DOCUMENT RESUME

ED 136 221		CS 003 277
AUTHOR	Bulcock, Jeffrey W.; And Others	
TITLE	Reading Competency as a Predictor of Scholastic Performance: Comparisons between Industrialized and Third-World Nations.	
PUB DATE	76	
NOTE	54p.; Paper presented at the Annual Meeting of the International Reading Association World Congress on Reading (6th, Singapore, August 17-19, 1976)	
EDRS PRICE	MF-$0.83 HC-$3.50 Plus Postage.	
DESCRIPTORS	*Academic Achievement; *Comparative Education; Content Reading; Foreign Countries; Natural Sciences; Predictive Measurement; Psycholinguistics; *Reading Achievement; Reading Comprehension; *Reading Research; Secondary Education; *Socioeconomic Background; *Thought Processes; Vocabulary	
IDENTIFIERS	England; India; Piaget (Jean)	

ABSTRACT

Using data collected by the International Association for the Evaluation of Educational Achievement (IEA), the authors of this study examined the reading achievement of 14-year-old boys in India and England. They sought to determine the factors involved in the academic achievement of these boys in the natural sciences. Factors studied, in addition to reading achievement, were socioeconomic background, vocabulary achievement, and thinking-stage development. The similarities between the two groups were found to outweigh the differences, although the effects of parental education and father's occupational status were less important in predicting academic success for Indian students. Reading achievement in both countries was consistently the most powerful predictor of science achievement, with the exception of performance in biology, in India. The thinking-stage variable had the next most powerful net effect, yet was only marginally ahead of meaning-vocabulary influences, in terms of direct effects. (MKM)

Conference Draft
June 19, 1976

READING COMPETENCY AS A PREDICTOR OF SCHOLASTIC PERFORMANCE: COMPARISONS BETWEEN INDUSTRIALIZED AND THIRD-WORLD NATIONS[1]

by

Jeffrey W. Bulcock

with

Rodney A. Clifton

and

Mona J. Beebe

Jeffrey W. Bulcock
Rodney A. Clifton
[illegible]

Mona J. Beebe
[illegible]

Memorial University of Newfoundland

Canada

[1] This work was supported by research grants from the Humanities and Social Sciences Division of the Canada Council. The data utilized in the study were made available by the International Association for the Evaluation of Educational Achievement (IEA) through the auspices of the data bank archive located at the University of Stockholm, Sweden. The data were originally collected by the IEA national centers in India, England, and the U.S.A. Responsibility for the data analysis is assumed by the first author. The opinions expressed in this study, and the interpretation of the results do not necessarily reflect the position, policy, or endorsement of IEA or the original collectors of the data. The study was [illegible] International Reading Association, Sixth World Congress [illegible] August [illegible], 1976.

READING COMPETENCY AS A PREDICTOR OF SCHOLASTIC PERFORMANCE: COMPARISONS BETWEEN INDUSTRIALIZED AND THIRD-WORLD NATIONS

Jeffrey W. Bulcock

with the assistance of

Rodney A. Clifton and Mona J. Beebe

Memorial University of Newfoundland
St. John's, Newfoundland, Canada

Introduction

The paper is organized as follows. Part one presents the research rationale. The problem from sociological, reading research, and cross-cultural perspectives is identified; the research objectives are formulated; and the three arguments composing the explanatory framework of the structure of scholastic performance are introduced; namely, the socializing differences, language factors, and piagetian thinking stage arguments. Part two is composed of three subsections: one formulating an auxiliary model; one describing the mode of analysis; and one presenting the research results. Part three discusses the theoretical implications of the results and suggests some policy implications.

The language factors argument, which is central to the purposes of this paper, is intended to popularize the work of R.L. Thorndike (1973-74) and K.S. Goodman (1969, 1970, 1973) and to underline the importance of the comparative reading perspective begun by Gray (1956) and extended by Thorndike (1973a) and Downing (1973).

I am grateful to the organizers of the International Reading Association Sixth World Congress on Reading for the opportunity to participate. Thanks also go to the Council of the International Association for the Evaluation of Educational Achievement (IEA), under whose auspices the data used in this study were collected.

I. RESEARCH RATIONALE

The Problem

The problem is identified from three perspectives: the sociological, reading research, and cross-cultural. The paper focuses on the problem of trying to identify a set of common elements which explain the variability in the multiple subject-matter outcomes of schooling. Four sociological emphases in addressing this problem, and three associated consequences are briefly referred to.

In the first place, the sociologists' primary concern in addressing the cognitive outcomes of schooling problem has been to promote particular schools of sociological/social psychological thought. Each school has identified one or more operationalized determinants of scholastic achievement congruent with its theoretical emphasis, which intervene between the home backgrounds of pupils and their eventual subject-matter competencies.

Secondly, increased emphasis on the inequality theme in education, has resulted in close examination of the stratifying effects of differential group memberships - socioeconomic status, sex, ethnicity/race, and inner-city/suburban/nonurban residence - on a range of intellectual competencies. The notion is that equal educational opportunity exists, if, and only if, the criteria used in determining educational access and performance are made without reference to group memberships; that is, where group membership - school achievement relationships are effectively zero.

It is noted, third, that sociological research into these matters has represented discipline-oriented, in contrast with policy-oriented, research. Problems originate in the discipline or, more accurately, the "school of thought" within the discipline. Research results are used to extend disciplinary frontiers, to enhance personal academic reputations, and to maintain institutional prestige. The rules of the academic games governing competition for the scarce resources - colleague esteem, international recognition, and research grants - were played in the familiar academic arena.

Fourth, the large-scale research efforts in this direction, and the host of carbon-copy small scale studies which followed them, are well known;

so are some of the disappointing social policy interventions which flowed from them. One consideration accounting for the discouraging results of educational policies designed to reduce educational inequalities through the promotion of compensatory educational treatments, is that few of the sociologically important intervening variables have short-term policy relevance. Thus, though biosocial, symbolic interactionist or reference group theories of school achievement have generated operationalized intervening variables such as (a) ability and motivation, (b) self concept and teacher prophecies, (c) significant other's influence and ambition respectively, they have proved little more manageable by policy-makers and educational practitioners than "fixed" or noncontrollable social background factors.

The doctrinal reactions to educational reforms by the ultra-conservatives, of which the Black Papers in England are one example, and the new-marxists such as Bowles and Gintis in the United States, has created an unanticipated pincer-like movement which remains unchallenged by the public schools. A second consequence resulting from efforts to document school effectiveness were the largely negative findings of the Coleman, et al. (1966) report and the Jencks, et al. (1972) study.

While crisis symptoms abound, modest but positive responses representing a middle-way persist. One such procedure involves the monitoring of innovative social policy legislation designed to solve problems. Evaluation of innovation provides an information base which may lead to further innovation requiring further evaluation and so on - a procedure leading to progressively more rational solutions. The International Association for the Evaluation of Educational Achievement (IEA) has a mandate, through its charter, for such action.[2] In a series of recent technical reports the predictive value of

---

[2] IEA, incorporated in 1967 under Belgian law, is a nonprofit, nongovernmental organization which undertakes educational and related research on an international scale in order to (a) examine educational problems common to many countries, and (b) to provide evidence which may help the improvement of educational systems. Major studies by IEA analysts include: Husen, (ed.) vols. 1 & 2 (1967); the Bloom Report (1969); Comber & Keeves (1973); Thorndike (1973a); Purves (1973); Peaker (1975); Carroll (1975); Torney, et al. (1976); Lewis and Massad (1976); Passow, et al. (1976); and Walker (1976).

language factors in causal models of scholastic performance has been noted. In particular, the impact of reading competency on multiple subject-matter achievements has been impressive.

Reading operates as an intervening variable in the structure of scholastic performance in much the same way as some of the sociological variables except that it may be several times more powerful. Thus, the influence of social background factors may be almost entirely mediated by reading comprehension. One purpose of this study is to familiarize the reading research community with recent IEA-related research in the reading area.

From a reading research perspective we note that before the beginning of the present decade, descriptions of the processes underlying the successful acquisition of reading competencies were dominated by "basic skills" explanations which were, for the most part, policy-oriented. Thus, the research problems examined originated in the world of the educational practitioner and the research results were destined for return to the real world of educational practice. D.H. Russell (1961) was representative of this approach, which supported the notion that reading is best viewed as a precise process involving the detailed and sequential perception and identification of letters, words, spelling patterns, and large language units. The notion was congruent with the belief that underlying comprehension in early reading are a number of "basic skills" such as meaning vocabulary, word recognition, and grammatical usage which constitute the key ingredients in the effective teaching of reading.

We note, too, that psycholinguistic theories of reading behaviour have been formulated in the interim which, it is claimed, constitute alternative explanations of the reading process (cf. Athey, 1971). We have been particularly impressed by the seminal work of the Goodman's, with Carolyn Burke, who stand with, say, Carroll and Smith, at the juncture of two disciplinary-oriented traditions;[3] namely, that stemming from the work of cognitive psychol-

[3] For representative examples of the work of the Goodman group see K. Goodman (1969, 1970, 1972), K. Goodman and Burke (1969), Y. Goodman (1971), and Y. Goodman and Burke (1972). For other examples of work in the Psycholinguistic tradition applied to reading see Carroll (1970, 1971) and Smith (1971, 1973, 1975).

ogists such as, Hochberg and Kolers, and that stemming from the work of structural linguists such as Bloomfield, Fries, and Lefevre, and the transformational linguists such as Wardhaugh.[4] In contrast with "basic skills" explanations, psycholinguists conceptualize reading as a selective procedure; as one in which the reader uses only part of what is on the printed page, plus what he already knows about the structure of language, and whatever background knowledge and experience he can marshal in order to gain meaning from graphic display.

Thus, the Goodman's posit that reading involves more than merely the identification of letters and words plus their associated meanings in a precise and sequential manner. Rather, they note and demonstrate that reading involves the utilization of three cueing strategies in the selective processing of available information; namely, information involving (a) the configuration of letters in a line of print, sentence or paragraph, (b) the syntactic, or grammatical cues inherent in that line, sentence, or paragraph, (c) the semantic, or meaning cues associated with the reading material, and (d) the interrelationships of (a), (b), and (c) with the reader's background of conceptual and language data.[5]

Just as we suspect that language factor and social-psychological explanations of subject-matter competencies may be complementary explanations, so we suspect that "basic skills" and psycholinguistic explanations of reading behaviour may be complementary rather than competing approaches. A second purpose of this study, then, is to consider the contributions of reading research to explanations of individual variability in reading comprehension; and the extent to which reading comprehension mediates the effects of social background factors on a range of logically distinct subject-matter outcomes of schooling.

---

[4] See, for example, Kolers (1969), Hochberg (1970), Hochberg and Brooks (1970), Bloomfield (1961), Fries (1962), Lefevre (1964), and Wardhaugh (1969).

[5] Note that mathematics is similarly involved with both syntactic and semantic cueing elements along with the grapho-phonic. It may be that problem-solving skills - or intuitive understanding - so valued by the mathematics teacher favouring the heuristic mode of instruction, involves the simultaneous application of mathematical syntax cues, mathematical semantic cues and mathematical graphic cues which the Goodman's show account for the development of reading competencies.

