: the first set employed all 21 linear composites, the second set used only those linear composites associated with the Social Environment (Groups 1 to 13), and the third set used only those linear composites associated with the Built Environment (Groups 14 to 22). The principal components analysis was carried out at each age level on all linear composites. In Table 7.3 the results of both the stepwise regression and principal component analyses at each age level have been summarized.

The entries in Table 7.3 have listed the metric regression coefficients for each linear composite which would be required to produce the indicators. The metric regression coefficients for the indicators derived from the stepwise regression analyses for all variables, SR(ALL), have been reported in the first two columns of Table 7.3. At each age level nine linear composites were used to create the indicators. However, only four of these were common to both age levels: Occupational Type (Females), Country of Birth, Bathroom and Kitchen, and Density. At each age level the SR(ALL) Indicator contained six linear composites describing the Social Environment and three describing the Built Environment.

The metric regression coefficients for the indicators derived from the Social Environment subset of linear composites, SR(SOCIAL), and for the

Table 7.3. The Coefficients which were Used to Combine the Linear Composites into the Indicators

Group Source	Stepwise Linear Regression						Principal Component	
	All		Social		Built			
	10	14	10	14	10	14	10	14
1. Occupational Status (M)	*	13	11	32			05	04
2. Occupational Status (F)	*	*	*	*			05	05
3. Occupational Type (M)	16	*	11	*			05	05
4. Occupational Type (F)	00[b]	14	22	33			04	05
5. Industry Type	23	*	19	*			04	05
6. Marital Status	*	38	34	46			06	05
7. Religion	*	*	13	*			04	05
8. Qualifications (Obtained)	37	*	37	*			04	05
9. Qualifications (Studying)	*	51	*	55			05	04
10. Qualifications (School)	*	*	*	*			05	05
11. Country of Birth	19	38	21	34			04	04
12. Period of Residence	40	*	12	*			04	04
13. Age	*	31	38	53			04	04
14. Type of Dwelling	34	*			60	*	04	05
15. Size of Dwelling	*	14			58	39	05	05
16. Age of Dwelling	**	**			**	**	**	**
17. Bathroom & Kitchen	48	30			*	42	05	04
18. Facilities (Sewerage,etc)	*	*			*	*	05	05
19. Vehicles	*	*			56	46	06	05
20. Household Class	*	*			*	*	05	05
21. Density	42	43			81	74	04	03
22. Occupancy	*	*			*	*	06	05
Regression Constant	-25.1	-25.5	-18.4	-22.5	-24.5	-14.9	-15.7	-14.2
R	72	73	69	71	64	66	69[c]	69[c]
$\bar{R}^2$	52	53	48	50	41	44	48	48
R^2 (full model)	54	54	48	51	43	45	48	48
Number of Schools (weighted)	271	256	271	256	271	256	271	256

Note: a Decimal points have been omitted from coefficients and R/R^2 values.

b All calculations were carried out using four decimal places. This linear composite had a regression weight of 0.0020 (See Appendix J.)

c The R values refer to the value of the correlation coefficient between the indicator and the criterion variable.

d Groups marked with an asterisk (*) refer to linear composites which did not enter the stepwise regression analyses. Groups marked with two asterisks (**) refer to groups for which no linear composite was prepared.

Indicators derived from the Built Environment subset of linear composites, SR(BUILT), have been reported in the second and third pairs of columns in Table 7.3.

The SR(BUILT) Indicators contained four linear composites. Three of these were common to each age level. The SR(SOCIAL) Indicators featured different numbers of linear composites at each age level: ten for the 10-year-old level and six for the 14-year-old level. The five common linear composites for the SR(SOCIAL) Indicators were Occupational Status (Males), Occupational Type (Females), Marital Status, Country of Birth, and Age.

The entries in the last two columns of Table 7.3 have recorded the metric regression coefficients for the principal components analyses. These entries were the coefficients which would be required to create the first principal component from the linear composites. The indicators derived from these analyses, PC(ALL), employed the whole 21 linear composites at both age levels.

The correlation between the indicators and the criterion variable have been recorded for each age level in the lower section of Table 7.3. These correlations ranged between 0.64 and 0.73. The highest values occurred for the SR(ALL) indicators with correlations of 0.72 and 0.73 for the 10-year-old and 14-year-old levels respectively. The lowest values occurred for the SR(BUILT) indicators with correlations of 0.64 and 0.66.

Summary

This chapter has presented a detailed description of the procedures employed to develop the indicators of educational disadvantage. In order to guide decisions about the development of these indicators a list of six items describing important properties of the indicators was prepared. Following an examination of these items, a three-stage strategy was prepared for the construction of the indicators.

The first stage of indicator construction involved the grouping of the 148 percentage variables, described in Chapter 6, into 22 groups which described various aspects of the neighbourhoods surrounding the schools in the sample. At the second stage, stepwise regression analysis was used to combine the percentage variables within each group into a linear composite by using school mean Word Knowledge scores as the criterion variable. The resulting 21 linear composites at each age level were employed in analyses to construct four indicators of educational disadvantage at the third stage. The third stage involved the preparation of three indicators based on stepwise regression analyses which also used school mean Word Knowledge as the criterion variable: the SR(ALL) indicator employed all linear composites as candidates for entry into the stepwise regression analyses, the SR(SOCIAL) indicator used only those linear composites with aspects of the social environment, and the SR(BUILT) indicator used only those linear composites associated with the built environment. A further indicator, PC(ALL), was also developed by employing all linear composites in a principal component analysis.

CHAPTER 8

THE INVESTIGATION OF INDICATOR CHARACTERISTICS

Introduction

In the previous chapter the three-stage strategy used to develop the indicators was described. In this chapter the indicators were examined with respect to a range of analyses which were designed to provide a detailed investigation of their properties. These analyses examined the nature of the dimensions assessed by the indicators, the predictive power of the indicators with respect to school mean achievement and school behavioural climate, the precision with which the indicators could be used for resource allocation, the properties of school mean achievement scores following residualization by the indicators, and the theoretical and 'cross-age' stability of the indicators as predictors of school mean achievement.

Relationships Between Indicators

The degree of similarity in the dimensions assessed by the indicators was examined by calculating the product moment correlations between the indicators both within and across age levels. These correlations have been presented in Table 8.1.

Within Age-Level Correlations. In the upper left-hand corner and lower right-hand corner of Table 8.1 the correlations between the indicators within each age group have been listed. For example, for 10-year-old schools the correlations between the PC(ALL) indicator developed at the 10-year-old level and the SR(ALL), SR(SOCIAL), and SR(BUILT) indicators developed at the 10-year-old level were 0.96, 0.95, and 0.90 respectively; the corresponding values for 14-year-old schools were 0.96, 0.94, and 0.94 respectively.

The correlations for each age group of schools were all high and positive between 0.80 and 0.97 which supported the previous assertion that, within age levels, the indicators were aligned along a common dimension. In fact, except for the two intercorrelations between SR(SOCIAL) and SR(BUILT), 0.80 and 0.83, the intercorrelations were all in the range 0.88 to 0.97. The slightly lower intercorrelations for SR(SOCIAL) and SR(BUILT) were due to the fact that each contained relatively few percentage variables and none of these were common to either indicator.

Table 8.1 Correlations Between the Indicators Developed at Each Age Level (Within and Across 10-Year-Old and 14-Year-Old Schools).

Indicator	Indicator							
	10-Year-Old Indicators				14-Year-Old Indicators			
	SR(ALL)	SR(SOCIAL)	SR(BUILT)	PC(ALL)	SR(ALL)	SR(SOCIAL)	SR(BUILT)	PC(ALL)
10-Year-Old Indicators Applied to 10-Year-Old Schools								
SR(ALL)	100				87	80	83	90
SR(SOCIAL)	95	100			85	85	73	87
SR(BUILT)	88	80	100		86	74	94	90
PC(ALL)	96	95	90	100	90	86	86	97
14-Year-Old Indicators Applied to 14-Year-Old Schools								
SR(ALL)	92	87	92	93	100			
SR(SOCIAL)	89	90	87	93	97	100		
SR(BUILT)	88	77	96	89	92	83	100	
PC(ALL)	92	88	94	97	96	94	94	100

a Decimal points have been omitted from correlation coefficients.

b Number of schools at 10-year-old/14-year-old levels (weighted) = 271/256.

The PC(ALL) indicator had consistently high intercorrelations with other indicators at both age levels: averaging 0.94 for the 10-year-old schools and 0.95 for 14-year-old schools. This reflected the larger number of percentage variables which were common between the PC(ALL) indicator and the other three indicators.

Across Age-Level Correlations. In the upper right-hand corner and lower right-hand corner of Table 8.1 the across age-level correlations between indicators have been listed.

The most interesting feature of these two matrices of correlations was their diagonal elements. These elements represented the intercorrelations between the same indicators developed at different age levels. For example, for 10-year-old schools, the SR(ALL) indicator developed at the 10-year-old level had a correlation of 0.87 with the SR(ALL) indicator developed at the 14-year-old level. These same two indicators had a correlation of 0.92 when applied to the 14-year-old schools.

The diagonal elements were all high and positive in the range 0.85 to 0.97 which demonstrated that, despite the structural differences in any one indicator developed for the two age levels, each indicator was aligned along a common dimension no matter to which sample of schools it was applied. This characteristic was particularly noticeable for the PC(ALL) indicators because the intercorrelation between the two forms of this indicator was 0.97 for both 10-year-old and 14-year-old schools.

School Neighbourhood Correlates

In the following discussion, a brief review has been presented of the relationships between the four indicators and the percentage variables which formed the basic building blocks in the construction of these indicators. The percentage variables provided conceptually simple descriptive information and were therefore suitable for an exploration of the nature of the dimensions assessed by the indicators.

From the large list of 148 percentage variables a subset of 26 was selected in order to cover a range of important characteristics of school neighbourhoods: occupation, education, housing, family structure, facilities, and ethnicity. These 26 percentage variables and their correlations with each of the four indicators have been listed for the 10-year-old and 14-year-old sample schools in Table 8.2. For example, the percentage variable describing the percentage of the male workforce in professional occupations, %OCC.PROF(M), had correlations at the 10-year-old level of 0.80, 0.82, 0.67, 0.78, and correlations at the 14-year-old level of 0.73, 0.78, 0.62, 0.76 with the indicators SR(ALL), SR(SOCIAL), SR(BUILT), PC(ALL), respectively.

The general pattern of correlation coefficients presented in Table 8.2 was similar across age levels. High positive or high negative coefficients between particular percentage variables and an indicator at one age level were generally associated with similar coefficients at the other age level. This consistency suggested that, despite the structural differences in a particular indicator between age levels, any one indicator was aligned along a common dimension for both age levels.

For all indicators there was a fairly even level of the magnitude of correlation coefficients across the main areas described by the percentage variables. That is, there was no particular area of the description of school neighbourhoods which had dominated the construction of the indicators at either age level. For example, the SR(ALL) indicator was highly correlated, both positively and negatively, with percentage variables describing the areas of occupation, education, housing, family structure, facilities, and ethnicity.

The complex nature of the dimensions which were assessed by the indicators can be seen from an inspection of the overall pattern of correlation coefficients across the main areas assessed by the percentage variables.

A high degree of educational disadvantage, which would be evidenced by low scores on the indicators, would tend to be associated with schools whose neighbourhoods had the following characteristics: high percentages of persons in the workforce with low status occupations (process/manual/labour, unemployed) and low percentages with high status occupations (professional, administrative/executive/managerial, clerical); high percentages of persons who had never attended school and low percentages of persons with high educational attainment (schooling greater than level 9, bachelors degree); high percentages of dwellings which were rented, over-crowded (6 or more persons per dwelling), substandard in structure (improvised house) and low percentages which were owned and large in structure (7 or more rooms); high percentages of persons with 'broken'

Table 8.2 Correlations Between the Indicators and a Subset of Percentage Variables (10-Year-Old Schools and 14-Year-Old Schools)

Percentage Variable	Indicator SR(ALL) 10	SR(ALL) 14	SR(SOCIAL) 10	SR(SOCIAL) 14	SR(BUILT) 10	SR(BUILT) 14	PC(ALL) 10	PC(ALL) 14
% OCC ADM/EXEC/MAN (M)	84	72	86	76	72	70	84	78
% OCC PROF (M)	80	73	82	78	67	62	78	76
% DWEL: 2 VEHICLES	58	70	59	74	63	74	71	82
% BACH D OBT (15+)	70	67	73	72	56	55	67	68
% DWEL: 7+ ROOMS	55	62	62	67	63	60	62	65
% SCHL GT LEVEL 9	61	59	64	62	52	51	63	64
% OCC PROF (FM)	61	59	68	68	49	45	59	57
% DWEL: SL (B+K)	39	63	21	47	50	77	41	66
% DWEL: OWNER OCCUPIED	35	55	37	53	52	61	48	63
% POPN: SINGLE FAM HSHOLD	33	58	20	51	40	66	40	66
% OCC CLERICAL (FM)	53	45	48	42	49	44	49	50
% OCC CLERICAL (M)	53	39	50	38	47	34	47	41
% OCC ADM/EXEC/MAN (FM)	51	39	54	43	39	34	48	38
% WKF UNEMP (FM)	-21	-27	-24	-31	-26	-24	-27	-28
% DWEL: IMPROVISED HOUSE	-25	-40	-08	-26	-39	-57	-24	-41
% WKF UNEMP (M)	-21	-44	-24	-41	-27	-46	-31	-44
% NEVER ATTND SCHL	-33	-44	-17	-31	-44	-59	-33	-48
% POPN: STH EUROPE BN	-40	-48	-42	-49	-24	-38	-38	-48
% DWEL: SHARE (B+K)	-35	-60	-27	-54	-26	-59	-37	-61
% DWEL: TENANT OCCUPIED	-30	-48	-34	-48	-48	-53	-44	-55
% SEP (EVER MAR M 15+)	-32	-55	-30	-55	-34	-55	-43	-62
% SEP (EVER MAR FM 15+)	-32	-53	-36	-55	-42	-51	-45	-58
% DWEL: NO VEHICLES	-36	-59	-31	-56	-38	-64	-47	-69
% DWEL: 6+ INMATES	-58	-50	-50	-39	-65	-55	-48	-38
% OCC PROC/MAN/LAB (FM)	-58	-49	-64	-53	-44	-38	-57	-45
% OCC PROC/MAN/LAB (M)	-77	-74	-81	-76	-66	-68	-81	-78

Note: a Decimal points have been omitted for correlation coefficients.

b Number of schools at 10-year-old/14-year-old levels (weighted) = 271/256.

c Confidence limits for correlation coefficients based on two standard errors were ±0.07 for 10-year-old schools, and ±0.08 for 14-year-old schools. (See Table 8.5, footnote c.)

d The 26 percentage variables were listed according to their mean correlation across all four indicators.

marriages (persons once married and 15 years of age or older who were separated) and low percentages of persons living in single family households; high percentages of dwellings with limited facilities (shared use of kitchen and bathroom, no vehicles) and low percentages of dwellings with facilities (sole use of kitchen and bathroom, 2 vehicles); and high percentages of the population born in southern European countries.

The above profile of the type of school neighbourhood associated with schools having low scores on the indicators provided a picture of a community in which there was a concentration of a range of social and physical conditions which have commonly been described in terms of 'disadvantage', 'deprivation', and 'poverty'. Therefore, while a premium had been placed on the development of indicators which had high predictive accuracy in terms of school mean achievement, the final indicators exhibited the highly desirable property of having balanced correlational associations across a number of environmental conditions which both individually and in combination have often been proposed as important barriers to achieving the goal of equality of educational opportunity.

School Achievement Correlates

In Table 8.3 the correlation coefficients for the relationships between the indicators and school mean scores on the Word Knowledge, Literacy, and Numeracy tests have been presented separately for 10-year-old and 14-year-old schools.

The correlations between the indicators and school mean scores were mostly in the range of 0.60 to 0.70. Generally higher correlations were associated with the Word Knowledge tests. This was to be expected because school mean scores on these tests had been used as scaling criteria in the development of the indicators.

Correlation coefficients less than 0.60 were obtained for the SR(SOCIAL) indicator with school mean scores on the Numeracy test at both age levels, and also for the SR(ALL) and PC(ALL) indicators with school mean scores on the Numeracy test at the 10-year-old level. Despite these lower individual correlations, the mean correlations for indicators across all school mean scores exceeded 0.60 and were mostly in the range 0.65 to 0.70 for both age levels.

In order to evaluate the magnitude of the correlations presented in Table 8.3 it was necessary to examine some other studies which had developed indicators of educational achievement. In particular, two points of comparison were considered to be of great importance. First, were the magnitudes of these correlations comparable with those from other large-scale studies in which indicators of school neighbourhood environment have been constructed from census information? And second, were the magnitudes of these correlations comparable with those from other large-scale studies in which indicators of school neighbourhood environment have been constructed by obtaining detailed information from individual students about their own home environments?

The first question was examined following a review of the studies carried out during 1973-1977 by Levine and coworkers at the University of Missouri, and the second question was examined following a review of the findings of cross-national studies conducted during the early 1970's by the International Association for the Evaluation of Educational Achievement (IEA).

These two sets of studies were selected because they had certain features which were important for the valid evaluation of the two questions. Both sets of studies had:

1. reported analyses which were carried out at the between-school level of analysis.
2. designed their analyses to optimize the correlation between indicators of the school neighbourhood environment and school mean achievement scores.
3. employed sufficiently large numbers of schools in their analyses to ensure stability in the obtained correlation coefficients.
4. conducted replicated analyses across different groups of sample schools. (Across big-city school systems in the University of Missouri studies, and across school systems in different countries in the IEA studies.)

The IEA studies had two further important characteristics. First, results had been reported for Australia on the same target population as was employed for the 14-year-old schools in this study, and secondly, school mean achievement scores had been calculated by using the same Word Knowledge test as was used in this study.

The University of Missouri studies lacked precise comparability in these two important areas. The target populations for these studies were associated with a group of big-city school systems in the United States,

Table 8.3 Correlations Between the Indicators and School Mean Scores on the Tests of Word-Knowledge, Literacy and Numeracy (10-Year-Old and 14-Year-Old Schools).

School Mean Scores	Indicator			
	SR(ALL)	SR(SOCIAL)	SR(BUILT)	PC(ALL)
10-Year-Old Indicators Applied to 10-Year-Old Schools				
10-Year-Old Test				
Word Knowledge	72	69	64	69
Literacy (Test 10R)	71	62	69	67
Numeracy (Test 10N)	59	51	62	58
Mean Correlation	67	61	65	65
14-Year-Old Indicators Applied to 14-Year-Old Schools				
14-Year-Old Test				
Word Knowledge	73	71	66	69
Literacy (Test 14R)	70	64	68	67
Numeracy (Test 14N)	66	57	69	63
Mean Correlation	70	64	68	66

Note: a Decimal points have been omitted from correlation coefficients.
b Number of schools at 10-year-old/14-year-old levels (weighted) = 271/256.

and the school mean test scores were mostly based on standardized achievement tests. However, this set of studies was selected because it appeared to represent the only research carried out to date which has employed both the same detailed linkage of schools to their census-described catchment areas, and the same stepwise multiple regression approach to the preparation of census-based composite predictors of school mean test scores as was employed in this study.

