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ABSTRACT

This third annual report on student achievement in Illinois continues the State Board of Education practice of providing a synthesis of a variety of achievement measures. Test results used for this report come from: (1) Illinois Inventory of Educational Progress (IIEP); (2) Scholastic Aptitude Test (SAT); (3) National Assessment of Educational Progress; (4) American College Test; (5) Decade Study Test; and (6) Second International Mathematics Study. Data collected regarding student performance in mathematics showed that although the achievement of Illinois students is at the national average, the nation as a whole compares unfavorably with other countries. Science scores for Illinois students were at the national average, and the IIEP (used only in Illinois) showed improvement in grades four, eight, and eleven. Reading achievement scores indicated that no great movement took place, although fourth, eighth and eleventh grades showed a slight drop. Across all curricular areas was the concern that students were not performing well on test items requiring higher order thinking skills (analysis, synthesis, evaluation, and problem-solving). Student factors most important in explaining performance levels were student expectations/standards of performance, number of relevant courses taken, and parental influences. School size was the strongest single influence among school factors and performance was higher in high schools with more than 215 students. The report provides support for at least four major reforms: (1) establishment of learner outcomes at the state and local levels; (2) need for a statewide assessment process; (3) reorganization and/or consolidation of small high schools; and (4) state initiative for early childhood education to increase levels of achievement. A brief list of references and related readings is included. (LMO)

ILLINOIS STATE BOARD OF EDUCATION

Date: June 5, 1985

MEMORANDUM

TO: State Board of Education

FROM: Ted Sanders

SUBJECT: Annual Report on Student Achievement

The attached third annual report on student achievement provides valuable dat for our continued examination of student performance trends and the fa s which influence them.

While the State is limited in its capacity to directly influence student achievement, it has the power and responsibility to set conditions in place which encourage higher achievement. The information from this year's report provides additional support for at least four major reforms which are now under consideration by the General Assembly:

1. There is clear empirical support for the establishment of learner outcomes at both the state and local levels. The report indicates that when students know there are high expectations and standards for performance, their achievement increases.

2. The report reinforces the fact that there is a need for a statewide assessment process which allows us to measure and monitor the achievement of students in all Illinois schools. This process must do more than sample the achievement of Illinois students, as is now the case, or merely test students and report their scores. The assessment system must hold schools accountable and provide a basis for program improvement in those areas in which student achievement does not meet established standards.

3. The report provides strong evidence that the small enrollment size of many Illinois high schools is related to lower achievement. The data clearly suggest that reorganization and/or consolidation of these small high schools may result in higher achievement.

4. The information reported here indicates that achievement generally is at less than desired levels. This supports the need for a state initiative in early childhood education, which strong evidence indicates produces increased levels of achievement in children.

Given these important implications, this report will be shared with members of the General Assembly and others who are currently considering major educational reforms.

Throughout the year, many aspects of the data provided in this report will influence the policy deliberations of the State Board of Education. However, it is our plan to give particular emphasis to the development of further action recommendations to address the concerns emanating from the international studies of mathematics achievement. To that end, we will plan to make mathematics an instructional program priority issue for action at the Board's work conference late this summer.

In addition, we may from time to time issue interim student achievement reports as a consequence of further research and analysis. The 1985 State Assessment has already collected extensive information on student writing and reading ability. The plan for the 1986 assessment in math and science will include efforts to more precisely evaluate student ability to solve math problems that are more complex and call for higher order thinking skills.

STUDENT ACHIEVEMENT IN ILLINOIS: 1984

EXECUTIVE SUMMARY

INTRODUCTION

This third annual report on student achievement in Illinois continues the State Board of Education practice of providing a synthesis of a variety of achievement measures. The data and information from these annual analyses of achievement become an integral part of the data base used in policy deliberations by the State Board of Education and other branches of state government.

Test results used for this report come from:

- the Illinois Inventory of Educational Progress (IIEP), a state assessment used in each of the prior two reports and administered since 1976;

- the Scholastic Aptitude Test (SAT) which, although taken by only 15% of Illinois college-bound students, is widely used by colleges and universities as part of entrance requirements;

- the National Assessment of Educational Progress (NAEP), a test designed to measure nationwide achievement;

- the American College Test (ACT), the standardized test most frequently taken by Illinois students as part of college entrance requirements;

- the Decade Study Test (DST), a test administered in 1970 and 1981 to an identical sample of Illinois high schools; and

- the Second International Mathematics Study (SIMS), a test administered in twenty-two countries for purposes of comparing mathematics achievement.

The subject areas reported on this year are mathematics, reading and science. Data collected regarding student performance in mathematics has made possible an in-depth analysis of the achievement of Illinois students in this subject area; however, in science and in reading, the data collected for this year's report are primarily descriptive of the trend in student achievement over the past several years.

This report gives the State Board of Education and the citizens of this State an overview of how well Illinois students perform or have performed when compared to students in other parts of the nation, to the nation as a whole, to students of previous years, and to students of other nations. In addition, it puts those results into perspective by analyzing how specific characteristics of students and schools relate to academic achievement.

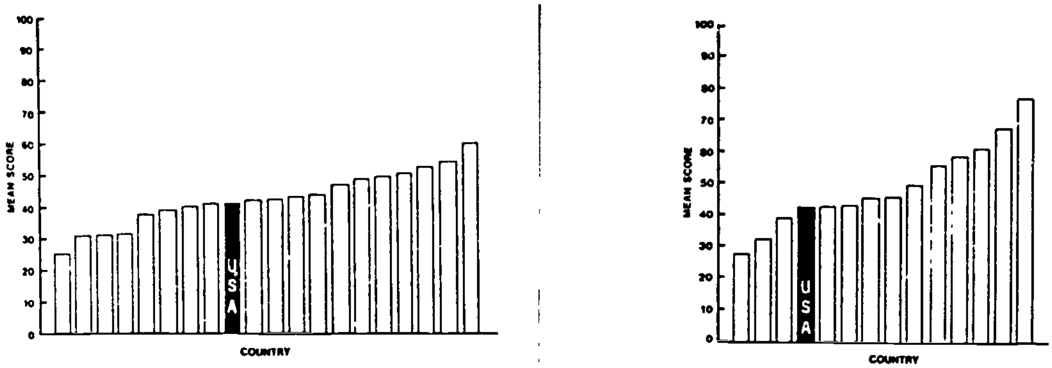
SUMMARY OF FINDINGS

Across all curricular areas is the concern that students are not performing well on test items which require higher order thinking skills: analysis, synthesis, evaluation and problem-solving. That is, students do well with facts and one-step problems, but performance generally drops off when students are asked to infer, integrate, evaluate, condense, apply and synthesize information.

Mathematics

Results in mathematics are a cause for deep concern. Although the achievement of Illinois students is at the national average, the nation as a whole compares unfavorably with other countries. International comparisons demonstrate that Illinois students (and those of the nation) fall behind those of other countries early in their school experience, and the gap widens as they progress through school. By grade eight, students in eleven of nineteen other countries did better on a mathematics test than did those of Illinois; by grade twelve, students in ten of thirteen other countries did better than those of Illinois. Figure 1 shows these results.

Figure 1. United States' Position Relative to the Positions of Other Countries in the Eighth and Twelfth Grade Studies of the Second International Mathematics Study.



United States' Position Among the 20 Countries in the Eighth Grade Study.

United States' Position Among the 11 Countries in the Twelfth Grade Study.

Previous claims that the best U.S. students were equal to the best of any other country in mathematics are contradicted by recent evidence from international studies, and the best mathematics students of many nations clearly achieve higher than the best Illinois students.

Illinois students are particularly weak in geometry and measurement, and their problem-solving skills have deteriorated significantly in the past twenty years.

Science

Since 1980, science scores for Illinois students have been at the national average. However, on IIEP items, which are only given in Illinois, some improvement has been noted in grades four, eight and eleven. Other questions used in the Illinois testing indicate that out-of-school student activities related to science tend to diminish as students work up through the grades. Much less science reading, television watching of science programs, and self-initiated project activity takes place at eleventh grade than at fourth grade.

Reading

Illinois reading achievement continues to hover at the mid-point of the percentage scale. A slight drop at the fourth grade, from 56% of items correct in 1983 down to 51% in 1984, added to non-significant changes at the eighth and eleventh grade (a two-percent drop), indicate that no great movement took place in this area.

ANALYSIS OF INDICATORS OF ACHIEVEMENT

As part of an effort to determine which factors inhibit or facilitate student performance, this report also includes an analysis of some specific indicators of achievement.

Among the student factors studied, three are most important in explaining performance levels: student expectation/standards of performance, the number of relevant courses taken, and parental influences. When schools hold high expectations of their students and the students attempt to meet these expectations, the number of relevant courses taken appear to be enhanced and achievement increased. Further research is needed to clarify those relationships.

Among school factors studied in an attempt to explain achievement differences, school size was noted as having the strongest single influence.

- Student performance on the American College Test is significantly lower for students from high schools enrolling fewer than 215 or more than 1,279 students compared to the students in schools with enrollments of 215-1,279.

- Across all curriculum areas of the Decade Study Tests, the highest achievement was in schools with more than 435 students, and the lowest mathematics achievement occurred in schools with less than 215 students.

- The effects of school size are also observable in results from the Illinois Inventory of Educational Progress. Eleventh grade students from high schools having 494-1279 students attained higher performances than students from smaller and larger schools in all areas measured by that test in 1984. The effects are notable when such features as school economic status and number of courses offered are taken into account.

STUDENT ACHIEVEMENT IN ILLINOIS:
AN ANALYSIS OF STUDENT PROGRESS

Illinois State Board of Education
June 1985

FOREWORD

The third annual Student Achievement report contains analyses of multiple indicators of student progress. This report concentrates on student mathematics achievement measured with Illinois, national and international tests. For the first time in the history of our assessment we are able to link multiple data sources to provide student comparisons at the state and national levels. In addition we describe the conditions related to student achievement such as school size, wealth, and course offerings.

We hope this information provides a framework for the improvement of student programs and outcome measures. For further information about this document, please contact Dr. Thomas Kerins, Manager of the Program Evaluation and Assessment Section, of the Illinois State Board of Education.

Ted Sanders
State Superintendent of Education

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CHAPTER I

READING RESULTS

In the last several years, the focus of reading assessments has shifted from testing students on literal reading skills to assessing what is known as inferential reading comprehension, or gaining meaning from written prose. The results of the recent tests continue to show a relatively low level of student inferential comprehension.

From 1976 to 1982, the Illinois reading assessment contained a number of items which had been used by NAEP. Many of these questions required short answers and reflected the 1970s testing philosophy of the separation of reading skills into such areas as "word attack," "vocabulary," and "decoding." Illinois students performed as well as their counterparts across the country in response to these types of questions.

In 1982, there was an attempt to develop a reading assessment which could more adequately assess student achievement of reading comprehension. The comprehension level is greatly influenced by what the student brings to the written page in terms of prior experience. Longer reading passages were used from the science and literature/reading textbooks appropriate to each grade level.

It appears from the 1982-84 IIEP reading and 1983 writing findings, and from NAEP's functional literacy assessments in the mid-seventies (NAEP 1976), that the vast majority of America's students are literate readers (close to 90 percent) and literate writers (probably close to 75 percent). However, the fact that achievement declines have occurred in inferential comprehension and in more difficult writing tasks should be cause for concern. It appears that a standard of literacy which was perfectly acceptable 10 to 15 years ago is rapidly becoming obsolete. To the extent that analytic, interpretive and evaluative literacy skills are increasingly demanded by an "Information Society," NAEP findings suggest that there is growing illiteracy in complex literacy skills.

Recent results of IIEP reading comprehension tests indicate that there is an average of only 50-60 percent correct response rate for student comprehension of lengthy passages in science and literature subject areas from 1982-84. In addition, recent writing results indicate that only 3 percent of the fourth grade students, 12 percent of the eighth grade students and 20 percent of the eleventh grade students could write a persuasive essay above the minimally developed level.

Reflecting the philosophy and direction of the State Board as stated in the Outcomes for Student Learning (adopted June, 1984), the Board endorses the concept that a comprehensive language arts curriculum is essential for student success in the development of clear expression and critical thinking. Research supports the integration of reading and writing at both the elementary and the secondary levels. Reading and writing are interactive and fundamentally complementary communication skills.

The next stage in the development of the reading assessment also reflects the Board's philosophy and direction. The 1985 assessment requires a writing assignment response to literature, social studies, and science reading passages which will enable us to more accurately assess the student's knowledge and comprehension and his/her ability to analyze, synthesize and evaluate. With this type of information, it will be possible to more accurately identify the level of literacy of Illinois students in the "Information Society."

IIEP

Student achievement in reading comprehension was measured at fourth, eighth, and eleventh grades with the use of reading passages followed by inferential questions. These reading selections included literature and science subjects in order to simulate the type of reading students are expected to do in their classes. Longer reading passages create more realistic memory demands on students and allow them to use a greater amount of context in responding to questions.

These reading questions were also used in the 1982 and the 1983 IIEP assessment. The results show that there is a decline in reading achievement in Expository/Science passages from 1983 and 1984 at all grade levels. The declines in the other areas are not statistically significant and are well above the 1982 results.

Table 1.1 Student Achievement in Reading Comprehension

Grade	Type of Reading Passage Style/Subject	Average Percent Correct by Passage 1982	1983	1984	Average Percentage Correct Across Years
4	Expository/Science	36%	44%	40%	
4	Expository/Science	51%	60%	51%	
4	Narrative/Literature (The Courage of Sarah Noble)	45%	61%	59%	
	Average	45%	56%	51%	50%
8	Expository/Science	64%	76%	72%	
8	Expository/Science	53%	63%	61%	
8	Narrative/Literature (Great Expectations)	37%	52%	51%	
	Average	51%	64%	62%	59%
11	Expository/Literature (Napoleon, Epic Poem)	57%	62%	61%	
11	Expository/Literature (Antigone)	45%	56%	55%	
11	Expository/Science	53%	69%	65%	
	Average	52%	62%	60%	58%

All of the reading comprehension questions, when statistically analyzed, created one factor. This indicates that the students responded to both the science and literature passages with the same degree of comprehension. At eighth and eleventh grades, the ability of students to read and comprehend lengthy reading passages in both scientific and literary subjects appears to be fairly stable from 1983 to 1984 but significantly higher than when measured in 1982. Significant differences with 1982 were also found in grade four. This significant difference is not modified by scientific or literary subject matter. However, at eighth and eleventh grade, the lowest comprehensive performance was in complex narrative literature, not on scientific material. At fourth grade, the weakest performance was in science.

CHAPTER II

MATHEMATICS ACHIEVEMENT

Introduction

Student achievement in mathematics is currently one of the most studied and discussed topics in education. The situation in Illinois is no different. Illinois students have just completed four major assessments of their abilities and aptitudes in mathematics. The findings of these studies, as well as their comparisons to earlier benchmark data, comprise the major content of the present chapter.

While all of the data necessary for summary reports on these four studies are not yet available, the picture they describe is becoming quite clear. Illinois students, on the whole, perform neither better nor worse than their counterparts in other parts of the United States, but they appear to fall farther and farther behind the students of other industrialized nations as they progress through school.

This chapter reports on statewide, national and international testing data which reveal the status of mathematics achievement in Illinois. Four studies are described. Three studies have complete findings, while one study has only preliminary results available. These four studies are:

The Second International Mathematics Study
The Mathematics Decade Study Test: Illinois and Japan
The Illinois Inventory of Educational Progress
The Illinois Universities Test of College Preparatory Mathematics (Preliminary findings)

An outline comparison of these four tests is displayed in the chart on the next page. Specific sections of this chapter will describe each test more fully. Generalizations will be drawn in the concluding paragraphs of each section.

The International Association for the Evaluation of Educational Achievement (IEA) conducted the Second International Mathematics Study in 1981-82. The University of Illinois at Urbana-Champaign carried out the study in the United States. Among test findings of the Second International Study are:

> In twelfth grade, the U.S. pre-calculus students (the majority of twelfth grade mathematics students) achieve at a level which is substantially below the international mean scores for all countries in the Study, and in some cases are ranked with the lower one-fourth internationally.
>
> In eighth grade, U.S. students are slightly above the international average in computational arithmetic (calculation) and well below the international average in non-computational arithmetic (e.g., problem solving).

OUTLINES OF THE FOUR STUDIES

Study Title:	Second International Mathematics Study	Mathematics Decade Study: Illinois & Japan	Illinois Inventory of Educational Progress	Illinois Universities Test of College Preparatory Mathematics
Sponsored by:	International Assoc. for the Evaluation of Educational Achievement	Ill. State Bd. Ed. Univ. of Ill. Nippon Electric Co., Ltd. C & C Systems Research Laboratories Tokyo, Japan	Ill. State Bd. Ed.	Ill. State Universities
Developed by:	Representatives of 22 countries	Educational Testing Service	Ill. Inventory of Educational Progress Staff Dr. John A. Dossey Ill. State Univ. (Normal, Illinois)	Ill. State Universities Committee for College Preparatory Mathematics Tests
Coordinated by:	Dr. Kenneth J. Travers Univ. of Ill. (Urbana/Champaign)	Dr. Delwyn Harnisch Univ. of Ill. (Urbana/Champaign)	Ill. Inventory of Educational Progress Staff	Dr. Anthony Peressini Univ. of Illinois (Urbana/Champaign)
Analyzed By:	Dr. John A. Dossey Ill. State Univ. (Normal, Illinois)	Dr. Delwyn Harnisch Univ. of Ill. (Urbana/Champaign)	Illinois Inventory Educational Progress Staff Dr. John A. Dossey Ill. State Univ. (Normal, Illinois)	Ill. State Universities Committee for College Preparatory Mathematics Tests
Participants:	Illinois, U.S., & 22 countries 8th grade: general students in 20 countries 12th grade: 4 yr. math students in 14 countries.	Illinois, Japan 11th grade students 11th grade	Illinois students 4th grade 8th grade	Illinois 11th grade college-bound students
Time of Administration:	1981-82	Illinois: 1981 Japan: 1982	1976 1978 through 1984	1985

Since the First International Mathematics Study in 1964, eighth grade classes showed a modest decline in end-of-year performance on the 36 items in common between the First International Mathematics Study and the present Second International Mathematics Study. The declines were somewhat greater for more demanding comprehension and application items than they were for computation items.