From a cross-cultural perspective the question arises as to the replicability of the basic model of the structure of scholastic performance, formulated in one national system, in culturally diverse systems. In particular, the question arises as to the extent to which reading competency as an intervening variable operates in a consistent fashion across cultural boundaries to account for schooling achievements.

We regard such questions as extensions of the pioneering work of Gray (1956), who examined the behaviour and processes in reading and writing in different cultures; and, more recently, as complementary to the comparative reading studies by Thorndike (1973a) and Downing (1973). Like these prior studies, we anticipate that the present research will raise more questions than it resolves.

Research Objectives

There has been no large-scale attempt to assess the relative effect of reading as an intervening variable in models of the structure of scholastic performance in diverse cultural settings. In this study the subject-matter outcomes of interest are the natural sciences - physics, chemistry, biology - and practical work. "International" variables - that is, variables with the same metric, gathered by standardized instruments in different countries - are used to provide a tentative answer to the question: Is the structure of scholastic achievement in the natural sciences the same in India - a Third World country - as in England - an industrialized country-for 14 year-old boys? At this stage of our work the emphasis is a disciplinary one. Though we anticipate that the research findings will eventually have significant policy-making implications for action programmes directed at within-system, and within-school resource allocation practices, we do not address ourselves to the policy implications of the findings in detail.

In broad terms the objective of the study is to find preliminary answers to several sets of perplexing questions concerned with the relative effects of differential socialization, language factors, and thinking stage explanations of performances in the natural sciences. Special emphasis is given to the relative effectiveness of reading competency as a predictor of scholastic performance. These questions include the following:

1. To what extent is reading comprehension an independent function of the social background characteristics of pupils?

2. To what extent is reading comprehension an independent function of (a) the acquisition of such basic language skills as meaning vocabulary, and (b) the pupil's piagetian thinking stage?
3. To what extent do meaning vocabulary and thinking stage factors attenuate the relative effects of socioeconomic and other social background characteristics of pupils on reading comprehension?
4. To what extent does reading comprehension, as a reasoning resource, mediate the effects of (a) background factors, (b) meaning vocabulary, and (c) thinking stage; (i) for achievement in science, (ii) for achievement in chemistry, (iii) for achievement in biology, (iv) for achievement in practical work in science, and (v) for achievement in general science - a composite of (i) through (iv)? In other words, to what extent is the covariance between every possible two-way combination of the four natural science outcomes of schooling, a function of the direct and indirect effects of the background characteristics, meaning vocabulary levels, thinking stage, and reading as a set of common causes?
5. What are the similarities and differences between 14 year-old boys in England and India regarding the four aforementioned objectives?

The answers to these questions will provide additional insights into the class-biased schools thesis, the language factor and learning thesis, and the thinking stage and science achievement thesis.

Explanations

In this section of the paper three commonly-asserted arguments promotive of scholastic excellence are examined. Though the proponents of these arguments tend to assume that each represents a discrete perspective, they will be treated eclectically for heuristic purposes. The explanations are referred to as: (a) the socializing differences argument, (b) the language factors argument, and (c) the thinking stage argument. Underlying these arguments is the common theme that the family and the school successively and jointly provide the treatments whereby the biological, social psychological, and economic resources of children are converted into school-related competencies; which, in turn, constitute the resources convertible through appropriate opportunity structures into subsequent socioeconomic career attainments. Thus, for example, if reading in the Thorndikes' (1917, 1973-74) sense, as reasoning, is distributed unequally, its translation into subject-matter performances will be distributed unequally.

1. Socializing Differences.

The socialization argument is based on the simple premise that there are considerable within- and between-group differences in child rearing; expecially in terms of the learning environments, and the associated economic and psychological support conditions, provided within the family. Such differences govern the impact of schooling on the cognitive, affective, and conative outcomes of schooling. The notion is that the child's resources are converted into additional resources (assets or liabilities) through interaction with the within-classroom learning environments. Eventually, the effectiveness of the within-family and within-school socializing treatments determines the variability in the zero-sum distribution of scarce societal resources such as school achievement, social prestige, and income. One such school related and, hence, policy manageable resource, is reading competency.

The extreme socializing differences position holds that a child's progress through school is more a function of social class - the father's status in the occupational order - than of meritocratic criteria such as ability, effort, and motivation. The three factors which are commonly used as measures of the effects of social backgrounds are father's occupation (the socioeconomic status variable), mother's and father's (or parental) education, and the family configuration (the number and spacing of children).

In meaning vocabulary terms the effect of the socioeconomic variable is attributable to the fact that socioeconomic status is a proxy for environmental complexity and cultural enrichment. Thus, it is noted, in the first instance, that children from relatively complex home socializing environments have the opportunity to develop more precocious meaning vocabularies through the necessity of being initiated into the common language meanings that such environments hold for their members. In the second place, it is noted that material deprivation is highly correlated with cultural impoverishment - at least in those economic systems with highly developed commutative mechanisms - and that the child's cultural circumstances will determine the opportunity at home for learning and practicing school-relevant behaviours.

In reading comprehension terms, though socioeconomic status will have modest net effects on reading, its major impact will be an indirect one as mediated by the meaning vocabulary variable.

A similar logic prevails in the case of the other background factors - parental education and family configuration. Thus, children whose parents are well-educated and, hence, highly articulate, are likely to utilize more precocious language skills and codes than children whose parents are less well educated, ceteris paribus. It is believed, therefore, that the importance of early language learning for intellectual growth is more likely to be stressed and recognized by well-educated mothers; that these mothers will be more skillful in the transmission of the primary learning elements required for decoding/encoding precocity, than their less well-educated counterparts.

The family configuration sub-argument (Zajonc and Markus, 1975; Zajonc, 1976) is based on the postulate that different family configurations constitute different intellectual environments; hence, formulation of the proposition that, if the intellectual environment is the aggregate level of all family members' absolute intellectual contribution, then not only does it change continually as the children develop, but is a function of the number of additions or departures from the family and the spacing of children. The intellectual environment of the family is captured by the family configuration variable which will be related to vocabulary, thinking stage, and reading resource acquisitions of children.

2. The Language Factors Argument.

Family socializing differences explanations address the question of how family environments both account for and translate the unequal biological, linguistic, and socioeconomic resources of children into unequal educational attainments. Language factors such as those represented by "basic skills" and psycholinguistic explanations of reading competency constitute the basic learning resources of children. These language factors include the cueing strategy variables - grapho-phonic, syntactic and semantic cues - and the "basic skills" variables - meaning vocabulary, word recognition, and grammatical usage - though their interrelationships in terms of reading comprehension outcomes are imperfectly understood. Nevertheless, they constitute linguistic resource assets which are inequitably distributed and which account to some considerable extent for the fact that children entering school each year do so with different levels of the resources required as prerequisites to successful performances during the year.

In the general case, the greater the linguistic resource assets of the pupil in terms of coping with the progressively more complex environments of the school - especially in terms of subject-matter complexity - and the more effective the teacher treatments in relation to these primary resources, the greater the probability that the individual will receive preferred treatments in the different settings at later grade levels. It follows that the primary linguistic resources are translatable in school settings into additional resources such as reading competencies, which in the form of "reading as reasoning" constitute a secondary resource asset. Reading on a priori grounds is a common cause of the multiple subject-matter achievements of pupils at the upper-elementary and secondary school levels. It is the relative magnitude of this dependency which is assessed in the present study.

The dependence of subject-matter performance on reading resources has been demonstrated in several studies. Thus, Hauser (1971, pp. 77-80) showed: (a) that the reading comprehension of Tennessee high school students was a powerful intervening variable mediating the distal effects of family background factors and mathematics, and (b) that the direction of the relationship was recursive, not reciprocal. Similarly, verbal reasoning is shown to mediate background variables and the relative importance of parents, teachers, and peers as sources of psychological support in accounting for the observed educational inequalities of Canadian high school students (Williams, 1972). E.L. Thorndike (1973a, p. 160) notes that inequalities in science and literature achievements are mediated by reading comprehension, and postulates that reading plays a key role as a predictor agent for more specific subject-matter areas.

The linguistic factor thesis has been powerfully demonstrated in causal models of school achievement in literature by Bulcock (1974), and Bulcock and Finn (1975). The importance of meaning vocabulary levels as predictors of the multiple outcomes of science performances - physics, chemistry, biology, and practical work - has been shown in a series of multivariate models by Finn and Mattsson (1974). Both meaning vocabulary levels and reading competencies were shown to be powerful intervening variablesin multivariate models of the structure of scholastic performance in science and literature by Bulcock (1976) and [illegible] and [illegible] ([illegible]) [illegible] studies, sponsored by the Institute for the Study of International Problems in Education, University of [illegible], utilize national-level probability samples of 14 year-olds from Sweden and England [illegible] from the [illegible].

. [illegible] Stage Argument.

The Piagetian [illegible] stage argument [illegible] for two reasons. In the first place we accept the postulate that scientific understanding is, on a priori grounds, dependent on (a) development of the logic of propositions, and (b) [illegible] of the operations of combinations and proportions; that is, the hypothetico-deductive mode of thinking (Piaget, [illegible]). Thus, failure to take the [illegible] stage argument into account in explaining achievement in the natural sciences would constitute a serious conceptual limitation in the development of [illegible] the structure of scholastic performance.

We have argued in our description of the epigenesis of language in the [illegible] that reading resources are acquired as a function of the [illegible] through both [illegible] strategy and [illegible]. The argument was extended on a priori grounds [illegible] achievement in the natural sciences were at least a partial function of reading competency, that is, the relationship between reading competency and [illegible] was expected to be positive. It was also postulated that the [illegible], and that science achievement is [illegible] of reading [illegible] but [illegible] was [illegible].

[illegible] the language [illegible]

[illegible]

[illegible] explanation. Thus, the [illegible] as a [illegible] concern. In order to [illegible] of the language factor argument when [illegible] reading and science achievement [illegible]

[illegible]

[illegible] whether language plays a [illegible] in the intellectual development of children ([illegible]), or whether the development of language seems to [illegible] that of operations (Piaget, [illegible]). The [illegible], the issue, but [illegible].

[illegible]

[illegible]

II. RESEARCH DESIGN AND FINDINGS

Model Formulation

The extent to which socializing differences, language factors, and thinking stage explanations account for the covariation between natural science achievements, and the extent to which these explanations are complementary or competing approaches, is examined through the analysis of a recursive model designed to map the complexities underlying scientific understanding. The model may be subdivided into four segments: (a) meaning vocabulary as dependent, three source variables congruent with the socializing differences argument - father's occupational status, parental education and family size - as independent; (b) thinking stage as dependent, the three source variables and meaning vocabulary as independent; (c) reading comprehension as dependent, the three source variables, meaning vocabulary and thinking stage as independent; and (d) physics, chemistry, biology, and practical work, each as dependent outcomes simultaneously considered as a function of a set of common predictors - the source variables, meaning vocabulary, thinking stage and reading comprehension. The complexity of these pathways is illustrated in a basic conceptual model followed by an elaborated version of the model in Figure 1.