In the following discussion a short review of the relevant procedures and results associated with the University of Missouri and IEA studies has been presented. The two questions listed above have then been addressed following a comparison of the magnitudes of the appropriate correlation coefficients with the results obtained in this study.

The University of Missouri Studies: Review and Comparison

In a series of studies carried out at the University of Missouri, Levine and his co-workers investigated the utility of census descriptions of school catchment areas for predicting school mean achievement scores (Levine et al, 1973; Levine et al, 1974; Meyer and Levine, 1976; Levine et al, 1977; Meyer and Levine, 1977).

This series of studies commenced with an investigation (Levine et al, 1973) which aimed to assess whether independent variables based on census information for school catchment areas could be used to predict school mean scores on achievement tests. Levine et al reasoned that if the predictive power of the census information was sufficiently accurate then easily retrievable data from the census could be used in the preparation and revision of formulae used to allocate resources to schools.

A sample of 122 elementary schools in Chicago was selected for the study. Each school's catchment area was linked to its census 'block' boundaries thereby permitting the preparation of census descriptions of the neighbourhoods from which each school obtained its students. Data describing the mean reading achievement scores of sixth grade students in each school were obtained from the official testing programs carried out by the Chicago Board of Education.

Levine et al demonstrated that a multiple correlation coefficient of 0.87 could be obtained when only four census variables, Percentage of Females Separated, Percentage of Families Which Lack One or More Plumbing Facilities, Percentage of Dwellings which are Owner Occupied, and Percentage of Dwellings with 6 Persons or More, were used as independent variables. The composite census measure was shown to have predictive power which compared favourably with composites which had earlier been constructed from data describing the particular family circumstances of individual students.

Further results from this study, which were published in a separate report (Levine et al, 1974), considered the predictive power of census composites for both fourth and sixth grade levels over a number of years. In these analyses three census variables, and several product terms created from these three variables, were used to construct the composites. The variable Percentage of Families Which Lack One or More Plumbing Facilities was excluded from the analyses. Multiple correlation coefficients in the range of 0.80 to 0.90 were obtained when school mean reading achievement was used as the criterion.

A supplementary set of analyses presented in this report used census 'tracts' rather than 'blocks' as the unit with which to describe school catchment areas. The tracts covered a larger geographical area - each being composed of many blocks. The composites resulting from these analyses employed logarithmic, square root, and quadratic transformations of the independent variables. The predictive power of these 'tract-level' composites were generally of similar order to those created from 'block-level' information.

Meyer and Levine (1976) employed similar methodology for the preparation of block-level data in a study of 48 elementary schools in Kansas City. However the construction of composite predictor variables included both census descriptions of school catchment areas and a set of variables denoting neighbourhood typology classifications which had been derived from a variety of factor analytic and clustering techniques. The multiple correlations for the resulting composite measures were again generally in the range 0.80 to 0.90 when school mean scores on standardized achievement tests, the Iowa Test of Basic Skills and the Stanford Achievement Test, were used as criterion measures for samples of fourth, fifth, and sixth grade students.

Levine <u>et al</u> (1977) and Meyer and Levine (1977) extended their examination of the association between school catchment area social characteristics and school mean achievement scores by conducting analyses which were replicated in five big city school districts: Chicago, Cleveland, Cincinatti, Kansas City, and St Louis. The census-based descriptions of school neighbourhoods were supplemented with data obtained from local government agencies and school district offices. The unit of census information selected to describe school catchment areas was the census tract. In each of the five cities reading achievement data were gathered respectively from 275, 105, 69, 55, and 65 elementary schools. Certain transformations of the independent variables (logarithmic, reciprocal, quadratic, and square root) were tested in order to explore whether predictions of school-level achievement obtained from stepwise multiple regression analysis could be improved by taking curvilinearity into account.

The stepwise regression procedure reported by Meyer and Levine selected from five to nine independent variables across the five cities and obtained multiple correlation coefficients at the sixth grade level across several years averaged 0.88, 0.77, 0.91, 0.85, and 0.84 respectively for the five cities. The selected independent variables were mostly logarithmic transformations; very few 'untransformed' variables entered the final regression equations. Across the five cities there was a large range of different types of variables selected however the researchers concluded that the high intercorrelation among these variables demonstrated that they were reflecting differing aspects of a complex situation involving disorganization in big city social systems (Meyer and Levine, 1977:18).

The multiple correlations between the composites describing school neighbourhood environments and school mean achievement criteria were generally in the range of 0.80 to 0.90 across all of the University of Missouri studies. These values were consistently higher than the multiple correlations of mostly around 0.70 when school mean achievement scores on tests of Word Knowledge were used as criteria in this study.

The differences in the predictive power of the composites most probably have their origins in differences between the nature of the target populations which were examined. From the estimates of the coefficients of intraclass correlation given in Table 3.4, it may be seen that the between-school component of variance in Word Knowledge scores in the United States is almost twice the size of the Australian value at both the 10-year-old and 14-year-old levels. Consequently, analyses conducted at the between-school level for similar criteria could be expected to have a larger amount of criterion variance available for 'explanation' in the United States. Further, since the University of Missouri studies considered only school systems in large cities it could be expected that the well-known high degree of residential segregation in cities like Chicago would result in census percentage variables exhibiting a greater degree of variation between school neighbourhoods when compared to school neighbourhoods for Australia overall. Inspection of the reported standard deviations for some census percentage variables in fact confirmed this speculation. For example, the percentage variables in the Chicago studies (Levine et al, 1973:18) which described the percentage of females who were separated and the percentage of dwellings with six or more inmates had standard deviations which were around five times and two times larger respectively than for the same variables describing Australian school neighbourhoods at both age levels.

While it was possible that the 'true' correlations between the census composites and school mean achievement scores were quite different between countries, it would appear reasonable to suggest that the comparatively large 'restriction in range' in both the independent and criterion variables was in part responsible for the relative 'attenuation' of the magnitude of the multiple correlation coefficients in the results for Australia (Nunnally, 1967:126; Allen and Yen, 1979:34).

The IEA Studies: Review and Comparison

As part of an international study of educational achievement conducted by the International Association for the Evaluation of Educational Achievement (IEA), Comber and Keeves (1973) developed a composite measure which was intended to assess the educational climate of the homes of students attending their sample schools. This measure was conceptualized as being partly associated with the 'socioeconomic level' of the students' parents, and partly associated with the 'cultural level' of the students' home environments. A single indicator, called 'The School Handicap Score', was developed for each school by combining information describing these two areas. This indicator was prepared in order to assess the effectiveness of the education provided by the school after allowance had been made for the nature of the community in which the school was operating.

Following an inspection of both between-student and between-school correlation matrices, six variables were selected to form the School Handicap Score: Father's Occupation, Father's Education, Mother's Education, Use of Dictionary, Number of Books in the Home, and Family Size. The Father's Occupation variable was prepared by the application of criterion scaling (Beaton, 1969) to a 9-point occupation classification system.

The researchers used regression analyses to determine the weights required to combine the six variables into the School Handicap Score. For each country the six variables were included in separate between-school analyses with school mean test scores for Reading, Science and Word Knowledge as criteria. The averages of the regression weights were calculated and rounded to form the weights for combining the six variables into the composite measure. Since Australia did not gather Reading scores the rounded regression coefficients were taken from analyses using Science and Word Knowledge as criteria.

The correlations between the School Handicap Score and school mean achievement scores on the tests of Word Knowledge, Reading, and Science have been presented for 12 countries in Table 8.4. Australia participated

Table 8.4 Correlations Obtained During the IEA Six-Subject Studies Between the 'School Handicap Score' and School Mean Achievement for Tests of Word Knowledge, Reading and Science.

Country	Age Level						Number of Schools	
	10-Year-Old			14-Year-Old			10-Year-Old	14-Year-Old
	Word Knowledge	Reading	Science	Word Knowledge	Reading	Science		
Australia	-	-	-	73	-	59	-	221
England	80	77	81	53	82	80	162	144
Finland	44	50	32	82	87	78	97	77
Germany (FRG)	42	-	45	86	-	68	68	85
Hungary	76	68	37	64	76	45	152	210
Italy	48	41	26	69	67	37	264	327
Japan	-	-	61	-	-	65	250	196
Netherlands	55	63	61	71	70	56	60	49
New Zealand	-	-	-	74	79	66	-	74
Scotland	80	84	81	81	87	90	104	70
Sweden	44	47	48	47	27	29	97	95
United States	80	79	81	84	82	78	255	137
Mean Correlation	61	64	55	74	73	63		

Note: a Decimal points have been omitted from correlation coefficients.

b The source of correlations for Science was Comber and Keeves (1973:205, 215), and the sources of correlations for Reading and Word Knowledge were various computer printouts which described the between-school analyses carried out during the IEA Six-Subject Studies (IEA, 1972).

c A dash in the table (-) means that the country did not gather data which would allow the calculation of a correlation coefficient.

in only the Science phase of the IEA studies at the 14-year-old level. Therefore no correlations were available at the 10-year-old level or at the 14-year-old level for Reading.

Since both the Word Knowledge Tests and the sample designs used at the 14-year-old level in the Australian IEA studies were the same as was used in this study it was possible to make some direct comparisons between the predictive powers of the School Handicap Score and the census based indicators.

The correlation listed in Table 8.4 between the IEA School Handicap Score and school mean achievement in Word Knowledge at the 14-year-old level was 0.73. The correlations listed in Table 8.3 for the census based indicators (SR(ALL), SR(SOCIAL), SR(BUILT), and PC(ALL) were 0.73, 0.71, 0.66, and 0.69 respectively. That is, at the 14-year-old level SR(ALL) had equivalent predictive power to the School Handicap Score with respect to school mean Word Knowledge scores and the other census based indicators had slightly lower predictive power. Further, while there were no other common measures of school mean achievement used in either study, it was important to note that the correlations between the census based indicators and school mean achievement scores in Literacy and Numeracy all, except for one correlation of 0.57, considerably exceeded the correlation of 0.59 between the IEA School Handicap Score and school mean achievement in Science.

No data were collected at the 10-year-old level for Australia in the IEA studies. Therefore it was not possible to make direct comparisons between the predictive power of the School Handicap Score and the census based indicators. However, the proximity of the correlations for Australia at the 14-year-old level to the mean correlations for the IEA countries listed at the bottom of Table 8.4, suggested that the mean correlations at the 10-year-old level might be a fair estimate of the results which would have been obtained if data had been gathered at the 10-year-old level in Australia. Following the pattern for most other countries we would expect that, if data were available, the correlations for Australia at the 10-year-old level would be slightly lower than the values established during the IEA studies at the 14-year-old level.

If these assumptions were accepted as being reasonably accurate, then inspection of the correlations for census based indicators in Table 8.3 showed again that the predictive power of the census based indicators would compare favourably with the predictive power of the School Handicap Score at the 10-year-old level in the IEA studies.

Social and Learning Handicap Correlates

The examination of the properties of the indicators was extended beyond their educational achievement correlates by considering information, provided by classroom teachers, which described the students in terms of certain social and learning handicaps. It was important to note that the validity of this information depended on classroom teachers' perceptions rather than, for example, the skilled diagnosis of a psychologist. However, it was argued that the daily contact of classroom teachers with their students would enable the teachers to provide sufficiently accurate information because the social and learning handicaps considered were based on overt student behaviour rather than more abstract constructs such as attitudes and aptitudes.

The responses provided by teachers about the 25 students in each sample school were scored dichotomously and then averaged to obtain a school mean score on each response. For example, the item which considered the 'social acceptance' of students required the teachers to state whether each sample student was 'Rejected or avoided by other students', 'Tolerated by other students', 'Liked by other students', 'Well liked by other students', or 'Very popular, sought out by other students'. The first two responses to this item were scored '1' and the other responses were scored '0'. Thus, when averaged for a sample school, this item referred to the proportion of students in a sample school who were 'Tolerated or Rejected by Students'. This school mean characteristic has been listed as the first item under the 'Social Handicaps' heading in Table 8.5. A similar scoring procedure was adopted for all other items in Table 8.5. Detailed descriptions of these items have been presented in Keeves and Bourke (1976). In general a high score for a school on an item showed that the school had a high proportion of students with that particular handicap.

The correlations between the indicators and each of the school mean characteristics have been listed in Table 8.5 for schools at each age level. For example the item describing the proportion of students in a school who had 'Difficulty in Using Pen/Pencil' had correlations of -0.14, -0.11, -0.16, and -0.12 at the 10-year-old level and correlations of -0.26, -0.24, -0.23, and -0.22 at the 14-year-old level with the indicators SR(ALL), SR(SOCIAL), SR(BUILT), and PC(ALL) respectively.

Table 8.5 Correlations Between the Census-Based Indicators and School Mean Scores for the Descriptions of Student Characteristics (10-Year-Old Schools and 14-Year-Old Schools.

School Mean Characteristics	Indicator							
	SR(ALL)		SR(SOCIAL)		SR(BUILT)		PC(ALL)	
	10	14	10	14	10	14	10	14
Social Handicaps								
Tolerated/Rejected	-21	-09	-19	-11	-14	*	-19	-08
Unable to Co-operate	-12	-17	-11	-16	-15	-17	-11	-17
Shy/Timid	-23	-12	-21	*	-13	-17	-20	-08
Abnormal Level Activity	-29	-08	-27	-08	-23	-12	-28	*
Isolates Self	-11	-10	-09	-08	-10	-11	-11	-09
Mean Correlation	-19	-11	-17	-10	-15	-13	-17	-10
Learning Handicaps								
Using Pen/Pencil	-14	-26	-11	-24	-16	-23	-12	-22
Following Instructions	-30	-23	-22	-23	-29	-23	-29	-23
Copying Written Work	-23	-27	-19	-27	-23	-27	-21	-27
Spelling Simple Words	-29	-30	-24	-27	-29	-32	-27	-31
Reading Reversals	-29	-16	-20	-12	-30	-19	-28	-15
Classroom English	-19	-10	-10	-08	-18	-13	-18	-08
Mean Correlation	-24	-22	-18	-20	-24	-23	-20	-16

Note: a Decimal points have been omitted from correlation coefficients.

b Number of schools at 10-year-old/14-year-old levels (weighted) = 271/256.

c The standard error for correlation coefficients at the between-school level of analysis was estimated by using the Jackknife technique. The results of these analyses have been reported in Appendix G. The average standard error for correlations was 0.035 and 0.042 at the 10-year-old and 14-year-old levels respectively. This gave confidence limits, based on two standard errors of ±0.07 for 10-year-old schools and ±0.08 for 14-year-old schools. Correlation coefficients which did not exceed two standard errors in magnitude have been marked with an asterisk (*).

All correlations between the indicators and the items describing social and learning handicaps in Table 8.5 were negative. At the 10-year-old level all correlations exceeded two standard errors in magnitude, and at the 14-year-old level this also occurred for the majority of the correlations. A low score on any of the four indicators would tend to identify a school having relatively high proportions of students both with social handicaps (associated with being tolerated/rejected, unable to cooperate, shy/timid, isolated, and abnormally active) and learning handicaps (associated with difficulties in using pen/pencil, following instructions, copying written work, spelling simple words, understanding classroom English, and exhibiting reading reversals).

The pattern of correlations in Table 8.5 enhanced the confidence which could be attributed to the use of the indicators as indicators of educational disadvantage. Although the development of the indicators had emphasized the need for high correlations with school mean achievement scores, these correlations showed that the indicators were also significantly related to a range of school mean behavioural characteristics which in themselves have been accepted by classroom teachers as both symptoms and causes of the inability to engage in effective learning.

Precision in Resource Allocation

The precision with which the indicators may be used to make resource allocation decisions was compared by constructing a table of average Accuracy and average Leakage coefficients for the Literacy and Numeracy tests at each age level. The Word Knowledge tests were not used in these comparisons because they had been used as the key scaling measures during the development of the indicators and hence evidence concerning these tests would have lacked generalizability.

In Tables 8.6 and 8.7 the values of average Accuracy coefficients and average Leakage coefficients, based on the theoretical model developed in Chapter 3, have been compared with coefficients calculated from sample data for the census-based indicators.

The coefficients of intraclass correlation for the Literacy and Numeracy tests were applied to the theoretical model in order to obtain the 'optimal' average Accuracy and Leakage values. The corresponding Accuracy and Leakage coefficients for the indicators were calculated from sample data by using the two-way table described in Figure 8.1.

	Students with Test Scores Below the 10th Percentile for Students	Students with Test Scores Above the 10th Percentile for Students
Students in Schools with Indicator Scores Above the 10th Percentile for Schools	n_a	n_b
Students in Schools with Indicator Scores Below the 10th Percentile for Schools	n_c	n_d

Figure 8.1 An Example of the Two-Way Tables Required for the Calculation of Accuracy and Leakage Coefficients for the Census-Based Indicators.

The example table in Figure 8.1 split the sample of students into four groups each of size n_a, n_b, n_c, and n_d, respectively. The average accuracy coefficient for schools with indicator scores below the 10th percentile for schools and students with test scores below the 10th percentile for students was then estimated by $100n_c/(n_c+n_d)$. For the theoretical model this corresponded to the value of average $A(10,p_2)$ taken over the lowest 10 per cent of schools.

For example, at the 10-year-old level the estimated average Accuracy coefficient was 21.4 for schools with SR(ALL) indicator scores below the 10th percentile for schools and students with Literacy scores on Test 10R below the 10th percentile for students. The corresponding theoretical model value based on an intraclass correlation coefficient of 0.156 was estimated to be 33.9. This theoretical model value was calculated by using PROGRAM NORMAL (See Appendix G).

The differences between the average Accuracy estimate obtained for an indicator and for the theoretical model provided a measure of the 'loss' in Accuracy associated with using the indicator, rather than school mean test scores, to identify groups of students with low test performance. In the above example, the theoretical model value of 33.9 represented an estimate of the 'optimal' average Accuracy value for Literacy scores on

Table 8.6 Comparison of Average Accuracy/Leakage Coefficients Obtained For the Indicators with 'Optimal' Average Accuracy/Leakage Coefficients Obtained from the Theoretical Model (10-Year-Old Schools)

Indicator	Groups of Schools						Mean Difference Between Indicator and Model	
	Lowest 10% of Schools			Lowest 20% of Schools				
	Accuracy		Leakage	Accuracy		Leakage	Accuracy Losses	Leakage Losses
	Lowest 10% Students	Lowest 20% Students		Lowest 10% Students	Lowest 20% Students			
Literacy (Test 10R: roh = 0.156)								
SR(ALL)	21.4	38.5	25.6	20.1	34.9	30.4	-9.3	+6.0
SR(SOCIAL)	19.4	34.0	28.0	17.5	32.8	33.0	-12.1	+8.5
SR(BUILT)	21.6	38.2	26.9	18.7	33.4	33.2	-10.1	+8.1
PC(ALL)	18.7	34.0	27.9	19.4	34.6	30.8	-11.4	+7.4
Theoretical Model	33.9	50.1	19.2	26.2	42.0	24.8		
Numeracy (Test 10N: roh = 0.122)								
SR(ALL)	19.2	31.3	29.8	17.2	29.5	36.1	-11.9	+8.8
SR(SOCIAL)	17.3	32.6	32.2	15.3	28.9	36.6	-12.5	+10.3
SR(BUILT)	18.0	32.1	33.7	17.2	27.8	37.6	-12.4	+11.5
PC(ALL)	15.9	31.1	34.5	17.4	30.3	34.7	-12.5	+10.5
Theoretical Model	32.1	47.7	21.4	24.9	40.1	26.9		

Note: a Number of schools/students at 10-year-old level (weighted) = 271/6416.

b. Number of schools/students at 14-year-old level (weighted) = 256/6046.