(Second International Mathematics Study: United States Summary Report, January 1985. pp. ix-x.)

Three aspects of curriculum were considered when the four tests were developed and analyzed. These aspects are described as follows in an article by Travers and McKnight (1985):

<u>Intended curriculum</u>: The content which schools intend to cover in order for students to learn specific skills. Intended curriculum is reflected in curriculum guides, course outlines, syllabi, and textbooks.

<u>Implemented curriculum</u>: The content/skills actually covered in classrooms. Classroom observation, teacher questionnaires, homework assignments and teacher-made tests are indicators of implemented curriculum.

<u>Attained curriculum</u>: Student accomplishment. Test scores, teacher evaluations and student projects are measures of attained curriculum.

The Second International Mathematics Study

The Second International Mathematics Study revealed several significant facts concerning the status of mathematics learning and achievement in the United States, as well as several other countries around the globe. As several Illinois high schools also participated in the U.S. sample for the study, the data from those classrooms make some comparisons of Illinois classes to U.S. and International classes possible. Participating were:

Australia	Hungary	New Zealand
Belgium (French & Flemish)	Ireland	Nigeria
Canada (British Columbia and Ontario)	Israel	Scotland
Chile	The Ivory Coast	Swaziland
England and Wales	Japan	Sweden
Finland	Luxemburg	Thailand
France	The Netherlands	United States
Hong Kong		

The tentative conclusions made from these comparisons must be interpreted with care, as the Illinois classes, whose data were analyzed, were part of a larger portion of the U.S. sample of high school classrooms. This set of Illinois classes may thus not be entirely representative of Illinois secondary school classrooms as a whole.

Mathematics curricula in the various samples were examined at two levels. The first level (Population A) was sampled from 20 countries and represented the end of compulsory mathematics education for all students. This corresponded to the eighth grade level in the United States and is hereafter referred to as the eighth grade test. The second level (Population B) was sampled from 14 countries and represented students who were enrolled in mathematics courses intended for those in the terminal year of a collegiate preparatory program. In the United States, this level corresponded to the precalculus/calculus level of twelfth grade and is hereafter referred to as the twelfth grade test.

Distilled results of the eighth grade study have not yet been made public. However, the preliminary United States report indicates the United States eighth grade students scored at the 50th percentile overall. Figure 2.1 shows the typical United States students' position among the 20 countries in this study.

Figure 2.2, adapted from the United States report, shows that the twelfth grade U.S. sample scored near the 30th percentile among the 14 participating countries.

When the results of the Illinois twelfth grade classes participating in the study are compared with those of the United States classes, it is found that Illinois students are not significantly different from other United States classes. Keeping in mind that the Illinois class scores are unweighted and small in number, the data suggest that Illinois' calculus students may be marginally stronger than typical United States' calculus students in algebra, geometry, elementary functions and calculus, probability & statistics, and finite mathematics. Illinois' precalculus students appear to be slightly weaker than their counterparts throughout the United States.

When Illinois twelfth grade classes are compared with their counterparts in Japan and at the international level, they, like the United States' average class, score lower than the Japanese classes and the average international classes. Only in the area of algebra for calculus students is Illinois able to match or exceed the average performance level attained by typical Japanese classes. Illinois calculus classes compare well with international average classes. However, given that Illinois calculus students are a more select group of students than is typically found in an advanced twelfth grade mathematics class, this is less than impressive.

The data in Table 2.1 show the differences that exist at the precalculus and calculus levels between students in Illinois, the United States, and Japan as well as the international mean. In all cases, the Japanese class means exceeded the United States class means and the international class means. In all but two content areas, the United States calculus class means were at, or exceeded, the international mean. This indicates that the best of the United States twelfth grade students scored only slightly above the average twelfth grade students participating in the study.

Figure 2.1 United States' Position Among the 20 Countries in the Eighth Grade Study.

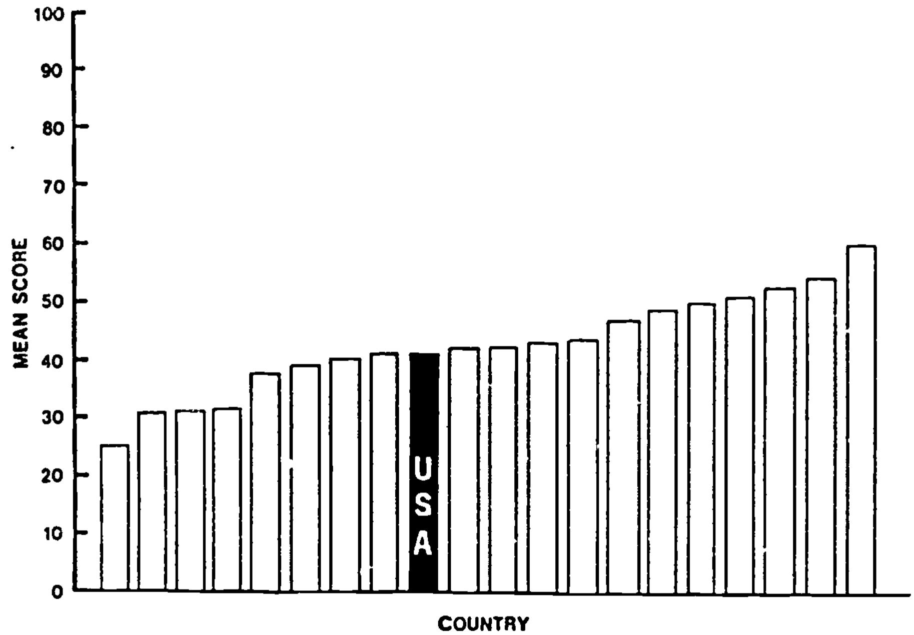
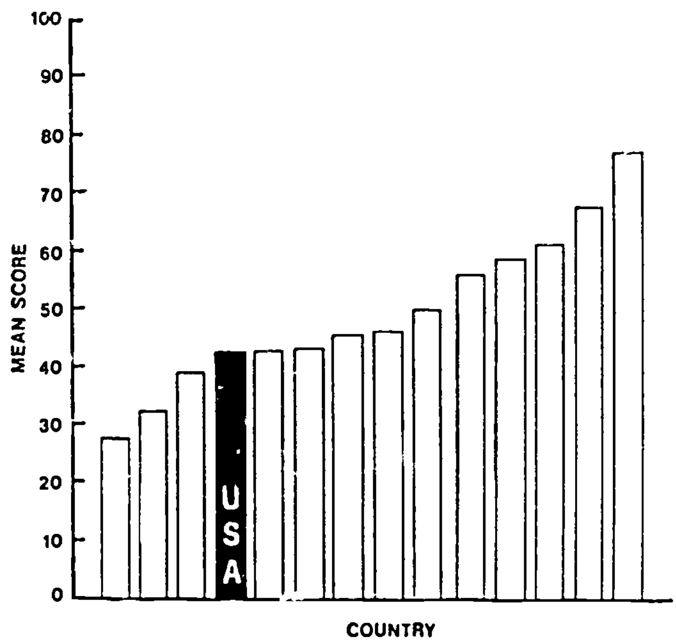


Figure 2.2 United States' Position Among the 14 Countries in the Twelfth Grade Study.



The data from Illinois' and United States' classrooms require more study before the precise influence of the various factors can be described. Nevertheless, two facts are apparent. First, it is clear that the items on the tests are not atypical for United States students, and second, United States students scored at the 50th percentile in the eighth grade study and at the 30th percentile in the twelfth grade study.

Table 2.1 Mean Performance Scores on the Twelfth Grade Subtests of the Second International Mathematics Study

Topics	Illinois Precalculus Sample	Illinois Calculus Sample	United States Precalculus Sample	United States Calculus Sample	United States Total Sample*	Japan Total Sample*	International Total Sample**
Sets/Rel/Functions	48%	63%	54%	64%	56%	80%	62%
Number Systems	35%	49%	38%	48%	40%	70%	50%
Algebra	39%	64%	40%	57%	43%	61%	57%
Geometry	31%	46%	30%	38%	31%	61%	42%
Elem. Functions and Calculus	26%	54%	25%	49%	29%	68%	44%
Prob. & Statistics	34%	56%	39%	48%	40%	72%	50%
Finite Math	23%	52%	29%	38%	31%	76%	--

*sample of all participating students in the country
**sample of all participating students in the 14 countries

The Second International Mathematics Study (SIMS) began with the development of a content grid which identified intended curricula and incorporated appropriate content for eighth grade students in the study. Analysis of the various curricula indicated that the test matched intended curricula quite well, and the item pool was narrowed to exclude all but the most appropriate items. The same process and results were true for the twelfth grade curricula and test. Analysis indicated that over 90% of the sets of items are included in Illinois' and United States' intended curricula.

Extensive questionnaires were answered by all teachers whose students participated in the SIMS. These responses indicated two things: the implemented curriculum matched the test reasonably well, and the implemented curriculum did not cover all of the intended curriculum.

The plan was to report the data for the twelfth grade international study as a whole and for all participating countries. The composite international data are available. However, only the data from the countries of Japan and the United States have been made public at this time.

Table 2.2 shows that in the areas of algebra; sets, relations, and functions; and number systems, twelfth grade students in the United States receive more coverage than the average twelfth grade students in the international sample. However, these United States students ranked below the international average in coverage of each of the other tested areas. It may be that the other countries' curricula are more advanced in their topic coverage and that United States students are covering material from one to one and a half years later than students in other countries. In contrast, Japanese students had coverage levels which exceeded both the United States and International means for every one of the seven curriculum areas.

Table 2.2 Implemented Curriculum: Percent of Test Items Taught in Twelfth Grade Classrooms by Topic

Test Topic	United States	International	Japan
Algebra	87%	82%	100%
Sets, Relations, Functions	81%	73%	95%
Number Systems	80%	76%	82%
Analysis	57%	77%	94%
Finite Mathematics	56%	66%	99%
Geometry	52%	61%	85%
Probability, Statistics	46%	63%	83%
Average	65%	73%	91%

A number of explanations for the low United States scores have been suggested by members of the National Committee responsible for the Second International Mathematics Study in the United States. The most frequent of these are:

- United States' curricula are inconsistent and slow paced in many instances; other countries implement rigorous national curricula consistently throughout their nation.

- United States' standards and expectations may be low in regard to previously covered content; other countries appear to insist that students retain whatever was covered in previous years.

- United States' teachers report that they cover a great many topics and devote similar amounts of time to each topic; other countries appear to identify a limited number of topics as essential and spend proportionately more time on them.

- United States' curricula include limited time for measurement and geometry; other countries spend considerable time on these content areas and emphasize spatial ability almost as much as numerical reasoning.

- United States' teaching practices emphasize factual knowledge and computation; other countries appear to give greater emphasis to problem solving.

The Mathematics Decade Study Test

The Mathematics Decade Study Test is a 60-item high school test which measures student ability in arithmetic, algebra, geometry, advanced algebra, advanced geometry, trigonometry and calculus.

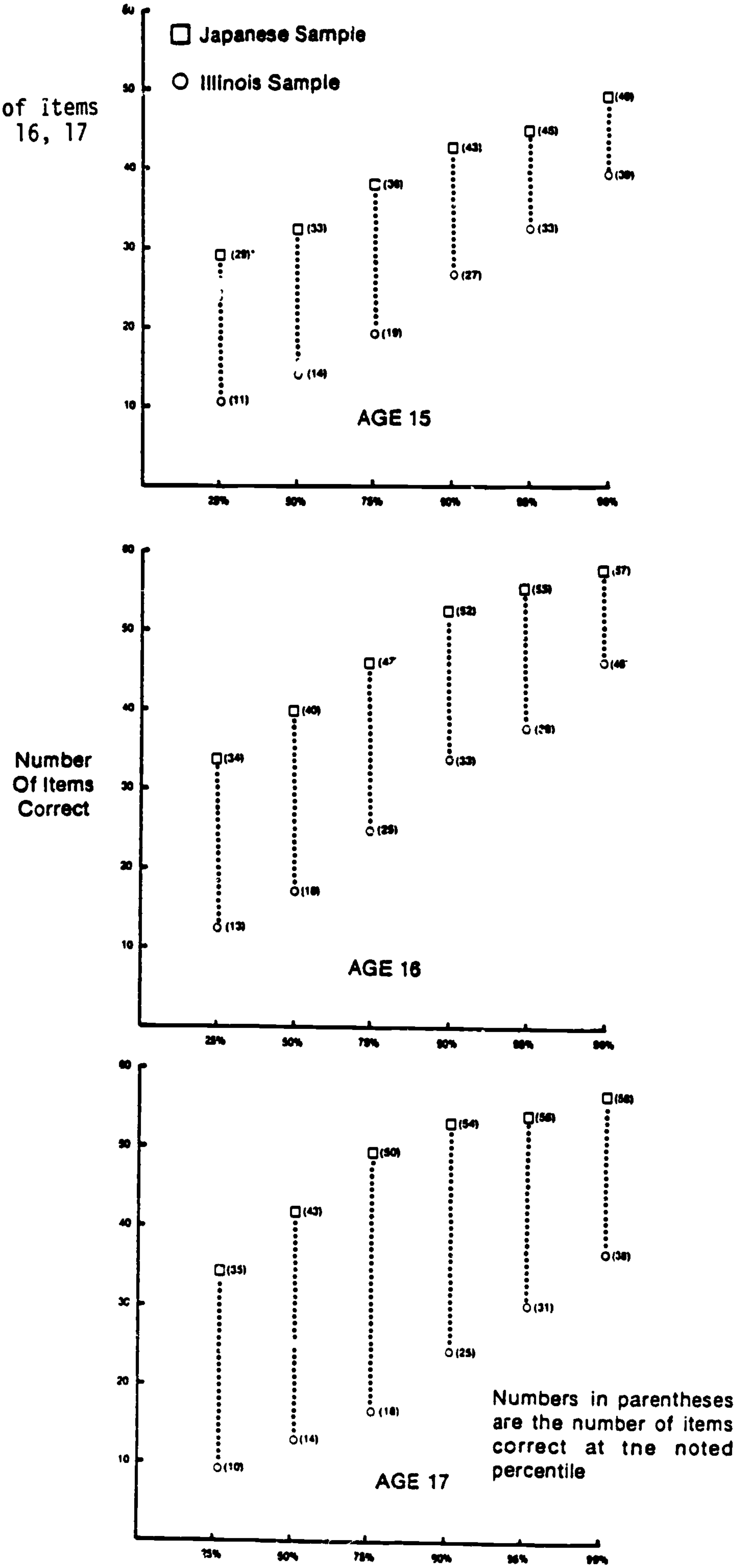
In the 1981 Illinois student sample of 9,582 eleventh grade students, an average of 19.6 correct items were scored on the Mathematics Decade Study Test; the 1970 score was 20.9 items correct. In 1982, this same Mathematics Decade Study Test was administered to a random sample of 1,700 eleventh grade students in Japan. The Japanese sample was designed and drawn by Dr. Takahiro Sato, and the 60-item test was administered under his direction. Test instructions and items were translated into Japanese and then back-translated into English to ensure accuracy. Utmost care was taken to render the Japanese test, student sample, and test administration as equivalent as possible to the Illinois sample. The Japanese average score was 39.6 items correct.

These results show a substantial gap in mathematics performance between the Illinois and Japanese samples. The Japanese students averaged 20 more correct items on a test which was originally designed for United States students. This score is double that of the Illinois students.

The students in both the Illinois and Japanese samples were asked for and gave their ages. As part of additional analyses, comparisons were made between the top 99th, 95th, 90th, 75th, 50th, and 25th percentiles of the two samples for each age level reported. Figure 2.3 shows these comparisons.

Figure 2.3

Average Number of Items Correct for 15, 16, 17 Year-Olds



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In each age level and ability level, Illinois students scored lower than their Japanese counterparts. It is true that the gap narrowed at the highest ability level, but this narrowing may have occurred because the Japanese score may have been constrained by a "ceiling effect." A ceiling effect occurs when most test scores being considered are near the highest possible score.

United States' scores on the First International Mathematics Study led Husen to do a secondary analysis of the study. He had observed that some countries had an elitist educational system while others (like the United States) attempted to educate all children. He conjectured that if only the top percentiles of each country were compared, United States scores would equal those of other countries. Husen's analysis (1983) showed eight countries above the United States and three countries below the United States. From this Husen concluded that the "top 4% of United States students' scores are at about the same level as the corresponding group in the other countries" (p. 460). With Husen's study in mind, the Decade Study comparison with Japan considered the educational policies of both countries.