In anticipation of criticism two rejoinders are advisable at this point to prevent unnecessary misinterpretation. In the first instance it is desirable to address the structural equation commandment that there shall be no ambiguity in the causal ordering of the variables. Weak causal ordering of the kind depicted in Figure 1.. assumes that independent variables X_i may (or may not) affect dependent variables Y_i at each model segment, but that Y_i cannot affect X_i. The causal ordering is far from unequivocal, which is almost necessary in cross-sectional, quasi-experimental designs, with several intervening variables. Nevertheless, it is plausible to assume that the natural cycle ordering of the parent — child variety justifies placement of background factors and events (the socializing differences variables) prior to outcomes dependent on more recent events and experiences.

What is more problematic is the relationship between language (in which words as representations of existential reality facilitate the development and [illegible] facilitative

FIGURE 2

BASIC AND ELABORATED CONCEPTUAL MODELS ILLUSTRATING THE RELATIONSHIPS BETWEEN VARIABLES SUGGESTED BY SOCIALIZING DIFFERENCES, LANGUAGE FACTORS, AND THINKING STAGE ASSESSMENT, EXPLAINING [illegible] ACHIEVEMENT IN THE NATURAL SCIENCES

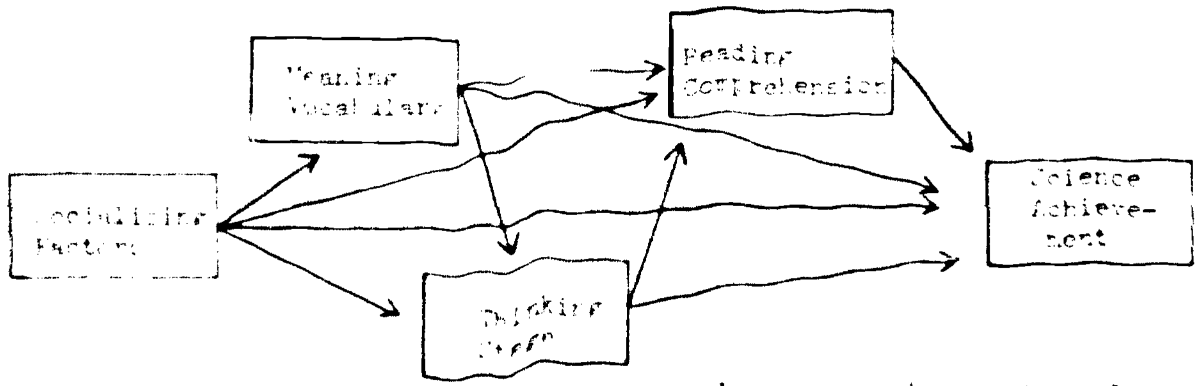


Figure 1.1. Basic Conceptual Model of School Achievement in the Natural Sciences Illustrating the Pivotal Position of Reading as an Intervening Variable

Figure 1.2. Elaborated Model of School Achievement in the Natural Sciences.[a]

[a] [illegible] = father's occupational status; [illegible] = parental education; [illegible] = size of [illegible]; [illegible] = thinking stage; [illegible] = reading comprehension; [illegible] = reading vocabulary; [illegible] = chemistry; [illegible] = biology; [illegible] = practical work. [illegible] which each variable is affected by [illegible] variables which are shown in vertical [illegible].

of shared communication with others and interpretations of oneself. Resolution of the Vygotsky vs Piaget dilemma is not attempted here. Rather a compromise solution is attempted. A child's meaning vocabulary is well-developed prior to the dual assimilative-accommodation processes which generate that epigenetic intellectual stage referred to as the formal operational stage of thinking and upon which scientific understanding depends. Thus, the development of a child's meaning vocabulary, conceived of as a relatively enduring measure of verbal precocity, is chronologically prior to the development of hypothetico-deductive thought processes.

One regret is that an examination of the role played by the psycholinguistic encoding systems in the development of intelligence is not possible given the IEA data base. We harbour the hunch that it might be considerable; in which case most current research on the language thought controversy is misspecified due to the erroneous omission of important variables.

There is still the problem of the relationship between thinking stage and reading comprehension. In this issue we have followed our Canadian colleague Mildred Fawcett (19[illegible]) who examined the contribution of five logical operations - conservation, classification, deduction, induction, and probability reasoning - to the reading performances of grade 4 (9-10 year-old) pupils, and the implicit assumptions in E.L. Thorndike's (1917) classic study. While the possibility must be entertained that a functional or reciprocal relationship exists between thinking stage and reading, this hypothesis - though eminently testable - is not examined in this research. It seems that the thinking-reading relationship is not resolvable on a priori grounds and must, therefore, remain as an outstanding research issue.

The second rejoinder concerns the isomorphism between verbal or main theory explanations and the auxiliary or operational models deduced from them. The analyst's task is to formulate a best-fitting auxiliary model to the conceptual model in such a way that the associated hypotheses are falsifiable. In this task the admixture of theory and observation is sometimes formidable. Notwithstanding the strong claims (e.g. Brodbeck, 19[illegible]) we share the position that complete isomorphism between conceptual models and their man-made analogues is unattainable; that, therefore, subsequent analysis does not liberate the reader from the necessity of exercising independent judgment and a healthy scepticism.

Analytical Strategy

Instrumentation questions are briefly taken up in technical appendix A; and the statistical results are presented in the Tables of technical appendix B. It is hoped that by relegating routine procedural matters to the appendices they will, thereby, not interfere with substantive concerns. The evidence constituting the results, and the basis for the interpretations which follow, is thereby presented for the expert, but not in a way which intrudes on, or inhibits, consideration of more central concerns.

For the most part analyses revolve around the development and test of structural equation models (e.g. Blalock, 1971; Duncan, 1975) designed to be isomorphic with the auxiliary models and the verbal theories explaining the aspects of reading and science performance under examination. Recursive models are tested through the estimation of model parameters using path analysis (Wright, 1934; Duncan, 1966), which is a generalization of multiple linear regression estimation procedures to systems of causally related variables. The parameters are estimated as partial regression coefficients and interpreted as measures of effect.

The unstandardized regression coefficients of all intervening variables - reading vocabulary, thinking stage, and reading comprehension - are allowed to assume a substantive meaning that is uncommon in studies composed of sets of variables, each characterized by a different metric. This is because they are to be inputted as percentages in a model where the four dependent variables are also percentage measures. Thus, a unit change in, say, reading comprehension, will refer to a percentage unit. Since unstandardized coefficients are interpretable as the unique influence of a variable, given controls over other variables in the model, the findings may be interpretable in such terms as: an "x" percent improvement in reading comprehension will produce an "x" percent improvement in physics, <u>ceteris paribus</u>, and so on. Since the effects are additive, the estimation of the effects of several predictors simultaneously makes it possible to estimate resource costs in terms of expected natural science outcomes.

Following Finney (1972), a second type of analysis is conducted, in which the gross or total effects of the relationship between two variables is decomposed into three independent elements: (a) the net or direct effect, (b) the indirect effect, and (c) a non-causal spurious component. The first two elements (a and b) may be summed to represent the total causal effects (TCEs). The utility of the

TCEs lies in the fact that they represent exact estimates of the total relative impact of explanatory variables on the outcomes of interest. TCEs may be ranked for comparative purposes.

Findings

1. England.

Zero-order relations are presented in Appendix B, Table B-1. It is noted that the associations between reading and all science subtests is greater than 0.5; and that the reading-overall science performance relationship has a correlation coefficient greater than 0.7. The relationships between background factors and natural science performances are as hypothesized. Thus, the coefficients in the 0.3 range for the father's occupation - natural science and father's occupation - reading relationships are about the same order of magnitude as those reported in other industrialized nations (cf. Rehberg and Rosenthal, 1975).

The thinking stage variable is strongly associated with achievements in the natural sciences with most coefficients in the 0.4 range. It is useful to note that the piagetian variable is not overly deterministic - a fact probably demonstrating that natural science performances in school settings do not always depend on the application of higher order thinking processes; or, obversely, that rote recall and knowledge of mere information will go a long way in some school systems to account for cognitive achievements. The high correlations - in the 0.5 range - between meaning vocabulary and subtest performances in science is particularly noteworthy in view of the emphasis placed on language factors explanations.

The advantage of Table B-2 is that the structural coefficients may be interpreted as measures of the unique influence of a variable, given controls over the other variables in the model. For example, because all the endogenous variables in the model - the intervening variables and the outcome variables - are percentage scores, the regression coefficients may be interpreted as follows: an "x" percent improvement in, say, reading will likely produce an "x" percent improvement in some outcome - say, overall science performance - ceteris paribus. Take the science outcome in Table B-2. Column 1 in science provides the regression coefficients for each of the predictor variables in the model of scholastic performance. With the important exception of the three source variables (FATHOCC, PARED, AND SIBSZ) the remaining predictors lend themselves to the following interpretation: a ten percent improvement in reading comprehension will produce a 4.48 percent improvement in science performance, <u>ceteris paribus</u>. Since the model is an additive one it is possible to interpret the effects of reading and thinking in the following manner: if as a function of teacher treatments and pupil effort a ten percent gain in both reading and thinking performances was accomplished the net expected gain in science performance would be 4.21 + 1.82 = 6.03 percent.

School systems knowing this kind of information could eventually estimate how resource costs might be weighed against expected outcomes in their planning of school curricula. If it were thought that language factors were more policy manageable than thinking stage elements - e.g. more responsive to teacher treatments and the concomitant pupil effort - the expected impact of the combined language factors might be contrasted with the combined impact of reading and thinking. In this hypothetical example the language factors account for effects of .136 + .421 = .557 (versus .182 + .421 = .603) on science performance. The difference (.046) is modest. The decision to emphasize the teaching of the language arts including reading might be a sound one if thinking stage elements prove less amenable to teacher treatments than language factors. There can be little doubt, however, that the teaching of reading is of crucial importance in terms of pupil achievements in the natural sciences.

The relative effect of a predictor variable - i.e., relative to all other model predictors - is noted in column II which reports the path coefficients. It is noted that in terms of overall science achievement reading has the most powerful net effect (.487), relative to the other predicators; followed by thinking (.225) and meaning vocabulary (.178) in that order. Reading has more than twice the impact on science than the thinking variable; and, incidentally, eight times the impact of father's occupation or any other background variable.

Since some of the effects of the more distal factors are mediated by intervening variables, their total causal influences may be underestimated on the basis of an examination of their structural coefficients. Following Finney (1972) the total causal effect (TCE) of each predictor in the model is calculated (Table B-3) and ranked for comparative purposes (Table B-4). The utility of the TCEs lies in the fact that they represent exact estimates of the total relative impact - both direct and indirect - on the outcomes of interest.

From Column 4, Table B-3, one notes that the direct effect of father's occupational status on science is a modest .058; whereas the total causal effect - the direct effect, plus the effect of father's occupational status on science as mediated by the intervening variables VOCAB, THINK and READ - is .259. Though the TCE of FATHOCC on SCIENCE is considerable, it is shown in Table B-4 that the TCEs of VOCAB, THINK, and READ are even greater. Similarly, it is shown in Table B-4 that the impact of the variables stemming from language factor and thinking stage explanations for the English data is considerably greater than for those stemming from socializing differences explanations.

2. India.

It is noted from the correlation matrix (Table B-1) that reading - natural science relationships in India lack uniformity. The correlation between reading and biology is .27; correlations between reading and physics, and reading and practical work are in the 0.3-0.4 range; and those between reading and chemistry, and reading and total science performance in the 0.4-0.5 range. Though the significance levels were less than .001, the unanticipated range in the magnitudes of the scores remain difficult to explain.