Test 10R at the 10-year-old level. The value of 33.9 estimated the percentage of students at the 10-year-old level in schools with mean scores on Test 10R below the 10th percentile for schools who had Test 10R scores which were below the 10th percentile for students. The 'loss' in accuracy for this example was 21.4 - 33.9 = -12.5.

Similarly, the average Leakage coefficient for the SR(ALL) indicator applied to Literacy scores at the 10-year-old level was 25.6 which represented a 'loss' of 25.6 - 19.2 = +6.4 compared to the theoretical model estimate.

Since the theoretical model average Accuracy values were the 'optimal' highest average Accuracy values and the theoretical model average Leakage values were the 'optimal' lowest average Leakage values, the 'losses' for Accuracy and Leakage were less than or equal to zero, and greater than or equal to zero, respectively. The indicators could therefore be judged in terms of their precision for identifying low performing students by comparing the magnitudes of the losses in Accuracy and Leakage. The most desirable indicator had 'losses' which approached zero (from below) for average Accuracy values and which approached zero (from above) for average Leakage values.

The first three columns of Tables 8.6 and 8.7 have listed the estimates of $A(10,p_2)$, $A(20,p_2)$, and $L(p_2)$ taken over the lowest 10 per cent of schools. The second three columns in this table have listed the same coefficients taken over the lowest 20 per cent of schools. The final two columns were obtained by calculating the mean losses separately for the four estimates of average Accuracy coefficients and the two estimates of average Leakage coefficients which were associated with each indicator.

For Literacy scores at the 10-year-old level the SR(ALL) indicator has the lowest average Accuracy loss, 9.3, and also the lowest average Leakage loss, 6.0. The lowest average losses for both Accuracy and Leakage also occurred for the SR(ALL) with respect to Numeracy at the 10-year-old level and Literacy at the 14-year-old level. At the 14-year-old level the SR(BUILT) indicator had slightly lower average losses for Numeracy than the SR(ALL) indicator. The SR(SOCIAL) indicator had the highest average losses in Accuracy for Literacy and Numeracy at both age levels.

Table 8.7 Comparison of Average Accuracy/Leakage Coefficients Obtained for the Indicators with 'Optimal' Averag[e] Accuracy/Leakage Coefficients Obtained from the Theoretical Model (14-Year-Old Schools)

Indicator	Groups of Schools: Lowest 10% of Schools — Accuracy: Lowest 10% Students	Lowest 10% of Schools — Accuracy: Lowest 20% Students	Lowest 10% of Schools — Leakage	Lowest 20% of Schools — Accuracy: Lowest 10% Students	Lowest 20% of Schools — Accuracy: Lowest 20% Students	Lowest 20% of Schools — Leakage	Mean Difference Bet[ween] Indicator and Model: Accuracy Losses	Mean Difference Bet[ween] Indicator and Model: Leak[age] Loss[es]
Literacy (Test 14R: roh = 0.194)								
SR(ALL)	33.7	52.4	16.7	20.8	35.2	32.5	-4.5	+4
SR(SOCIAL)	28.9	47.7	20.6	21.3	35.4	32.5	-6.7	+6
SR(BUILT)	31.0	48.6	20.2	21.4	35.4	33.9	-5.9	+7
PC(ALL)	29.8	49.2	21.1	21.0	35.5	33.7	-6.2	+7
Theoretical Model	35.8	52.8	16.8	27.5	44.0	22.6		
Numeracy (Test 14N: roh = 0.150)								
SR(ALL)	27.5	44.7	26.6	18.9	32.4	36.4	-7.0	+9
SR(SOCIAL)	23.4	39.7	27.8	18.4	31.5	37.4	-9.5	+10
SR(BUILT)	27.5	44.0	27.1	20.0	33.8	34.7	-6.5	+8
PC(ALL)	25.4	40.9	27.7	18.5	32.8	35.1	-8.4	+9
Theoretical Model	33.6	49.8	19.5	26.0	41.7	25.1		

Note: a Number of schools/students at 10-year-old level (weighted) = 271/6416.

b Number of schools/students at 14-year-old level (weighted) = 256/6046.

Investigation of Residuals

The school neighbourhood information which was used to construct the indicators was based solely on census percentage variables. However two other variables, Type of School (Government, Catholic, Independent) and School Location (Metropolitan, Non-Metropolitan), were available from the data used to construct the sampling frames. While these variables did not give specific information about the nature of school communities, they could be seen as surrogate measures for certain community characteristics which have been shown to be correlated with educational achievement. For example, communities having many students who attend non-government rather than government schools may differ a great deal in terms of income, attitudes, and aspirations. Also, communities having many students who attend non-metropolitan rather than metropolitan schools may differ in terms of physical and social isolation.

Inspection of the means on the Literacy and Numeracy tests for the categories of the Type of School and School Location variables revealed a consistent pattern across both age levels. The Type of School variable categories showed that the means for Independent schools were higher than for Catholic schools which in turn were higher than for Government schools. Also, the School Location variable categories showed that the means for Metropolitan schools were higher than for Non-Metropolitan schools. This general pattern of achievement across different types of schools in Australia has also been documented in studies carried out by the International Association for the Evaluation of Educational Achievement (Keeves, 1978).

These two variables therefore provided an opportunity to examine the nature of the residual variation associated with the use of the indicators as predictors of school mean achievement in the basic skills of Literacy and Numeracy. Accordingly, a between-school stagewise regression technique was used to assess whether the Type of School variable and the School Location variable could be used to explain differences in school mean achievement scores 'over and above' the differences explained by the indicators. For each age level each of the indicators was initially introduced into a regression analysis using, in turn, school mean Literacy scores and school mean Numeracy scores as criterion variables. At a second stage of the analyses two dummy variables (Independent School, Catholic School) created from the three categories of the Type of School variable and one dummy variable (Non-Metropolitan School) created from the two categories of the School Location variable were entered into the regression analysis.

The results of these analyses have been summarized in Tables 8.8 and 8.9. For each regression equation the correlation coefficients between predictor and criterion variables (r) and the multiple correlation coefficient for the two stages of the regression analyses (R) have been listed.

The correlation coefficients displayed a similar pattern for all predictor variables. Large positive correlations were obtained for the indicators and correlations smaller in magnitude were obtained for the dummy variables. The correlations between the dummy variables and the school mean scores for Literacy and Numeracy followed a pattern which had been expected after examination of the means of the categories of the Type of School and School Location variables: positive correlations were associated with the Independent School and Catholic School dummy variables and negative correlations were associated with the Non-Metropolitan School dummy variable. The correlations presented for school mean scores in Literacy, at both age levels, all had magnitudes in excess of two standard errors after adjustment for the sample design. However, for school mean scores in Numeracy, the correlation with the Non-Metropolitan School dummy variable was slightly within these limits at the 14-year-old level and the correlation with the Independent School dummy variable was well within these limits at the 10-year-old level.

Statistical tests were conducted to assess whether the contributions of the second stage variables to predictive power were significantly different from zero. A statistically significant contribution at the 95 per cent level has been denoted by an asterisk beside the multiple correlation coefficient at the second stage. There were no statistically significant contributions obtained for any of the analyses conducted at the 10-year-old level. However at the 14-year-old level six of the eight stepwise regression analyses showed statistically significant contributions.

The statistically significant contributions found for certain of the 14-year-old analyses inferred that the hypothesis that the second stage contributions to predictive power were zero was rejected at the 95 per cent confidence level. An inspection of these significant contributions demonstrated however that the 'practical' contributions to predictive power were virtually negligible. This negligible practical contribution

Table 8.8 Stepwise Regression Analyses Used to Examine Residuals for School Mean Literacy Scores (10-Year-Old Schools and 14-Year-Old Schools)

Stage	Variable	SR(ALL) r	SR(ALL) R	SR(SOCIAL) r	SR(SOCIAL) R	SR(BUILT) r	SR(BUILT) R	PC(ALL) r	PC(ALL) R
10-Year-Old Schools									
1	Indicator	71	71	62	62	69	69	67	67
2	Independent School	09	71	09	63	09	69	09	67
	Catholic School	11		11		11		11	
	Non-Metro School	-13		-13		-13		-13	
14-Year-Old Schools									
1	Indicator	70	70	64	64	68	68	67	67
2	Independent School	30	71*	30	65*	30	72*	30	70*
	Catholic School	20		20		20		20	
	Non-Metro School	-09		-09		-09		-09	

(Column groups: Regression Equation with Literacy Criterion)

Note: a Decimal points have been omitted from correlation coefficients.

b Number of schools at 10-year-old/14-year-old levels (weighted) = 271/256.

c Confidence limits for correlation coefficients based on two standard errors were ±0.07 for 10-year-old schools, and ±0.08 for 14-year-old schools. (See Table 8.5, footnote c.)

d Confidence limits for multiple correlation coefficients were taken to be equal to those for correlation coefficients. This followed results presented by Ross (1978) concerning the similarity of design effects for these two statistics for stratified sample designs.

e The statistical test for the significance of the contribution of the second stage variables to variance explanation was based on the formula for the F statistic given by Thorndike (1978:162). An asterisk (*) has been placed beside the R value for the second stage of the stepwise regression analysis to denote that the contribution to explained variance at the second stage was significantly different from zero at the 95 per cent confidence level.

may be seen by comparing the very small changes between the multiple correlation coefficients for each stage of the stepwise regression analyses.

Further, at the 14-year-old level, the relatively high zero order correlations between the Independent School and Catholic School dummy variables and school mean scores on the Literacy and Numeracy tests had

Table 8.9 Stepwise Regression Analyses Used to Examine Residuals for School Mean Numeracy Scores (10-Year-Old Schools and 14-Year-Old Schools)

Stage	Variable	Regression Equation with Numeracy Criterion							
		SR(ALL)		SR(SOCIAL)		SR(BUILT)		PC(ALL)	
		r	R	r	R	r	R	r	R
10-Year-Old Schools									
1	Indicator	59	59	51	51	62	62	58	58
2	Independent School	04	60	04	52	04	62	04	58
	Catholic School	13		13		13		13	
	Non-Metro School	-08		-08		-08		-08	
14-Year-Old Schools									
1	Indicator	66	66	57	57	69	69	63	63
2	Independent School	29	67	29	59	29	71*	29	65*
	Catholic School	14		14		14		14	
	Non-Metro School	-08		-08		-08		-08	

Note: a Decimal points have been omitted from correlation coefficients.

b Number of schools at 10-year-old/14-year-old levels (weighted) = 271/256.

c Confidence limits for correlation coefficients based on two standard errors were ±0.07 for 10-year-old schools, and ±0.08 for 14-year-old schools. (See Table 8.5, footnote c.)

d Confidence limits for multiple correlation coefficients were taken to be equal to those for correlation coefficients. This followed results presented by Ross (1978) concerning the similarity of design effects for these two statistics for stratified sample designs.

e The statistical test for the significance of the contribution of the second stage variables to variance explanation was based on the formula for the F statistic given by Thorndike (1978:162). An asterisk (*) has been placed beside the R value for the second stage of the stepwise regression analysis to denote that the contribution to explained variance at the second stage was significantly different from zero at the 95 per cent confidence level.

minimal impact on the difference between the multiple correlations coefficients and standard error of estimates at each stage. In general the changes in multiple correlation coefficients between stages for all analyses were well within the bounds of two standard errors at the 10-year-old level (±0.07) and the 14-year-old level (±0.08). That is, the differences between multiple correlation coefficients between stages were well within the limits which could be expected to cover the random sampling fluctuations associated with the estimate of any one multiple correlation coefficient.

These results demonstrated that the Type of School and School Location variables were able to add little, or nothing, to the explanation of variation in school mean achievement scores 'over and above' the explanatory power of the indicator scores. That is, the information contained within these two variables was rendered mostly redundant because it was already incorporated in the structure of the indicators.

This was an important property of the indicators because it demonstrated that, if they were to be used in Australia-wide resource allocation programs, then schools from different school systems and in different locations could be compared directly by examination of their indicator scores.

Indicator Stability: Theoretical and Cross Age

The preparation of the indicators was based on a least squares procedure which used certain combinations of census percentage variables to predict school mean Word Knowledge scores. However, it was known that least squares procedures tended to capitalize on relationships that exist within particular samples of data. This characteristic has often limited the predictive power of composites arising from regression analysis when they have been applied to new samples of data because successive random samples from the same population may differ in the nature and extent of the relationships among the variables being studied. Thorndike has described the tendency for differences to exist between relationships in random samples from the same population as 'sample-specific covariation' (Thorndike, 1978:162).

McNemar (1969:205) has provided a formula which may be used to estimate the degree of 'shrinkage' in multiple correlation coefficients when a regression equation has been applied to new random samples from the same population:

$$\hat{R}^2 = 1-(1-R^2)\frac{N-1}{N-n}$$

where $\hat{R}^2$ = the 'shrunken' estimate of the multiple correlation coefficient,
N = the sample size,
R = the observed estimate of the multiple correlation coefficient,
and n = the number of variables used in the regression analysis.

When this equation was applied to the indicators the resulting estimates of shrinkage in the multiple correlation coefficients were around 0.01 for all indicators. For example, the SR(ALL) indicator at the 10-year-old level was based on ten linear composites (see Table 7.3). Also, the sample size was 271 and the observed multiple correlation coefficient was 0.71.

$$\text{Thus} \quad \hat{R}^2 = 1-(1-(0.71)^2)\,\frac{271-1}{271-11}$$

$$= 0.49$$

That is, the theoretical estimate of the correlation between the SR(ALL) indicator and school mean Word Knowledge scores for a new sample from the same population of 10-year-old schools was 0.70.

The estimate of shrinkage in the above formula was derived under the assumption of ideal random samples. Under less-than-perfect sampling conditions this formula provides an estimate of the minimum amount of shrinkage which could be expected. Thorndike (1978) has suggested that a more realistic method for establishing the stability of the predictive power of a regression equation is to divide the available data into two parts and then conduct a 'cross-validation' in which the regression equation is developed for the first part of the data and then tested or validated on the second part.

Due to the limited number of observations available it was not possible to divide the data into 'development' and 'holdout' samples. Rather, it was decided to conduct a cross-validation by testing the indicators across age levels. The indicators developed at the 10-year-old level were tested with the 14-year-old level data and vice-versa. This 'cross-age' validation provided a more demanding test of the stability of the indicators as predictors of school mean achievement than the assessment based on the theoretical formula. Further, since the instruments used to measure school mean achievement were different between age levels, this cross-age validation extended the evaluation of the stability of the indicators to an even more exacting situation by combining a test of the indicators in a sample from a different population with a test of the indicators with respect to different instruments used to measure school mean achievement.

The results of the cross-age validation have been presented in Table 8.10. The differences between the correlations in this table and the correlations presented in Table 8.3 provided an assessment of the shrinkage

Table 8.10 Cross-Age Correlations Between School Mean Scores at One Age Level and Indicators Developed at the Other Age Level

School Mean Scores	Indicator			
	SR(ALL)	SR(SOCIAL)	SR(BUILT)	PC(ALL)
10-Year-Old Indicators Applied to 14-Year-Old Schools				
Word Knowledge (14-Year-Old)	65	61	66	66
Literacy (Test 14R)	61	54	64	62
Numeracy (Test 14N)	56	46	64	57
Mean Correlation	61	54	65	62
14-Year-Old Indicators Applied to 10-Year-Old Schools				
Word Knowledge (10-Year-Old)	61	57	58	64
Literacy (Test 10R)	60	50	67	65
Numeracy (Test 10N)	54	46	61	59
Mean Correlation	58	51	62	63

associated with the application of the indicators to different age samples. The correlations were, as expected, somewhat lower when the indicators developed at one age level were applied to the sample from the other age level. The only exception to this was the SR(BUILT) indicator developed at the 10-year-old level. This indicator had higher correlations when applied to the 14-year-old sample for both school mean Word Knowledge and Numeracy scores.

The SR(ALL) and the SR(SOCIAL) indicators suffered the greatest degree of shrinkage for indicators developed at both age levels. This was particularly noticeable for these two indicators developed at the 14-year-old level because the mean correlations 'shrunk' from 0.70 to 0.58, and from 0.64 to 0.51 for the SR(ALL) and SR(SOCIAL) indicators respectively. The SR(BUILT) and the PC(ALL) indicators exhibited a low degree of shrinkage for indicators developed at both age levels. The SR(BUILT) indicator developed at the 10-year-old level was the most robust of all the indicators. This indicator had the same mean correlations when applied to either the 10-year-old or 14-year-old samples.

Comparison of Indicator Performance

In order to make an overall comparison of the performance of the indicators a list of seven criteria was prepared. Five of these described correlational properties of the indicators and the remaining two were concerned with assessments of the precision with which the indicators could be used for resource allocation. At each age level the indicators were given a ranking according to their performance with respect to the seven criteria. These rankings have been presented in Table 8.11.

In the following discussion each of the criteria and the procedures used to rank the indicators have been described.

Achievement Variables. The development of the indicators aimed to provide composites based on census percentage variables which were highly correlated with school mean achievement scores. Therefore, for this criterion, the indicators were compared according to the average of the correlations between the indicators and the three measures of school mean achievement in Table 8.3.

The average correlations were highest at both age levels for the SR(ALL) indicator. At both age levels the average correlations then decreased in magnitude for the SR(BUILT), PC(ALL), and SR(SOCIAL) indicators. The rankings for this criterion have been presented for each age level in the first row of Table 8.11.

Social and Learning Handicaps. Although the indicators were developed to have high correlations with school mean achievement scores, it was considered desirable that they should also be significantly correlated with certain school behavioural characteristics. The 'Social' and 'Learning' handicaps in Table 8.5 represented a list of behavioural characteristics which, if found in high concentrations in certain schools, would limit the capacity of these schools to proceed with most aspects of the educational process. The indicators were therefore ranked separately for the Social and Learning handicaps according to the average correlations between the indicators and the handicaps listed in Table 8.5.

The average correlations were very similar for all indicators at each age level. For example, at both age levels the average correlations for the SR(SOCIAL) and PC(ALL) indicators with Social handicaps were equal to the second decimal place. Calculations to the third decimal place were therefore carried out in order to obtain the rankings. This similarity

Table 8.11 Comparison of Indicator Performance According to Seven Criteria (10-Year-Old Schools and 14-Year-Old Schools)

Criterion	SR(ALL) 10	SR(ALL) 14	SR(SOCIAL) 10	SR(SOCIAL) 14	SR(BUILT) 10	SR(BUILT) 14	PC(ALL) 10	PC(ALL) 14
Achievement Variables	1	1	4	4	2	2	3	3
Social Handicaps	1	2	3	4	4	1	2	3
Learning Handicaps	2	2	4	3	1	1	3	4
Cross-Age Stability	3	3	4	4	1	2	2	1
Residuals	2	1	4	2	1	4	3	3
Accuracy	1	1	4	4	2	2	3	3
Leakage	1	1	3	4	4	2	2	3
Mean Rank	1.6	1.6	3.7	3.6	2.1	2.0	2.6	2.9

in indicator performance was evident throughout many of the calculations carried out to compare the indicators on the seven criteria.