Since Japan now has the comparable policy of educating all students through high school, a further scrutiny was made to compare the "holding power" of Japan and Illinois. "Holding power" is the percentage of entering high school freshmen who graduate from high school. As far as can be determined, nearly all students in both Japan and Illinois enter high school. Holding power in Japan is 90%; in Illinois, 75%. Both samples were then scrutinized to determine whether either sample contained a disproportion of low achieving schools. It appears from this scrutiny that both samples are representative of their respective populations.

Japan's educational system has been studied by many American scholars in the past ten years. Walberg (1983, 1985), Harnisch (1984), Cummings (1980), and Easely (1983) have reported results similar to the discussions of the United States' Committee of the Second International Mathematics Study. The recurring themes are:

- Japan is a homogeneous society whose upper classes are not unusually different from its lower classes; the United States is a heterogeneous society with large differences among classes.

- Japan has a national curriculum with high standards and challenges all students to meet those standards; the United States has disparate curricula and strives to meet the needs and interests of widely varying students.

- Japanese education includes a 240-day school year, intense family involvement in children's education, and a 2-3 hour "juku" (school-after-school) every day for many children; the United States has a 176-day school year with little involvement by many families and no school-after-school. By eleventh grade, Japanese students have 3 1/3 more U.S. school years (64 more school days per year) than their U.S. counterparts.

The Illinois Inventory of Educational Progress

The Illinois Inventory of Educational Progress (IIEP) was instituted as the testing program of the Illinois State Board of Education in 1976 and has tested fourth, eighth and eleventh grade students in mathematics every year since then except 1977. The 1984 IIEP tested students in general mathematics and geometry. Results reported here come principally from the 1984 IIEP, but comparative results of previous years are included to give a fuller context.

Detailed results of analyses of data gathered from the 1984 IIEP will be given in the curricular report to be published by the Illinois State Board of Education. Generalizations from preliminary analyses can be presented from three perspectives: Illinois trends in mathematical achievement, relative levels of competence, and development of mathematical ability. These perspectives are subdivided as follows and then discussed.

- Illinois Trends in Mathematical Achievement
  - Trends in general mathematics
  - Trends for mathematical topics
- Relative Levels of Competence
  - Comparison of rote knowledge with problem-solving ability
  - Comparison of general mathematics with geometry
  - Comparison of rote knowledge in arithmetic and geometry with problem-solving ability in arithmetic and geometry
- Development of Mathematical Ability
  - In general mathematics
  - In geometry
  - Abilities underlying success on the IIEP

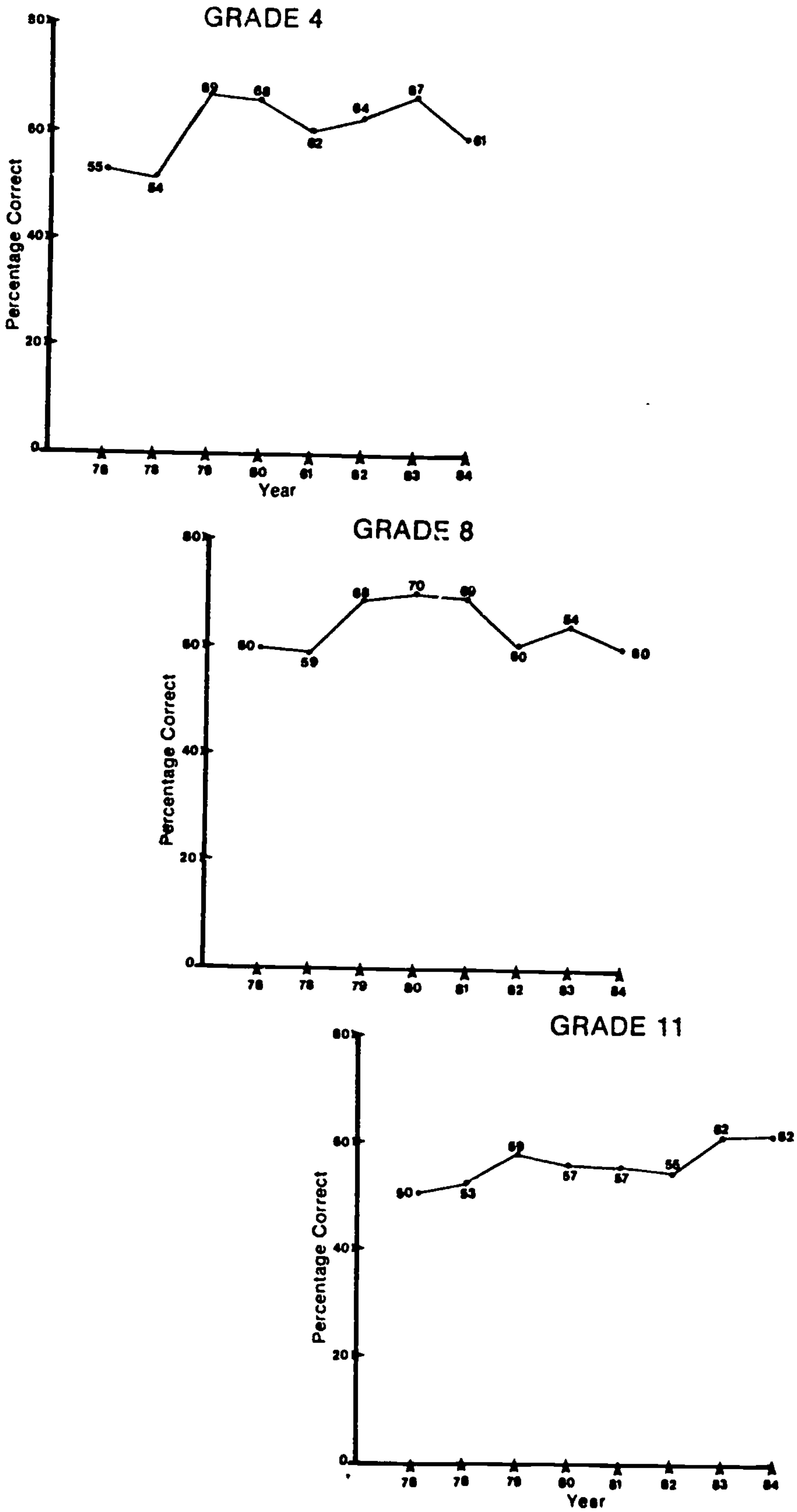
Illinois Trends in Mathematical Achievement

One of the primary goals for the IIEP program is to provide an ongoing picture of student achievement patterns in basic areas of the school curriculum. As part of this effort, the IIEP mathematics tests have offered a common set of items to students over the years in an attempt to discern trends in student performance on these items. These items have been carefully selected on the basis of stability, ability to discriminate, and relationship to central areas of the school curriculum.

The graphs in Figure 2.4 illustrate the results from the use of these items from 1976 to the present. Performance on the items in 1984 cause concern. Drops at the 4th and 8th grade levels from 1983 are statistically significant and bring performance levels to one of their lowest points since the inception of the trend item comparisons, while performance at the 11th grade level equals the highest ever recorded on the IIEP.

ILLINOIS INVENTORY OF EDUCATIONAL PROGRESS

Figure 2.4 **Trends in Mathematics**



Review of the item responses and item types from the trend item set did not provide a ready explanation for the decrease in scores at the fourth and eighth grade levels. Student performance on these items in the 1985 IIEP will be studied carefully.

Performance has been charted each year on the Illinois Inventory of Educational Progress for various mathematical topics. Although the number of items per topic is small and thus warrants caution, the consistency of student performance in regard to each topic is significant. The 1984 data were consistent with every previous data set. Results indicate that student performance at all three grade levels is highest in whole number computation and lowest in measurement and geometry. The rank order of performance for the various topics is: whole number computation; mathematical concepts; application; fractions, decimals, and percents; prealgebra; measurement; and geometry.

Relative Levels of Competence

Despite the fact that sets of rote knowledge items and sets of problem-solving items were matched for the average student's ability, student performance was higher on the rote items than on the problem-solving items. Table 2.3 displays the comparisons.

Table 2.3 Comparisons between Rote Knowledge and Problem-Solving Skills on the 1984 IIEP

MEAN SCORES

Grade Level	Rote Knowledge	Problem Solving	Difference
4	56%	45%	11%
8	63%	38%	25%
11	64%	51%	13%

Rote knowledge was also compared with problem solving in 1982 and 1983. Those patterns were identical to 1984. Performance is higher when only memory is needed than when thinking is also required.

The data in Table 2.4 show that student performance is higher in general mathematics than in geometry.

Table 2.4 Comparisons between General Mathematics and Geometry on the 1984 IIEP

MEAN SCORES

Grade Level	General Mathematics	Geometry	Difference
4	59%	35%	24%
8	57%	39%	18%
11	58%	50%	8%

Student performance in geometry is clearly lower than in general mathematics. However, students are given little or no exposure to geometry by fourth grade, some exposure to it by eighth grade, and still more exposure by eleventh grade. Analyses are now underway to determine the extent to which exposure accounts for the differences in performance.

What happens if the preceding two sections are put together? It appears that a pattern develops which is more closely related to the type of mental ability required than to the type of mathematical content in the test item. The rank order of performance is:

rote knowledge in general mathematics
rote knowledge in geometry
problem solving in general mathematics
problem solving in geometry

The pattern is broken in fourth grade where little geometry instruction is given. And, eleventh graders appear to have an equal amount of rote knowledge in general mathematics and geometry. Table 2.5 displays the data.

Table 2.5 Patterns in Rote Knowledge and Problem Solving for General Mathematics and Geometry

	Factual Knowledge		Problem Solving	
	General Mathematics	Geometry	General Mathematics	Geometry
Grade 4	63%	43%	56%	29%
Grade 8	67%	55%	45%	33%
Grade 11	64%	64%	57%	46%

These data correspond closely with the comparisons made earlier about the amount of geometry covered in the school curriculum. They also appear to indicate the strong computational character of our mathematics curricula across the grades.

Questionnaires were sent to every school which participated in the IIEP. Teachers were asked to answer these four questions for every item on the general mathematics and geometry tests:

- To what extent have students been exposed to the content of this item?
- How well does this item measure the content you are teaching?
- How difficult is this item?
- What percentage of your students will get this item correct?

Teachers reported that the students had been adequately exposed to the general mathematics test items, that these items measured the content very well, and that most of the items were toward the easy side of the scale with only a few rated moderately difficult. Table 2.6 shows the overall averages of teacher estimates and actual student performance for the general mathematics tests.

Table 2.6 Teacher Estimates and Student Performance in General Mathematics

MEAN SCORES

Grade	Teacher Estimate	Student Performance	Difference
4	63%	60%	+3
8	68%	57%	+11
11	62%	59%	+3

Geometry test responses were significantly different. Fourth grade students had generally not been exposed to the content at all, while eighth and eleventh grade students had been. Teachers judged the fourth grade test to be somewhat difficult overall; the eighth grade test to be average; and the eleventh grade test to be somewhat easy. Table 2.7 displays the averages of teacher estimates and actual student performance for the geometry tests.

Table 2.7 Teacher Estimates and Student Performance on the Geometry Tests

MEAN SCORES

Grade	Teacher Estimate	Student Performance	Difference
4	27%	36%	-9
8	46%	40%	+6
11	60%	51%	+9

Development of Mathematical Ability

Comparisons in general mathematics across grade levels have been very difficult within any given year. Items that are reasonable at one grade level are usually too easy or too difficult at another. However, we now have enough data across years to take an initial look at the growth patterns of students as they progress through school. This initial look comes from an analytic approach called cohort analysis. A "cohort" is a group of students entering school in a specific calendar year and continuing through the succeeding grades together. The IIEP has been able to chart the complete progression of only one cohort so far. This cohort, born in 1965, entered kindergarten in 1971 and took the fourth grade IIEP in 1976, the eighth grade test in 1980, and the eleventh grade test in 1983. Table 2.8 shows the cohort comparisons.

Table 2.8 Comparative Trend Scores for Students on the IIEP

Test Year	Grade 4	Grade 8	Grade 11
1976	55	60	50
1977*	—	—	—
1978	54	58	53
1979	69	68	59
1980	68	70	57
1981	62	69	57
1982	64	60	55
1983	67	64	62
1984	61	60	62

*trend item set not administered

Two growth patterns in the table have sufficient data to scrutinize for patterns. The dotted lines compare cohorts in their progress from fourth to eighth grade. The pattern is not clear. Some cohorts appear to improve while others appear to decline.

A more consistent pattern occurs in the transition from eighth to eleventh grade. The trend seems to be a decline in mathematical achievement during the students' high school years. The decline for the average student may be more pronounced than the table appears to indicate. For students who pursue the college preparatory sequence of mathematical courses in high school, the likelihood is that they would score quite well on the IIEP thus raising the state average. Other eleventh grade students would have to score considerably below what they did as eighth graders to depress the cohort average below its eighth grade level.

Seven identical geometry items were imbedded in all three grade level geometry tests, thus allowing for study of student growth. Table 2.9 shows the data on these items.

Table 2.9 Cross-Grade Comparisons in Geometry

Mean Scores Grade Levels			Gains		
4	8	11	4-8	8-11	4-11
33%	53%	67%	+20	+14	+34

Considerable gain is made in knowledge of geometry as students progress through school: 34 percentage points from fourth to eleventh grade. An additional set of three items was found to be reasonable for both fourth and eighth grade students, and twenty-two additional items were found to be appropriate for both eighth and eleventh grade students. The gains for these sets confirmed the results displayed in Table 2.9.

Complex statistical analyses were undertaken to identify those abilities which contributed most to successful student performance on the IIEP. Results indicate that mastery of mathematical concepts introduced at the grade level tested, coupled with the ability to solve problems requiring use of those concepts, produced the highest scores.

Table 2.10 shows the most important of these skills and concepts by grade level and test.

Table 2.10 Most Important Concepts and Skills for Success on the IIEP

Grade Level	General Mathematics	Geometry
4	An understanding of number and numeration Skill in computation with whole numbers	Knowledge of basic terms in geometry An understanding of perimeter
8	An understanding of percentage An understanding of estimation Skill in computation with fractions Skill in computation with decimals	Knowledge of basic terms in geometry An ability to solve simple geometry problems Ability to solve problems not usually found in textbooks
11	An understanding of basic algebra An ability to solve word problems An ability to work with percent	Knowledge of basic terms in geometry An understanding of basic relationships in geometry An ability to solve problems involving area and volume

The descriptions given in Table 2.10 point to the need for both factual knowledge and problem-solving ability. These data would not appear to recommend a concentration on problem solving to the exclusion of factual knowledge, nor the opposite. Rather, the question appears to be: how can students best be helped to acquire both?

The Illinois Universities Test of College Preparatory Mathematics

The Illinois Universities Test of College Preparatory Mathematics is designed to provide a diagnostic measure of proficiency in a variety of mathematical skills essential to success in college-level programs requiring high school mathematics. This examination is divided into two segments:

1) A two-part main examination designed to produce subscores in elementary algebra, geometry, and first-semester advanced algebra.

2) A trigonometry and second-semester advanced algebra examination which can be given at a later date than the two-part examination and is scored locally with the help of an examination key and sample solutions.

These tests are designed to be given to college-preparatory students in their junior year so they will have their senior year to correct any deficiencies which may be identified.

The Illinois Universities Test of College Preparatory Mathematics was developed on the basis of abilities needed to be successful in college mathematics courses. Thus, intended curriculum was defined by the university mathematics professors as what the high school curriculum should be. This went beyond the usual approach to intended curriculum, i.e., the description of what teachers intend to teach. And, it identified what should be required for success at the next higher level.

Developers of the Illinois Universities Test of College Preparatory Mathematics made no formal assessment of high school curricula or content coverage. Assessment of implemented curricula was limited to a critique of the test by selected high school mathematics teachers.

The Illinois Universities Committee for College Preparatory Mathematics Tests releases only diagnostic results which are sent to the participating schools for the benefit of individual students. This makes measurement of attained curriculum on a wider basis impossible. However, the committee has noted that only a small percentage of Illinois high school students are progressing at a rate which will adequately prepare them for college-level mathematics courses by the tir they graduate from high school.

Conclusion

Mathematical achievement has recently been called a problem of national concern. Results of the Second International Mathematics Study and the Mathematics Decade Study: Illinois and Japan add further evidence to the widespread perception that education in the United States is of considerably lower quality than concerned citizens would like it to be.

Data from the Second International Mathematics Study (SIMS) and the Decade Study Test: Illinois and Japan contradict earlier evidence that the best mathematics students in the United States are equal to the best in any other country. Instead, the best mathematics students of many nations clearly surpass the best Illinois and U.S. students.

Data from the SIMS also show that Illinois students fall farther and farther behind the students of other nations as they progress through school. By eighth grade, Illinois students ranked at the 50th percentile; by twelfth grade, Illinois students slipped to the 30th percentile.

The 1984 Illinois Inventory of Educational Progress (IIEP) results, together with SIMS results, indicate that Illinois students are especially weak in geometry, measurement and problem solving. Results from the SIMS also show that students' problem-solving skills have declined significantly in the past twenty years.