Correlations between background variables and natural science performances were well below those anticipated. While findings regarding the effects of the thinking stage variable were less problematic, the modest strength of the associations (from .10 to .25) should be noted. The range of zero-order relations between meaning vocabulary on the one hand, and the natural science achievements on the other, was consistent with the language factors explanation. Table B-2 evidence is supportative of the complementarity thesis, where it is noted thatthe effects of the thinking stage variable on all natural science outcomes except practical work are statistically and substantively significant over-and-above the effects of the language factors explanations.

Examination of the TCEs of the source variables in India (Table B-3) confirm the negligible effects of background factors noted from their zero-order measures of association. In fact the family configuration variable had negligible effects on all endogenous variables. The TCEs of intervening variables, with the exception of thinking as a predictor of reading and practical work, were either moderate or strong. Most were in the 0.2 to 0.4 range and sufficient to be regarded as being of substantive, as well as statistical, significance. All these relationships were in the hypothesized direction.

Note that in TCE terms the effects of the meaning vocabulary variable outranked all other effects on the natural sciences. TCEs of the reading variable were in second rank (Table B-4) and thinking stage influences were in third place. The impact of the intervening variables on practical work in science were, however, noticeably less powerful than on physics, chemistry and biology.

3. England/India Comparisons.

Similarities clearly outweigh the differences. The most important differences to be noted concern the socializing explanation. Whereas the TCEs of father's occupational status in England on all endogenous variables were significant - six out of the eight relationships in TCE terms were greater than 0.2 - the same was far from the case in India. Two of the TCEs of father's occupational status in India were negligible; only one was above 0.1; and the remainder were between .05 and .1 which is regarded as being of marginal substantive signigicance.

The effects of parental education in the India sample were similarly modest. Impact on meaning vocabulary, thinking, and practical work was negligible. Though in chemistry a TCE of .113 was recorded, the remaining relationships were of marginal importance. Since all the number of children TCEs were negligible (Table B-4) the variable effectively played no part in accounting for the natural science outcomes. Such a specification error - that of erroneous inclusion - may be rectified by respecifying the model as in Figure B-1. In the respecified India model the vocabulary and thinking variables are shown as source variables since there are no associative relationships between them or between them and the remaining background factors. This leaves reading as the only mediating variable between four source variables and four natural science outcomes. The evidence supports this model respecification as being the most accurate representation of the structure of scholastic performance for 14 year-old boys in Hindi-speaking India.[7]

---

[7] See Peaker (1975) for details for the 3 stage sampling design for the 6 Hindi-speaking states sampled. These states contain approximately 41% of the Indian population.

A second difference between the countries concerns the extent to which antecedent variables account for variance in natural science outcomes. Though in both countries the model is obviously an effective one for accounting for science achievement, the explanatory power of the English application ($100R^2$ = 59.5) is greater than that of the Indian ($100R^2$ = 35.9).

Similar differences are noted in terms of the extent to which the antecedent variables constitute a set of common causes accounting for the covariation between subtest performances in the natural sciences. Thus, it is noted from Table B-6 that with the exception of the chemistry-biology relationship the predictors in the English model of scholastic performance accounted for greater proportions of the covariance between natural science outcomes than did the common predictors in the India model. The median proportion explained in England was .45 and in India .38.

The three noted differences should not be exaggerated. Except for these, the model of scholastic achievement in the natural sciences operated in the predictable way in both countries. Reading in England was consistently the most powerful predictor of science achievements; and the same was true in India with the exception of performance in biology. Most of the time, the thinking stage variable had the next most powerful net effects when simultaneously considering the effects of all other system variables. Thinking was only marginally ahead of meaning vocabularly influences in terms of direct effects. When the indirect effects of meaning vocabulary on natural science performances as mediated by thinking and reading are considered as in Table B-4 it is shown that its TCEs in both England and India rank in first place.

III. INTERPRETATIONS

Theoretical Implications

In England, but not in India, reading was significantly influenced by variables generated by socializing differences arguments. Even in England the direct effects of the three family background variables on reading were of modest magnitude. Their total causal effects, however, were several times larger as shown in Table B-3. Since the TCE of father's occupational status on reading for the English sample was considerable, the question arises whether English schools are class biased institutions; that is, whether socio-economic status is more important than merit in determining school achievement.

The importance of the question stems from the fact that if English schools are class biased the societal effort necessary to implement educational reforms will be of a different order of magnitude than if the schools themselves control the reformist mechanisms. Background variables are not in the short term amenable to policy intervention. To clarify the problem three sources of evidence are available. First, zero-order relationships are presented between the first five predictor variables in the model and reading.

TABLE 1

ZERO-ORDER RELATIONSHIPS BETWEEN FIVE PREDICTOR VARIABLES AND READING: ENGLAND/INDIA/U.S. COMPARISONS.[a]

Relationship	England	India	U.S.
r_{16}	.295	.013	.306
r_{26}	.129	.031	.310
r_{36}	-.166	.033	-.096
r_{46}	.647	.364	.666
r_{56}	.365	.087	(b)

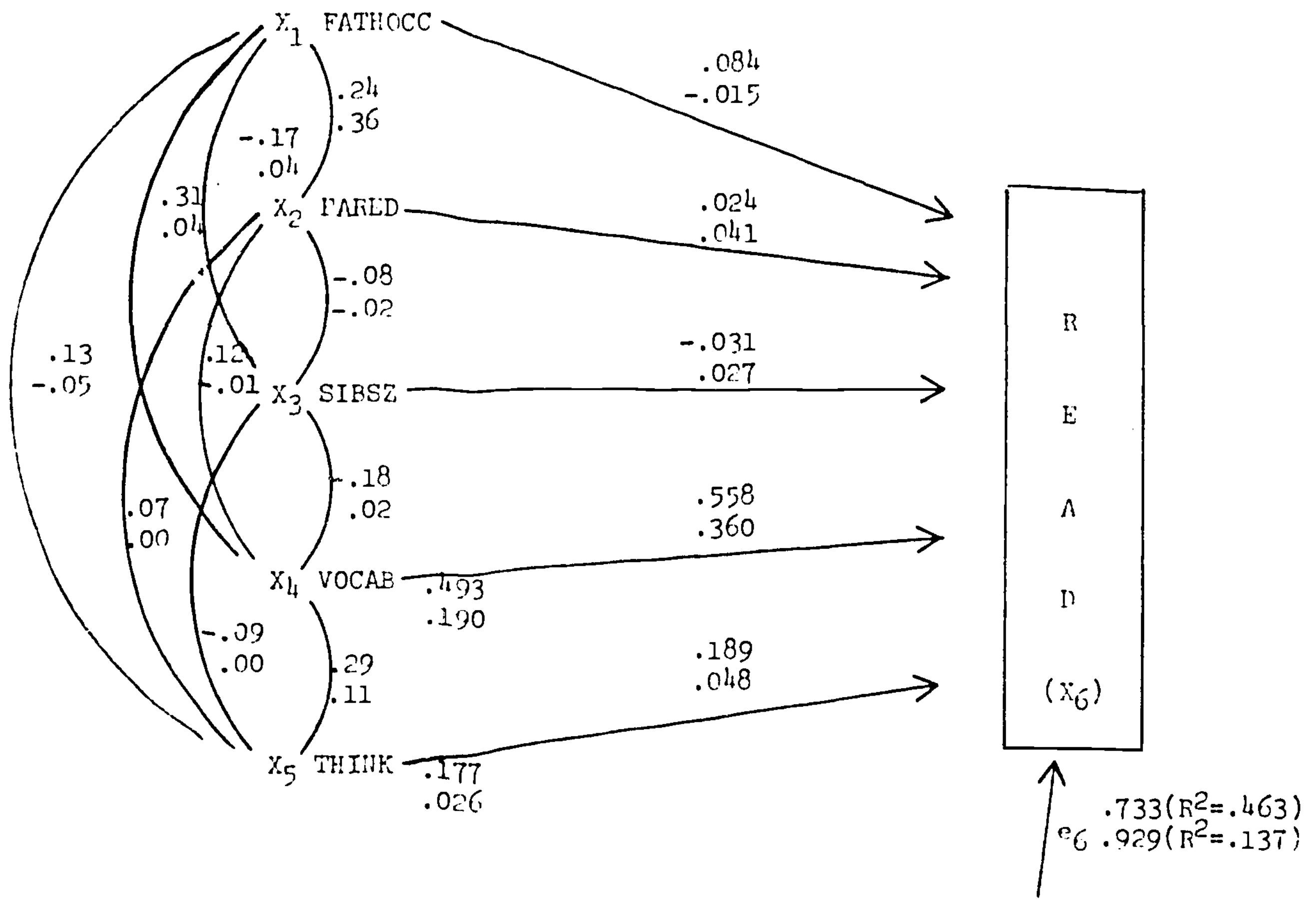
[a] Where X_1 = FATHOCC, X_2 = PARED, X_3 = SIBSZ, X_4 = VOCAB, X_5 = THINK, and X_6 = READ.

[b] The r_{56} relationship is not available for the U.S. The THINK variable was constructed from the distractors to four science test items, but in the U.S. 14 year-olds who wrote the IEA science test did not write the IEA reading comprehension test. This means that the structure of scholastic performance model cannot be tested using the IEA-U.S. data.

Data in Table 1 from the IEA U.S. sample is included for comparative purposes. Second, the direct effects of the predictors are shown in a path model (Figure 2). Third, the total causal effect coefficients of the predictors presented in Table B-4 are compared.

FIGURE 2

PATH MODEL OF READING COMPREHENSION IN ENGLAND AND INDIA[a]



a Path coefficients are presented above the paths. The top coefficient is for England in each case. The regression coefficients for VOCAB and THINK only, are presented below the paths (cf. Table B-2).

The zero-order relationships between father's occupation and reading, and meaning vocabulary and reading, are the same in the industrialized nations of England and the U.S. Relationships between parental education and reading, and between number of children and reading are different in the industrialized nations. Though different background variables have different effects they are all outranked in magnitude by the effect on reading of the meaning vocabulary variable.

A more stringent test of the class bias thesis involves examination of the relative effect of each predictor while simultaneously taking other predictors into account. Such a test is presented in Figure 2 where it is shown: (a) that father's occupational status is a more powerful predictor of reading than the other background factors, and (b) that the effects of meaning vocabulary and thinking stage variables on reading are over six times and twice as powerful respectively as the father's occupation variable.

It must be recognized, however, that some of the effects of the background factors on reading are indirect. For example, father's occupation influences meaning vocabulary; similarly it influences thinking stage development; and it influences reading via these mediating pathways. In view of the potentially powerful indirect effects of the background variables it becomes important to examine their total causal effects as presented in Table B-4. It is noted that the direct effects are underestimates of the total effect of the background factors.

Nevertheless, Table B-4 evidence does not support a class biased interpretation, but rather a language factor bias. The TCE ranking of FATHOCC is behind that of VOCAB, but more important is the fact that the TCE for FATHOCC is less than half that of VOCAB. It is inferred from these (Table B-4) results that the three explanations are complementary not competing notions. They are necessary, but not sufficient, for explaining variability in reading in England. Though socializing differences variables are of substantive importance their impact is less than that of either the meaning vocabulary or the thinking stage variables. One cannot reasonably conclude from this evidence that English schools are class biased.