Cross-Age Stability. In order for the indicators to be useful for application to schools in general, it was essential that the strength of the relationships between the indicators and school mean achievement scores obtained for the 'development' samples be maintained for different samples of schools and different measures of school mean achievement. The indicators were compared by considering the average correlations between the indicators and school mean Word Knowledge, Literacy and Numeracy scores for the 'cross-age' analyses described in Table 8.10. The rankings of the indicators were constructed from these average correlations.

There was a great deal of similarity in the average correlations for the SR(ALL), SR(BUILT) and PC(ALL) indicators at both age levels. The predictive power of the SR(SOCIAL) indicator was considerably less than the other three indicators at both age levels.

Residuals. An important characteristic of the indicators was that they should be able to be applied to schools in general without recourse to the use of additional information concerning special subgroups of schools. The investigation of residual variation described in Tables 8.8 and 8.9 demonstrated that negligible gains in predictive power were associated with the Type of School and School Location variables.

The rankings for the 'Residuals' criterion were based on the average of the additional contributions to variance explanation in Literacy and Numeracy school mean scores which occurred when the Type of School and School location information was included in a stepwise regression model following the inclusion of each indicator. The indicator having the smallest mean additional contributions was ranked highest and so on for the other indicators. Calculations to the level of 0.1 per cent of variance were required to discriminate between the performances of the indicators on this criterion. Therefore, while the rankings of the indicators differed between age levels it was important to remember that, again, the degree of difference between indicator performance was very small.

Accuracy and Leakage. The rankings of the indicators for these two criteria were obtained by calculating the average of the indicator estimates derived from the theoretical model for Literacy and Numeracy school mean scores presented in Tables 8.6 and 8.7.

The rankings were the same for the Accuracy criterion at both age levels, but different for the Leakage criterion. The differences between the indicators on these two criteria were also very small. Within age levels the maximum difference in Accuracy Losses and Leakage Losses for both Literacy and Numeracy was around 2 per cent, and the maximum difference in the average of these Losses across the Literacy and Numeracy criteria was around 1.5 per cent.

Overall Performance

The means of the performance rankings of the indicators with respect to the seven criteria have been presented in Table 8.11. At both age levels the high mean rankings of the SR(ALL) indicator showed that it had the best overall performance on these criteria. In addition it was important to note that the SR(ALL) indicator had clearly better performance on the most critical areas of these criteria - the Accuracy and Leakage associated with precision in resource allocation to those students who would be in most need of assistance. This indicator was therefore selected as the 'preferred' indicator of educational disadvantage among the four which had been developed for the identification of educationally disadvantaged schools in Australia.

Summary

In this chapter the four indicators of educational disadvantage, SR(ALL), SR(SOCIAL), SR(BUILT), and PC(ALL), were subjected to a range of analyses which were designed to provide a detailed investigation of their properties. The performance of the indicators was examined in terms of their capacity to (1) predict school mean achievement scores (Word Knowledge, Literacy, and Numeracy) and school mean behavioural climate scores (Social and Learning Handicaps), (2) maintain predictive power with respect to school mean achievement scores when applied to different samples of schools and students, (3) be able to be applied to schools in general without recourse to the use of additional information concerning special subgroups of schools (Type of School and School Location), and (4) display high levels of precision (Accuracy and Leakage) associated with the identification of students who would be in most need of assistance.

The overall performance of the indicators across these criteria was compared by ranking the indicators for each criterion and then calculating the mean of these rankings. At both age levels the mean ranks of the indicators suggested that, with respect to the criteria considered, the SR(ALL) indicator provided the best overall performance. Therefore, this indicator emerged as the 'preferred' indicator among the four which had been developed for the identification of educationally disadvantaged schools in Australia.

CHAPTER 9

THE 'MEANING' OF THE INDICATORS: REVIEW OF MODELS OF RESIDENTIAL DIFFERENTIATION

Introduction

The indicators which were prepared and examined in the previous chapters were based on school neighbourhood information. Their success as predictors of both school mean achievement scores and the incidence of learning and social handicaps in schools depended, in part, upon the situation that Australian school neighbourhoods do vary in terms of census-based information. If all Australian school neighbourhoods had exhibited the same profile of census characteristics then the indicators would have had zero correlation with any other variable. In fact, if this had occurred, then it would have been impossible to construct the indicators because the basic census percentage variables which were used in their construction would have had zero correlation with the criterion variable used in the scaling procedures.

The tendency for communities to exhibit differences in geographical space has received considerable attention by social science research workers during this century because of the growing availability of census information and high-speed computers in many countries. This research has mainly been concerned with attempts to develop models of residential differentiation which describe the patterns and social dimensions associated with observed variations in community characteristics. In this chapter a review of these approaches has been presented with aim of selecting a model of residential differentiation which would enable a discussion of the meaning of the dimensions assessed by the indicators to be placed within a theoretical framework.

The review initially summarized features of the 'classical' models of residential differentiation which were developed in the United States during the first half of this century. This section of the review was relatively brief for the reason that detailed descriptions of these models and critiques of their performance have been discussed at length in the literature (for example, Robson, 1969; Timms, 1971; Murdie, 1976). A more detailed review of the Shevky-Bell Social Area Analysis model was then undertaken because this model provided an opportunity to evaluate the meaning of the indicators in terms of three dimensions of residential differentiation which have been shown to exhibit a high degree of generality across a range of studies and settings.

Human Ecology Models

The word 'ecology' was originally used by botanists and zoologists to describe the study of the relationships of plants and animals to their physical environment. Around the early part of this century a group of sociologists, led by R.E. Park at the University of Chicago, applied some of the theories and procedures of biological ecology to the study of the growth of cities and thereby established the field of 'human ecology' (Park, Burgess and McKenzie, 1925).

Certain processes which had been proposed by Darwin and accepted by botanists were translated by the Chicago school into human terms. For example, they discussed competition between different population groups in terms of areal 'invasion' eventually leading to 'succession' (Burgess, 1925).

At the centre of the human ecology model was the assumption that the urban environment was not a random collection of buildings and people but rather 'a mosaic of social worlds' (Wirth, 1938:2). The pieces in this mosaic were described as 'natural areas' each of which represented 'a territorial unit whose distinctive characteristics - physical, economic and cultural - are the result of the unplanned operation of ecological and social processes' (Burgess, 1964:458).

In later empirical studies (reviewed by Robson (1969:17-18)) researchers began to question whether the natural area was an acceptable unit with which to describe the structure of human communities. These studies demonstrated that the identification of natural areas was dependent upon the type of data which was examined, and also that the ecological forces which had been proposed to be instrumental in the formation of natural areas had taken no account of the importance of an individual's sentimental and symbolic attachments to a residential area.

Burgess' Concentric Zone Model

The investigations of the Chicago ecologists associated with the natural areas of the city were extended by Burgess (1925) in order to explain certain spatial patterns in the development and community structure of urban areas in the United States. The ecological concepts of invasion and succession were combined into a theory which portrayed urban growth as a series of concentric circles surrounding the central business area.

Burgess (1925) presented two charts which showed five concentric circles describing the zones of development in an idealized city and the city of Chicago. These zones were defined according to principal land usage: (1) 'loop' - the central business district, (2) 'zone in transition' - an originally residential zone which was being subjected to invasion by business and industry, (3) 'zone of workingmen's homes' - a zone inhabited by workers in industries who have 'escaped' from the inner zones but who desired to live within easy reach of their work, (4) residential zone' - a zone of high class apartment buildings or of exclusive districts of single family dwellings, and (5) 'commuters zone' - a zone of suburban areas or satellite cities which were within thirty to sixty minutes of travel time from the central business district.

Since the publication of the Burgess model a range of critiques and empirical studies (reviewed by Timms (1971:218-223) have been carried out to assess the theoretical foundations and generalizability of the model. The most severe criticisms emerging from these investigations have been that Burgess' zones were merely arbitrary classifications rather than 'real' divisions describing distinct social units, and that the model was not applicable to small non-industrial cities.

Hoyt's Sector Model

Hoyt (1939) suggested that the distribution of city neighbourhoods according to their social prestige ratings was characterized by a tendency to follow sectoral patterns emerging from the city centre. The sector model accordingly proposed that different types of residential areas grew outward along distinct radii, and that new growth on the arc of a given sector tended to take on the character of the initial growth in that sector.

The sector model was based on Hoyt's examination of average rent levels in a large number of cities in the United States. Hoyt presented maps of the average rent levels in the cities in order to demonstrate that high and low rent neighbourhoods were not aligned concentrically, as the Burgess model would have predicted, but rather in a sectoral fashion. Giving prime importance to the high rent sector, Hoyt suggested that the point of origin of this sector focussed on the location of the retail and office centres where members of the population with high incomes tended to work. The growth of this sector dominated all others as it moved outward from the centre along lines of travel or towards another building or trading centre and away from areas of current or potential industrial growth. Intermediate level rental areas tended to surround the high rental areas on each side. The low rental areas either filled in the available sectoral gaps or were located in what were once high or intermediated level areas before the previous residents moved outwards in a sectoral fashion.

Criticism of the Hoyt model (reviewed by Timms (1971:227-229) has centred on the use of rent as an operational measure of social prestige, and also on the vague definition and positioning of sectors within the model. This latter problem has limited the usefulness of many subsequent attempts to test the generalizability of the model because researchers have, in the absence of a detailed and objective definition of a 'sector', often resorted to the use of arbitrary geometric sectoral divisions of the city area.

Harris and Ullman's Multiple Nuclei Model

Harris and Ullman (1945) rejected the concept of a single centre of urban development which had been a feature of both the zonal and sectoral models. The number and type of centres or nuclei were considered to vary from city to city. However the development of separate nuclei was believed to be associated with four common factors: (1) the need for specialized areas, for example large scale transportation by rail, water, etc., (2) the clustering together of industries for mutual benefit, (3) the incompatability of certain areas, for example high status residential areas and industrial estates, (4) the need for storage and distribution centres outside the high-cost central business areas.

The multiple nuclei model described a much more complex pattern of urban development than the zonal or sectoral models. It was not a radically different approach but rather an attempt to introduce an extra feature into the explanation of the nature of urban development which would account for the observed deviation of many cities from these two models. Timms (1971:211) has described this model as 'a caveat to the more general zonal and sectoral models'.

Integration of the Zonal and Sectoral Models

A great deal of the initial empirical investigations of the zonal and sectoral models of urban structure were concerned with separate tests of the utility of each model and each of the models was shown to have limited generalizability. Eventually Berry (1965) proposed a multidimensional approach to the problem by suggesting that the zonal and sectoral models were independent, additive contributors to the total socio-economic structuring of city neighbourhoods. Berry suggested that residential structure could be characterized by axial variation of neighbourhoods according to socioeconomic rank, and concentric variation of neighbourhoods according to family structure.

The evidence for Berry's proposal seems to have rested on research studies which had employed analysis of variance techniques to assess the separate effects of zones and sectors in the distribution of social characteristics. The earliest of these studies appears to have been Anderson and Egeland's (1961) analysis of the spatial variance of a number of socioeconomic measures within four cities in the United States. Anderson and Egeland used a two-factor analysis of variance design to assess the spatial variation of an index of 'social rank', composed of occupation and education measures, and an index of 'urbanization', composed of measures of family characteristics. The results of the analyses demonstrated that social rank varied principally by sector, and urbanization by concentric ring. Later studies which had employed similar statistical designs obtained similar results. A range of these studies has been reviewed by Murdie (1976:247-258).

Shevky and Bell's Social Area Analysis Model

In the 1950's interest in the theories of the Chicago school of human ecologists began to wane as sociologists on the West Coast of the United States commenced to question the assumption that the spatial arrangement of one city, Chicago, could be considered to be typical of urban society. The most important chall[illegible] this assumption emerged following investigations of social [illegible] and residential differentiation in the cities of Los Ang[illegible]sco (Shevky and Williams, 1949; Bell, 1953; Shevky and [illegible].

These 'social [illegible]' studies represented a change in emphasis from a search for consistent patterns of urban growth to a concern with the key social dimensions which described residential patterns in geographical space. Rather than attempt to describe residential structure in terms of ecological processes, Shevky and his colleagues sought to relate the nature and extent of residential differentiation to the social forces which were characteristic of society as a whole.

> We conceive of the city as a product of the complex whole of modern society; thus the social forms of urban life are to be understood within the context of the changing character of the larger containing society. (Shevky and Bell, 1955:3)

The theoretical rationale for the social area analysis approach was described in detail by Shevky and Bell (1955). The cornerstone for the rationale was the concept of societal 'scale', a term which had earlier been employed by social anthropologists to describe 'the number of people in relation and the intensity of these relations' (Wilson and Wilson, 1945:25). By combining this concept with Clark's (1951) research into the division of labour in society, Shevky and Bell suggested that an increase in societal scale was synonymous with the emergence of modern urban-industrial society:

> It is our contention that the postulate of increasing scale in modern society gains in analytic utility when we are able to specify that in all technologically advanced modern societies the most important concomitant of changes in productivity, and changes in economic organization with the consequent alterations of social relations, has been the movement of working population from agriculture to manufacture, and from manufacture to commerce, communication, transport, and service. (Shevky and Bell, 1955:8-9)

The effects of increasing societal scale were linked by Shevky and Bell to Wirth's (1938) sociological definition of the city in relation to population size, population density, and heterogeneity in the social composition of the population. However they challenged his assumption that it was the city which was the underlying 'prime mover' in the recent transformation in the scale of Western society. Rather, the 'necessities of economic expansion' were considered more important because the focus for an increase in scale was on the 'total society' as well as on cities within that society.

The essential features of the social area model have been presented in diagrammatic form in Figure 9.1. An increase in societal scale was assumed to be reflected in three sets of trends: changes in the distribution of skills, changes in the structure of productive activity, and changes in the composition of the population. These three trends were considered to lead to 'three structural reflections of change which can be used as factors for the study of social differentiation and stratification at a particular time in modern society' (Shevky and Bell, 1955:4-5). The final step was to select measures which could be used to assess the factors (or constructs) labelled 'social rank', 'urbanization', and 'segregation'. The construct labels in brackets in Figure 9.1 refer to Bell's (1955) revised formulation of the original Shevky and Williams (1949) labels.

The first construct 'social rank', or 'economic status', was measured by 'occupation' (based on 'the total number of craftsmen, operatives and labourers per 1,000 employed persons' (Shevky and Bell, 1955:54)), and 'schooling' (based on 'the number of persons who have completed no more than grade school per 1,000 persons 25 years old and over' (Shevky and Bell, 1955:55)). 'Rent' was later removed from the measurement of the social rank construct because it was considered that the rental controls introduced by the United States government during the Second World War might have affected the validity of rent as an index of social rank.

The second construct 'urbanization', or 'family status', was measured by 'fertility' (based on 'the number of children under 5 years per 1,000 females aged 15 through 44' (Shevky and Bell, 1955:55)), 'women at work' (based on 'the number of females in the labour force per 1,000 females 14 years old and over' (Shevky and Bell, 1955:55), and 'single-family dwelling units' (based on 'the number of single-family dwelling units per 1,000 dwelling units of all types' (Shevky and Bell, 1955:56).

The third construct 'segregation', or 'ethnic status', was measured by 'racial and national groups in isolation' (based on the number of non-white minority persons, for example Negroes, Mexicans, Cubans, etc., and the number of foreign-born whites, for example Poles, Czechoslovakians, Hungarians, etc. (Shevky and Bell, 1955:56-57).

For each of the three constructs two alternative names were presented by Shevky and Bell. The first referred to the name preferred by Shevky and the second to the name preferred by Bell. In an appendix to Shevky and Bell's (1955:68) description of how to construct the three indices, each author provided a brief statement in support of his position.

Bell emphasized that his preference for the word 'status' did not refer to a prestige connotation. Rather, the word status described 'each sub-population's position with respect to each dimension or factor' (Shevky and Bell, 1955:68). The main point of disagreement between the authors appears to have been associated with the labelling of the second construct as either 'urbanization' or 'family status'. Bell considered 'family status' to be a more limited concept than 'urbanization' and was both closer to the variables which were used in its measurement and more easily interpretable.

In a later publication Bell (1965) made further modifications to the names of the constructs by replacing 'economic status' with 'socioeconomic status', 'family status' with 'familism', and 'ethnic status' with 'ethnicity'. These names appeared to be more congruent with the measures which were used to construct the indices. In particular, the removal of the word 'status' from the names of the second and third constructs satisfied the earlier concern expressed by Bell that there should be no connotation of prestige associated with these constructs. These later labels have been used in the discussion which follows in this chapter.

Debate and Evaluation Associated with Shevky and Bell's Social Area Analysis Model.

Since the initial publication of the Shevky-Bell social area analysis model there has been considerable debate concerning both the theoretical foundations of the model and the generality of the three dimensions of residential differentiation.

Theoretical Foundations. The debate in this area has mostly centred on Shevky and Bell's reliance on the concept of 'scale' and their proposition that a causal sequence could be established which began with a theory of social change, evidenced by changes in 'scale', and ended with a theory of residential differentiation, evidenced by the emergence of the 'socioeconomic status', 'familism', and 'ethnicity' dimensions.