New findings on factors which affect student achievement in mathematics, combined with findings from earlier studies, indicate that student time-on-task cannot be considered in isolation. Levels of a system's expected outcomes, a school's curricular objectives, and the students' efforts to meet these expectations must also be taken into account.

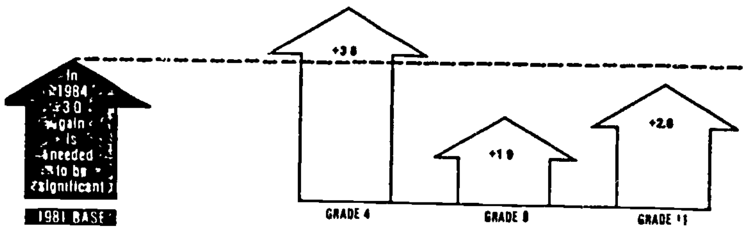
CHAPTER III

SCIENCE ACHIEVEMENT

The latest report from NAEP (National Assessment of Educational Progress) on science has supported the contention that there are serious problems in the conduct of science programs in the schools. Reporting data from 1981, it concluded that there was a general decline in science performance across the content tested at all grade levels.

That conclusion is not totally supported by the data from the most recent Illinois Inventory of Educational Progress Science Assessment. Student performances are either stable or somewhat improved for the science topics tested and for all grade levels in the assessment plan. Students in fourth grade performed notably better on the 1984 Science Assessment than did fourth graders in 1981. Performances at eighth and eleventh grades were at approximately the same level in 1984 as they were in 1981. The following figure summarizes those results.

Figure 3.1. 1981-1984 Differences in Science Achievement



In addition to presenting these test results as total scores, the same items are also grouped as seven subtests to characterize student performance in content and skill areas. Students performed well in a number of the content and skill areas included in the Science Assessment when compared with performances in the same areas four years earlier. Significant gains are apparent in a number of areas. Improved performance occurred for life science at each grade level. Fourth and eleventh grade student performance on items dealing with higher order thinking skills and scientific processes also improved. Eleventh grade students also did better in 1984 than in 1981 on items dealing with earth science.

A second way of reviewing these results is to compare the 1984 averages for each of the subtests to the average performance on the entire test for the same year. That comparison indicates which of the subtest areas fell above or below the average.

Fourth grade students scored above the test average for earth science items and items calling for recall of knowledge or comprehension; eighth grade results were above the test average for life science, physical science and items covering the higher order thinking skills of analysis, synthesis and evaluation; and eleventh grade students did well on life science items as well as the types of items dealing with higher order thinking skills. The subtest areas where students scored significantly below the average for the entire test included physical science at the fourth grade level; earth science, the nature of science, and knowledge and comprehension at the eighth grade level; and earth science and knowledge and comprehension at the eleventh grade level.

This chapter presents information about the performance for each grade level assessed within each of these subtest topics for the 1984 assessment (see Tables 3.2 and 3.3). Performance information includes comparisons of students in the 1984 assessment to students in the 1981 assessment when virtually the same questions were administered. (See Tables 3.4 and 3.5 for year to year comparisons of content and skill area performance.) Growth of student performance from grade level to grade level is also documented. The performance of eighth grade students from 1981 as eleventh grade students in 1984 is also included (refer to the cohort information in Table 3.1).

In addition to achievement results, sections of this chapter describe conditions that influence student achievement. These sections depict setting characteristics, attitudes and values about science reported by students and school staff.

The Nature of the Science Assessment

The Illinois Inventory of Educational Progress Science Assessment was designed to test student performance both in content areas and in areas of cognitive skills applied to science. The content considered for the test included Life Sciences, Physical Science, Earth Science, Scientific Processes, Technology and Science, and The Nature of Science. The content of the test varied from grade level to grade level. At fourth grade, 31 items covered all content areas except Technology and Science and the Nature of Science. Forty-one items at eighth grade and 46 items at eleventh grade touched upon all of the content areas.

Those same items are also categorized according to cognitive skills as schematicized in the Taxonomy of Educational Objectives edited by Benjamin Bloom (1956). That taxonomy provides a range of cognitive abilities from simple to complex which include knowledge, comprehension, application, analysis, synthesis, and evaluation. For the purposes of the Science Assessment some of the skills were grouped together. Knowledge and comprehension of content formed one group tested by 8 items at fourth grade, 15 items at eighth grade, and 18 items at eleventh grade. Application of scientific knowledge in content areas was tested by 16 items for fourth graders, 15 items for eighth graders, and 17 items for eleventh graders. The remaining skills--analysis, synthesis, and evaluation (sometimes called higher order thinking skills)--were tested by 7 items, 11 items, and 11 items at fourth, eighth, and eleventh grades, respectively.

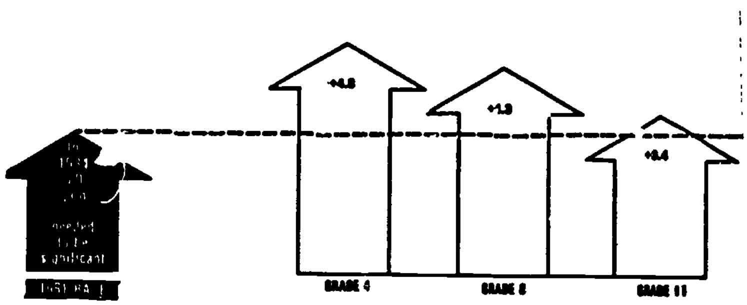
The intent of the test developers was to provide a test emphasizing the practice of science, not science as information obtained largely through reading. In this sense, the Illinois Inventory of Educational Progress Science Assessment is as much a test of how well students think as it is a test of how much specific information students remember. This presentation of achievement results will reflect the content and skills outlined above.

Life Science Results

The Life Science items in the test dealt with the subject matter commonly taught under the title of Biology. Other courses where such information might also appear are Ecology or Environmental Studies. The items in this area reflected information dealing with living things. Not only were living organisms considered separately, but also as groups or systems. Items examined student understanding of the relationships among individuals, groups, systems, and their environment. For example, one of the Life Science assessment items asked students about the components of cells at the knowledge and comprehension level of skill, while another item, at the higher order level of skills asked students about the conditions necessary for seeds to sprout and grow.

Results at all three grade levels indicate that students did well on the Life Science items (Figure 3.2). Performance on each item in this area was often above performances from that of three years earlier. In addition, performance on these items was either at or above the average for the test as a whole.

Figure 3.2 1981-1984 Differences in Life Science Achievement



Fourth grade performance for 1984 averaged 57.4% correct on the Life Science items and 55.4% correct for the entire test. This result was a significant improvement in performance over 1981 when the typical Life Science item was answered correctly by 52.6% of the students.

At eighth grade, Life Science performance was significantly higher than the average performance for the whole test in 1984 and the Life Science performance in 1981. Eighth graders answered the Life Science items correctly at a rate of 68.8%. (The test standard was 60.8% in 1984 and the Life Science average in 1981 was 64.5%.)

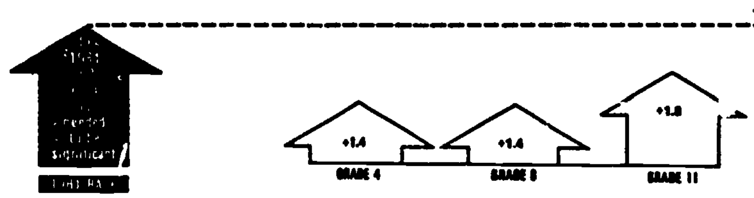
Similarly, eleventh grade students performed significantly better in 1984 than they did in 1981. An average of 78% of the present day students responded to items correctly compared to 74.6% of the eleventh graders in 1981. That performance was also significantly higher than the performance for the average proportion correct on the entire 1984 exam--66.8% correct.

Physical Science Results

The content area of Physical Science is most closely related to courses labeled as Physics in schools. Although Physics is most often thought of as a high school course, many of the concepts and processes related to the physical world around us are included in the content of science at lower grade levels too. The Physical Science assessment included on the Illinois Inventory of Educational Progress included knowledge-oriented questions about such matters as the freezing point of water in terms of Celsius temperature. More advanced knowledge was needed to answer a question about cloud seeding. In addition, higher order thinking skills were tested through questions about the density of floating objects and evaporation.

Although Physical Science results from 1984 are slightly higher than they were in 1981, the differences are not statistically significant. Figure 3.3 summarizes the data.

Figure 3.3 1981-1984 Differences in Physical Science Achievement



Performances for fourth graders in 1984 are statistically similar to performances on the 1981 assessment. Regardless of the stable performance, fourth grade results for the Physical Science items are below the average item on the entire test. An average of 47.5% of the students answered the Physical Science items correctly, while the average for the entire test was at 55.4% correct.

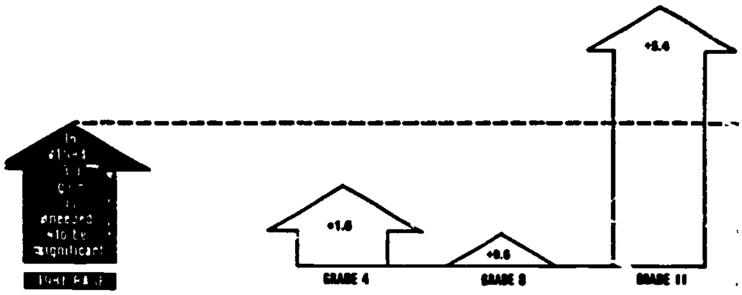
The performance for eighth graders in 1984 was also very similar to performances on the 1981 assessment. While the year to year comparison for eighth graders is similar to the fourth grade performance, the eighth graders did not find the Physical Science items to be as difficult as the fourth graders. The Physical Science results at the eighth grade level for 1984 are significantly higher than the average for the entire test which is 60.8% correct.

The 1984 eleventh grade performance is also similar to the 1981 performance. The 1984 result is not significantly different from the average for the entire test.

Earth Science Results

The content area of Earth Science is closely related to Geology. Knowledge of the "mountain building" dynamics of the crust of the earth was included in one of the lower-level cognitive skills items tested. More complex cognitive skills were called for in questions about erosion and rainfall patterns related to geographic features. Figure 3.4 summarizes performance results comparing 1981 to 1984 in this area.

Figure 3.4 1981-1984 Differences in Earth Science Achievement



Fourth grade students found the items covering the Earth Science topics to be easier than the average item on the test. The average score of 66.1% correct for items dealing with Earth Science was slightly more than 10 percentage points better than the 55.4% average for the entire test. Since the fourth grade students from three years ago also did well in this area, there was no significant difference between performances in 1981 and 1984.

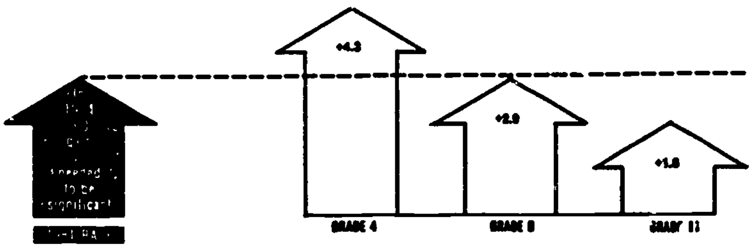
By contrast, eighth graders found Earth Science items to be more difficult than the average item on the test at that level. Eighth grade students scored nearly 10 points below the 60.8% test average at 51.9% correct for the Earth Science items. Those scores were similar to those from four years earlier in Earth Science.

For eleventh graders too, the items were more difficult than the other items on the test. In spite of that, however, the result was a significant improvement over the 1981 result. In 1984, eleventh graders averaged 64.9% correct for Earth Science items while their average for the entire test was 69.4%. Earth Science performance in 1984 was 5.4 percentage points better than the 59.5% correct in 1981.

Scientific Processes Results

Less traditional content than that previously described is included in the Illinois Inventory of Educational Process Science Assessment area labeled "Process." Scientific processes include scientific methods and applications or logical analyses of problems amenable to scientific experimental examination. These "Process" items are designed to discern how well students know about or use skills related to doing science. Without such knowledge and skill, the real work of science could not be accomplished. This area represents a dividing point between students who will simply appreciate science as opposed to those who could become practitioners of the craft. Performance on "Process" items shows an improvement over the 1981 test results for each of the grades in the assessment (Figure 3.5).

Figure 3.5 1981-1984 Differences in Scientific Processes Achievement



Fourth grade students responded correctly 55.1% of the time for "Process" items and 55.4% for the entire test. Although it is a performance comparable to the average for the test, it represents a significant improvement over the 1981 performance of 50.8% correct.

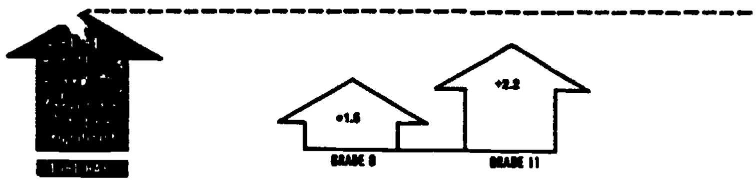
Eighth graders performed at 59.3% correct on "Process" items and 60.8% for the entire test. This was not significantly above the 1981 level of 56.4% correct on the average.

Eleventh graders also scored near the average for the entire test on the Process items. That result was 72.2% correct for the Process items and 69.4% correct for the test. The 1984 result was, however, significantly higher than the 1981 result of 67.5% correct.

Nature of Science Results

The Nature of Science was tested at eighth and eleventh grades on the 1984 Science Assessment. The items included under that title do not reflect any of the traditional subject matter classifications that most people remember as part of the school program. Rather, the nature of science category is characterized by answering such general questions as: What is science? What does a scientist do? And what are the implications of doing science? Such matters may be touched upon in each of the science classes provided for students. Lower cognitive level items on the Science Assessment called for a true characterization of the information produced by scientists while higher cognitive skills applied to this category called for an inference about the unexpected or serendipitous phenomena sometimes discovered in the practice of science. Overall performance results between 1981 and 1984 are compared in Figure 3.6.

Figure 3.6 1981-1984 Differences in Nature of Science Achievement



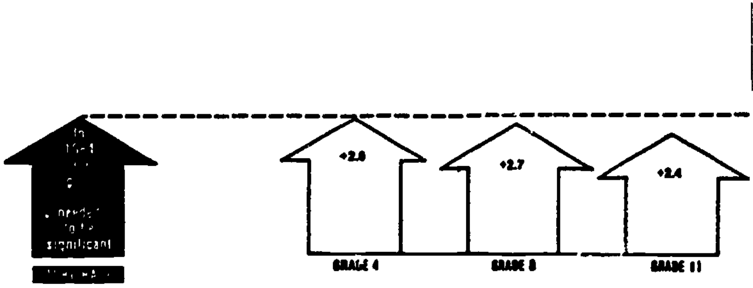
Eighth grade students found the Nature of Science items more difficult than the average items on the test. Their average of 50.9% correct was nearly 10 percentage points below the test average of 60.8% correct. That performance was similiar to the 1981 test results for this area. The stability of the score over time resulted in the lower comparative performance while other areas improved.

Eleventh grade students, on the other hand, performed at about the same level for the Nature of Science items as they did for the test as a whole. They answered Nature of Science items correctly at an average of 67.4% correct compared to the 69.4% correct for the entire test. The Nature of Science results from 1981 were similar to this.

Knowledge and Comprehension Results

The skills tested as Knowledge and Comprehension relate to specific recall of knowledge, deciding what alternative represents an accurate "translation" of an idea or concept; reordering ideas, or extending those ideas or concepts as a trend. While knowledge and comprehension are often considered to be among the "lower order" cognitive skills, that designation in no way is intended to reflect the difficulty of test items falling into this classification. One only has to reflect upon the types of questions collected for games of trivia to appreciate the potential difficulty of such items. Indeed, for students at the two upper grade levels, the knowledge and comprehension items were more difficult than the average. For example, only about half of the eighth and eleventh graders taking the test were able to identify "tissue" not to be a component of a cell. A comparison of 1981 to 1984 results, however, show student performances to be at roughly the same levels. (See Figure 3.7.)

Figure 3.7 1981-1984 Differences in Knowledge and Comprehension Achievement



Similar to the 1981 students, the 1984 fourth grade students answered items correctly at a rate about the same as the average test item in 1984. For that test administration, students averaged 61.4% correct for items in this category and 55.4% for all items on the test.

While an average of 60.8% of the eighth grade students responded correctly to items on the test, the average for the Knowledge and Comprehension items was significantly lower. For that subgroup of items, 56.8% of the eighth graders responded correctly. That performance was comparable to the 1981 average for knowledge and comprehension.

Elev rade students also found the Knowledge and Comprehension items to be more difficult than the average while performing as .ell as students in 1981. While their average for items for the total test was 69.4% correct, their average for Knowledge and Comprehension items was 61.0% correct.

Application Results

The type of skill included as Application in Bloom's Taxonomy is more complex than knowledge or comprehension. In science applications, for example, the student would be expected to apply knowledge, methods, theories, or principles to tasks, problems, or situations new to the student. In the 1984 Science Assessment, Application items dealt with reading the temperature on a thermometer or applying the Piagetian concept of "conservation" in selecting one diagram from a set of diagrams illustrating the concept. At all grade levels Application items were of about the same difficulty as the average for the entire test. Those results were similar to student performances in 1981 (Figure 3.8).