Application of the same logic to the English natural science outcomes results in the same conclusion in so far as the class bias thesis is concerned. What seems problematic is the failure of the socializing differences explanation in the case of India. The effects of the social background variables on meaning vocabulary, thinking, and reading are negligible. Literally, this means that in India neither the material circumstances of the home, nor differences in parental education, nor the family configuration in terms of size, have effects on variation in meaning vocabulary's, thinking stage, or reading comprehension. On the other hand, thinking and reading are influenced by meaning vocabulary.

Several ex-post-facto considerations are compatible with these findings. In the first place, it is conceivable that the effects of social background factors may already have occurred prior to Indian school children reaching the age of fourteen. Second, Thorndike (1973b) suggests that reading performances in India were sufficiently low that the children were unable to read the student questionnaires; that, therefore, many students resorted to random guessing. On the other hand, the language and thinking stage arguments were supported. For purposes of analysis those students reading below a designated level of performance were eliminated from the sample as is pointed out in Appendix B. For these reasons the random guessing explanation might be discounted.

Third, it is important to note that describing selected characteristics of a family is not the same as describing the socializing mechanisms; that is, how a family socializes children. It is conceivable that family characteristics in India fail to operate as viable proxies for family socializing treatments as in industrialized nations. Alternatively, there may be no significant differences in the socializing treatments preferred in Hindi-speaking India on the basis of socioeconomic differences; in which case the support for a null hypothesis is real, not spurious. Before reaching such a conclusion, however, further research is desirable. It is prudent not to prejudge in these important matters; and especially because socializing differences explanations of natural science performances in India are viable. Note from Table B-4 the TCE's of father's occupational status on physics, and overall science performances; and the TCE of parental education on chemistry.

The fourth objective of this research is important because it concerns the relative effect of reading performance on natural science performances while taking other determinants of science achievement into account simultaneously. Another way of stating the objective is as follows: to what extent are socializing differences, language factors and thinking stage explanations of achievements in the natural sciences complementary or competing arguments. As was pointed out in the findings section the three arguments in the case of both countries are complementary - each has to be considered. In view of the magnitude of the independent effects of reading on science outcomes, however, the relationship deserves special consideration.

The view is held that the findings represent prima facie support for the Thorndikes' (1917, 1973-4) postulate; namely, that "performance in reading, at least after the basic decoding skills are mastered, is primarily an indicator of the general level of the individual's thinking and reasoning processes rather than a set of distinct and specialized skills". It is reading in this sense that accounts for its effectiveness as a common determinant of the covariation between the natural science subtest performances (Table B-5).

Though the Thorndike's describe the relationship between reading and reasoning thereby justifying their synonymy, it is the Goodman's that account for the process underlying reading as reasoning. Their cueing strategy thesis is congruent with the reasoning thesis in that it describes the selective processes used in the reading act which are paradigmatic of the reasoning process. Application of cueing strategies involve reactions to printed material in a number of ways - checking validity, making inferences, drawing conclusions - all of which may be regarded as reasoning. Thus, although the Goodman thesis is not tested in this research it promoted the formulation of the research hypotheses, and the findings are congruent with the "guessing game" reading thesis.

Undoubtedly, however, the effects of reading on natural science achievements were attenuated by the thinking stage factor. In both countries the thinking variable proved a powerful determinant of science over-and-above all other predictors. The percentage effect estimates of the three intervening variables are presented in Table [illegible]. It will be noted that in physics and chemistry their combined effects are about the same in both England and India. In biology, practical work and science the combined effects of language factor and thinking stage variables are more powerful in England than in India. Since the intervening variables - especially the reading variable - are the ones most manageable by school authorities, and since these variables have decidedly greater influence than the background factors in TCF terms, there seems little doubt that schools may be held accountable for pupil performances in the natural sciences. Further, the importance of reading precocity as the single most powerful mediating variable in the flow of effects accounting for natural science achievements can not be doubted on the basis of IEA evidence.

TABLE 2

PERCENTAGE EFFECTS OF LANGUAGE FACTORS AND THINKING STAGE VARIABLES ON NATURAL SCIENCE PERFORMANCES[a]

Effect of a 10 per cent increase in:		Outcomes (%)				
		Physics	Chemistry	Biology	Practical	Science
X_4 VOCAB	E	1.2	1.6	1.1	1.5	1.4
	I	1.7	1.1	1.3	1.2	1.3
X_5 THINK	E	1.7	2.0	2.2	1.4	1.8
	I	1.1	1.4	1.2	0.2	1.0
X_6 READ	E	4.8	4.0	3.4	4.5	4.2
	I	4.2	4.6	2.0	3.2	3.5
Combined language factors (X_4+X_6)	E	6.0	5.6	4.52	6.0	5.6
	I	5.9	5.7	3.3	4.4	4.8
Combined language factors & thinking stage ($X_4+X_5+X_6$)	E	7.8	7.6	6.7	7.4	7.4
	I	7.0	7.1	4.5	4.6	5.8

[a] The table may be read as follows: a ten percent increase in reading will account for a 4.2 percent increase in science performance for English 14 year-old boys or a 3.5 percent increase in science performance for Indian 14 year-old boys, <u>ceteris paribus</u>. Similarly, if the three factors VOCAB, THINK and READ could each be simultaneously improved by 10 percent, the resultant effect on science performance would probably be in the region 7.4 percent in England and 5.8 percent in India, <u>ceteris paribus</u>.

Conclusions

This paper attempted:

1. to formulate and test a general model of the structure of scholastic performance;
2. to popularize the notion of reading as a school dependent personality resource asset, readily convertible in classroom treatment settings into additional desired scholastic performances;
3. to demonstrate the pivotal role that reading, as reasoning, plays in accounting for natural science achievements in physics, chemistry, biology, practical work, and an overall science performance composite;
4. to test the proposition that socializing differences, language factors, and thinking stage arguments are complementary rather than competing explanations of school achievements in the content fields;
5. to assess the extent to which reading as a school dependent resource translates the unequal socioeconomic and linguistic resources of children into unequal natural science achievements; and
6. to examine the operation ofthe structure of scholastic performance model in two culturally and economically different nations - England and India.

It was concluded, first, that the socializing differences argument was defensible in England, but less so in India. The extreme socializing differences argument that a child's progress through school is more a function of social class than ability and motivation was rejected. The linguistic resources of children and their stage of thinking had effects on the natural science performances of children which were greater in magnitude in both England and India than social background factors.

Several ex-post-facto explanations of the almost negligible impact of social background factors in India on reading competency and science achievements were considered. Two explanations seemed worthy of further investigation. The first notion holds that by the age of 14 the effects of social circumstances in India may already have operated; and that those boys with severe social handicaps may have already withdrawn from formal schooling. The second explanation concerns the differences between what home circumstances are, and what they do. Thus, in India the social background factors may not operate as adequate proxies for the differences in the actual socializing treatments provided in the home. Alternatively, home socializing treatments may be more uniform in India than in England across socioeconomic status boundaries.

Because language factors and thinking stage arguments were independently operative in accounting for science performance it was concluded that the three autonomous explanations of scholastic performances complemented one another. As expected, the piagetian position that achievements in the sciences are dependent upon the attainment of formal operational thought was strongly supported in both countries. The test was a stringent one in that the piagetian variable operated over-and-above simultaneous consideration of five other contenders. Of these other contenders, however, the language factors proved particularly powerful. Language factor arguments were traced to the recent work of R.L. Thorndike and the Goodman's. While there are few parallels this century to the sustained intellectual effort in developmental psychology than that of Jean Piaget, the results of this research suggest that Thorndike's work in educational psychology and Kenneth Goodman's work in applied psycholinguistic also merit careful attention.

The results of this research show that reading as a policy manageable variable amenable to within-classroom treatments is the single most powerful mechanism known for determining school achievements in physics, chemistry, biology, practical work, and overall science performance. This is interpreted to mean that teachers, individually and collectively, may legitimately assume greater responsibility for the intellectual performances of students than heretofore; and, by the same token, may be legitimately held accountable for the quality of service they provide their clientele. Because reading in both an industrialized and a Third-World nation has been shown to be a crucially important resource mechanism in the structure of scholastic performances; because this mechanism accounts for the translation of socializing and linguistic resources into the additional desired resources of multiple subject-matter achievements; and since these achievements constitute important criteria in the allocation of scarce societal resources such as statuses, incomes, and associated psychological satisfactions, it is easily concluded that no teacher is more important than the reading teacher.

Attention might be given to the political implications of these findings. Individually reading teachers play crucial roles in the initiation of pupils into the logic of reasoning. Collectively reading teachers represent a powerful political force. The evidence suggests that there may be no more subtle way of impoverishing the cultural resources of a society than by placing constraints on the opportunities that children have for learning how to read. Conversely, there would seem to be no more effective way of liberating the intellect, of overcoming cultural impoverishment, than through the development of reading competency, and *ipso facto* of reason.

REFERENCES

ATHEY, IRENE J. "Synthesis of papers on language development and reading." In F.B. Davis (Ed.), The literature of research in reading with emphasis on models. New Brunswick, N.J.: Graduate School of Education, Rutgers-The State University, 1971.

BLALOCK, HUBERT M. JR. Causal models in the social sciences. Chicago: Aldine Atherton, 1971.

BERGLING, KURT. The development of hypothetico-deductive thinking in children. New York: Wiley (Halstead Press), 1974.

BLOOM, BENJAMIN S. Cross-national study of educational attainment: stage 1 of the IEA investigation in six subject areas. Department of Health, Education and Welfare, Office of Education, Washington, D.C. Final Report Project No. 6-2527, Grant No. HEW-OEG-3-6-062527-2226, 1969.

BLOOMFIELD, LEONARD & BARNHART, C Let's read: a linguistic approach. Detroit: Wayne State University Press, 1961.

BRODBECK, M. "Models, meaning, and theories." In L. Gross (Ed.), Symposium on sociological theory. New York: Harper and Row, 1959.

BULCOCK, JEFFREY W. Achievement in mother tongue literature. Report No. 5, Institute for the Study of International Problems in Education, University of Stockholm, Sweden, 1974.

BULCOCK, JEFFREY W. Toward a general model of the structure of scholastic performance. Report No. 12, Institute for the Study of International Problems in Education, University of Stockholm, Sweden, 1976.

BULCOCK, JEFFREY W. & BEEBE, MONA J. Reading in the structure of scholastic performance. Report No. 13, Institute for the Study of International Problems in Education, University of Stockholm, Sweden, 1976.

BULCOCK, JEFFREY W. & FINN, JEREMY D. "Explaining school performance in literature: some strategies of causal analysis." Scandinavian Journal of Educational Research, 1975, 19, 75-110.

CARROLL, JOHN B. "The nature of the reading process." In H.S. Singer & R.B. Ruddell (Eds.), Theoretical models and processes of reading. Newark, Delaware: International Reading Association, 1970.

CARROLL, JOHN B. Learning from verbal discourse in educational media: a review of the literature. (U.S.O.E. Final Report. Project No. 7-1069) Princeton, N.J., Educational Testing Service, 1971.