Shevky and Bell's use of the concept of 'scale' borrowed heavily from the work of Wilson and Wilson (1945) and was defined as 'the scope of social interaction and dependency' (Shevky and Bell, 1955:7). However, as Timms (1971) has noted, the presentation of the steps in the formation of constructs and indices included this meaning as only one of the 'aspects of increasing scale':

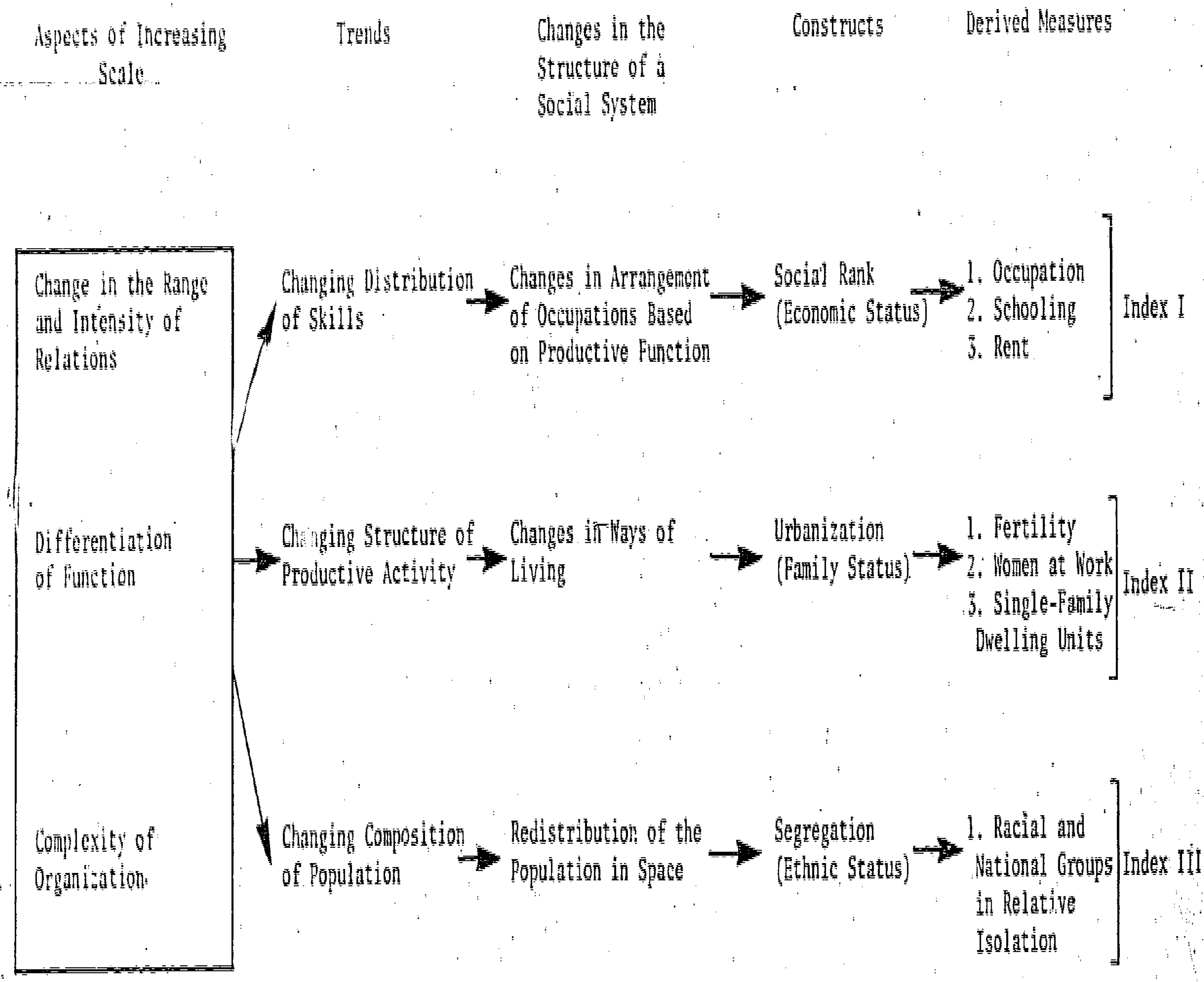

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Figure 9.1 Steps in the Shevky-Bell Scheme for Construct Formation and Index Construction.

Source: Based on table presented on page 4 of Shevky and Bell, Social Area Analysis (1955).

> What is elsewhere treated as providing the definition of changes in scale is here treated as but one aspect of them. It is unclear whether the concept of increasing scale is intended to reference an independent set of phenomena, concerned with social interaction, or whether it is merely intended as a general term to describe all those historical trends which reflect the change from traditional agrarian forms of social organization to those characteristic of modern industrial society. (Timms, 1971:139)

While Timms noted some lack of clarity in the way in which societal scale was defined and then applied, Nadel (1953) and later Jones (1969) pointed out that difficulties of interpretation were also associated with the interpretation of this concept provided by the originators of the term 'scale'. Therefore there seems to have been some degree of inevitability in the criticism which has been levelled at Shevky and Bell's use of the concept.

Extensive consideration of the nexus between the issues of definition and application of the concept of 'scale' has generally been avoided by the proponents of social area analysis. It would appear that most authors have been content to accept the notion of increasing societal scale as 'a shorthand equivalent for the processes of urbanization, industrialization, and modernization' (Jones, 1969:17).

The second aspect of the theoretical development of the Shevky-Bell model which received a great deal of criticism was concerned with the proposed linkage between increasing societal scale and the dimensions of residential differentiation. Shevky and Bell provided limited evidence to support any meaningful linkages between these two societal characteristics. For example, they provided no substantial evidence to explain why 'a changing distribution of skills' should necessarily result in the construct of social rank being 'a significant differentiating factor among individuals and subpopulations in modern society' (Shevky and Bell, 1955:17).

Critiques by Hawley and Duncan (1957) and Udry (1964) highlighted this deficiency in the social area analysis model. Udry extended his analysis of the model to suggest that Shevky and Bell's 'theory of increasing scale' and their 'theory of subarea differentiation' should be considered as separate theories (Udry, 1964:408-409). An attempt by Bell and Moskos (1964) to answer these issues was presented in the form of a simple analogy - but this has generally been considered by experienced sociologists to be an inadequate justification (Jones, 1969:18; Timms, 1971:141).

Dimensions of Residential Differentiation. The debate in this area has been concerned with a group of empirical studies which were carried out to test the Shevky-Bell hypothesis concerning the dimensions of residential differentiation. These studies may be classified into two broad groupings: studies which have examined the dimensionality of the variables which were used by Shevky and Bell, and studies which have examined the dimensionality of these variables in addition to a broader set of variables derived from census information.

(a) Dimensions Associated with the Shevky-Bell Variables. The first systematic examination of the dimensions associated with the Shevky-Bell variables was carried out by Bell (1955). This study employed factor analysis to examine the intercorrelations among these variables for Los Angeles and San Francisco. The centroid technique of factor analysis was used to extract three factors which were then rotated to an oblique solution.

The three factors which emerged from these analyses confirmed the Shevky-Bell hypothesis that socioeconomic status (with high loadings on 'occupation', 'education', and 'rent'), familism (with high loadings on 'fertility', 'women in the labour force', and 'single-family dwelling units'), and ethnicity (with high loadings on 'subordinate ethnic groups') each represented a 'discrete social factor which was necessary to account for the differences between urban subpopulations with respect to social characteristics' (Bell, 1955:46).

Inspection of the item-factor correlations provided strong support for the Shevky-Bell postulate that the indexes selected to measure the socioeconomic status and familism constructs formed unidimensional measurement instruments.

Van Arsdol et al (1958a) used similar methodology to test the Shevky-Bell model for a group of cities in the United States. The results confirmed the existence of the three Shevky-Bell dimensions in six out of the ten cities which were examined. The four cities which did not exactly fit the model displayed relatively high item-factor correlations with the socioeconomic status factor. These cities were found to be located in the South of the United States and had high proportions of Negro populations. Van Arsdol et al proposed that these findings indicated that 'the range of family forms in these [four] cities, as described by the fertility measure, has not become disassociated from social rank' (Van Arsdol et al, 1958a: 282). Timms later hinted that these 'deviant' cities might well reflect variations in societal scale within the United States and therefore it was 'clearly unrealistic to ignore regional differences in modernization that may occur within national boundaries' (Timms, 1971:156).

In a second investigation Van Arsdol et al (1958b) tested the Shevky-Bell model by applying factor analysis to a correlation matrix obtained by combining the census information from the ten cities which had been examined separately in their first study. The three factors which emerged were closely in agreement with the model and the results previously obtained by Bell (1955).

(b) Dimensions Associated with a Wider Set of Variables. Tryon (1955) was the first researcher to employ a wider list o[illegible]bles than those proposed by Shevky and Bell in order to identify [illegible] areas. He applied a cluster analysis technique to 33 census variables to obtain clusters of related measures. Examination of the intercorrelations suggested that three dimensions were sufficient to account for the relationships between the variables: 'socioeconomic independence', 'family life', and 'assimilation'. Tryon noted that there was considerable similarity between these empirically derived clusters and the three constructs proposed by Shevky and Bell.

Later reviews (Robson, 1969; Rees, 1972) have suggested that there was a high degree of subjectivity associated with Tryon's clustering decisions and that for this reason his technique has had limited further application.

Anderson and Bean (1961) also employed a wider group of variables to test the generality of the Shevky-Bell dimensions. The study was designed to assess whether similar factorial structures to those obtained by Van Arsdol et al (1958a) would emerge if a range of variables in addition to the Shevky-Bell variables were included in the analyses.

The matrix of factor loadings which emerged showed that the socio-economic status and ethnicity factors were reproduced but the familism factor split into two separate factors. Anderson and Bean labelled these two factors as 'urbanization' (which tended to discriminate between apartment house areas and single family dwelling unit areas) and 'family status' (which tended to discriminate between areas with different fertility levels).

The pattern of loadings between these two factors suggested that 'urbanization' was mostly describing variations in housing characteristics while 'family status' was mostly describing variations in the social characteristics of the family.

Schmid and Tagashira (1964) demonstrated that the basic factors of socioeconomic status, familism and ethnicity were invariant under the conditions of change in the numbers of variables which were employed to represent the same community. The three basic factors emerged from factor analyses of sets of 42, 21, 12 and 10 variables which had been used to describe the residential structure of the city of Seattle. Further analyses carried out by Sweetser (1965) in Helsinki validated this finding and prompted the conclusion that 'ecological factors are invariant under substitution, addition, and subtraction of variables' (Sweetser, 1965:379).

Following the initial use of factor analysis for wider sets of variables by Anderson and Bean there has been a virtual avalanche of studies which have applied the same methodology to ever-growing numbers of social settings and variables. An excellent systematic review of these studies has been presented by Rees (1972). Among the studies carried out in the United States, Rees found that most identified one socioeconomic factor and at least one ethnicity factor (depending on whether ethnic groups were assessed by one or more variables describing minority groups). Most studies also showed some form of familism factor, however there was a substantial number of studies in which two factors bearing some connection with this theoretical construct emerged.

In addition to the emergence of the traditional Shevky-Bell factors, many studies obtained factors related to the mobility of the population, to the degree of recent migration, and to areas of recent population growth. While some suggestions were made that a factor describing these processes should be introduced into the 'triad of Shevky and Bell constructs', Rees commented that these mobility/migration processes were dynamic in nature and would confuse the generally 'static nature' of the social characteristics of residential structure (Rees, 1972:287).

Rees attempted to extend his comparative analysis to similar studies carried out in places outside the United States. However certain difficulties were experienced with the classification of variables into the same sets used to describe the United States Studies. These reviews, which covered studies carried out in Europe, Canada, Egypt, and India will not be further discussed because the technical difficulties of comparison led Rees to consider this section of his summary analysis as 'tentative in the extreme' (Rees, 1972:288).

A more recent review of 'factorial ecology' studies by Johnston (1976) came to a similar conclusion as Rees with respect to the consistency of the Shevky and Bell dimensions:

> By far the major finding, common to a majority of studies, irrespective of location and cultural context of the relevant city, is the generality of Shevky and Bell's three-dimensional model of the bases to residential area differentiation.
> (Johnston, 1976:217)

Johnston also commented that the accessibility of high speed computer facilities which had allowed researchers to employ increasingly larger numbers of variables had not negated the Shevky and Bell model. Rather, these larger scale investigations had added to the model by 'developing aspects which were either overlooked by those authors in their search for high-level generalizations or were not relevant to their data sets and study areas' (Johnston, 1976:217).

In Australia the first substantial investigation of the social dimensions of residential differentiation was carried out by Jones (1969). This study focussed on the city of Melbourne and employed principal component analysis to investigate the factor structure of 24 census variables describing residential characteristics. Three principal components emerged from these analyses: 'SES-Ethnicity', 'Familism' and 'Northwestern European Settlers'. These three dimensions provided a reasonably similar structure to the Shevky-Bell model, however the coalescence of Socioeconomic Status and Ethnicity on the first principal component could well have been associated with the orthogonality and rotation restrictions placed on the factor structure. Jones (1969) rejection of rotational procedures was 'by design, not ignorance' because he had structured the analyses on the basis of a priori expectation rather than notions of data exploration.

A later large-scale investigation of the structure of residential differentiation in Australia was carried out by Logan et al (1975). Principal component analysis followed by Varimax rotation of factors was employed to separately examine a set of 22 census variables which described the Australian State capital cities and the non-metropolitan regions of Australia.

The factor structure of residential differentiation of the capital cities closely followed the Shevky-Bell model - although some city-specific factors also emerged from the analyses. The strongest factors to emerge in all cities were 'Socioeconomic Status'; 'A Factor Identifying Differences in Dwelling Types' (which was closely linked to the Familism construct). Logan et al (1975) noted that in most cities familism was divided into two or three separate dimensions, one which identified dwelling type variation, one which identified the very recent, high fertility, suburban areas, and, in some cases, another which separated out the proportion of females in the workforce.

The factor analyses carried out for the non-metropolitan regions employed a different list of census variables and therefore it was not possible to compare these results with those obtained for the cities. This list of variables was narrowly defined to be 'indicative of standard of living' or 'quality of life measures' (Logan et al, 1975:61). The factors which emerged from the analyses were, not surprisingly, somewhat different from the analyses for cities - and they lacked simplicity of structure and interpretation.

Summary

In this chapter a range of models of residential differentiation has been reviewed. These models have ranged from the early human ecology and zonal/sectoral descriptions of urban growth to the more recent Shevky-Bell proposals concerning a rationale for the evolution of three social dimensions which describe residential patterns in geographical space.

Certain aspects of the theoretical foundations of Shevky and Bell's social area analysis model have received considerable criticism. In particular, many authors have disputed the validity of the implied causal link between societal scale and residential differentiation. Some critics (Johnston, 1971:58; Robson, 1969:52) have even hinted that there was a high degree of ex post facto rationalization in the theoretical exposition which Shevky and Bell provided as a justification for the variables and indices which they selected as the key measures of social structure. Nevertheless, the incidence of their three basic dimensions of residential differentiation in studies carried out for different social settings and employing a wide range of variables has been consistently established.

The researcher faced with the evidence of this debate is therefore left with a 'theory' which has questionable logical structure and yet reasonably firm predictive properties with respect to the nature of residential differentiation. The most useful resolution of this difficult situation has been presented by Jones (1969):

> ... I propose to accept Shevky and Bell's discussion of the major trends in recent social change not as a formal theory dictating the lines of subsequent analysis of urban residential differentiation, but rather as a set of sensitizing concepts directing attention to basic forms of social differentiation in modern industrial society, a view which seems quite consonant with their original intentions. Seen in this way, postulates about increasing societal scale constitute a conceptual scheme within which changes in social differentiation and stratification can be analysed. (Jones, 1969:21)

The majority of the studies which have investigated the generalizability of the Shevky-Bell dimensions appear to have concentrated upon the use of census data to examine aspects of residential differentiation in urban areas. This focus of researchers' efforts on urban environments probably has its origins in Shevky and Bell's original use of the cities of San Francisco and Los Angeles to present detailed descriptions of applications of their theory (Shevky and Bell, 1955) and to provide validatory evidence for the existence of their three dimensions of residential differentiation (Bell, 1955).

A concentration on urban settings was, in Shevky and Bell's view, an unnecessary constraint on the situations in which their theory could be applied:

> To date all the published work utilizing this method has dealt with the census tract as the unit of analysis ... and the major focus of interest is the internal differentiation of a particular urban area. There is no reason, however, why a typology based on the three social dimensions - social rank, urbanization, and segregation - could not be utilized, with different specific measures in the indexes if necessary, for the study of cities with the city as the unit of analysis, for the study of regions, or even for the study of countries.
> (Shevky and Bell, 1955:20)

In this study the 'preferred' indicator of educational disadvantage, SR(ALL), was developed from census data descriptions of the characteristics of neighbourhoods surrounding Australian schools. Therefore, in keeping with Shevky and Bell's proposal that their three social dimensions were applicable to units of study beyond census descriptions of urban settings, it was decided to investigate the utility of these dimensions for examining the 'meaning' of the rank order of schools obtained from the SR(ALL) indicator scores. This investigation has been discussed in detail in the following chapter.

CHAPTER 10

THE 'MEANING' OF THE INDICATORS: COMPARISON OF THE INDICATORS WITH THE DIMENSIONS OF SCHOOL NEIGHBOURHOOD RESIDENTIAL DIFFERENTIATION

Introduction

The SR(ALL) indicator was selected as the 'preferred' indicator of educational disadvantage in Chapter 8 because of its better all-round performance on seven important criteria. In this chapter consideration has been given to an investigation of the meaning of the scores obtained from this indicator.

The development of the SR(ALL) indicator was centred around a series of stepwise regression analyses which selected subsets of census percentage variables to form linear composites and then combined these in order to provide an indicator which was maximally correlated with school mean achievement scores. This procedure was primarily guided by the aim to optimize the predictive power of the indicator scores. Some minor intervention was taken during this procedure to avoid technical problems of face validity associated with the appearance of suppressor relationships in the regression analyses. However the overall development strategy was not concerned with the fashioning of indicators whose face validity would fit some current or past sociological model of causation to the educational environments of Australian students.

By way of example, the inclusion of the linear composite describing bathroom and kitchen facilities in the SR(ALL) indicator at both age levels occurred because this linear composite added to predictive power. It was not added because the linear composite fitted some causal model of educational achievement concerned with either the effects of washing and cooking facilities, or the effects of adequate housing, for which this linear composite might have provided a surrogate measure.

Consequently, when the question 'What is the meaning of the SR(ALL) indicator scores?' was posed, there was some temptation to retreat to a response couched in terms of the technical procedures used in the strategies of indicator construction rather than attempt to answer in terms of a description of those social characteristics of school neighbourhoods which were associated with the indicator scores. The difficulties involved in providing a simple and intelligible answer of the latter kind may be readily demonstrated by an inspection of the correlation coefficients between the indicator scores and the complete set of linear composites which were candidates for inclusion in the SR(ALL) indicator. These correlation coefficients have been listed for both age levels in Table 10.1.

Although only nine linear composites entered the SR(ALL) indicator, four being common to both age levels, the correlation coefficients ranged from moderate to high positive values for all linear composites. It was interesting to note that, due to the intercorrelation among the linear composites themselves, there were many linear composites not included in the SR(ALL) indicator which had higher correlations than those which were included.

The pattern of moderate to large positive correlation coefficients for the linear composites included in the SR(ALL) indicator showed that the SR(ALL) indicator was a complex dimension related to a wide spectrum of school neighbourhood characteristics: occupation, education, industry type, country of birth, period of residence, age, type and size of dwelling, bathroom and kitchen facilities, and density of living arrangements. This wide spectrum of characteristics made it difficult, if not impossible, to readily deduce a descriptive name for the SR(ALL) indicator from the pattern of correlations in Table 10.1 which would 'capsulize the substantive nature of the factor and enable others to grasp its meaning' (Rummel, 1970:474).