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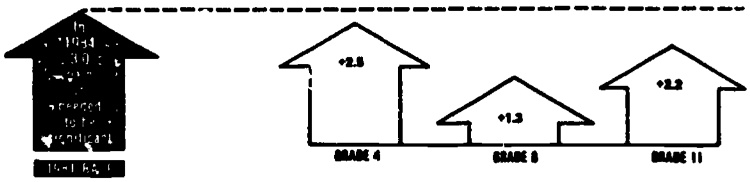
Figure 3.8 1981-1984 Differences in Application Achievement



Fourth grade students answered Application items at a rate of 53.1% correct. The total test average was 55.4% correct. The difference is not significant.

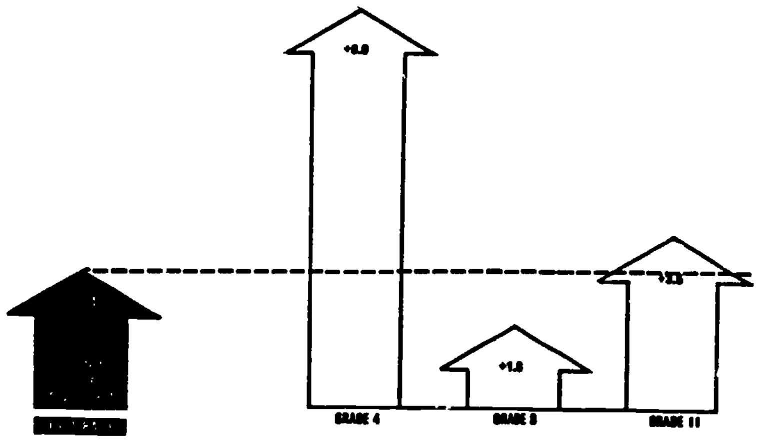
Eighth grade students performed at virtually the same rate for both Application items and the items for the entire test. Their Application performance obtained a 60.9% correct response while the test results were 60.8% correct.

The 1984 eleventh grade students performed just slightly above the 1981 students on Application items. The difference, however, is not significant. The 1984 results were 71.1% correct and the results for the entire test were 69.4% correct.

Analysis/Synthesis/Evaluation Results

Higher order thinking skills are often depicted as relating to analysis, synthesis, or evaluation. Analysis consists of identifying the components and relationships between components in something under study. Synthesis entails taking disparate elements and putting them together in a new and reasonable manner. Evaluation, in a formal sense, consists of determining internal consistency or correspondence to external standards. Analysis/Synthesis/Evaluation items included having students use information from a narrative and a diagram to arrive at an appropriate conclusion. For such skills, students performed at least at the average for the entire Science Assessment or better. Further, student performances were significantly improved over performances in 1981 in two of the three grade levels tested. The differences are depicted in Figure 3.9.

Figure 3.9 1981-1984 Differences in Analysis/Synthesis/Evaluation Achievement



Fourth grade students' performance in Analysis/Synthesis/Evaluation was about the same as their performance on the test as a whole. Yet that performance was significantly improved from 1981. Fourth graders averaged 55.4% for the entire test, while their Analysis/Synthesis/Evaluation average for 1984 was 53.7% correct, an 8-point gain from the 1981 average of 45.7%.

The 1984 eighth grade performance in this area was significantly above the average performance on the test, yet similar to the 1981 result. Eighth graders scored 66.1% correct for Analysis/Synthesis/Evaluation and 60.9% correct for the test as a whole.

Eleventh graders were above average in performance for this category of items. Their Analysis/Synthesis/Evaluation average was 80.4% correct, while their total test average was 69.4% correct, an eleven point difference. That performance was significantly higher than the average of 76.9% correct from 1981.

Cohort Comparison Results

The 1984 administration of the Science Assessment was the second time the Illinois Inventory of Educational Progress included this subject area. The previous administration was in 1981. This three-year cycle allows the results from the eighth graders of 1981 to be compared to the results from the eleventh graders of 1984 as they are the same group of students moving through the educational system. The comparison is further facilitated by the design of the test. Thirty-six of the same items are taken both by eighth and eleventh grade students.

The eighth graders of 1981 performed slightly below, but about as well as, the present day eighth graders on these items. As eleventh graders in 1984 those eighth graders are performing slightly, but not significantly, above the eleventh graders of three years ago. Three years ago the eighth to eleventh grade difference was 10.2 percentage points. In 1984 the difference was 11.0 percentage points. The difference between the eighth graders of 1981 and the eleventh graders of 1984 is 12.8 percentage points. Strong subtest differences in Life Science and Scientific Processes items contributed to this gain. (See Table 3.1.)

Table 3.1 Cohort Comparisons

Grade	Year	Grade	Year	Differences
8	1981	11	1981	+ 10.2
8	1984	11	1984	+ 11.0
8	1981	11	1984	+ 12.8

Students and Science

It is readily apparent that the experiences students have outside of school can contribute to performance in school and on tests. The 1984 Illinois Inventory of Educational Progress gathered information about science experiences from students through a questionnaire included with the Science Assessment. This section describes the questionnaire results.

Student Involvement in Science at School

Previous studies associated with the Illinois Inventory of Educational Progress have shown that the number of courses a student has taken in a subject area is an important indicator of how well a student will perform on tests such as the Science Assessment. Obviously, if a test relates to subject matter of optional classes, as in the case of many high school science courses, the average performance on a test will be influenced by the proportion of students not taking the course. At elementary and middle schools, the number of students who reported not having science as a subject of study is small. The analyses presented in Chapter IV demonstrate the significance of this information in predicting student test performance.

At the fourth grade level, 72.7% of the students reported they had participated in a science class more recently than the previous semester. An additional 18% had science sometime during the year. This totals 90.7% of the fourth graders with experiences in a science class relatively close to the time they took the Science Assessment. A larger portion of eighth (89.2%) than fourth graders had science class near to the time they were asked to perform on the Science Assessment. A total of 95.6% of the eighth graders had science at least during the previous semester. The least amount of exposure is found among eleventh grade students where science is predominantly an elective course. At that grade level, only 30.7% of the students reported they were enrolled in science during the semester they took the Science Assessment. An additional 6.4% had been enrolled during the previous semester. In addition to this information, juniors were asked to report the number of semesters of science they had during their high school career. The most common pattern for eleventh graders was one or two semesters of science. This was reported by 41.3% of the students. An additional 25.8% reported three or four semesters of science.

Science in the Home Environment

Home environments contribute to student performance in science. (See Chapter IV for the analyses depicting the extent of this contribution.) Parents certainly may be role models for their children. As an indicator of home conditions that could provide a favorable environment for student interest or work with science, one question asked if either of the student's parents worked in a science-related area such as medicine, chemistry, or research. Close to the same proportion of students at each grade level indicated that their parents had science-related work. This suggests that the self-reported information is accurate or at least defines a probable range of results. At fourth grade, 16.5%; at eighth grade, 15.4%; and at eleventh grade, 13%--a range of 13 to 17%--of the home environments include a parent involved in a science-related occupation.

Students as Science Consumers and Doers

The experiences of students as consumers of science-related information and as actively engaged in science can form a significant influence in the knowledge and skills of a student. Exposure information in Chapter IV illustrates the importance of these experiences for achievement. Questions related to consumerism asked students about their science reading and television viewing habits. The questions dealing with involvement asked if students talk with parents about science (a low level of involvement) or if they did science projects for themselves (a high level of involvement). The results show that both science consumerism and involvement decline as students get older.

While approximately half of the fourth grade students read books about science during a month, that proportion drops to about 40% at eighth grade and 24% at eleventh grade. Viewing programs about science on the television also becomes less frequent. Two out of three (66.8%) of the fourth graders view science programs on television during a month. For eighth graders the proportion is 6 out of 10 (60.3%). By eleventh grade less than half (45.2%) of the students watch that often.

Another way to review the information about students as consumers of science is to note the proportion of students who avoid science consumer experiences. About 3 out of 10 (27%) of the fourth graders reported rarely or never reading about science. At eighth grade that proportion increased to 4 out of 10 (40.9%), and at the eleventh grade the ratio was in excess of 5 out of 10 (55%). Absolute avoidance or rare viewing of science programs on television remains very much the same across grade levels. For each level, about a quarter of the students (25% at fourth, 25.4% at eighth and 26.2% at eleventh grades) avoid science programs.

Student involvement in doing science declines as students get older. More than 4 out of 10 fourth graders (44.7%) talk to parents about science at least weekly. About 3 out of 10 (28.4%) eighth graders discuss the subject with parents. By the eleventh grade the proportion of students broaching the subject is fewer than 2 in 10 (15.3%). There is a corresponding increase of students reporting that they rarely or never talk with their parents about science, about 4 out of 10 fourth graders, 5 out of 10 eighth graders, and more than 6 out of 10 eleventh graders.

The proportion of students who do their own science projects for their own purposes declines sharply from fourth to eighth grade. At fourth grade better than 4 out of 10 students (42.9%) indicate doing projects of their own during a month. The proportion drops to less than 2 out of 10 (15%) of the students reporting such activity at eighth grade. The decline apparently continues through eleventh grade. By that time, fewer than 1 out of 10 students (7.5%) do projects on their own. Those students avoiding personal science projects doubles from 4 out of 10 (40.6%) at the fourth grade to 8 out of 10 (78.3%) at eleventh grade. Eighth graders report never or rarely doing science projects for themselves at a rate of 63.9%.

Appraisal of Science

Student appraisal of science was examined through an eleven-item section on the questionnaire. Underlying these questions was an assumption that appraisal is an important feature of motivation. It was assumed that all of the external efforts employed by teachers to promote student interest in a subject are limited in impact by the values actually held by students for or against the discipline being taught. In part, this information answers the question, "How receptive are students to science?"

At all grade levels between three-quarters and four-fifths of the students agreed that the contribution of science to their understanding of the world around them was important. At least four-fifths of the students at each grade level agreed that knowledge of science would actually contribute to that understanding. Student responses to opinion questions also show that fourth graders are more positive about the value of science than either eighth or eleventh graders. The values declining from grade to grade in proportion of approval were: the study of science would be good for grades, science is fun, knowledge of science would earn the approval of teachers, knowledge of science would impress friends, and knowledge of science would get them a good job. The least approved of the values of science included gaining approval from teachers and impressing friends. Chapter IV uses these data as "perceived value of achievement" to predict test results.

School Professionals and Science

Part of the environment for science education relates to characteristics of the classroom teacher. Students are taught by teachers with different backgrounds and with different teaching styles, all of which could influence student achievement.

Teachers and principals in the schools where the Science Assessment was administered were asked to respond to questionnaires to provide background information about the setting for science education. Questions included demographic characteristics of principals and teachers, questions about training related to science, pedagogy, academic standards, and values about science. The results presented here, in part, reflect the analysis conducted by Dr. Delwyn Harnisch of the University of Illinois.

Teachers

Questionnaires for teachers in schools where the Illinois Inventory of Educational Progress was administered brought responses from 554 teachers. Instructions for the distribution of the questionnaires were for the principal to select teachers of science to complete the information at the grade level where testing was taking place. While it is not suggested that the results are randomly representative of all of the teachers at grades four, eight or eleven, these data do appear to be internally consistent suggesting that they are an indicator of actual conditions.

Virtually all of the schools in the sample are represented by at least one teacher. There were 195 replies at fourth, 162 at eighth and 197 at eleventh grades. While the entire set of replies included equal numbers of male and female teachers, the proportion at fourth grade was approximately four females to every male teacher. At the eighth and eleventh grades, the ratio was three males for every female teacher. Analyses of questionnaire data show no significant differences between male and female responses.

Typically, the teachers at all grade levels had more than eleven years of teaching experience. Fourth grade teachers typically reported that they had less than a minor in science preparation. At eighth grade, 5 out of 10 teachers reported having a major in science, while nearly 9 out of 10 high school teachers had a major. The median amount of education also tended to increase as grade levels increased. Fourth grade teachers typically have a BA/BS with 15 hours additional credit or less. Commonly, eighth and eleventh grade teachers reported a MA/MS degree.

Principals

Another part of the environment for science education relates to the principal of the school. Researchers contend that one of the roles of the principal is the instructional leader and that the settings where the principal exerts that influence are more productive than where the principal is less involved in the curriculum. Researchers suggest that the climate for instruction in schools differs greatly depending on the background and beliefs of the principal.

Questionnaires for principals, therefore, were also included as part of the Illinois Inventory of Educational Progress. Principals from more than 85% of the participating schools returned the questionnaires. The 344 responses included 121 at fourth grade, 111 at eighth grade, and 112 at eleventh grade.

It was anticipated that the background of principals might be related to their "leadership" in science. Principals were asked to report how many courses they had taken in science. It was found that approximately one-quarter of the principals at the fourth grade, just less than one-third of the eighth grade principals, and just over one-third of the eleventh grade principals had at least a minor in science. The most common amount of preparation at all grade levels for between 60 and 70% of the principals was less than a minor, but more than one course in science.

An interesting note here is that at the fourth grade level the typical principal and the typical teacher have about the same preparation in science. For that level, it could make sense for the principal to act as the instructional leader and provide curricular advice. At the eighth and eleventh grades, however, the science teacher is more likely to have a greater amount of content preparation than the principal. At those levels the instructional leader concept will have to refer to a more general role in support of science education.

Training in Science

Inservice and continuing education were two topics explored through the survey questionnaire. Inservice generally refers to workshops and training sessions held during the school year. Continuing education refers to the formal classes that include college credit and work toward advanced degrees.

Inservice dealing with science is not a common experience for fourth grade teachers who responded to the survey. Six out of 10 of the teachers at that level did not participate in inservice related to science within a year and a half prior to completing the questionnaire. That proportion drops to 1 out of 4 at eighth grade and only 1 out of 5 at eleventh grade. One possible explanation for this result is that fourth grade teachers are not departmentalized and have a broad range of interests and needs to be served through inservice education. The specialization of teachers at eighth and eleventh grades would be likely to narrow inservice options considerably for teachers at those levels.

In addition to this finding, eleventh grade teachers who need science inservice the most are the least likely to receive it. At the same time, reports from the teachers with advanced degrees indicate that they are more comfortable teaching science than their colleagues who have less preparation. The juxtaposition of these two bits of information would suggest that the design and implementation of inservice programs might benefit from attention to the length of service, the degree attainment and the self-reported comfort of teachers in subject areas where they direct student learning.

Both teachers and principals were asked if they participated in professional meetings dealing with science or science education. At the fourth grade level, approximately 7 out of 10 of both teachers and principals had done so at least once during the previous 18 months. While this pattern suggests that there may have been some recent emphasis on science in the elementary program, the pattern is different for the eighth and eleventh grade settings. For both of those more advanced grade levels, only about one-fourth of the principals had participated at least once in such meetings, while 7 out of 10 eighth grade teachers and 3 out of 4 eleventh grade teachers had done so. The fact that the principals at the higher grade levels are less involved in recent professional meetings dealing with science may be an indication of less specific attention to science education at this time.

Pedagogy

The questionnaires for both the principals and the teachers contained a list of twelve pedagogical techniques that could apply to teaching science. Both groups were asked to rate the utility of the techniques from very useful to not very useful (see Table 3.6). It is anticipated that the supportive role of the principals as instructional leaders is likely to be more effective in settings where agreement occurs between principals and teachers about teaching practices.

"Hands-on activities by students" was the most favored pedagogical technique at all grade levels for both teachers and principals. The belief that hands-on activities are important can be placed in perspective of the reported time spent on hands-on and/or laboratory experiences at each of the grade levels. Fourth graders typically are exposed to science 105 times during the year for 30 minutes at a time. One-fifth of the total time was estimated by teachers to be hands-on experience. At eighth grade just over one-third of the 176 class periods of 44 minutes in duration were reported to be hands-on or laboratory experience. Curiously, only one-fourth of the eleventh grade science class time is reported to be hands-on or laboratory experiences. At that grade level, classes average 50 minutes and the programs typically are 180 days in length. This means that eleventh graders actually have slightly less hands-on or laboratory time than the eighth graders. While eleventh graders have approximately 41 hours of that type of activity in a year, eighth graders have it 44 hours a year.

Considerable agreement among teachers and principals exists in support of "student discussion" as a pedagogical technique. It shows up as second or third favored by teachers and third or fourth in rank using the average preferences of principals. Disagreement about the utility of "student discussion" exists among eighth grade teachers. At that grade level "student discussion" is not viewed as favorably by teachers with more advanced degrees as their colleagues teaching at the same level.

Teachers do not agree on a third pedagogy from grade level to grade level. Fourth grade teachers include "student independent projects," eighth grade teachers include "demonstration by teachers," and eleventh grade teachers add "lectures or teacher presentation." These differences are likely to reflect what is considered appropriate for students of different age groups.

Principals include "demonstration by teachers" in second place among their preferences for each grade level. This matches teacher preferences only at the eighth grade.

While some agreements exist about the most preferred techniques, there is somewhat less consensus about those techniques viewed to be of lesser utility. (It should be noted that none of the pedagogical tactics received an average rating below the mid-point of the scale used in the rating.) Memory work does show up as one of the least preferred techniques for all lists. Contests or science fairs are of lesser utility in the opinion of teachers and high school principals. Guest speakers show up among the lowest average ratings for eighth and eleventh grade teachers and principals. Finally, worksheets show up among the lower average utility ratings of fourth grade teachers and principals for fourth and eighth grade settings.