CARROLL, JOHN B. French as a foreign language in seven countries. Stockholm: Almqvist & Wiksell, 1975.

COMBER, L. C. & Keeves, John P. Science education in nineteen countries. Stockholm: Almqvist & Wiksell, 1973.

DAY, DAVID E. "Language instruction for young children: what ten years of confusion has taught us." Interchange, 1974, 5, 59-72.

DOWNING, JOHN. Comparative reading: cross-national studies of behavior and processes in reading and writing. New York: Macmillan and Company, 1973.

DUNCAN, OTIS D. "Path analysis: sociological examples." American Journal of Sociology, 1966, 72, 1-16.

DUNCAN, OTIS D. Introduction to structural equation models. New York: Academic Press, 1975.

FINN, JEREMY D. & MATTSSON INGRID. Multivariate analysis in educational research: some applications. Report No. 7, Institute for the Study of International Problems in Education, University of Stockholm, Sweden.

FINNEY, J "Indirect effects in path analysis." Sociological Methods and Research, 1972, 1, 175-186.

FRIES, CHARLES C. Linguistics and reading. New York; Holt, Rinehart, 1962.

GOODMAN, KENNETH S. "Reading: a psycholinguistic guessing game." In H.S. Singer & R.B. Ruddel (Eds.), Theoretical models and processes of reading. Newark, Delaware: International Reading Association, 1970. (Originally published: Journal of the Reading Specialist, 1976, 6, 126-135.)

GOODMAN, KENNETH S. "Analysis of oral reading miscues: applied psycholinguistics." Reading Research Quarterly, 1969, 5, 9-30.

GOODMAN, KENNETH S. "The reading process: theory and practice." In R.E. Hodges & E.H. Rudorf (Eds.), Language and learning to read: what teachers ought to know about language. Boston: Houghton Mifflin, 1972.

GOODMAN, KENNETH S. & BURKE, CAROLYN L. Study of oral reading miscues that result in grammatical retransformations. (U.S.O.E. Final Report. Project No. 7-E-219) Washington, D.C., U.S. Department of Health, Education, and Welfare, 1969, Eric: ED039101.

GOODMAN, YETTA M. Longitudinal study of children's oral reading behavior. (U.S.O.E. Final Report. Project No. 9-E-062) Washington, D.C., Department of Health, Education, and Welfare, 1971.

GOODMAN, YETTA M. & BURKE, CAROLYN L. Reading miscue inventory. New York: Macmillan, 1972.

GRAY, WILLIAM S. The teaching of reading and writing. Paris: UNESCO, 1956.

GREEN, BERT F. "Attitude Measurement." In G. Lindzey (Ed.), Handbook of Social Psychology. Reading, Mass.: Addison-Wesley, 1954, 335-369.

HAUSER, ROBERT M. Socioeconomic background and educational performance. The Arnold Rose Monograph Series in Sociology. Washington, D.C.: American Sociological Association, 1971.

HOCHBERG, J "Components of literacy: speculations and exploratory research." In H. Levin & J.P. Williams (Eds.), Basic studies on reading. New York: Basic Books, 1970.

HOCHBERG J & BROOKS, V "Reading as an intentional behavior." In H.S. Singer & R.B. Ruddell (Eds.), Theoretical models and processes of reading. Newark, Delaware: International Reading Association, 1970.

HUSEN, TORSTEN (Ed.). International study of achievement in mathematics, vols. 1 and 2. New York: Wiley, 1967.

KOLERS, P. A. "Reading is only incidentally visual." In K. Goodman & J. Fleming (Eds.), Psycholinguistics and the teaching of reading. Newark, Delaware: International Reading Association, 1969.

LEFEVRE, CARL A. Linguistics and the teaching of reading. New York: McGraw-Hill, 1964.

LEWIS, E G. & MASSAD, CAROLYN. English as a foreign language in ten countries: an empirical study. Stockholm: Almqvist & Wiksell, 1976.

PASSOW, A.H., NOAH, E.J. & ECKSTEIN, M. The national case study: an empirical study. Stockholm: Almqvist & Wiksell, 1976.

PEAKER, GILBERT F. An empirical study of education in twenty-one countries: a technical report. Stockholm: Almqvist & Wiksell, 1976.

PFLAUM, SUSANNA W. The development of language and reading in the young child. Columbus, Ohio: Charles E. Merrill, 1974.

PIAGET, JEAN. "The attainment of invariants and reversible operations in the development of thinking." Social Research, 1963, 30:283-299.

PAIGET, JEAN. "Autobiography." In S.F. Campbell (Ed.), Piaget sampler. New York: Wiley, 1976 (Originally published in Cahiers Vilfred Pareto, 1966, 10, translated by S.F. Campbell & E. Rutschi-Herrmann).

PURVES, ALAN C. Literature education in ten countries. Stockholm: Almqvist & Wiksell, 1973.

RAWSON, HILDRED. A study of the relationships and development of reading and cognition. Unpublished Ph.D. dissertation, University of Alberta, 1969.

REHBERG, RICHARD A. & ROSENTHAL, EVELYN. Social class and merit in high school: a multi-study analysis. Center for Comparative Political Research, SUNY, Binghamton, 1975.

RUSSELL, DAVID H. Children learn to read. New York: Ginn, 1961.

SINCLAIR-DE-ZWART, H.A. "A possible theory of language acquisition within the general framework of Piaget's developmental theory." In P. Adams (Ed.), Language in thinking. Baltimore: Penguin, 1972, 364-373.

SMITH, FRANK. Understanding reading. Toronto: Holt, Rinehart, & Winston, 1971.

SMITH, FRANK. "Decoding: the great fallacy." In F. Smith (Ed.). Psycholinguistics and reading. Toronto: Holt, Rinehart, and Winston, 1973.

SMITH, FRANK. Comprehension and learning. Toronto: Holt, Rinehart, & Winston, 1975.

THORNDIKE, EDWARD L. "Reading as reasoning: a study of mistakes in paragraph reading." Journal of Educational Psychology, June 1917, 8, 323-332. Reprinted in Reading Research Quarterly, 1971, 6, 425-448.

THORNDIKE, ROBERT L. Reading comprehension education in fifteen countries. Stockholm: Almqvist and Wiksell, 1973a.

THORNDIKE, ROBERT L. "The relation of school achievements to the differences in the backgrounds of children." Paper presented at the IEA Conference on Educational Achievement, Harvard University (November), 1973b.

THORNDIKE, ROBERT L. "Reading as reasoning." Reading Research Quarterly, 1973-4, 9, 135-147.

TORNEY, JUDITH V., OPPENHEM, A.N. & FARNEN, R.F. Civic education in ten countries an impirical study. Almgrist & Wiksell, Stockholm 1975.

VYGOTSKY, LEV S. Thought and language. Cambridge, Mass.: MIT Press, 19[illegible].

WALKER, D A. The IEA six-subject survey: an empirical study of education in twenty-one countries. Stockholm: Almqvist & Wiksell, 1976.

WARDHAUGH, R Reading: a linguistic perspective. New York: Harcourt, Brace & World, 1969.

WRIGHT, SEWELL. "The method of path coefficients." Annals of Mathematical Statistics, 1934, 5, 161-215.

WILLIAMS, TREVOR H. "Educational aspirations: longitudinal evidence on their development in Canadian youth." Sociology of Education, 1972, 45 (Spring), 197-133.

ZAJONC, R.B. "Family configuration and intelligence." Science, 1976, 192 (April), 192-[illegible].

ZAJONC, R.B. & MARKUS, GREGORY B. "Intellectual environment and intelligence." Psychological Review, 1975, 82.

TECHNICAL APPENDIX A: INSTRUMENTATION

The purpose of this appendix is twofold: a) to describe the ten variables constituting the anxiliary model, and b) to present their frequency distributions. Where possible, the data for England and India are interposed for ease of comparison.

(1) Variables

X_1 FATHOCC - Father's occupational status. Each national center participating in the stage two, three-subject survey was asked to design its own occupational status scale on the basis of whatever national norms were considered most valid. In England, the procedure adopted was one in which professional, managerial, and business owners were ranked in categories 6 and 7; clerical workers, supervisory personnel, and service workers, in categories 5,4, and 3; skilled blue collar in category 2, unskilled manual workers and unclassifiable personnel in categories 1 and 0.

The father's occupational code, adopted in India, was more precise in that nine categories were employed. The differences in coding, attributable to the different economic systems in the two countries, made direct comparisons impossible. In India, professional, managerial, and semi-professionals were ranked in categories 9,8, and 7; small businessmen, large scale farmers and clerical workers in categories 6,5, and 4, semi-skilled workers, farm labourers, and unskilled labourers in categories 3,2, and 1, and those without occupations, or unclassifiable,, were coded zero.

X_2 PARED - Parental Education. Both mother's and father's education were scored on a five category scale in terms of years of schooling: 0 years, 1-5, 6-10, 11-15, and greater than 15. These variables were added in order to estimate parental education. The variable was constructed in the same manner for both countries.

X_3 SIBSZ - Number of brothers and sisters. In both countries, the variable was operationalized by the question: "How many brothers and sisters have you?" The response categories (1-5) were: 0,1,2,3,4 or more.

X_4 VOCAB - Meaning vocabulary. The IEA word knowledge test, after correction for guessing, would seem to represent an accurate within-country estimate of a pupil's meaning vocabulary, and might be considered an acceptable proxy of verbal ability (Thorndike, 1973a, p. 36). It is assumed that the variation in test scores from country to country was a function of shifts in the discrimatory power of some of the 40 test items after translation. Nevertheless, within country discrimination was satisfactory as indicated by K-R formula 20 reliability coefficients (Kuder and Richardson, 1937) of .833 for England and .812 for India. Raw scores in both countries were converted into percentages.

X_5 THINK - Piagetian thinking stage. Following Bergling (1974), item analysis data derived from multiple-choice items on the IEA science test were used to construct a piagetian thinking stage variable common to both English and Indian populations. The variable structure was established by means of scalogram analysis (Guttman, 1950). The analysis is designed to examine the relationships between the scale items in which a perfect scale is one in which a person who passes an item of given difficulty will also pass any other item of lesser difficulty. Conversely, an individual who fails an item of given difficulty will also fail any other item of greater difficulty.

Three considerations are briefly taken up:

Consideration 1 - ordering response categories.

The science test items had five distractors or response categories which would be ordered on the items selected for examination in a sequence from highest to lowest. Piagetian theory dictated the three category order: where (3) was classified as formal operational thinking, (2) as concrete operational thinking, and (1) preoperational thinking.

Consideration 2 - classifying distractors.

The validity of the constructed piagetian variable will be unacceptable unless the classifications are correct. The usual classification of distructors is into "right" or "wrong" answers. The classification formal thinking, while always connected with the usual classification "right", could also be connected with a distractor with the usual classification "wrong", where the item in question could be classified as a logically correct response. More problemmatic perhaps was the separation of distractors normally classified as "wrongs" into pre-operational thinking and concrete operational thinking. What is important to note, however, is that "wrong" classifications in the sense of a distractor being an incorrect answer to a question could be an indicator of formal thinking; thus, it was possible for a student with little formal knowledge of science to be classified in the formal thinking category. It follows, then, that a student who failed to obtain the conventionally "right" answers to the scale items could still give the logically correct answers, thereby obtaining a "high" thinking stage score.