While simple inspection of the pattern of correlations between the SR(ALL) indicator and the linear composites used in its construction provided little assistance in describing the 'meaning' of the indicator, an examination of the groupings of linear composites hinted at the existence of three subdimensions within the overall indicator scores which paralleled the three Shevky-Bell dimensions. For example, linear composites 1, 3, 4, 5, 8 and 9 were concerned with the occupational and educational characteristics of school neighbourhoods and thus could be linked to the Socioeconomic Status dimension; linear composites 11 and 12 described the country of birth and the period of residence of the overseas born population and could be appropriately linked to the Ethnicity dimension; linear composites 6 and 13 described family (marital) stability and age distribution and were therefore associated with the Familism dimension;

Table 10.1 Correlations Between the SR(ALL) Indicator and the Linear Composites of Percentage Variables (10-Year-Old Schools and 14-Year-Old Schools)

Group Source of Linear Composite	Age Level			
	10-Year-Old		14-Year-Old	
	r	Included in SR(ALL)	r	Included in SR(ALL)
1. Occupational Status (M)	44		60	YES
2. Occupational Status (F)	27		30	
3. Occupational Type (M)	90	YES	82	
4. Occupational Type (F)	86	YES	82	YES
5. Industry Type	85	YES	71	
6. Marital Status	37		53	YES
7. Religion	54		62	
8. Qualifications (Obtained)	83	YES	75	
9. Qualifications (Studying)	46		60	YES
10. Qualifications (School)	66		68	
11. Country of Birth	62	YES	64	YES
12. Period of Residence	42	YES	28	
13. Age	39		50	YES
14. Type of Dwelling	45	YES	62	
15. Size of Dwelling	57		77	YES
16. Age of Dwelling	**	**	**	**
17. Bathroom + Kitchen	44	YES	71	YES
18. Facilities (Sewerage, etc)	30		53	
19. Vehicles	58		70	
20. Household Class	35		58	
21. Density	58	YES	50	YES
22. Occupancy	35		55	

Note: a Number of schools at 10-year-old/14-year-old levels (weighted) = 271/256.

b Decimal points have been omitted from correlation coefficients.

c There was no linear composite prepared for the Age of Dwelling group (See Appendix I). This group was therefore excluded from the analyses.

d The correlations for all indicators have been presented in Appendix K.

linear constructs 11, 15, 17 and 21 described the type, size, and facilities of the dwellings and the number of inmates per dwelling - this latter group of linear constructs also appeared to be linked to the familism dimension because they were concerned with aspects of the housing environment which were of central importance to living arrangements in family life.

The observation of these broad groupings led to the postulate that, while the SR(ALL) indicator was based on a complex series of amalgamations of many census percentage variables combined to form linear composites which in turn had been combined to form indicator scores, the meaning of the degree of school neighbourhood residential differentiation reflected by the indicator scores could be described in terms of relatively more simple dimensions associated with the Shevky-Bell model.

The main aim of the analyses described in this chapter was, therefore, to investigate whether the scores on the SR(ALL) indicator were amenable to a more parsimonious and more readily interpretable description in terms of the social characteristics of school neighbourhoods described by the Shevky-Bell dimensions than could be ascertained by simple inspection of the indicator's component parts or census correlates.

The Shevky-Bell Model Applied to Australian School Neighbourhoods

The Shevky-Bell Model: The 'Scale' of Australian Society

The relevance of the Shevky-Bell model to the pattern of residential differentiation in Australian society required an examination of those factors which were considered to be measures of societal scale. At the core of a wide-ranging discussion under the heading of 'the primitive idea of scale', Shevky and Bell presented the notion of increasing scale as being synonymous with the emergence of modern urban-industrial society. It was of some interest that Shevky and Bell grouped Australia with the United States and Britain as examples of countries which have experienced the type of transformation in the nature of productive activity which they considered to be typical of increasing societal scale. The transformation was described as a movement of working population from the primary sector (agriculture) to the secondary sector (manufacture) and then to the tertiary sector (commerce, communication, transport and service).

The percentages of the Australian workforce engaged in these three sectors during this century has been presented in Table 10.2. The general

Table 10.2 Percentage Distribution of the Australian Workforce by Occupation Groups for the Censuses 1901-1971.

Industry	Census Year								
	1901	1911	1921	1933	1947	1954	1961	1966	1971
Primary	33	30	26	24	18	15	12	11	9
Secondary	17	20	21	19	28	28	28	28	25
Tertiary	50	50	53	57	55	57	60	61	66

Note: a Source: Logan et al (1975:18)

pattern of the distribution of occupations between 1901 and 1971 was characterized by a dramatic fall in the proportion engaged in the primary sector and corresponding increases in the secondary and tertiary sectors. By 1971 the tertiary sector had emerged as the overwhelmingly dominant sector by encompassing two-thirds of the Australian workforce.

In parallel with the movement of the workforce between sectors, Australian society has experienced substantial growth in the percentage of the population living in urban settings. This growth has been particularly noticeable since the close of the Second World War. In 1947 Australia's urban population was around 65 per cent of the total population, however by 1971 this percentage had increased to around 85 per cent (Kilmartin and Thorns, 1978:46).

The urban predominance of Australian society may be further emphasized by an examination of the population of Australia's ten largest cities listed in Table 10.3. More than 40 per cent of the Australian population in 1978 was located in two cities: Sydney and Melbourne. Further, around 70 per cent of the population in 1978 was located in these ten cities. In recent years the emergence of such high growth urban areas as the Gold Coast and Albury-Wodonga will inevitably contribute substantially to the already large percentage of Australian population living in urban environments.

The structure of productive activity, as described by the allocation of the workforce among three sectors, and the dominance of the urban mode of living provided firm support that Australian society closely fitted Shevky and Bell's conception of a society which is in an advanced position on the spectrum of 'societal scale'. This evidence therefore suggested

Table 10.3 Population of the Ten Largest Cities in Australia

State	City	City Population ('000)	Percentage of Australian Population (%)
New South Wales	Sydney[b]	3,155.2	22.1
	Newcastle	375.3	2.6
	Wollongong	222.0	1.6
Victoria	Melbourne	2,717.6	19.1
	Geelong	139.8	1.0
Queensland	Brisbane	1,004.5	7.0
South Australia	Adelaide	930.5	6.5
Western Australia	Perth	864.9	6.1
Tasmania	Hobart	166.5	1.2
Australian Capital Territory	Canberra	234.7	1.6
Total for All Cities		9,811.0	68.9

Note: a Source: Australian Bureau of Statistics (1980).

b Figures refer to estimates for 30 June 1978. The total population of Australia was given as 14,248,600.

that the interrelated trends which they have postulated as being characteristic of 'organizational complexity' (changes in the distribution of skills, productive activity and composition of population) should also give rise to their three dimensions of residential differentiation (socioeconomic status, familism, and ethnicity). In the following sections of this chapter the emergence of these three dimensions has been explored with respect to the nature of residential differentiation among school neighbourhoods.

The Shevky-Bell Model: Choice of Variables

The three Shevky-Bell dimensions of residential differentiation have emerged as stable constructs across a range of social environments. However the variables used to measure these constructs have often varied considerably between research studies. Different variables from those used by Shevky and Bell have been selected often because researchers have been limited in variable choice due to the census data which was available, or because of a desire to improve and/or extend the list of variables which were to be used as measures of the constructs.

Shevky and Bell themselves often seemed to be uncertain as to the appropriate choice of variables. In the 1955 monograph which described the 'theory, illustrative application and computational procedures' of social area analysis, Shevky and Bell devoted a whole chapter to 'revisions' associated with the choice and measurement of variables. For example, the 'rent' variable which had been considered an appropriate measure of the Socioeconomic Status construct in 1940 was rejected in 1950 because of the rent controls which were instituted in the United States in the years during and following the Second World War. Also, initially the Ethnicity construct had been based on ethnic groups which were residentially concentrated at a certain level defined by an 'index of isolation'. Later applications rejected the selection of groups according to isolation and instead based the measurement on a count of population associated with a list of specific national and racial groups.

In Table 10.4 the three constructs and the 'revised' variables which were accepted by Shevky and Bell as suitable measurements have been listed. In order to test the utility of the model for describing the dimensions of residential differentiation among school neighbourhoods it was considered important to attempt to closely follow the measurement procedures suggested by these 'revised' variables. An examination of the data which was available for the description of school neighbourhoods suggested however that certain improvements could be made to the selection and measurement of variables which would result in closer links between the constructs, as described by Bell's 'groupings' in column 2 of Table 10.4, and the selected variables.

The decisions which were made concerning variable selection have been listed in column 5 of Table 10.4. These decisions have been described in detail in the following paragraphs.

1 Socioeconomic Status. It was decided to extend the measurement of the Education and Occupation variables in order to more closely reflect the distribution of societal characteristics inferred by the use of the word 'status' in the name of the construct. Accordingly, rather than follow Shevky and Bell by creating simple proportion measures based on single classifications of education and occupation groups, two clusters each based on five proportion (percentage) measures were selected in order to represent a spectrum of classifications describing education and occupation levels. Two linear combinations of these measures were then constructed in order to maximally summarize the variation between school neighbourhoods with respect to the five measures within each cluster.

The linear combinations within the education and occupation clusters were obtained by using principal component analysis (Rummel, 1970:338). The first of the principal components represents a single dimension which accounts for the most variance among the variables and therefore was selected to form the linear combinations. The results of these analyses have been presented for each age level in Table 10.5.

For both clusters of variables the variance explained by the first principal component was quite large and no other components had eigen values greater than one. In the occupation cluster the first principal component accounted for 62 and 64 per cent of the variance for 10-year-old and 14-year-old schools respectively. While in the education cluster the first principal component accounted for 77 and 82 per cent of the variance.

The factor loadings listed in Table 10.5 represented the correlations between these percentage variables and the first principal components. The Occupation variable represented by the first principal component had high positive correlations with the percentages of the male workforce having professional, administrative/executive/management, occupations; high negative correlations were associated with the percentages of the male workforce having transport/communication and process/manual/labouring occupations. The Education variable represented by the first principal component had high positive correlations with the percentages of the population aged 15+ years who had completed a higher degree, bachelors degree, tertiary non-degree qualifications or who had completed the final two years of secondary education; high negative correlations were associated with the percentage of persons who had completed their schooling but had completed levels which were below the currently expected compulsory minimal level of education (level 8).

The strength and direction of the factor loadings were completely congruent with the construct of Socioeconomic Status which the Occupation and Education variables were intended to represent. Therefore these linear combinations were accepted as more appropriate 'extended' variables for the measurement of socioeconomic status. In the second two columns of Table 10.5 the coefficients and constants required to calculate the first principal component scores from the percentage variables have been listed.

Table 10.4 The Constructs and Variables Used to Test the Shevky-Bell Model

Construct Name Bell (1965)	Grouping of Variables Bell (1965:238)	Shevky-Bell (1955) Variables: Name	Shevky-Bell (1955) Variables: Definition	Variables Used in This Study: Decision	Variables Used in This Study: Name	Variables Used in This Study: Definition
Socioeconomic Status	Variables which are socioeconomic or socioeconomic related	Education	Number of persons who have completed no more than grade school per 1000 persons 25 years old and older	Extended	Education	Score on first principal component extracted from five variables describing educational qualifications
		Occupation	Number of craftsmen, operatives, labourers per 1000 employed persons	Extended	Occupation	Score on first principal component extracted from five variables describing occupational classifications
		Rent	Rejected in later work due to rent controls	Rejected	—	—
Familism	Variables which indicate the presence or lack of families	Single Family Dwelling Units	Number of single-family dwelling units per 1000 dwelling units of all types	Accepted	Single Family Households	Percentage of occupied dwellings which contain single-family households
		Fertility	Number of children under 5 years of age per 1000 females aged 15 to 55 years	Replaced	Separate House	Percentage of occupied dwellings which were separate dwellings
		Women in the Labour Force	Number of females in the labour force per 1000 females aged 14 years and older	Replaced	Family Stability	Score on first principal component extracted from six variables describing family/marital stability
Ethnicity	Variables which reflect the presence or absence of certain racial and national groups.	Segregation Index	Proportion of total population born in non-English-speaking European countries, Mexico, French Canada or Latin America, or of Negro or "other" racial origin	Modified Slightly	European Born	Percentage of total population born in non-English-speaking European countries.

the rent variable, which had been rejected by Shevky and Bell during their 'revisions', was also rejected for the study of school neighbourhoods because suitable data were not available for the measurement of this variable.

2 Familism. The selection of appropriate variables for the measurement of this construct has been subjected by researchers to a lively debate. Much of the controversy has followed issues associated with the original disagreement between Shevky and Bell as to whether the construct should be named 'Urbanization' or 'Family Status'/'Familism' (Shevky and Bell, 1955: 68). In a later paper Bell criticised Shevky's selection of variables for this construct:

> ... his [Shevky's] designation contains conceptual elements inadequately measured by the items comprising the index ... additional marital and family characteristics probably should be added to the index if a better indicator of the family life characteristics of census tract populations is desired. (Bell, 1965:241)

Bell's criticism may be highlighted by a consideration of the linkage between the Shevky and Bell variable Women in the Labour Force and the construct of Familism. The direction in which this variable was scored by Shevky and Bell inferred that a high proportion of women in the labour force identified areas in which, to use Bell's description from Table 10.4, there would be a 'lack of families'. In the light of more modern attitudes towards the role of women in society, women's choices of whether to work or not have become increasingly associated with motivations for gaining greater self-fulfillment and independence. The decision to work has therefore lost its validity as an indicator of the rejection of a family and motherhood oriented role. This trend has been recognized and received growing support by employers in many countries through the introduction of paid maternity leave from work and the growing availability of creches at places of work. Further, the economic cost of supporting a young family in recent times has often necessitated that women continue to work until all children have completed their education and have entered the workforce themselves. That is, they often continue to stay in the labour force while the family is intact and living under the one roof - and then leave work when the nuclear family disintegrates as the children leave to pursue their own careers and life styles.

Table 10.5 Principal Component Factor Loadings and Score Coefficients for the Occupation, Education and Family Stability Variables (10-Year-Old Schools and 14-Year-Old Schools).

Variable Name/ Percentage Variable	Factor Loadings		Score Coefficients	
	10-Year-Old	14-Year-Old	10-Year-Old	14-Year-Old
Occupation				
% OCC PROF (M)	91	94	06	06
% OCC ADM/EXEC/MAN (M)	86	90	06	05
% OCC CLERICAL (M)	68	64	06	06
% OCC TRANS/COMN (M)	-77	-75	-03	-03
% OCC PROC/MAN/LAB (M)	-69	-74	-09	-12
Percentage of Variance	62	64		
Regression Constant			-20	-10
Education				
% HIGHER D OBT	86	89	74	61
% BACH D OBT	94	95	17	15
% TERT ND OBT	84	89	12	12
% SCHOOL GT LEV 9 COMPLETE	94	94	03	03
% SCHOOL UP TO LEV 7 COMPLETE	-78	-84	-01	-01
Percentage of Variance	77	82		
Regression Constant			-52	-54
Family Stability				
% SEP (EVER MAR M 15+)	73	85	-18	-20
% SEP (EVER MAR FM 15+)	64	85	-15	-21
% DIV (EVER MAR M 15+)	81	88	-25	-24
% DIV (EVER MAR FM 15+)	81	78	-24	-21
% WID (EVER MAR M 15+)	77	73	-13	-14
% WID (EVER MAR FM 15+)	81	74	-05	-05
Percentage of Variance	58	65		
Regression Constant			250	275

Note: a Number of schools at 10-year-old/14-year-old levels (weighted) = 271/256.

b Decimal points have been omitted from factor loadings, raw score coefficients and the regression constants.

c The score coefficients and constants for the Family Stability variable were reversed in sign so that a high score on this variable indicated a high level of family stability.

In response to the problems associated with the use of Women in the Labour Force as a measure of the 'presence or lack of families' an alternative variable was prepared as a replacement. This variable was based on the first principal component extracted from a cluster of six percentage variables which assessed the degree of Family (marital) Stability or intactness. Following Bell's suggestion above, it was reasoned that a suitable set of descriptions of marital characteristics would provide identification of areas in which there was a presence or lack of families. The six percentage variables described the percentages of ever married males or females who were 15 years of age or older and who were separated, divorced, or widowed.

The results of the principal component analyses have been presented in Table 10.5. For this cluster of variables the first principal component accounted for 58 and 65 per cent of the variance for the 10-year-old and 14-year-old schools respectively. Only the first components had eigen values greater than one. The score coefficients and constants were reversed in sign compared to those obtained from the analyses. Thus, a high score on the component associated with the Family Stability variable indicated school neighbourhoods with a low incidence of marital (and hence family) instability caused through separation, divorce, or death.

The Fertility variable employed by Shevky and Bell had close links with the construct of Familism. This variable was measured by calculating the ratio of the number of children under five years of age to the number of females aged 15 to 44 years. However, the use of this variable would have created some conceptual problems when applied to the different age samples. For example, one would expect that school neighbourhoods associated with schools at the 10-year-old level would have higher fertility scores than schools at the 14-year-old level. This difference would be expected because families in neighbourhoods having many 10-year-olds would be more likely to have children under 5 years old than neighbourhoods having many 14-year-olds. This difference would not necessarily indicate the 'presence or lack of families' but rather reflect the age difference in the target populations for each sample.

The Fertility variable was therefore rejected and replaced by another variable which was considered to have less conceptual problems of interpretation between the age samples. The selected variable was Separate House which was measured by the percentage of occupied dwellings which were separate houses. This variable was selected to replace Fertility because family ownership of a separate home on its own block of land has become an integral part of the value structure of the Australian family. Family ownership of a separate house has been both encouraged and supported by Australian governments through low interest housing loans and government 'grants' to families purchasing their first homes. The acknowledged and preferred family life-style in Australia has been one with family life in owner-occupied private homes which have space available for gardens (Kilmartin and Thorns, 1978).

The Single Family Dwelling Units variable employed by Shevky and Bell was accepted with only a change in the variable name. The Single Family Households variable was measured by calculating the percentage of occupied dwellings which contained single family households.

3. Ethnicity. The basic structure of the Shevky-Bell Segregation Index was accepted except for some slight modifications. Certain categories of national and racial groups: Mexicans, French Canadians, Latin Americans and Negroes, were not relevant to Australia and were excluded. Therefore the measure of the Ethnicity construct was limited to the percentage of the total population born in non-English-speaking European countries.

The Shevky-Bell Model: Factorial Investigation

The utility of the Shevky-Bell model for the study of residential differentiation associated with school neighbourhoods depended upon its capacity to define three distinct dimensions, corresponding to the three Shevky-Bell constructs, which would provide a meaningful basis for the description and comparison of school neighbourhoods. The original formulation of the model by Shevky and Bell (1955) merely suggested that the variables within each construct 'grouping' should be simply added together following a 'standardization' method based on score ranges (Shevky and Bell, 1955:67-68).

Rather than accept these simple summation procedures for the construction of the Shevky-Bell dimensions it was decided to test the 'fit' of the postulated constructs to the school neighbourhood data which were available to describe the variables purported to measure these constructs. The techniques of principal component analysis and oblique factor rotation were selected to provide empirical information with respect to the appropriateness of the variable 'groupings' and with respect to the number and nature of the dimensions of school neighbourhood residential differentiation.

This factor analytic strategy was similar to the line of argument presented in Bell's (1955) initial validation study.

At the first stage of investigation a principal component analysis was conducted on the correlations between the six variables described in Table 10.4. Since the Shevky-Bell model had postulated the existence of three dimensions, the principal component solution was constrained to extract only three components. The component loadings associated with each age level have been presented in Table 10.6. At the 10-year-old and 14-year-old levels the three components accounted for 87 per cent and 90 per cent of the variance respectively.