The pedagogical styles characterized as didactic and heuristic also served as the basis for a question for teachers and principals. This area appears to disclose a difference between teachers and principals. Didactic instruction was defined as involving teacher-led settings where there is a high degree of daily teacher direction in the activities. A heuristic setting was defined as involving the teacher and class in processes such as experiment, discovery, or problem solving with a modest degree of teacher direction in the activities. Principals at all grade levels tended to respond to the heuristic approach more favorably than the teachers. Among the principals, those supervising fourth grade settings were decidedly more favorable to heuristics. For the teacher groups the most favorable toward didactic techniques were fourth and eleventh grade teachers. Eighth grade teachers also tended to favor didactics, but were a bit less emphatic about it than their colleagues at other grade levels.

These self-reported characterizations are consistent with other information from the questionnaires. Hands-on activities would be expected to be favored by heuristically oriented teachers and correlations show this to be the case for teachers at all grade levels.

Standards

One of the criticisms leveled at schools is that the decline in achievement has taken place because of a decline in standards. Questions were included to examine the nature of standards as applied to science. Six questions asked what it should take to get an A, A-, or B+ in science. The questions were about attendance, extra time, homework, knowledge, assignments, and the ability to go beyond what is given in class. (The results are summarized in Table 3.7.) There is considerable agreement in the most preferred standards from grade level to grade level and between teachers and principals, with one notable exception. Principals believed students should be able to go beyond what is given in class while that idea was among the least preferred by teachers at all grade levels.

The standards most preferred by teachers at all grade levels included "doing all of the activities or assignments," "knowing all of the material," and "attending every day." The principals from all grade levels agreed with attendance and assignments as standards.

The teachers and principals were somewhat less favorable toward the necessity for students to put in a lot of extra time and to do homework every night. It should be noted again that while these items were lower in average rating than the other items on the list, they were generally still viewed as being positive standards. There are exceptions, however. A majority of the fourth grade principals did disagree with the necessity of nightly homework as a component of a high grade. A majority of teachers at the fourth grade also did not support the "homework every night" idea. In addition, a majority of fourth and eighth grade teachers also disagreed with the need to put in a lot of extra time. The extra time standard was highly favored by eleventh grade teachers with advanced degrees.

Appraisal of Science

Teachers and principals were presented with a list of five possible values for science education. All of the values were perceived positively by these professionals, however, a few were more highly prized than the others. Some agreement exists for teachers and for principals about some of the values. However, between the two groups of professionals, there is less agreement here than for other matters described in this report (refer to Table 3.8).

Among the teacher groups there was agreement that the knowledge of science is important for students in their everyday lives. Among the principals agreement existed for the statement that "science is a good career for students of this generation."

Other positively perceived values for science among the teachers included fourth grade teachers acknowledging science as a good career, eighth grade teachers viewing science as useful in problem solving for students in school, and eleventh grade teachers viewing problem solving for students in life as being positive. Fourth and eleventh grade teachers with higher degrees are most favorable about this value. Eleventh grade teachers with two to four years of teaching experience were noticeably less positive about this value.

Principals at the fourth grade level were favorable about the potential of science as a problem-solving tool for students in school. Eighth grade principals believed in the importance of knowledge of science for students in everyday life, and at the eleventh grade level principals viewed scientific knowledge as important for students in future schooling.

Conclusion

A recent meta-analysis review of the effects of the innovative science curricula of the 1960's by Shymansky, Kyle, and Alport ("Research Synthesis," pp. 63-66 in Educational Leadership, v.40, n.1, October 1982) concluded that science taught in a manner that emphasized scientific processes had a number of significant advantages over the "traditional" approaches to science education at all grade levels. These included improved achievement, improved student analytic skills, improved process skills, and improved attitude toward science.

The magnitude of the performance differences were all greater than 10 percentile points in all of these areas. The authors also report "...we observed this same increase in achievement scores consistently in elementary, junior high, and high school. Achievement scores were most generally enhanced for female students (21 percentile points), urban students (29 percentile points), and low and high socio-economic status students (35 percentile points)." (p. 64).

It is just this type of approach to science that was incorporated in the Illinois Inventory of Educational Progress. The emphasis on scientific process; application of scientific concepts, ideas, and skills; and the use of higher order thinking skills were designed to be major components of the Science Assessment.

The questionnaire data from principals and teachers somewhat surprisingly show that there is greater emphasis on process-oriented science than had been thought by contemporary critics of science education such as Fletcher Watson (pp. 79-83 in Science Teaching: A Profession Speaks, National Science Teachers Association, 1982). The reader may be skeptical about self-reported data, such as is used here, and contend that questions oriented toward process approaches may appear to be more socially desirable than items tending toward other pedagogies. The questionnaires, however, do show strong internal consistency, an indicator that the responses are accurate. The results in student achievement showing good performances on process-type and higher order thinking skills items also appear to corroborate the claim. Students in Illinois do well on some types of process items and on some items dealing with higher order thinking skills applied to science.

Just how optimistic should one be when reading the description of results for the Science Assessment in Illinois? Although direct comparison of these results to national results cannot be made, in several cases inferences are possible. This section will characterize the science results from the National Assessment of Educational Progress and the American College Test. In addition, the International Educational Assessment of science is also used to provide a view of the broad context of student performance.

The first International Educational Assessment of science took place in the mid-60's with the second assessment taking place in 1983-84. The most recent results are not yet available. The first administration showed that the top science students (the upper 5%) in the United States did as well as students in 19 other countries. For students in general, however, the United States results were among the poorest on the test.

There is apprehension among science educators that the latest results will repeat the poor showing of the entire sample of students from the United States on the earlier assessment. In addition, there is an anticipation of the possibility of poorer results for the top students when considering the general decline in student achievement in the United States during the 1970's.

Since the results from the United States component of the International Assessment are not broken down into state-level results, no Illinois-specific data are available. However, the performance of Illinois students on other instruments, such as those discussed below, shows average or slightly better than average performance. The possible inference, then, is that students in Illinois would also not perform as well as students from many other nations.

One point of comparison used in Illinois Inventory of Educational Progress assessments in the past has been the National Assessment of Educational Progress--a test of similar difficulty. We can assume this similarity since a number of the items used on the IIEP were items from earlier versions of NAEP.

The last National Assessment took place in 1981. At that time the reports of educational decline still had no contrary findings. Indeed, Pakow, Welch, and Hueftle writing in Science Education (v. 65, n. 5, 1984, p. 578) about the National Assessment conclude that the decline still was in evidence--though the extent of the decline had moderated. They say "...while there are a few positive results among the younger age groups (e.g., 9-year-old gains, leveling of 13-year-old scores, increased enrollments in science), the overall results are disappointing to most educators."

The Illinois Inventory of Educational Progress results bracket the time of the National Assessment. Illinois testing took place in 1981, just prior to the National Assessment, and in 1984 after the last National Assessment. A general review of those results suggests that Illinois students are doing as well, if not better, than their counterparts nationwide, where the national results show that performance in higher order thinking skills fall below the average for the test. The similar presentation of results for the IIEP has positive results.

The college entrance examination commonly known as the ACT has a subtest of interest, the Natural Science Reading Test. The national averages for that portion of the ACT have been essentially stable since 1971. The results show the Natural Science results higher than the national average with males performing slightly better than females.

The ACT results for Illinois show a similar pattern. Illinois students perform at about the national average on the Natural Science Reading Test. Those results fall above the composite average for all of the other subtests in the ACT battery. In addition, men consistently perform slightly better than women on that portion of the ACT.

The conclusion that appears to be justified is that Illinois students are performing as well, if not better, than they did four years ago and that results are as good, and perhaps better, than students nationally. The setting for those results also appears to be favorable for science education. The value of science is generally agreed upon, and the pedagogical techniques favored represent approaches suggested to be more productive than other techniques. These findings provide some optimism in meeting the challenge of science results of studies comparing students in different countries. While the Illinois students are not likely to equal their peers from other nations, they will have a foundation in science that will allow them to proceed to the experiences of higher education and, perhaps at that point, to become competitive intellectually with the students of the world.

Table 3.2 1984 Percentage of Items Correct by Grade-Level and Content Areas

Performance Level	4th	8th	11th
Above Average Range	Earth Science 66.1	Life Science 68.8 Physical Science 68.8	Life Science 78.0
Average Range	Life Science 57.4 TEST TOTAL 55.4 Scientific Processes 55.1	TEST TOTAL 60.8 Scientific Processes 59.3	Scientific Processes 72.2 TEST TOTAL 69.4 Physical Science 68.9 Nature of Science 67.4
Below Average Range	Physical Science 47.5	Earth Science 51.9 Nature of Science 50.9	Earth Science 64.9

Table 3.3 1984 Percentage of Items Correct by Grade-Level and Skill Areas

Performance Level	4th	8th	11th
Above Average Range	Knowledge & Comprehension 61.4	Analysis, Synthesis & Evaluation 66.1	Analysis, Synthesis & Evaluation 80.4
Average Range		Application 60.9	Application 71.1
	TEST TOTAL 55.4	TEST TOTAL 60.8	TEST TOTAL 69.4
	Analysis, Synthesis & Evaluation 53.7		
	Applications 53.1		
Below Average Range		Knowledge & Comprehension 56.8	Knowledge & Comprehension 61.0

Table 3.4 Percentage of Items Correct 1981-1984
Comparison by Grade-Level and Content Area

Performance Level	4th	8th	11th
Improved	Life Science (52.6 - 57.4)	Life Science (64.5 - 68.8)	Life Science (74.6 - 78.0)
	Scientific Processes (50.8 - 55.1)		Earth Science (59.5 - 64.9)
Similar	Earth Science (64.5 - 66.1)	Earth Science (51.3 - 51.9)	Physical Science (67.1 - 68.9)
	Physical Science (46.1 - 47.5)	Physical Science (67.0 - 68.4)	Nature of Science (65.2 - 67.4)
		Scientific Processes (56.4 - 59.3)	
		Nature of Science (49.4 - 50.9)	

Table 3.5 1981-84 Percentage of Items Correct
Comparison by Grade-Level and Skill Area

Performance Level	4th	8th	11th
Improved	Analysis, Synthesis & Evaluation (45.7 - 53.7)		Analysis, Synthesis & Evaluation (76.9 - 80. 4)
Similar	Knowledge & Comprehension (58.6-61.4)	Application (59.6 - 60.9)	
	Application (50.6 - 53.1)	Knowledge & Comprehension (54.1-56.8)	Knowledge & Comprehension (58.6 - 60.0)
		Analysis & Synthesis Evaluation (64.3-66.1)	Application (68.9 - 71.1)

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Table 3.6 Pedagogy

At These Grade Levels -		
4th Grade	**8th Grade**	**11th Grade**
Teachers Are More Favorable toward. . .		
Hands-on Activities	Hands-on Activities	Hands-on Activities
Student Discussion	Student Discussion	Lecture
Independent Projects	Demonstration	Discussion
Teachers Are Less Favorable about. . .		
Memory Work	Memory Work	Contests/Science Fairs
Contests/Science Fairs	Guest Speakers	Memory Work
Work Sheets	Contests/Science Fairs	Guest Speakers
Principals Are More Favorable toward. . .		
Hands-on Activities	Hands-on Activities	Hands-on Activities
Demonstration	Demonstration	Demonstration
Independent Projects	Independent Projects	Questions and Answers
Student Discussion	Student Discussion	Student Discussion
Principals Are Less Favorable about. . .		
Worksheets	Memory Work	Memory Work
Memory Work	Worksheets	Guest Speakers
Lecture	Guest Speakers	Contests/Science Fairs

Table 3.7 Standards

At These Grade Levels -		
4th Grade	8th Grade	11th Grade
Teachers Are More Favorable toward. . .		
Do All Assignments	Do All Assignments	Do All Assignments
Know All Material	Know All Material	Attend Daily
	Attend Daily	Know All Material
Teachers Are Less Favorable about. . .		
Put in Extra Time	Put in Extra Time	Put in Extra Time
Do All Homework	Do All Homework	Do All Homework
Go Beyond What's Given	Go Beyond What's Given	Go Beyond What's Given
Principals Are More Favorable toward. . .		
Attend Daily	Do All Assignments	Attend Daily
Do All Assignments	Attend Daily	Do All Assignments
Go Beyond What's Given	Go Beyond What's Given	Go Beyond What's Given
Principals Are Less Favorable about. . .		
Do All Homework	Put in Extra Time	Put in Extra Time
Put in Extra Time	Do All Homework	Do All Homework
Know All Material	Know All Material	Know All Material

Table 3.8 Value of Science

At These Grade Levels -

4th Grade	8th Grade	11th Grade
Teachers Are More Favorable toward. . .		
Careers Knowledge for Life	Knowlege for Life Problem Solving in School	Knowledge for Life Problem Solving in School
Teachers Are Less Favorable about. . .		
Problem Solving in Life	Knowledge for School Careers	Careers Knowledge for School
Principals Are More Favorable about. . .		
Careers Problem Solving in School	Careers Knowledge for Life	Careers Problem Solving in School
Principals Are Less Favorable about. . .		
Problem Solving in Life Knowledge for Life	Knowledge for School Problem Solving in Life	Knowledge for School Problem Solving in Life

CHAPTER IV

ANALYSES OF EDUCATIONAL OUTCOMES AND PRODUCTIVITY

For the last two years the United States Department of Education has published a wall chart ranking states in terms of indicators of student achievement and other variables the Department believes to be associated with achievement. While the chart reflects national concern for improving education, it also reflects an inadequate understanding of achievement and factors which may inhibit or facilitate performance.

Intense national concern for improving student achievement may seem to be a relatively recent phenomenon, but it has a long history in educational research and evaluation. Indeed, some (Dreeben and Thomas, 1980) feel that this is simply the third generation of major investigations into educational effects. The first generation of studies attempted to link global school characteristics to student performance. The most representative study of this type is the Coleman Report (Coleman, et al., 1966). In the main, these studies used relatively unrefined indicators of school resources to account for differences of performance among students. The second type had as their central focus, the individual student, not the schools. The purpose was to determine how far an individual student would progress given certain background characteristics. Thus, phrases such as overachievers and underachievers were found in this literature, and longitudinal studies began to plot student growth (Project Talent, National Longitudinal Study, Project Follow Through).

However, using only one of these approaches (school or student) to study educational effects has certain drawbacks. First, they were insensitive to studying both differences between schools and also within schools. Much of the early work only addressed differences which could be seen when comparing school A to school B (the Coleman Report). The students within each school were assumed to be homogeneous and no variations among them were evaluated. This within-school variation has subsequently been shown to be critical in understanding the nature of achievement (Walberg, 1980). In that light, the whole of the educational process must be assessed from a multi-level perspective (Burstein, 1980, Fyans, 1983). Students are members of classrooms and classrooms are members of schools and schools are members of school districts, which are, in turn, members of states. Investigations of performance must be carried out at each of these levels.

The previous attempts also failed to comprehensively portray the achievement process: financial models focused solely upon fiscal factors to explain performance; resource models stressed curriculum and instructional differences; and psychological models stressed student self-concept and interest. This myopia allowed only limited explanations of the complex process of achievement.

The approach taken in this chapter goes beyond the aforementioned limitations. First, it is multi-level in orientation. Differences in performance were studied at the state, school and student levels. Second, the results were evaluated in terms of characteristics within schools as well as those at the conventional between school level. Third, differences in student performance were analyzed both in terms of school context variables (size, course offerings, geographic location, community type, and socioeconomic status (SES) of the school and student characteristics (achievement motivation, intrinsic interest, opportunities taken to learn, parental involvement, gender, ethnicity, etc.). Three research questions guided this inquiry:

1. Are there real differences in student achievement between schools, and, if so, what is the magnitude of these differences?

2. Which school-level characteristics account for these differences in performance?

3. What student-level characteristics account for these differences in performance?

An extensive comparison of Illinois students with their national counterparts concludes the chapter. The comparison focuses on longitudinal data gathered by the College Board on the Scholastic Aptitude Test (SAT) and the American College Test (ACT).

The IIEP findings indicate that:

Question 1: Are there real differences in student achievement between schools, and, if so, what is the magnitude of those differences?

* Yes, there are significant differences in achievement noted among the schools. District clusters of schools exist in relation to performance (exemplary, moderate, deficit).

Question 2: Which school-level characteristics account for these differences in performance?

* Student performance, monitored by college entrance tests such as the ACT, is found to be lower in high schools enrolling 214 or fewer or 1,280 or more students. Analysis revealed significant differences in performance of students of high schools from these enrollments when compared to the achievement of students in schools enrolling 215-1,279 students.

* Results on the Illinois Inventory of Educational Progress indicate the highest performance of 11th grade students in science, mathematics, geometry and reading occurs in high schools containing 494-1,279 students. This result occurs after controlling for school economic status and the courses offered by the school. The IIEP analysis also found lower performance of students from schools with 214 or fewer students when compared to those enrolling 215-1,279 students.

* Results for eleventh graders on the Decade Study indicated the lowest mathematics achievement occurs in schools with less than 215 students. This compares unfavorably to the means of students of moderate-size schools. Across all curriculum areas of the Decade Study tests, the highest achievement is observable in schools with more than 435 students.