Consideration 3 - scale reliability.

Following Bergling (1974, p. 36) a scale was accepted as acceptable if it gave a coefficient of reproducibility of ≥80 even though the general guideline given is that a coefficient of reproducibility greater than 0.90 indicates a valid scale (Green, 1954, p. 356). This optimum figure is desirable because coefficients in this range have little error of measurement because sampling variance is small; hence, their high reliability estimates. Nevertheless, coefficients of this magnitude are rare in the empirical literature.

The scale adopted in this study was originally developed by the first authors for 14 year-old boys and girls in Sweden. It was arbitrarily applied to the England and India samples. Though the resultant scales are judged adequate for the purposes of falsifying the hypotheses generated by the structure of scholastic performance model, further manipulation of some of the item cutting points should result in improvements in the magnitude of the coefficients of reproducibility for the two nations.* For the expert reader, the three coefficients - minimum marginal reproducibility, the percent improvement, and the coefficient of scalability - are also provided as aids to evaluating the scalability of the items.

*Dr. Glen Clarke - a Memorial University colleaque - has recently achieved coefficients greater than .88 for United States and English data and .80 for India data. These results were obtained too late to rerun the analyses reported in this paper involving a more valid and accurate "THINK" variable.

TABLE A.1.

Coefficients for Scales based on IEA Science Test Items[a]:

COUNTRY	COEFFICIENTS[b]			
	1	2	3	4
England	.811	.670	.141	.427
India	.765	.675	.090	.276
U.S.A.[c]	.851	.723	.129	.464

a) Results are for those boys who could read. The readability criterion was a score greater than one on the reading comprehension test after correction for guessing; where the correction for guessing formula was R-W/K-1 (R = no. correct answers, W = no. wrong answers, K = no. alternatives in multiple choice items).

b) 1 = coefficient of reproducibility

2 = minimum marginal reproducibility

3 = percent improvement

4 = coefficient of scalability

c) U.S.A. results are provided as a second industrialized nation referent. They may provide some further reassurance that models of the kind being tested remain stable despite being tested on data from a variety of nations. It is unfortunate that at the present stage of the ongoing research, an additional Third World referent could not be provided.

Because thinking stage is regarded as a partial function of age, the variable was transformed into a thinking stage quotient by dividing the absolute thinking stage score by the respondent's age in months and multiplying by a constant so that it became a percentage figure. Thus, thinking stage is not an absolute quantity but, rather, a quotient or quantity relative to age varying from a low of zero to a high of one hundred.

X_6 READ - Reading comprehension. The Thorndike (1973a, Chap. 2) reading comprehension test, corrected for guessing, was used in two ways. First, it was used to define illiteracy in order that illiterates could be eliminated from the samples. The correction for guessing formula (see footnote (a) to Table A.1 above) allows for a score of 0.0 by random guessing. In order to permit the study of the largest possible samples, the liberal cut-off point of scores greater than one was used. This eliminated 100 - (1289/1821) x 100 = 29.2 percent of the India sample, and 100 - (1419/1474) x 100 = 3.7 percent of the England sample. Secondly, the test was used as the measure of the reading comprehension variable. The tests consisted of reading passages followed by multiple choice questions designed to cover a wide range of reading skills. The K-R 20 formula provided reliability coefficients in England of .887, and in India of .684. The India K-R 20 coefficient might not normally be regarded as high enough to permit useful studies of individual correlates of reading. In the present instance, however, the non-readers - 29 percent of the total - were eliminated from the India sample. By definition, reliability is the tendency toward consistency from one set of measurements to another. Undoubtedly, much of the unreliability of the reading test in India was attributable to the presence of pupils who randomly guessed at test items because of their reading disability. By eliminating mere "guesses" from the sample, it is predicted that the reliability of the test sample would approximate the median reliability of .85 for the fifteen IEA countries taking part in the reading survey. Note that the corrected reading score was transformed into a percentage figure.

X_7 thru X_{10} - Physics, chemistry, biology, practical. The test items and the test construction procedures of the IEA science committee are described in Comber and Keeves (1973, chap. 2, Appendix ix, and xiii). The overall science test score for each child was based on an additive combination of four sub-test scores in physics, chemistry, biology, and practical work. Only about ten questions were related to each subtest area in order to limit testing time to about one hour. The result was that subtest reliabilities were on the modest side, though, the overall K-R 20 reliability coefficient in science was high enough (median value = .83) to permit useful correlates of it. The relevant science test reliabilities for India and England are provided in Table A.2. All subtest science scores were converted into percentages.

TABLE A.2.

Science Test Reliabilities for England and India (Kuder-Richardson 20)[a]

TESTS	ENGLAND[b]	INDIA[b]
Science Total	.89	.78
Physics	.72	.56
Chemistry	.70	.52
Biology	.60	.32
Practical	.68	.48

a) Source: Comber & Keeves (1973, p. 396)

b) In both England and India some boys were included in the samples even though they fell outside the age range (1-.0 - 14.11). These "outsiders" were eliminated from the test sample. Similarly, illiterates were eliminated. Since the eliminated pupils were likely to constitute the majority of the random guessers, it is predicted, but not demonstrated here, that some of the moderate sub-test coefficients will be strengthened by their elimination from the test sample.

(2) Frequency Distributions

The dispersion statistics for the ten variables are presented in Table A.3.

Figure A.3.: Means, Standard Deviations, Kurtosis, Skewness, Minimum and Maximum Scores, Case Base, and Missing Data for Variables Included in the General Model of the Structure of Scholastic Performance in England and India (Boys only)a.

TABLE A.3.

VARIBLE	$\bar{X}$	SD	Kurt-osis	Skew-ness	Minimum	Maximum	Case Base	Miss-ing Data[c]
X_1 FATHOCC	2.8 3.9	1.8 1.7	-0.02 0.5	0.86 1.19	0.0 0.0	7.0 9.0	1467 1208	1.0 8.8
X_2 PARED	6.5 3.8	1.3 2.0	1.29 0.92	-0.23 1.23	2.0 2.0	10.0 10.0	1412 1288	4.7 2.7
X_3 SIBSZ	3.2 4.2	1.3 1.1	-1.2 0.90	0.09 -1.32	1.0 1.0	5.0 5.0	1473 1294	0.6 2.3
X_4 VOCAB*	37.0 18.9	23.4 22.0	-0.15 0.25	-0.26 0.54	-24.7 -24.7	100.0 95.0	1475 1271	0.5 4.0
X_5 THINK*	52.6 42.3	22.0 21.8	-0.51 -0.35	0.00 0.09	0.0 0.0	96.6 99.5	1247 1091	15.8 17.6
X_6 READ*	48.0 16.3	20.6 11.7	-0.75 1.00	-0.18 1.15	2.5 2.5	94.8 59.0	1419 1289	4.2 2.6
X_7 PHYSICS*	40.3 18.2	21.6 16.8	-0.39 0.79	0.30 0.70	-17.7 -20.0	100.00 84.1	1421 1277	4.1 3.5
X_8 CHEMISTRY*	22.3 10.3	21.3 16.4	0.38 1.52	0.70 0.95	-24.7 -24.7	100.00 81.6	1420 1264	4.2 4.5
X_9 BIOLOGY*	27.6 12.0	18.9 13.4	0.00 0.52	0.34 0.48	-17.9 -24.7	93.7 67.4	1421 1277	4.1 3.5
X_{10} PRACTICAL*	24.1 6.4	21.9 14.4	-0.12 0.84	0.61 0.86	-18.5 -24.5	100.0 62.5	1408 1271	5.0 7.8
X_{11} SCIENCE[b]*	28.8 11.7	17.8 11.1	0.09 2.26	0.70 1.13	-11.5 -12.4	87.5 62.9	1421 1277	4.1 3.5

a) Statistics for England on the upper line; statistics for India on the bottom line, in each instance.

b) SCIENCE = $X_7 + X_8 + X_9 + X_{10}$. The raw science score corrected for guessing was transformed into a percentage figure

* starred variables are reported as percentages

c) Minus quantities are possible because raw scores were corrected for guessing.

TECHNICAL APPENDIX B: STATISTICAL RESULTS

Five sets of data are presented in Appendix B. First, the zero-order correlations between the variables in the model of the structure of scholastic performance are presented in Table B.1. Second, the correlations are used to generate the structural coefficients for a full-identified model by ordinary least squares. These comparisons are presented in Table B.2. Thirdly, the total causal effects of predicted variables are presented in Table B.3., followed by a summary Table (B.4.) in which the total causal effects are ranked for ease of reference. Tables B.5. and B.6. relate to the interpretation of residual scores. Finally, using India data from Table B.2. a respecified final form path model is presented.

Table B.1 Correlations, Means, Standard Deviations, and Case Base of Variables in the Model of the Structure of Scholastic for England and India. (a)

VARIABLES	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	$\bar{X}$	SD	CASES
X_1 FATHOCC		.242	-.171	.314	.129	.295	.279	.235	.249	.272	.307	2.83	1.8	1467
X_2 PARED	.360		-.081	.122	.074	.129	.124	.138	.161	.162	.171	6.5	1.3	1412
X_3 SIBS2	.041	-.025		-.182	-.091	-.166	-.165	-.145	-.163	-.184	-.195	3.2	1.3	1473
X_4 VOCAB	.041	-.010	.023		.287	.647	.511	.503	.479	.509	.591	37.0	23.4	1475
X_5 THINK	-.052	.000	-.004	.107		.365	.398	.406	.448	.358	.469	52.6	22.0	1247
X_6 READ	.012	.031	.033	.364	.087		.638	.592	.585	.610	.716	48.0	20.6	1419
X_7 PHYSICS	.138	.103	-.001	.345	.186	.386		.642	.588	.681	.874	40.3	21.6	1421
X_8 CHEMISTRY	.101	.122	.009	.290	.224	.400	.471		.569	.666	.847	22.3	21.3	1420
X_9 BIOLOGY	.041	.050	.025	.297	.235	.275	.338	.240		.591	.791	27.6	18.9	1421
X_{10} PRACTICAL	.120	.092	.025	.281	.066	.329	.403	.439	.266		.873	24.1	21.9	1408
X_{11} SCIENCE	.240	.132	.019	.421	.244	.481	.808	.755	.596	.720		28.8	17.8	1421
$\bar{X}$	3.9	3.8	4.2	18.9	42.3	16.3	18.2	10.3	12.0	6.4	11.7			
SD	1.7	2.0	1.1	22.0	21.8	11.7	16.8	16.4	13.4	14.4	11.1			
CASES	1208	1288	1294	1271	1091	1289	1277	1264	1277	1221	1277			

(a) English data above the diagonal; India data below the diagonal.