An inspection of the component loadings in Table 10.6 showed that neither a consistent nor a clear structure emerged across age levels. For example, at the 10-year-old level the first component appeared to represent a combined socioeconomic status-ethnicity dimension, while at the 14-year-old level the first component represented an even less clear dimension which combined the socioeconomic status, ethnicity and familism variables. The clearest component to emerge at both age levels was the third component which had high positive loadings for the European Born variable and relatively low loadings for all other variables.

Since the Shevky-Bell model did not specify that the three constructs described orthogonal dimensions, it was decided to conduct an oblique rotation of the principal component solution in order to examine the effect of relaxing the constraint of dimensional orthogonality on the structure of the factor loadings. The results of the oblique rotation for each age level have been presented in Tables 10.7, 10.8 and 10.9.

The 'oblimin' method developed by Carroll (1958) was used to conduct the factor rotation. The gamma criterion was set at a very low value of 0.01 in order to place a premium on the clarity of the factor structure without emphasizing attempts to hold the oblique solution near to an orthogonal solution. In this sense the derived oblique solution approximated the 'quartimin' method which was developed by Carroll (1953) as a special case of the 'oblimin' approach for the gamma criterion set at zero.

The use of oblique factor rotation provided three matrices: the primary pattern matrix (which represented the regression coefficients of the variables on the factors), the primary structure matrix (which represented the correlations of the variables with the factors), and the correlation matrix for the primary factors.

Table 10.6 Principal Component Factor Loadings for the Three Factor Solution Obtained from the Six Shevky-Bell Variables 10-Year-Old Schools and 14-Year-Old Schools.

Variable	Principal Component Factor Loadings					
	10-Year-Old			14-Year-Old		
	I	II	III	I	II	III
Education	-03	96	15	49	84	12
Occupation	08	96	05	56	80	05
Separate House	84	-19	10	78	-46	-01
Family Stability	87	-05	26	83	-36	25
Single Family Households	87	06	12	84	-26	19
European Born	-50	-20	84	-53	-02	85
Percentage Variance	41	31	14	47	29	14

Note: a Number of schools at 10-year-old/14-year-old levels (weighted) = 271/256.

b Decimal points have been omitted from factor loadings.

The key matrix for factor interpretation was the primary pattern matrix (Rummel, 1970:401). This matrix has been presented in Table 10.7. It is important to note that, since the primary pattern factor loadings are equivalent to the co-ordinates of the variable with respect to the primary factor axes, the absolute values of primary pattern loadings may exceed a value of 1.00 (Rummel, 1970:405).

In comparison to the principal component solution the pattern factor loadings at both age levels provided an extremely clear picture of three distinct factors which corresponded directly with Shevky and Bell's constructs. The first factor had high positive loadings on the Separate House, Family Stability, and Single Family Household variables, and almost zero level loadings on all other variables. This factor was clearly representing the 'Familism' dimension. The second factor represented the 'Socioeconomic Status' dimension because it had extremely high positive loadings on the Education and Occupation variables, and low loadings on all other variables. Similarly, the third factor was clearly the 'Ethnicity' dimension because it had a high positive loading on the European Born variable and low loadings on all other variables.

Table 10.7 Pattern Factor Loadings Obtained Following the Oblimin Rotation of the Three-Factor Solution (10-Year-Old Schools and 14-Year-Old Schools)

Variable	Pattern Factor Loadings					
	10-Year-Old			14-Year-Old		
	I	II	III	I	II	III
Education	-02	98	06	-02	99	03
Occupation	03	96	-07	02	96	-06
Separate House	84	-14	-05	85	-14	-16
Family Stability	94	04	10	96	02	10
Single Family Households	86	10	-06	89	10	04
European Born	02	00	100	03	-03	100

Note: a Number of schools at 10-year-old/14-year-old level (weighted) = 271/256.

b Decimal points have been omitted from factor loadings

c Factors were rotated by using the 'oblimin' technique with the gamma function set at 0.01 (Rummel, 1970:415).

A striking feature of the pattern factor loadings across age levels was the similarity in magnitude and direction of the loadings. Many loadings had the same value at both age levels and, except for two loadings, the difference between particular loadings across age levels did not exceed ±0.03. The similarity of the loadings across age levels showed that, not only did the three Shevky-Bell constructs emerge as very clear dimensions, but also that the variable weightings for the dimensions measured by the primary pattern factors were effectively equivalent for both age groups.

The primary factor structure matrix for each age level has been described in Table 10.8. The loadings in this matrix indicated that some degree of factor intercorrelation was present. If the factors had been orthogonal then the pattern and structure matrices would have been equivalent (Rummel, 1970:399). The most noticeable feature of the structure matrix at both age levels was the relatively high negative correlation between the European Born variable and the first oblique factor which was described above as the 'Familism' dimension. This negative correlation suggested that, since the Ethnicity dimension was effectively only measured by the European Born variable, there would also be a negative correlation between the Familism and Ethnicity dimensions at both age levels.

Table 10.8 Structure Loadings Obtained Following the Oblimin Rotation of the Three-Factor Solution (10-Year-Old Schools and 14-Year-Old Schools)

Variable	Structure Loadings					
	10-Year-Old			14-Year-Old		
	I	II	III	I	II	III
Education	-07	97	-05	13	98	-14
Occupation	03	97	-19	20	98	-24
Separate House	86	-16	-32	88	02	-43
Family Stability	90	00	-22	93	16	-24
Single Family Households	88	09	-36	89	24	-30
European Born	-32	-12	99	-33	-20	99

Note: a Number of schools at 10-year-old/14-year-old levels (weighted) = 271/256.

b Decimal points have been omitted from factor loadings.

c Factors were rotated by using the 'oblimin' technique with the gamma function set at 0.01 (Rummel, 1970:415).

Similarly, the small loadings of the Education and Occupation variables on the Familism factor at the 10-year-old level suggested a degree of orthogonality between the Socioeconomic Status factor and the Familism factor. The corresponding loadings at the 14-year-old level inferred a small positive correlation between these factors.

In Table 10.9 the correlations between factors, within and across age groups, have been presented. Within each age group the correlations between factors have been presented in the upper left-hand matrix and the lower right-hand matrix. The factor intercorrelations support the clues which were given by the structure loadings. At both age levels the correlation between the Familism and Ethnicity factors was a moderate negative value: -0.34 at the 10-year-old level and -0.36 at the 14-year-old level. The correlation between the Socioeconomic Status and Familism factors was close to zero at the 10-year-old level and took a small positive value of 0.16 at the 14-year-old level. Small negative correlations of -0.12 at the 10-year-old level and -0.18 at the 14-year-old level were obtained for the Socioeconomic Status and Ethnicity factors.

Table 10.9 Correlations Between the Shevky-Bell Dimensions Developed at Each Age Level (Within and Across 10-Year-Old Schools and 14-Year-Old Schools)

Factor	Factor					
	10-Year-Old Factors			14-Year-Old Factors		
	Socio-economic	Familism	Ethnicity	Socio-economic	Familism	Ethnicity
10-Year-Old Factors Applied to 10-Year-Old Schools						
Socioeconomic	100			100	-01	-10
Familism	-02	100		-02	100	-35
Ethnicity	-12	-34	100	-12	-35	100
14-Year-Old Factors Applied to 14-Year-Old Schools						
Socioeconomic	100	15	-20	100		
Familism	16	100	-36	16	100	
Ethnicity	-18	-36	100	-18	-36	100

Note: a Number of schools at 10-year-old/14-year-old levels (weighted) = 271/256.

b Decimal points have been omitted from correlation coefficients.

c The correlation coefficients in the diagonals of the upper right hand matrix and the lower left hand matrix ranged from 0.9966 to 0.9997.

The matrices in the top right-hand corner and lower left-hand corner of Table 10.9 have listed the correlations between the 10-year-old factors and the 14-year-old factors scored for 10-year-old schools, and the correlations between the 14-year-old factors and the 10-year-old factors scored for 14-year-old schools, respectively. The most interesting feature of these matrices was the unities in the diagonals of these matrices. These unities showed that, although the factors had been developed in separate analyses within age groups, they were measuring precisely the same dimensions across age groups. This finding supported the earlier discussion concerning the similarity in pattern loadings across the age levels in Table 10.7.

Some further analyses were conducted to investigate the suitability of the construct names attached to the three factors which had emerged at each age level. A list of variables was prepared which provided information about school neighbourhoods with respect to socioeconomic, familism, and ethnicity characteristics. The correlations between each of the three factors and the variables on this list were then calculated. Only variables which had not been used in the construction of the factors were listed. The correlations between the factors and the list of variables at each age level have been presented in Table 10.10.

At both age levels the Socioeconomic Status factor showed high positive correlations with the percentages of the female workforce in professional, administrative/executive/managerial, and clerical occupations. This factor also showed high positive correlations with the percentage of dwellings having seven or more rooms. These correlations were supportive of the name which had been given to the Socioeconomic Status factor because it was expected that high scores on the factor would also identify school neighbourhoods with high concentrations of white collar-professional workforce members, and with high concentrations of large (and expensive) occupied private dwellings.

The correlations between the Familism factor and the variables selected to describe familism characteristics were also supportive of the name given to this factor. High positive correlations were obtained between the factor and variables describing concentration of children (age ranges of 0-4, 5-9, and 10-14) and low to medium positive correlations for the variable describing the concentration of adults in the 'child rearing' age groups (age range 25-44). High negative correlations were obtained for the variables describing concentrations of young adults (age range 20-24) and older/retired age level adults (age ranges 45-64, 65+). The age profile reflected in the pattern of correlations showed that the Familism factor formed a dimension which separated school neighbourhoods on the basis of age cohorts which reflected the critical years of family life.

These results were further supported by the correlations between the Familism factor and the variables describing the number of inmates per dwelling. High negative correlations were obtained for the variables which described the concentration of dwellings having only one or two inmates, while positive and high positive correlations were noted for three, four or five inmates. The density-of-living profile reflected in these correlations showed that the Familism factor was discriminating between living arrangements which would be typical of Australian families (two parents and one, two, or three children per dwelling), and living arrangements which would be typical of young adults, broken families, older/retired adults (one or two persons per dwelling).

Table 10.10 Correlations Between the Shevky-Bell Dimensions and a Subset of Percentage Variables (10-Year-Old Schools and 14-Year-Old Schools)

Percentage Variable	Shevky-Bell Dimension					
	Socioeconomic		Familism		Ethnicity	
	10	14	10	14	10	14
Socioeconomic Descriptors						
% OCC PROF (FM)	50	66	-16	06	-31	-44
% OCC ADM/EXEC/MAN (FM)	44	42	-06	-03	-19	-25
% OCC CLERICAL (FM)	60	58	09	12	09	03
% DWEL: 7+ ROOMS	49	66	-07	14	-32	-41
Familism Descriptors						
% AGE 0-4 (POP)	-13	-22	51	39	-05	-01
% AGE 5-9 (POP)	-26	-15	61	57	-19	-10
% AGE 10-14 (POP)	-30	-05	48	58	-29	-31
% AGE 15-19 (POP)	-12	-11	-05	11	-04	-09
% AGE 20-24 (POP)	-01	-14	-47	-64	38	39
% AGE 25-44 (POP)	14	09	35	17	23	40
% AGE 45-64 (POP)	13	16	-47	-35	-06	-09
% AGE 65+ (POP)	18	01	-57	-42	-02	-18
% DWEL: 1 INMATE	09	-05	-74	-71	04	-01
% DWEL: 2 INMATES	27	07	-53	-42	-06	-20
% DWEL: 3 INMATES	15	15	16	14	18	16
% DWEL: 4 INMATES	-02	20	68	60	05	18
% DWEL: 5 INMATES	-10	08	66	67	-06	-02
Ethnicity Descriptors						
% PROTESTANT RELIG	04	07	26	38	-49	-48
% CHURCH OF E RELIG	05	21	23	14	-49	-52
% CATHOLIC RELIG	-17	-33	-18	-20	64	58

Note: a Number of schools at 10-year-old/14-year-old levels (weighted) = 271/256.

b Decimal points have been omitted from correlation coefficient.

c Confidence limits for correlation coefficients based on two standard errors were ±0.07 for 10-year-old schools and ±0.08 for 14-year-old schools (See Table 8.5, footnote c).

The Ethnicity factor was principally dominated by a single variable, European Born, and therefore was not subject to questions of appropriate labelling as were the other two factors. However, following Jones (1969) approach, several variables associated with religious affiliation were selected as surrogate measures of the ethnicity of school neighbourhoods. The profile of correlations showed that the Ethnicity factor formed a dimension which separated the religious affiliation typical of many persons of Australian/English-born origin (Church of England, Protestant) from the religious affiliation typical of many persons of European origin (Catholic).

Relationships Between the Shevky-Bell Dimensions and the SR(ALL) Indicator

Correlational Associations

The bivariate relationships between the SR(ALL) indicator and the three Shevky-Bell dimensions were examined by calculating correlation coefficients. These coefficients have been listed in Table 10.11. The Socioeconomic Status dimension had high positive correlations of 0.84 and 0.75 with the indicator scores at the 10-year-old and 14-year-old levels respectively. Similar medium sized negative correlations of -0.43 and -0.46 were obtained for the Ethnicity dimension at both age levels. The Familism dimension showed considerable differences between age levels with respect to the magnitude of its correlations with the SR(ALL) indicator: at the 10-year-old level the Familism dimension had a small positive correlation of 0.16 with the indicator, but at the 14-year-old level this correlation was a substantially larger value of 0.46.

At both age levels, the SR(ALL) indicator appeared to be a complex mixture of the three Shevky-Bell dimensions. This complex mixture was dominated by the Socioeconomic Status dimension at the 10-year-old level. Whereas at the 14-year-old level there were relatively more evenly distributed associations between the SR(ALL) indicator and the three dimensions.

On the final line of Table 10.11 the multiple correlation coefficients for the Shevky-Bell dimensions as predictors of the SR(ALL) indicator have been listed. These high values, of 0.90 and 0.86 for 10-year-old and 14-year-old schools respectively, showed that the factor assessed by the SR(ALL) indicator was almost completely accounted for by the three dimensions combined into a simple additive model. Therefore, before proceeding to further analyses, the capacity of these three dimensions in explaining variation in school mean achievement scores was compared with the SR(ALL) indicator.

Table 10.11 Correlations Between the SR(ALL) Indicator and the Shevky-Bell Dimensions (10-Year-Old Schools and 14-Year-Old Schools)

Variable	Age Level	
	10-Year-Old	14-Year-Old
Socioeconomic Status	84	75
Familism	16	46
Ethnicity	-43	-46
f(S,F,E)	90	86

Note: a Number of schools at 10-year-old/14-year-old levels (weighted) = 271/256.

b Decimal points have been omitted from correlation coefficients.

c The variable denoted f(S,F,E) was the linear combination of the Shevky-Bell dimensions derived from a regression analysis using the SR(ALL) indicator as a criterion variable.

The results of these analyses have been presented in Table 10.12. The correlation coefficients showed that neither the Shevky-Bell dimensions taken separately, nor in combination as part of a regression analysis, provided sufficiently high correlations with school mean achievement scores to be considered as rival indicators to the SR(ALL) indicator.

A feature of this table was the similarity in the pattern of the bivariate correlation coefficients to those presented for the SR(ALL) indicator in Table 10.11: the Socioeconomic Status variable had the highest correlations with school mean achievement scores; the correlations for the Familism dimension were noticeably smaller at the 10-year-old level than at the 14-year-old level; the correlations for the Ethnicity dimension were similar across age levels and were roughly equal in magnitude to the correlations for Familism at the 14-year-old level. These similarities in pattern were expected because the SR(ALL) indicator had been constructed to be maximally correlated with school mean achievement scores.

Commonality Associations

Since the three Shevky-Bell dimensions had been derived from oblique factor rotations it was important to interpret their bivariate relationships with the SR(ALL) indicator in conjunction with the knowledge that there were varying levels of association between the dimensions themselves. In order to investigate this problem the technique of 'commonality analysis' (Mood, 1971) was used to examine the 'unique' and 'common' components of the bivariate relationships between the SR(ALL) indicator and the three dimensions. The formulae required for this technique have been described in detail by Mayeske et al (1969).

For each dimension the total variance 'explained', represented by the squares of the bivariate correlation coefficients in Table 10.11, was divided into a unique component, two pair-wise components, and a three-way component. The unique component represented that part of the total 'explanatory' power of a dimension which could be attributed solely to the particular dimension. The pair-wise component represented the part which could only be attributed to two dimensions jointly and, because of the intercorrelation between dimensions, could not be 'disentangled' into separate unique components. The three-way component similarly represented the part which could only be attributed to the three dimensions jointly.

The results of the commonality analyses have been presented in Table 10.13. By examining each column of the table it was possible to identify the unique and common sources of the total correlational association between each dimension and the SR(ALL) indicator. For example, at the 10-year-old level, Socioeconomic Status accounted for a total of 70 per cent of the variance in the SR(ALL) indicator. This total of 70 per cent, derived from the square of the bivariate correlation, resulted from 63 per cent being uniquely associated with Socioeconomic Status and 8 per cent in common between Socioeconomic Status and Ethnicity. The components which were associated with the common contribution of Socioeconomic Status and Familism, and the common contribution of all three dimensions, were both zero.

At both age levels the general pattern of results showed that the unique contribution of Socioeconomic Status was very large compared with either the unique contributions of Familism and Ethnicity or the pair-wise and three-way contributions of the dimensions.

At the 10-year-old level the total Familism contribution of 3 per cent was solely attributable to the common component associated with Familism and Ethnicity. This result contrasted markedly with the relatively larger unique and common components associated with Familism for the 14-year-old schools. At the 14-year-old level the unique and common contributions of Familism and Ethnicity dimensions were almost exactly equivalent. At both

Table 10.12 Correlations Between the SR(ALL) Indicator, the Shevky-Bell Dimensions and School Mean Scores on the Tests of Word Knowledge, Literacy and Numeracy (10-Year-Old Schools and 14-Year-Old Schools)

Variable	Age Level					
	10-Year-Old			14-Year-Old		
	Word Knowledge (10-y.o. Test)	Literacy (Test 10R)	Numeracy (Test 10N)	Word Knowledge (14-y.o. Test)	Literacy (Test 14R)	Numeracy (Test 14N)
Shevky-Bell Dimensions						
Socioeconomic Status	59	56	41	54	45	36
Familism	12	14	17	31	29	30
Ethnicity	-33	-24	-22	-32	-30	-23
f(S,F,E)	64	60	46	60	52	44
Indicator						
SR(ALL)	72	71	59	73	70	66

a Number of schools at 10-year-old/14-year-old levels (Weighted) = 271/256.

b Decimal points have been omitted from correlation coefficients.

c The variable denoted f(S,F,E) was the linear combination of the Shevky-Bell dimensions derived from a regression analysis using school mean achievement scores as criterion variables.

Table 10.13 Correlational Commonality Table for the Shevky-Bell Dimension as Predictors of the SR(ALL) Indicator (10-Year-Old Schools and 14-Year-Old Schools).