* Among several "school" factors such as enrollment, courses offered, economic status, location, and community type, school size had the single, strongest predictive weight in explaining performance in geometry, science, and mathematics at eleventh grade on the Illinois Inventory of Educational Progress.

Question 3. What student-level characteristics account for these differences in performance?

* Three student factors are most influential. They are the students' expectations and standards of performance, the number of relevant courses taken, and parental influences. The achievement of a student is directly linked to how well that student feels he or she should perform and the number of relevant courses the student has taken.

* Differences in performance among students of different ethnic groups and genders are attributable to the number of courses taken, the expectations and standards held by these students and whether the students place a high value on achievement.

* Consistent school climate effects were detected at each grade level. However, this "press to achieve" within a school was not directly related to school wealth, location, or courses offered.

* An unfortunate association is noted for minority students who lacked exposure to courses and had subsequent lower performance. This matches national data suggesting that schools containing a high concentration of minority students lack relevant courses or guidance for minority students.

A Composite Look

The results of both the school-level and student-level findings on the IIEP can be reviewed jointly. Overall, at the eleventh-grade level, student factors accounted for 33% of student science performance. School factors accounted for approximately 17% of science performance. Taken together then, about one-half of a student's performance at eleventh grade can be explained by the information provided by these subsets of school and student factors. The single strongest student variable is that of expectations/standards, followed by experience on relevant courses and parental influence. The single strongest school predictor was that of school size. While it accounted for less performance than student expectations/standards, it was clearly the predominant school factor at grade eleven. At grade four, school factors affected performance more than student variables.

Comparative Information

One of the primary requests received from schools participating in each annual assessment is for comparative information regarding the performance of their students and students from other similar schools. The state assessment has never released results identifying specific schools. In the appendix, the results associated with certain school factors such as size, SES, location, and courses offered are presented. School personnel can compare the performance of the students from their school with schools having similar characteristics.

Question 1: Are There Real Differences between Schools in Student Achievement, and, If So, What Is the Magnitude of These Differences?

The answer to this question is yes. The support for this answer is derived from a series of analyses determining the extent of significant school to school differences in each of the subject areas of reading, geometry, science and mathematics. Table 4.1 indicates the magnitude and range of the between-school differences for eleventh, eighth, and fourth grades.

Table 4.1 reflects the wide discrepancies among the performance of schools. The student means indicate that while there are exemplary performances, there are still very low scoring schools. The range of differences from the highest to the lowest performance varies by subject area. At each grade level, the widest range of performance is found for the area of mathematics. The differences in achievement between the highest and lowest school performance in that area is 30.9, 23.0, and 20.7 points in eleventh, eighth, and fourth grades, respectively. At eleventh grade a difference of 30.4 points between the highest and lowest school performance is found for geometry.

The school performance level can be split into three distinct groups of schools with similar performance in the upper, middle, and lower third of achievement demonstrating exemplary, moderate, and deficit performance.

Table 4.1 Range of School Differences in Performance

Grade Four

	Reading	Geometry	Science	Mathematics
Total Number of Test Items	18	27	31	40
Statewide Mean	9.4	9.5	16.7	23.8
Range of Performance	5.6-14.8	6.00-17.7	7.8-24.0	12.7-33.4
Upper Third	10.13-14.8	9.71-17.7	18.00-24.0	25.53-33.4
Middle Third	8.58-10.1	8.4-9.7	15.70-17.9	21.7-25.5
Lower Third	5.6-8.55	6.00-8.35	7.8-15.6	12.7-21.6

Grade Eight

	Reading	Geometry	Science	Mathematics
Total Number of Test Items	22	39	41	46
Statewide Mean	13.1	15.4	24.6	26.2
Range of Performance	8.5-16.5	7.5-24.0	15.7-31.5	15.0-38.0
Upper Third	13.6-16.5	16.5-24.0	26.6-31.5	28.1-38.0
Middle Third	12.5-13.5	12.7-16.3	23.1-26.5	23.7-28.1
Lower Third	8.5-12.4	7.5-12.7	15.7-22.7	15.0-23.3

Grade Eleven

	Reading	Geometry	Science	Mathematics
Total Number of Test Items	19	45	46	49
Statewide Mean	11.5	22.3	31.5	28.7
Range of Performance	7.6-14.2	8.2-38.6	18.2-39.3	12.5-43.4
Upper Third	12.0-14.2	23.3-38.6	33.5-39.3	30.3-43.4
Middle Third	11.1-11.9	20.1-23.3	30.9-33.4	26.6-30.1
Lower Third	7.6-11.00	8.2-20.0	18.2-30.6	12.5-26.1

Some previous studies of performance have implied there was essential homogeneity among schools in terms of outcomes. Clearly, this assumption is false. One can classify schools into groups in terms of the magnitude of their performance. This diversity among schools in performance has implications for how technical assistance programs should be directly tailored to the needs of a school. Past attempts at technical assistance may have been too global and less sensitive to the particular needs of a school.

Question 2: Which School Level Characteristics Account for Differences in Performance?

Given the range of these between-school differences, it is necessary to identify the factors which may explain these performance differences. The following factors were investigated:

* School Size
* Course Offered
* School/Student Socioeconomic Status
* School Geographical Location
* Community Type

Each of these five factors was first investigated in isolation, to determine its unique independent effect on school performance. Then in the second step, each of the school factors was analyzed in relation to the others. In the third step, the school factors were all analyzed at once with all their interacting effects upon achievement. (At fourth grade, due to lack of the information, the variables of community type and courses offered were not studied.) This controlled for any performance differences which may have been associated with the complex relations among these multiple factors (such as investigating the effect of courses offered across the range of school sizes and community types). The school factors investigated are defined first and then the results are presented.

School Size

School size is defined as the enrollment of students within a particular school in the sample. The data from the IIEP indicated that schools across the state could be classified in fourths (quartiles) in the following categories. These groupings were confirmed by an analysis of all schools in the state. These groupings are as follows.

Size	Grade Four	Grade Eight	Grade Eleven
Size I	1-222 students	1-264 students	1-214 students
Size II	223-322 students	265-441 students	215-493 students
Size III	323-449 students	442-628 students	494-1279 students
Size IV	450+ students	629+ students	1280+ students

It should be noted that these groupings are on a school, not district, size. Furthermore, the specific grade configuration patterns within a district were not studied. However, the sampling design incorporated enough diversity for grade configuration, district size, and district type to make the results associated with these school size groupings representative and generalizable to schools of these sizes in the State of Illinois.

These groups essentially match those in the report, Student Achievement in Illinois: An Analysis of Student Progress, 1983.

Courses Offered

At the eighth and eleventh grade, information was obtained regarding the number of courses offered in a particular school. This variable is defined operationally as breadth of opportunities to learn within the school and is based upon data prepared for the Census of Course Offerings. The schools can be classified in the following groups in terms of the total number of courses offered:

	Grade Eight	Grade Eleven
Courses I	1-26	1-24
Courses II	27-107	25-50
Courses III	108 +	51-129
Courses IV	----	130 +

Socioeconomic Status

For the purposes of this analysis, school socioeconomic status is determined by the number of free lunches to which the school is entitled. The number of free lunches to which a school is entitled is based upon the size of a family and family income of its students. The schools entitled to the fewest free lunches are considered to have the wealthiest students. This is a voluntary program. Thus, districts may contain eligible students whose parents do not want to participate. It is critical to note that this measure of socioeconomic status is at the school, not student, level. Indicators of student socioeconomic status would be variables such as parent education and family income. The impact of these student-level socioeconomic variables has been demonstrated in previous reports to the Board (Student Achievement in Illinois: An Analysis of Student Progress, February 1984, pages 95-97; Student Achievement in Illinois: 1970 and 1981, September 1983, page 4; and Student Achievement in Illinois: An Analysis of Student Progress, November 1982, page 62). These previous findings illustrate the direct influence of familial socioeconomic status upon student achievement. Schools were classified as to their variation in magnitude by quartiles as follows.

	Grade Four	Grade Eight	Grade Eleven
SES I	1-17,806	1-15,005	1-17,452
SES II	17,807-58,558	15,006-39,307	17,453-40,276
SES III	58,559-719,912	39,308-719,912	40,277-92,928
SES IV	719,913 +	719,913 +	92,929+

Therefore, SES IV schools would be considered to have the lowest socioeconomic status. SES I schools have the highest socioeconomic status.

School Geographical Location

Illinois covers a large and diverse geographic area. The counties in Illinois have been clustered by the State Board of Education into six geographic regions for the purpose of delivering educational services. This geographic information was used for determining if the same patterns or effect on achievement occur in the same manner across the state, that is, were they generalizable?

These regions are:

Northeast (NE): Cook, DuPage, Grundy, Kane, Kankakee, Kendall, Lake, McHenry, Will.

Northwest (NW): Boone, Bureau, Carroll, DeKalb, Henry, Jo Daviess, LaSalle, Lee, Marshall, Mercer, Ogle, Putnam, Rock Island, Stevenson, Whiteside, Winnebago.

Central West (CW): Adams, Brown, Cass, Christian, Fulton, Hancock, Henderson, Knox, Mason, McDonough, Menard, Morgan, Peoria, Pike, Sangamon, Schuyler, Scott, Stark, Tazewell, Warren.

Central East (CE): Champaign, Clark, Coles, Cumberland, DeWitt, Douglas, Edgar, Ford, Iroquois, Livingston, Logan, Macon, McLean, Moultrie, Piatt, Shelby, Vermilion, Woodford.

Southwest (SW): Bond, Calhoun, Clinton, Greene, Jersey, Macoupin, Madison, Monroe, Montgomery, Perry, Randolph, St. Clair, Washington.

Southeast (SE): Alexander, Clay, Crawford, Edwards, Effingham, Fayette, Franklin, Gallatin, Hamilton, Hardin, Jackson, Jasper, Jefferson, Johnson, Lawrence, Marion, Massac, Pope, Pulaski, Richland, Saline, Union, Wabash, Wayne, White, Williamson.

Community Type

The United States Bureau of the Census uses standard terms for defining community types. These are central city, suburbs, independent city, and rural areas. These terms are employed in this report for eighth grade students in junior high schools and for eleventh grade schools.

Initially, a district was designated as being urban or rural. A district is considered urban if one-half or more of its population lives in an incorporated city of 2,500 or more inhabitants. School districts not classified as urban were considered rural. The urban areas are then further subdivided. The Census Bureau designates certain large metropolitan areas (usually cities with 50,000 or more inhabitants) as central cities. Counties with one or more central cities that possess a high degree of economic and social integration are designated as standard metropolitan statistical areas (SMSAs). Districts located in central cities of SMSAs are designated as having a central city community type. Districts located in an SMSA but not in a central city are designated as having the suburb community type. Any district located in an urbanized area but not in an SMSA was assigned the independent city community type.

School Size and Student Achievement

Student achievement levels are widely regarded as reflective of the quality of educational program. As noted in the 1982 school district organization study, research on the relationship between school size and student achievement has in the past been generally inconclusive and could not be used to make inferences about desirable school size. However, over the past three years, the State Board's student assessment activities--namely, the Illinois Inventory of Educational Progress and the Decade Test--and staff research of ACT data for Illinois students have provided important new findings regarding the relationship of school size and student achievement.

The Illinois Inventory of Educational Progress

Students were tested on the IIEP in science, geometry, mathematics and reading. The IIEP staff analyzed differences in achievement by school size by the sizes above, having controlled for effects due to school economic status and the number of courses offered. The mean achievement levels of eleventh grade students by size of school in science, mathematics, geometry, and reading are given in Table 4.2 having controlled for school economic status and course offering. This analysis indicated significant differences between schools with 214 students or less (Size I) and 1,280 or more (Size IV) from the schools containing 215-1,279 students. The lowest achievement is found in mathematics, geometry, and reading in schools with less than 215 students. In all curriculum areas, the highest achievement is found in schools with 494 to 1,279 students. These school size results occurred when controlling for school economic status and courses offered.

Table 4.2 Mean Scores on IIEP Subtests by School Size Having Controlled for Effects of School Economic Status and Courses Offered

Grade Eleven

Science Subtest		Mathematics Subtest	
Size I (1-214 students)	30.84	Size I (1-214 students)	24.86
Size II (215-493 students)	31.19	Size II (215-493 students)	27.21
Size III (494-1279 students)	33.42	Size III (494-1279 students)	32.11
Size IV (1280+ students)	30.57	Size IV (1280+ students)	30.82

Geometry Subtest		Reading Subtest	
Size I (1-214 students)	20.26	Size I (1-214 students)	10.70
Size II (215-493 students)	21.32	Size II (215-493 students)	11.34
Size III (494-1279 students)	24.52	Size III (494-1279 students)	12.14
Size IV (1280+ students)	22.98	Size IV (1280+ students)	11.97

The results for fourth and eighth grades are presented in Table 4.3. At 4th grade, for the academic areas of mathematics, geometry, reading, and science, significantly lower performance is found in schools with 450 or more students. At grade 8, the statistical lower performance in geometry, mathematics and science was in schools with 441 students and above.

Table 4.3 Mean Scored on IIEP Subtests by School Size

Grade Four

School Size Total Test Items	Reading 18	Geometry 27	Science 31	Mathematics 40
I (1-222 students)	9.66	9.94	17.41	24.40
II (223-322 students)	9.77	9.70	17.34	24.63
III (323-449 students)	9.64	9.92	17.18	24.36
IV (450+ students)	8.66	8.70	14.88	21.90

Grade Eight

School Size Total Test Items	Reading 22	Geometry 39	Science 41	Mathematics 46
I (1-264 students)	13.49	16.52	25.92	27.95
II (265-441 students)	13.34	16.13	25.97	27.54
III (442-628 students)	13.10	15.28	24.72	26.35
IV (629+ students)	12.43	13.56	22.17	23.21

The American College Test

Almost two-thirds of high school graduates in Illinois take the American College Test (ACT) before going on to college. The items comprising the ACT subtests are difficult, technical and sensitive to differences in curriculum of advanced levels of complexity.

Differences in performance of Illinois students were found on the ACT in relation to school size. Table 4.4 contains the means of students taking the ACT in the areas of English, mathematics, social science, natural science, and the composite score for schools of the size groups.

The mean achievement displayed in Table 4.4 indicates that there was significantly lower performance in schools containing 214 or fewer or 1280 or more students in English, social science and natural science. A higher level of achievement in each curriculum area was noted for schools containing 494-1279 students. In no curricular area did schools with 214 or fewer students score as well as schools with 215-1279 students.

A statistical test was then conducted upon these ACT data to test the significance of scores of students from schools with 214 or fewer students (Size I) and 1280 or more students (Size IV) vis-a-vis those schools with 215 to 1279 students (Sizes II & III). This analysis also adjusted for the proportion of students within a school taking the ACT.

The findings present highly significant differences in this regard. For each subtest, and for the composite, these covariance differences between schools of Size I & IV versus II & III were significant on the order of .0001 or less. Furthermore, these school size differences accounted for 22%, 20%, 18%, 17% and 17% of the performance for English, the composite, natural science, mathematics, and social studies subtests, respectively. These findings would argue for an inverted "U" shape quadratic function relating school size to achievement indicating highest performance of moderate size schools.

Table 4.4 Analysis of Student Achievement on ACT by School Size

English Subtest Means

Size I (1-214 students)	17.82
Size II (215-493 students)	18.18
Size III (494-1279 students)	18.23
Size IV (1280+ students)	17.50

Mathematics Subtest Means

Size I (1-214 students)	16.18
Size II (215-493 students)	17.10
Size III (494-1279 students)	17.70
Size IV (1280+ students)	17.30

Social Science Subtest Means

Size I (1-214 students)	16.46
Size II (215-493 students)	17.27
Size III (494-1279 students)	17.51
Size IV (1280+ students)	16.91

Natural Science Subtest Means

Size I (1-214 students)	20.47
Size II (215-493 students)	21.21
Size III (494-1279 students)	21.26
Size IV (1280+ students)	20.48

The Decade Study Test

The Decade Study Test contained two subtests monitoring performance in mathematics (Math I and Math II), two subtests in English (English I and English II), a subtest in natural science, and one in social studies. The items comprising the Decade Study subtests are similar in difficulty to items found on tests such as the Scholastic Aptitude Test (SAT). Indeed, the Decade items were developed by the Educational Testing Service in the late 1960's for college-entrance examinations.

The high schools participating in 1981 were the same schools of 1970 in order to match the results of testing programs at the schools in 1970 administered by the University of Illinois. The profile of those schools tended to be smaller, more rural, and did not include any inner city schools as would a state representative sample of schools. However, the Decade Study student results were found to be generalizable to the state by statistical equating to the IIEP.

Previous analysis of the Decade Study data revealed significantly lower performance on both mathematics subtests, both English subtests, natural science and social science subtests for high schools containing 435 or fewer students.

Reanalysis was conducted upon these data in terms of the four school size groupings defined above and in terms of the responses of students to the number of courses in mathematics they state they took in school.

The reanalysis revealed that schools containing more than 214 students had students taking more than 2.5 courses in mathematics. Indeed, none of the schools with 215 or more students had students taking less than 2.60 courses in mathematics.

Performance re ults for the Mathematics II subtest indicate near significant differences (p = .06) for school size groupings. Students of the smallest high schools obt ined a mean of 7.82. This compares unfavorably to the means of 8.28 [illegible]0 and 8.20 for the moderate and largest schools (Sizes II, III, IV respe[illegible]ly).