Table B2. England/India comparisons of the structural coefficients fo
Ordinary Least Squares: (I) Regression Coefficients, (II)

Independent Variables	DEPENDENT											
	VOCAB(X_4)			THINK(X_5)			READ(X_6)			PHYSICS(X_7)		
	I	II	III	I	II	III	I	II	III	I	II	III
X_1 FATHOCC	3.745 .656	.281 .051	.349 .408	.400 -.839	.032 -.065	.377 .434	.990 -.106	.084 -.015	.271 .218	.850 1.125	.069 .114	.287 .296
X_2 PARED	.761 -.311	.043 -.028	.459 .351	.515 .271	.031 .025	.477 .374	.379 .241	.024 .041	.343 .188	.254 .470	.015 .055	.361 .254
X_3 SIBSZ	-2.359 .411	-.130 .020	.463 .602	-.586 -.064	-.034 -.003	.485 .640	-.503 .293	-.031 .027	.349 .321	-.593 -.283	-.035 -.018	.368 .435
X_4 VOCAB				.252 .109	.267 .110	.028 .031	.493 .190	.558 .360	.021 .016	.123 .167	.133 .220	.026 .023
X_5 THINK							.177 .026	.189 .048	.021 .016	.177 .110	.180 .143	.023 .022
X_6 READ										.480 .419	.458 .291	.030 .043
Residual	.939 .998			.956 .992			.733 .929			.736 .874		
Constant	26.938 15.653			40.678 42.744			16.730 9.848			1.193 -1.472		
$100R^2$	11.733 .003			8.626 1.524			46.334 13.725			45.893 23.642		

a) Statistics for England on the upper line; statistics for India on

Table B.3 Total Causal Effects of Predictor Variables for Scholastic Performances in the Natural Sciences: England/India Comparisons for Male Pupils (a)

(1) Independent Variables	(2) Dependent Variables	(3) Total Indirect Effects Through Intervening Variables	(4) Direct Effect	(5) Total Causal Effect
X_1 FATHOCC	X_4 VOCAB	- -	.281 .051	.281 .051
	X_5 THINK	.075 .006	.032 -.065	.107 -.059
	X_6 READ	.177 .015	.084 -.015	.261 .000
	X_7 PHYSICS	.175 .003	.069 .114	.244 .117
	X_8 CHEMISTRY	.171 -.008	.024 .069	.195 .061
	X_9 BIOLOGY	.167 -.004	.040 .026	.207 .022
	X_{10} PRACTICAL	.170 .003	.054 .079	.224 .082
	X_{11} SCIENCE	.201 .003	.058 .103	.259 .106

Table B.3 cont'd.

(1)	(2)	(3)	(4)	(5)
X_2PARED	X_4VOCAB	– –	.043 -.028	.043 -.028
	X_5THINK	.011 .003	.031 .025	.042 .028
	X_6READ	.032 .011	.024 .041	.056 .052
	X_7PHYSICS	.039 .025	.015 .055	.054 .080
	X_8CHEMISTRY	.038 .025	.044 .088	.082 .113
	X_9BIOLOGY	.038 .019	.064 .038	.102 .057
	X_{10}PRACTICAL	.036 .019	.059 .058	.095 .077
	X_{11}SCIENCE	.045 .008	.052 .086	.097 .094
X_3SIBS2	X_4VOCAB	– –	-.130 .020	-.130 .020
	X_5THINK	-.035 .002	-.034 -.003	-.069 -.001
	X_6READ	-.085 .001	-.031 .027	-.116 .028
	X_7PHYSICS	-.111 .004	-.035 -.018	-.146 -.014
	X_8CHEMISTRY	-.082 .003	-.022 -.004	-.104 -.001
	X_9BIOLOGY	-.079 .004	-.041 .015	-.120 .019
	X_{10}PRACTICAL	-.080 .004	-.057 .010	-.137 .014
	X_{11}SCIENCE	-.092 .012	-.047 .000	-.139 .012

Table B.3 cont'd

(1)	(2)	(3)	(4)	(5)
X_4VOCAB	X_5THINK	- -	.267 .110	.267 .110
	X_6READ	.050 .005	.558 .360	.608 .365
	X_7PHYSICS	.327 .122	.133 .220	.460 .342
	X_8CHEMISTRY	.290 .139	.177 .150	.467 .289
	X_9BIOLOGY	.299 .087	.132 .209	.431 .296
	X_{10}PRACTICAL	.294 .096	.161 .181	.455 .277
	X_{11}SCIENCE	.367 .154	.178 .264	.545 .418
X_5THINK	X_6READ	- -	.189 .048	.189 .048
	X_7PHYSICS	.087 .014	.180 .143	.267 .157
	X_8CHEMISTRY	.073 .016	.206 .183	.279 .199
	X_9BIOLOGY	.071 .009	.259 .199	.330 .208
	X_{10}PRACTICAL	.080 .012	.141 .029	.221 .041
	X_{11}SCIENCE	.092 .017	.225 .190	.317 .207

Table B.3 cont'd

(1)	(2)	(3)	(4)	(5)
X_6READ	X_7PHYSICS	- -	.458 .291	.458 .291
	X_8CHEMISTRY	- -	.386 .325	.386 .325
	X_9BIOLOGY	- -	.378 .179	.378 .179
	X_{10}PRACTICAL	- -	.421 .257	.421 .257
	X_{11}SCIENCE	- -	.487 .365	.487 .365

a) Statistics for England on the upper line. Statistics for India on the lower line in each instance.

Table B.4 Within - Country Rank Ordering of Total Causal Effects of Predictor Variables on Endogenous Variables: England/India Comparisons. (a)

	RANK ORDER							
Predictor	VOCAB	THINK	READ	PHYSICS	CHEMISTRY	BIOLOGY	PRACTICAL	SCIENCE
X_1 FATHOCC	1 .281 1 .051	2 .107 2 -.059	2 .261 5 .000	4 .244 4 .117	4 .195 5 .061	4 .207 5 .022	3 .224 3 .082	4 .259 4 .106
X_2 PARED	3 .043 2 -.028	4 .042 3 .028	5 .056 2 .052	6 .054 5 .080	6 .082 4 .113	6 .102 4 .057	6 .095 6 .007	6 .097 5 .094
X_3 SIBS2	2 -.130 3 .020	3 -.069 4 -.001	4 -.116 4 .028	5 -.146 6 -.014	5 -.104 6 -.001	5 -.120 6 .019	5 -.137 5 .014	5 -.139 6 .012
X_4 VOCAB		1 .267 1 .110	1 .608 1 .365	1 .460 1 .342	1 .467 2 .289	1 .431 1 .296	1 .455 1 .277	1 .545 1 .418
X_5 THINK			3 .189 3 .048	3 .267 3 .157	3 .279 3 .199	3 .330 2 .208	4 .221 4 .041	3 .317 3 .207
X_6 READ				2 .458 2 .291	2 .386 1 .325	2 .378 3 .179	2 .421 2 .257	2 .487 2 .365

(a) The total causal effects are to the right of the rank order figures in each column. Note that these total causal effects are relative not absolute totals. The underlined TCE's are considered to be of negligible substantive significance.

Table B.5 Correlations Between the Residuals of the Natural Science Outcomes: India/England Comparisons (a)

Variable		X_7	X_8	X_9	X_{10}
X_7 PHYSICS	E I		.370 .315	.272 .189	.435 .272
X_8 CHEMISTRY	E I	.642 .471		.259 .069	.430 .324
X_9 BIOLOGY	E I	.588 .338	.569 .240		.303 .152
X_{10} PRACTICAL	E I	.681 .403	.666 .439	.591 .266	

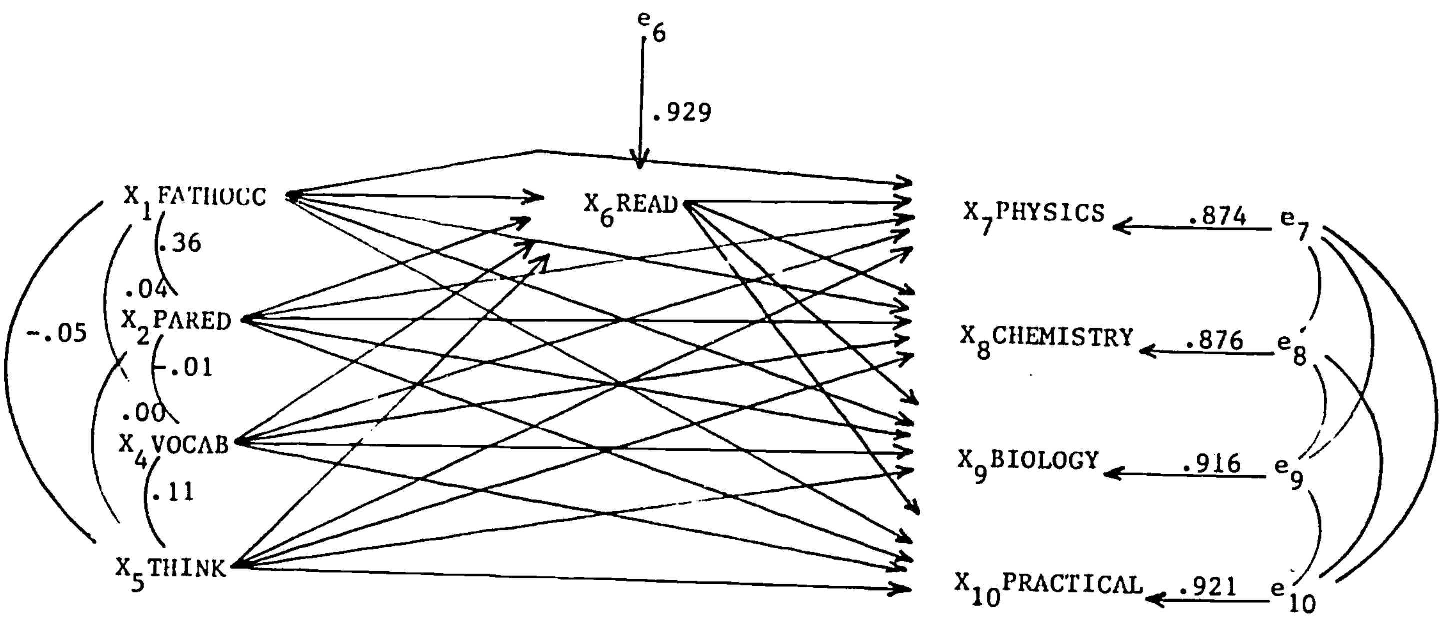
(a) Partial correlations controlling for all antecedent variables above the diagonal; zero-order relationships below the diagonal. Statistics for England on upper line; and for India on the lower line.

Table B.6 Proportion of Covariance Between Natural Science Performances Accounted for by the Antecedent Variables. (a)

Variable		X_7	X_8	X_9	X_{10}
X_7 PHYSICS	E I		.424 .331	.537 .441	.361 .325
X_8 CHEMISTRY	E I	- -		.545 .754	.354 .262
X_9 BIOLOGY	E I	- -	- -		.487 .428
X_{10} PRACTICAL	E I	- -	- -	- -	

(a) Statistics for England on upper line; and for India on lower line. Median proportions: England = .455; India = .379.

Figure B.1 Respecified Path Model of the Structure of Natural Science Performances for 14 Year-Old Boys in India. (a)



(a) Path coefficient approximations may be obtained from Table B.2. The correlations between the residuals may be obtained from Table B.5. The model differs from the conceptual model (Figure 1.1.) in that the SIBSZ(X_3) variable has been dropped and the VOCAB(X_4) and THINK(X_5) variables have been made into source variables.