Source of Variance	Shevky-Bell Dimensions					
	10-Year-Old Schools			14-Year-Old Schools		
	Socio-economic	Familism	Ethnicity	Socio-economic	Familism	Ethnicity
S	63			42		
F		00			06	
E			08			05
SF	00	00		04	04	
SE	08		08	05		05
FE		03	03		06	06
SFE	00	00	00	05	05	05
Total Variance	70	03	19	57	22	21

Note: a Number of schools at 10-year-old/14-year-old levels (weighted) = 271/256.

b All percentages have been rounded to whole numbers.

c The symbols S, F, E, in the 'Source of Variance' column refer to the three Shevky-Bell dimensions: Socioeconomic Status, Familism, Ethnicity.

d The 'Total Variance' referred to the square of the bivariate correlation between the SR(ALL) indicator and the Shevky-Bell dimension.

age levels the unique components of the Familism and Ethnicity dimensions were similar to the magnitude of the components which they had in common with the Socioeconomic Status dimension.

Conclusions and Cautions

In this chapter the three Shevky-Bell dimensions of residential differentiation were shown to be applicable to the social characteristics of neighbourhoods surrounding Australian schools. These dimensions facilitated an examination of the nature of the complex dimension encapsulated by the SR(ALL) indicator of educational disadvantage.

The first stage of the analyses employed factor analysis procedures to establish the suitability of the Shevky-Bell model for describing the residential differentiation among school neighbourhoods. The similarity of both the primary factor patterns and the factor intercorrelations across age levels demonstrated the congruence of each of the three Shevky-Bell dimensions for school neighbourhoods surrounding both the 10-year-old and 14-year-old sample schools. While these results paralleled many findings in social geography concerning the factorial structure of residential differentiation, some cautions should be expressed with respect to the sufficiency of the Shevky-Bell model.

The very nature of the data collected by census authorities in most countries of the world has placed limitations on the types of solutions which might emerge from factor analytic investigations of residential differentiation. The bulk of these data have [illegible]erally been collected according to content areas which can readily [illegible] [illegible]ouped on the basis of inspection, and without sophisticated multivariate analyses, into the same three groupings described by the Shevky-Bell dimensions. Consequently, the consistent emergence of the three Shevky-Bell dimensions in a range of social settings may well reflect the nature of available data.

It was therefore possible to postulate, but not check empirically, that the Shevky-Bell model provided three necessary but not sufficient dimensions with which residential differentiation among Australian school neighbourhoods could be described. Evaluation of this postulate would necessitate the collection of larger and more wide-ranging bodies of census data - an action which governments would be unlikely to support merely in order to satisfy the curiosities of social geographers.

The second stage of the analyses examined the associations between the Shevky-Bell dimensions and the SR(ALL) indicator of educational disadvantage. These analyses were conducted in order to provide a more parsimonious and more readily interpretable description of the 'meaning' of the indicator scores in terms of the social characteristics of school neighbourhoods described by the Shevky-Bell dimensions than could be ascertained by simple inspection of the indicator's component parts or census correlates.

The results of the second stage of the analyses demonstrated that the SR(ALL) indicator exhibited a complex overlapping pattern of associations with respect to three dimensions of school neighbourhood residential differentiation: Socioeconomic Status, Familism, Ethnicity. This pattern tended to be dominated by the Socioeconomic Status dimension -

but not to the extent that it was possible to ignore both the Familism and Ethnicity dimensions by labelling the SR(ALL) indicator as a measure of socioeconomic status. Rather, the scores derived from the SR(ALL) indicator appeared to represent a summary measure of a network of interrelated social features which closely covaried in geographical space with school mean achievement levels. This network presented a picture of the 'social landscape' surrounding the educationally disadvantaged school as one in which there were:

- high concentrations of persons in the economically and socially vulnerable position of having low levels of educational attainment and low levels of occupational skill,
- low concentrations of persons living according to a popular 'model' of Australian family life characterized by single family households, stable families/marriages, and separate dwellings,
- high concentrations of persons likely to have English language communication difficulties because they were born in non-English-speaking European countries.

The interpretation of the results of the second stage analyses must be approached with caution in order to avoid the possibility of involvement with 'ecological fallacies' (Alker, 1969). The 'social landscape' described above emerged from the correlational result that the dimensions of Socioeconomic Status, Familism, and Ethnicity displayed the property of <u>covarying in geographical space</u> with scores derived from the SR(ALL) indicator. This property enabled a parsimonious description to be made of the 'meaning' of the SR(ALL) indicator scores in terms of the dimensions of residential differentiation among school neighbourhoods. There has been no attempt to discuss these relationships at the individual student level nor to imply that causal connections might exist between the many variables which have been included individually and as composites in these analyses. Consequently, the 'social landscape' described above should <u>not</u> be treated as being either necessarily characteristic of the particular home environments of students who attend educationally disadvantaged schools, or being necessarily a set of causal environmental conditions which cause educational disadvantage.

CHAPTER 11

CONCLUSION

An Outline of the Study

The main aim of this study was to develop, validate, and describe the properties of a national indicator, based on census descriptions of school neighbourhoods, which could be used to guide policies designed to allocate supplementary resources to educationally disadvantaged schools.

As the first stage of this study a detailed review was undertaken in order to examine resource allocation responses which have been made to the changing concept of equality of educational opportunity. As part of this review, a description was presented of the structure of indicators which have formed integral parts of these resource allocation responses in Australia, United States, and United Kingdom. This first stage was followed by the development of a theoretical model that examined the influence of using indicators to identify educationally disadvantaged schools on the accuracy with which resources could be delivered to those students who were in need of assistance.

A program of research, based upon the results of these initial analyses, was designed to develop several indicators of educational disadvantage which would avoid the inadequacies of many of the currently available indicators. These indicators were based on census descriptions of school neighbourhoods and they were prepared so as to optimize the correlations between the indicators and school mean scores on a test of Word Knowledge.

The performance of these indicators was then compared with respect to their capacity to (1) predict school mean achievement scores, (2) predict the incidence of social and learning handicaps within schools, (3) maintain predictive power with respect to school mean achievement scores when applied to different samples of schools and students, (4) apply to schools in general without the need for supplementary information describing school location and school system, and (5) display high levels of accuracy associated with the identification of students who were in need of assistance.

The indicator with the best overall performance was examined with respect to the dimensions of residential differentiation associated with the Shevky-Be model. These analyses were designed to establish whether the information obtained from this indicator was amenable to a more readily interpretable description than would be ascertained by simple inspection of the indicator's component parts or census correlates. It was demonstrated that neighbourhoods associated with educationally disadvantaged schools were characterized by an overlapping network of social features associated with the socioeconomic status, ethnicity, and family living arrangements of the community.

The Policy Contributions of the Study

1 The Nature of Student Variation Within and Between Schools and its Influence on the Use of Indicators of Educational Disadvantage.

This study has shown that resource allocation programs, designed to assist educationally disadvantaged students, which employ schools as the units of identification and funding must take into account the nature of the variation in student characteristics within and between schools.

It was demonstrated that if the distribution of the criterion measure of educational disadvantage was mostly associated with variation between schools then the majority of educationally disadvantaged students would be located in schools with low mean criterion scores. In this situation, resource allocation based on the selection of schools with low mean scores would result in an accurate delivery of resources to those students who were in need of assistance. Conversely, if the distribution of the criterion measure was mostly associated with variation between students within schools then all schools would contain similar proportions of educationally disadvantaged students - with the result that resource allocation to schools with low mean scores would be very inaccurate.

The nature of student variation in Australian schools was found to be more similar to the second of these two extremes when a test of Word Knowledge was used as the criterion measure. For example, estimates derived from the theoretical model described in Chapter 3 suggested that the lowest 10 per cent of Australian schools would have 33 per cent of their students below the 10th percentile for students, and 20 per cent above the 50th percentile for students.

When compared with a range of developed countries these figures suggested that, when a test of Word Knowledge was used as the criterion measure, Australia was a relatively less appropriate setting for resource allocation programs which employed schools as the units of identification and funding.

This result did not automatically imply that students would be the most suitable units of identification and funding in Australia because the 'gains' associated with increased accuracy in the delivery of resources to students who were in need of assistance might be more than offset by the 'losses' associated with, for example, pedagogical problems of 'streaming' which could result from assisting subgroups of students within schools. However, this result did indicate that policy makers should be aware that the pathway to accuracy in resource allocation was concerned not only with the use of appropriate indicators but also with the nature of the variation of student characteristics within and between schools.

2 The Development and Evaluation of an Indicator for the Identification of Educationally Disadvantaged Schools in Australia.

This study has shown that it was possible to construct an indicator of educational disadvantage, based on census descriptions of school neighbourhoods, that had a range of properties which were superior to indicators currently being used by Australian school systems. This indicator was constructed by using stepwise regression analysis in which variables describing aspects of both the social and built environments of school neighbourhoods were candidates for inclusion in the indicator.

The use of this indicator to guide the allocation of resources to educationally disadvantaged schools in Australia would be associated with a number of important benefits.

(a) The Construct of 'Disadvantaged'. The indicator was designed to be in close agreement with the definition of 'disadvantaged' employed by the Australian Schools Commission to identify schools for participation in the Disadvantaged Schools Program (Karmel, 1973:92). In accordance with this definition the indicator (1) was constructed solely from information describing school neighbourhoods, and (2) employed a suitable criterion measure to ensure that this information described school neighbourhood characteristics associated with a low capacity to take advantage of educational facilities.

(b) Statistical Properties. The analyses which were employed during the indicator development and validation phases of the study revealed that the indicator possessed a number of important statistical properties.

(i) The predictive power of the indicator with respect to school mean achievement scores on a test of Word Knowledge was shown to be at least equivalent to an achievement-scaled indicator developed from a detailed evaluation of the home environments of students who attend Australian schools.

(ii) The indicator was examined in terms of its capacity to identify students who were in most need of assistance in the basic skills of Literacy and Numeracy. In particular, quantitative descriptions were prepared which summarized the accuracy with which the indicator could be used to identify the percentages of students below the 10th and 20th percentiles for students on tests of Literacy and Numeracy who were attending schools below the 10th and 20th percentiles for schools on the indicator scores.

For example, at the secondary school level, the lowest 10 per cent of schools on the indicator contained 34 per cent of students who were below the 10th percentile for students on the test of Literacy and 17 per cent who were above the national median on the test of Literacy. These two percentages compared favourably with the 'optimal' estimates of 36 per cent and 17 per cent, respectively, which had been obtained from the theoretical model.

(iii) The development of the indicator was accompanied by a detailed examination of important correlational properties of the indicator scores. For example, data were presented to show that the indicator (1) was highly correlated with school mean achievement scores on tests of Word Knowledge, Literacy, and Numeracy, (2) was significantly correlated with measures which described the incidence of social and learning handicaps within schools, (3) was highly correlated with a range of census-based descriptions of school neighbourhoods which have commonly been seen as being synonymous with disadvantage, deprivation, or poverty, and (4) had relatively invariant correlational associations with school mean achievement scores when supplementary information describing Type of School (Government, Catholic, Independent) and School Location (Metropolitan, Non-Metropolitan) was added to the indicator.

(c) Administrative Properties. The indicator was constructed from census data and was based on national samples of Australian schools. These procedures gave the indicator several important characteristics which would encourage its acceptance as a national indicator of educational disadvantage.

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(i) The indicator scores were prepared from simple weighted combinations of variables constructed from widely available census data. Consequently, the construction of an indicator score for a particular school would be well within the capabilities of the staff and parents associated with Australian schools. This simplicity of construction was extremely important because it would minimize the errors, effort, and resources required to prepare indicator scores, and also would enable a wider range of people to discuss and debate the suitability of the indicator for the identification of disadvantaged schools.

(ii) The indicator scores were prepared from census data without requiring the use of personal information which described individual students or their families. This characteristic was considered to be highly desirable because of the recent concerns being expressed in Australia about the potential threat to personal privacy which has emerged with the growing use of computer-stored data banks.

(iii) The construction of the indicator scores for all Australian schools would require substantially less time, resources, and expertise in comparison with indicators developed by gathering detailed information about students from every school. The main task involved in preparing the indicator scores would be the linking of school catchment areas to the appropriate census Collector's Districts. However, for the majority of schools, this linking operation could be readily carried out by using records available at the head offices of the various school systems.

(iv) The indicator was prepared from national samples of schools in order to facilitate the identification of the most educationally disadvantaged primary and secondary schools across Australia. This property was consistent with the aim of the federal program which was intended to provide assistance to Australia's most disadvantaged schools irrespective of their location or the school system to which they belonged.

The Theoretical Contributions of the Study

1 The Accuracy Coefficient and the Leakage Coefficient

The Accuracy coefficient and the Leakage coefficient were developed in order to make objective assessments of the accuracy associated with the delivery of supplementary educational resources to those students who were in most need of assistance. For the purposes of comparing the performance of the indicators of educational disadvantage prepared for this study, the phrase 'those students who were in most need of assistance' was interpreted to mean 'those students having low scores on tests of basic Numeracy and Literacy skills'. However, the application of the concepts of Accuracy and Leakage could be extended to other interpretations - provided that suitable data were available. Some examples of alternative interpretations might be 'those students having parents with low incomes', 'those students from single parent families', or 'those students living in geographically isolated environments'.

In Australia all of the above examples have at some time received high priority in the development of indicators of educational disadvantage. In future perhaps a completely new set of interpretations will be selected. Nevertheless, the importance of the Accuracy and Leakage coefficients remains that, once consensus has been reached on a specific set of interpretations, the indicators may be compared objectively in terms of the nature of the students who are receiving the benefits of supplementary resources. These two statistics therefore offer an important avenue for avoiding the dangers of ecological or individualistic fallacies (Dogan and Rokkan, 1969) which have been inherent in approaches to indicator construction based on appeals to the face validity of component variables that have been aggregated to the school level or above.

2 The Dimensions of Residential Differentiation Among Australian School Neighbourhoods

One of the most important findings arising from this study was that it was possible to use information which described the neighbourhoods from which Australian schools obtained their students to predict school mean achievement scores with approximately the same level of precision as may be obtained by using detailed information which described the home environments of students who attend these schools. In both cases the percentage of variance explained in school mean achievement scores was around fifty per cent.

This finding was based on correlational associations at the between-school level of analysis. Suitable data were not available which would permit statements to be made as to whether aspects of the social structure of school neighbourhoods would provide independent contributions to the explanation of variation in educational achievement at the between-student level of analysis.

Herbert's detailed review of the literature in this area concluded that 'the concept of a neighbourhood effect was intact as a contribution of some significance towards the understanding of differential educational performance' (Herbert, 1976:153). However, he also emphasized that a great deal of the research into the educational significance of a 'neighbourhood effect' should be regarded as incomplete because many studies lacked rigour in their approach to the development and measurement of the dimensions of residential differentiation.

In this study a detailed investigation was carried out to determine whether Shevky and Bell's three dimensional model of residential differentiation would contribute to an understanding of the nature of residential differentiation among Australian school neighbourhoods. It was noted that certain aspects of the theoretical foundations of this model had received considerable criticism. In particular, some sociologists have questioned the validity of the model's implied causal link between societal scale and residential differentiation. At the same time there has been substantial research support for the generality of Shevky and Bell's three dimensions: Socioeconomic Status, Familism, and Ethnicity.

The majority of this research support has been drawn from studies carried out in urban settings by using census-defined geographic areas as units of analysis. Prior to the investigation carried out in this study there would appear to be no published research that has tested the applicability of the three dimensions when applied to school neighbourhoods which were spread across a whole nation.

The results of this investigation demonstrated that the three Shevky-Bell dimensions emerged as distinct factors of residential differentiation among school neighbourhoods. In addition, the meaningfulness of the names that Shevky and Bell had associated with these dimensions was established by comparison with an independent set of variables which described aspects of the social structure of school neighbourhoods.

It must be conceded that these results did not suggest that the Shevky-Bell dimensions represented a sufficient solution for explaining residential differentiation among school neighbourhoods. An evaluation of the sufficiency of these dimensions would require the collection of more wide-ranging bodies of data than are currently collected by census authorities. However, the clear emergence of the three Shevky-Bell dimensions in this study provided an extremely valuable framework for examining the 'social landscape' of neighbourhoods surrounding educationally disadvantaged schools.

In recent years Australian education systems have encouraged local community involvement in decisions concerning the management and curriculum of schools. These initiatives will inevitably lead to a growing coalescence between each school's educational program and the needs and aspirations of its surrounding neighbourhood. Consequently, the methodology and results of the investigation of the dimensions of school neighbourhood residential differentiation which have been reported in this study should prove to be of considerable importance to future research aimed at understanding the processes and products of Australian schools.

A Concluding Comment

The allocation of supplementary resources in programs designed to alleviate the educational consequences of poverty, deprivation, or disadvantage has required an annual multi-million dollar investment in education by governments in the United States, the United Kingdom, and Australia. The implementation of these programs has been accompanied by debate concerning two main issues: the magnitude of the effects of the programs on participating students, and the construction of indicators which would assist with decision concerning the delivery of supplementary resources to those students whom the programs were intended to assist.

The first issue has been subjected to a considerable amount of research in the United States. The results of this research have not been conclusive because several of the key evaluation studies have received substantial methodological criticisms with respect to the appropriateness of their criterion measures and the validity of their research designs when applied to experiments conducted in naturalistic settings. It seems that a clear judgement concerning the magnitude of the effects of these programs will need to await the results of carefully planned longitudinal studies.

In contrast the second issue has received relatively little research attention. The majority of the work in this area has been confined to reports which document procedures for the construction of indicators for specific programs. These reports have rarely included detailed information which describes either the relationships between the indicators and other suitable criterion variables, or the characteristics of students who receive benefits from these programs. The rationales which have been presented in support of indicator construction procedures have therefore often been restricted to arguments that have concentrated on the face validity of the variables used in their construction. Since the indicators have generally been constructed from highly aggregated data, and have been employed to select groups of students rather than individual students, these arguments must be viewed with extreme caution in order to avoid the dangers of ecological or individualistic fallacies.

This study has contributed to the debate on the second issue by emphasizing several important points which should be acknowledged during the construction of indicators for programs designed to assist students who attend educationally disadvantaged schools:

- That the selection of schools rather than individual students for participation in these programs places upper limits on the performance of indicators in terms of their capacity to deliver resources to those students who are in most need of assistance.

- That the upper limits of indicator performance in these programs are a function of the variation in student characteristics within and between schools.

- That indicator performance in these programs may be compared objectively by using the Accuracy and Leakage coefficients to assess the characteristics of participating students.

These three points formed an integral part of the methodology that was adopted in this study for the development of an indicator of educational disadvantage which would be suitable for Australian schools. In addition, analyses were presented which focused on these three points in order to demonstrate that there would be considerable differences between ten developed countries in the performance of this type of indicator. The differences were shown to originate from differences between the countries with respect to the variation of student characteristics within and between schools.

In recent years the economic circumstances of many countries have resulted in widespread public demands for accountability in government expenditure. These demands will inevitably challenge the future survival of educational programs designed to assist special subgroups of students unless it can be demonstrated that resources have been allocated in an accurate fashion to the appropriate schools and students. This study has described the construction of an indicator that could be used to guide decisions concerning resource allocation in Australia - however many aspects of the methodology which were employed to develop this indicator should prove to be useful for similar programs in other countries.

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