An interaction analysis revealed the lowest achievement (an average of 7.67) by students from the smallest high schools and those taking the least courses in mathe[illegible]s. Students of secondary schools containing more than 214 students ac[illegible] higher than their peer [illegible] the smalle[illegible] schools, even when the students of the smallest schools rep[illegible]t they took the same number of courses in mathematics.

Results by Courses Offered

The relationship between courses in a school and the achievement of the students can be studied from two district perspectives. The first perspective is that of "courses-offered" by the [illegible]. Logic would argue that a certain number of courses in a school [illegible]sary for achievement. This is backed up with empirical findings at the [illegible]ghth grade with higher achievement in schools offering 27 or more courses when compared to schools offering less than 27 courses in reading, science, and mathematics. In geometry, a corresponding increase in achievement is noted as the number of courses offered in a school increased from <u>1 to 26</u> to <u>27-107</u> to <u>108 or more</u>.

However, while the courses offered by a school may provide a necessary threshold for achievement, they are not sufficient. The sufficient factor is the courses taken by the students. It is an important factor relating to student performance.

For example, these achievement findings are in terms of courses taken in science for eleventh grade:

Table 4.5 Mean Achievement on Eleventh Grade IIEP Subtest of Science by Semesters of Science Instruction Taken

Semesters	Mean Science Achievement	No. of Students Responding
Six or more	36.53 A	249
Four or Five	35.16 A	442
Three	31.63 B	583
One or Two	28.80 C	934
None	25.80 D	54

[Means with same letter are not significantly different.]

These findings on "courses-taken" reveal dramatic differences in achievement. These findings show that most eleventh grade students take only one or two semesters of science. They perform significantly higher than their peers who have no semesters of science, but perform significantly lower than peers taking three or more semesters of science. There is almost an eight point difference between the students taking one or two semesters of science and their peers taking six or more semesters.

The preceding findings indicate that the number of courses offered by a school is a necessary, but not sufficient, condition for achievement. What is sufficient is whether the students take the courses. However, the courses need to exist in a school in order for the students to take them. Results from the Decade Study indicate that while the number of courses taken in mathematics highly correlates with student performance, that moreover, the number of courses taken correlates with school size. That is, the students of the smallest schools are not taking as many courses as other students. Further discussion of this effect of exposure to courses taken and other student variables such as motivation will be treated in a later section of this chapter.

Results by School Geographic Location

The achievement results for reading, geometry, science, and mathematics in terms of geographic location are presented in Table 4.6. The groupings of the state are somewhat gross, however, clear and distinct differences among the regions can be seen.

Table 4.6 Differences in Achievement Related to Geographic Location

Grade Four

Geographic Location	Reading	Geometry	Science	Mathematics
Northeast	8.96 C	9.51 A	16.01 C	23.44 AB
Northwest	9.98 B	10.07 A	17.74 AB	24.85 A
Central West	9.60 BC	9.19 A	17.07 ABC	24.09 AB
Central East	9.91 B	9.44 A	17.16 AB	23.27 B
Southwest	9.14 C	9.71 A	16.86 BC	24.12 AB
Southeast	10.87 A	9.36 A	18.09 A	24.79 A

[Means with same letter are equivalent in performance. Schools with different letters are significantly different. Schools with two letters are not considered different from schools with only one of the letters.]

Grade Eight

Geographic Location	Reading	Geometry	Science	Mathematics
Northeast	13.01 A	14.89 AB	23.80 B	25.55 B
Northwest	13.33 A	16.36 A	25.72 A	27.33 AB
Central West	13.27 A	16.30 A	25.95 A	27.94 A
Central East	13.14 A	16.34 A	25.62 A	27.19 AB
Southwest	12.51 A	13.94 B	24.31 B	25.88 AB
Southeast	13.59 A	15.39 A	26.08 A	26.47 AB

Grade Eleven

Geographic Location	Reading	Geometry	Science	Mathematics
Northeast	11.31 B	21.71 B	29.58 C	28.23 C
Northwest	11.96 A	25.07 A	33.78 A	31.53 A
Central West	11.77 BA	22.83 B	32.51 B	29.48 B
Central East	11.51 BA	22.44 B	31.69 B	28.36 B
Southwest	11.44 BA	21.79 B	31.86 B	28.78 B
Southeast	11.26 B	19.39 C	30.54 C	25.80 C

Results by the Type of Community

The eleventh grade results are reviewed by community type in Table 4.7.

Table 4.7 Mean Achievement on Tests in Terms of Community Type

Grade Eleven

Community Type	Reading	Geometry	Science	Mathematics
Central City	10.24 A	16.31 CB	24.94 B	22.04 B
Suburb	11.99 A	24.39 A	32.53 A	30.99 A
Independent City	11.72 A	23.07 AB	32.39 A	29.36 AB
Rural	11.61 A	22.70 AB	32.60 A	29.33 AB

[Means with same letter are equivalent in performance. Schools with different letters are significantly different. Schools with two letters are not considered different from schools with only one of the letters.]

For geometry and mathematics, the significant difference is between students from suburbs and those from the central cities.

The scores on the science test show significantly lower score patterns for students from the central cities than for those from the rest of the state.

The Effect of Combined School Factors on Achievement

A school characteristic can influence performance not only as an independent, unique effect, but also in combination with other school factors. When two influences work together to affect performance, it is entitled an interaction effect on performance. The joint effects of school size with several other school influences such as courses offered, economic status, and community type were studied. The results indicated that in some cases there were interacting influences of certain other school factors with school size to affect student achievement. However, none of these interaction effects with school size were as strong as school size taken by itself in influencing performance. The effects of school size remained strong even after statistically controlling for the interacting effects of factors such as courses offered and economic status (see achivement means in Table 4.2).

The Combined Effect of All Studied School Variables

The combined influence of all the five school variables was studied. The results of these analyses suggest that knowledge of all these school factors is necessary before attempting to "rank order" schools as has been suggested by some educators.

Other questions may also be answered by these findings. In particular, which of these school factors is most related to school achievement? Is it school size, socioeconomic status, location, or community type? Moreover, how much of a student's performance can be explained by these school factors? Tables 4.8, 4.9, and 4.10 present the results of the analysis in terms of the relevance of each school factor to student performance.

Table 4.8 Predictive Weight of School Factors to Student Performance

Grade Eleven

School Predictor	Reading	Geometry	Science	Mathematics
School Size		++	++	++
Courses Offered			-	-
Community Type		+	+	+
Geographic Location				
School Socio-economic Status				-
Percent of Performance Explained	4%	9%	17%	10%

The plus and negative signs indicate the relative strengths of certain school factors for predicting performance. The symbols in Table 4.8 clearly indicate that at grade eleven the single strongest predictor of performance outcome is the size of the school. These results occur even when controlling for all other school variables and their interactions.

The percentages in Table 4.8 indicate the percent of performance of a student attributable to these school factors. For example, the state mean for eleventh grade science is 31.5 (see Table 4.1). These results indicate that 17% of that mean or 5.36 points is attributable to these school effects. If the student obtained a score of 20 correct, 3.40 of these points are explainable and derived from the characteristics of the school.

For the area of science, school-level factors are potent predictors of eleventh grade student performance. However, for reading, less than four percent of the variation in student achievement can be explained by the size of school, the courses offered, the type of community, the geographic location of the school, the SES of the school or their various patterns of interaction.

The ACT was also analyzed to determine the percentage of performance which could be attributable to school size. This analysis showed that upwards of one-fifth of student performance was explained by school size. School size accounted for 22%, 20%, 18%, 17%, and 17% of the performance for English, natural science, mathematics, and social studies subtests and the composite, of the ACT, respectively. These are significant magnitudes of performance accounted for by school size

The results for grade eight are presented in Table 4.9.

Table 4.9 Predictive Weight of School Factors to Student Performance

Grade Eight

School Predictor	Reading	Geometry	Science	Mathematics
School Size			+	
Courses Offered				+
Community Type			+	
Geographic Location			-	
School Socio-economic Status			-	-
Percent Performance Explained	6%	15%	20%	14%

Significant differences from the eleventh grade results are found at eighth grade. In particular, the results for school factors at grade eight account for a larger average portion of student performance when compared to eleventh grade.

Second, the effects associated with size of school are not the strongest for each particular subject area. In the area of mathematics, both courses offered and school socioeconomic status are highly significant predictors. These relationships indicate an increase in the number of courses offered and increases in school socioeconomic status are associated with high levels of mathematics performance at eighth grade. The results for science indicate that one-fifth of a student's performance is attributable to school characteristics.

The findings with regard to the importance of school factors, especially school size and school socioeconomic status provide great interest. The results show that at eleventh grade, school size is more predictive of student achievement than school socioeconomic status. However, at eighth grade, school socioeconomic status does become an important predictor. These eleventh grade results may at first glance appear counter-intuitive. However, several factors must be noted. First, the influences under study are at the school not student level. Thus, these findings are not negating the effects of family income and parent education which have been demonstrated in previous Board Reports. High school students with better educated parents and more wealthy backgrounds will perform higher in outcome measures, and these particular students within each school will show differential levels of achievement attributable to family income and parent education.

At eighth grade, perhaps where the students arrive from far fewer feeder schools and where there may be less diffusion of the wealth of the school, the direct impact of school socioeconomic status on achievement is noted.

Table 4.10 presents the results for fourth grade.

Table 4.10 Predictive Weight of School Factors to Student Performance

Grade Four

School Predictor	Reading	Geometry	Science	Mathematics
School Size	+	+	+	+
Geographic Location		-	-	-
School Socio-economic Status	-			
Percent of Performance Explained	8%	8%	11%	8%

The school-level factors account most for student performance in the area of science. (It should be noted that one cannot readily compare the magnitude of performance associated with fourth grade to the other grades since there are fewer predictors at the fourth grade.) School socioeconomic status appears to have relatively little relationship except in reading achievement.

Question 3: Which Student Level Characteristics Account for Differences in Student Performance?

Students responded to a 36-item questionnaire to obtain information regarding the effect of student variables on achievement and the relationship of "school climate" to performance. The responses to the 36 items were aggregated to construct five predictors of achievement. These were:

* Continuing Motivation
* Exposure and Opportunity to Learn
* Parental Influence on Achievement
* Expectation/Standard
* Perceived Value of Achievement

The area investigated was that of science. However, this analysis was conducted with the primary goal of showing differences between student versus school level predictors of performance and secondarily to more fully understand science as a domain itself.

Continuing Motivation expresses the intensity of studying outside of the school environment. How often do you read books about science other than the ones you read in school? How often do you watch television documentary programs about nature, medicine, the solar system, or the universe? How often do you do science projects other than the ones you do in school? These comprise the scale of contrasting motivation and intrinsic interest. The results for this variable will be labeled CM in the tables.

Exposure and Opportunity to Learn measure the frequency or recency of taking courses in the area of science. Are you studying science in school this year? How many semesters of science have you had in high school? When was your last science class in school? In the tables it will be labeled Exposure.

Parental Influence on Achievement measured direct parental influence on performance in science. How often do you talk to your parents about science? Does your mother or father work in some science-related area such as medicine, chemistry, or research? This variable will be labeled Parent in the tables.

Expectation/Standard has a solid foundation in psychology (Rotter 1958, and Crandall 1970). The focus is on how well the student feels he or she will perform and the standards the student uses to judge the performance.

Fishbein (1972) and others have shown that a product of expectations and standards can be accurately predictive of human performance. The scale was constructed of a product between expectation (Out of the 46 items in the science test, how many do you think you answered correctly?) and standards (Out of the 46 items in the science test, how low could you score and still be satisfied with the results?). The results of the variable will be labeled EXP/STD on the tables.

Perceived Value of Achievement measured the value each student attached to five different incentives for achievement. These five incentives are to get good grades, to understand the world around me, to impress my friends, to have fun learning, and to get approval from my teacher. This will be labeled Incentive in the tables.

Collectively, these five subscales were measured at fourth, eighth, and eleventh grades.

School Climate Effects

School climate has been defined in various ways. Earlier work in this area focused on responses from administrative personnel such as principals or teachers as to their perceptions of the school environment. However, work by individuals such as Moos and Brookover have shown that a more sensitive understanding of school climate can be obtained by aggregating the responses of the students to questions regarding school climate, such as their responses to questions on expectations and standards and perceived importance of schooling.

Thus, the student responses to the above described 36 item questionnaire can be evaluated from two distinct perspectives. At one level, the responses can be studied from the standpoint of students as a whole from across the state of Illinois and for particular subgroups of that whole (e.g., males, females, ethnic differences). In that way, the responses function as student-level factors.

From a second, different perspective the responses of students can be aggregated within each of their schools. This within-school data can then be compared school to school and also compared against findings pooled across all the within-school data. If school to school differences are found, this is defined as a school climate effect.

On one level they can be studied as how the questionnaire responses of a particular subset of students, e.g., males, females, etc., (or of students as a whole) relate to student achievement. In that way, they are student-level variables and these results will be discussed shortly.

The school climate influence is identified by the extent to which school to school differences in mean questionnaire responses relate to school to school differences in mean achievement.

Our analysis focused upon both of these perspectives for the student responses. The findings in regard to school climate will be presented first, and then the findings for the students as a whole.

To locate any school-climate effects, the student responses to each of the five subscales (defined above) were averaged at each school and then related to the achievement of that school. These school to school relationships were then pooled across all schools of the state to obtain statewide averages. School climate differences were detected on a school to school basis when comparing the relationship matrix of the questionnaire data for each school against the pooled statewide matrix of the data. Table 4.11 presents the statewide relationship matrix pooled across the separate matrices from each school. Several findings are associated with this data.

First, in terms of school climate, there are strong relationships between the school performance upon IIEP subtests and the school climate variable of expectations/standards.

Second, subsequent analyses revealed dramatic school to school differences in these school-climate correlations. For example, the correlation between expectation/standards and geometry performance was .53 in one school, .45 in a second, and .17 in a third school. Thus, the differences among schools in terms of their outcomes are at least partially attributable to the students' level of standards and expectations.

A final school climate result is noteworthy. The results in Table 4.11 indicate a high degree of intercorrelation among the subtests of the IIEP. For example, performance in science correlates .67 with geometry, .68 with mathematics, and .56 with reading. These findings tend to show that, on average, in terms of school climate, "success breeds success." That is, a press to achieve in one area is linked to outcomes in related areas. However, it should be noted that in some schools these intercorrelations varied by area. This variability in the correlation indicates weaknesses in the outcomes of particular curriculum areas.

Table 4.11 presents the pooled relationships found at grade eleven.

Table 4.11 Within-School Correlation Matrix of Student Achievement Indicators

Grade Eleven

	Read	Geom	Scie	Math	CM	Exposure	Parent	EXP/STD	Incentive
Reading	1.00	.55	.56	.56	.04	.28	.13	.38	.13
Geometry	.55	1.00	.67	.80	.12	.33	.18	.49	.17
Science	.56	.67	1.00	.68	.15	.36	.17	.52	.20
Math	.56	.80	.68	1.00	.09	.35	.15	.46	.12
CM	.04	.12	.15	.09	1.00	.18	.36	.20	.38
Exposure	.28	.33	.36	.35	.18	1.00	.21	.33	.25
Parent	.13	.18	.17	.15	.36	.21	1.00	.19	.30
EXP/STD	.38	.49	.52	.46	.20	.33	.19	1.00	.26
Incentive	.13	.17	.20	-.12	.38	.25	.30	.25	1.00

Student Variables

Student Predictors of Achievement in Science

The analysis was conducted across all the students included in this study (regardless of which school they attended) on the science subtest as well as the five predictors described above (continuing motivation, exposure/opportunity to learning, parental influence, expectation/standards, and incentive value). At this point the responses to the questionnaire were analyzed on a student to student basis and not aggregated to obtain school means. Thus, these findings are presented from a student-level perspective. The analysis was then conducted across all students evaluating the effectiveness of these five predictors in accounting for science performance.

For all students, much more of the performance is accounted for in grade eight and grade eleven by the student-level than school-level variables. At grade 11, approximately one-third of a student's performance in science is attributable to these student factors. For a student score of 90 on an examination in science, approximately 30 points of that are explained by these student variables. However, at fourth grade, school factors affected performance more than student variables.

Table 4.12 details the relative weight and predictive value of these student variables for achievement across all students of the state. It shows the relative change in performance associated with change in the student variables and amount of performance explained by student factors.

Table 4.12 The Predictive Relevance of Student Variables to Science Performance

Student Variable	Grade Four	Grade Eight	Grade Eleven
Continuing Motivation	-	-	-
Exposure/Opportunity to Learn	+	+	+
Parental Influence		+	+
Expectations/Standards	+	++	++
Perceived Value		-	-
Perceived Performance Explained:	4%	23%	33%

In a comparison of predictive weights for each grade, the strongest relationship is with the achievement expectations and standards of these students in all cases. The second strongest predictor is exposure and opportunity to learn. Parental influence was strongest at grade eight.

Analysis by Student Subgroup: Ethnicity and Gender

The student-level variables were then used to explain differences in performance in terms of ethnicity and gender. Past reports to the Board have demonstrated differences in performance between male and female students and between ethnic groups. In this report the student level approach was used to explain the differences in achievement between gender and ethnic subgroups in Illinois in science. Subgroups were defined in terms of a students' gender (male, female) and ethnicity (Hispanic, black, white and oriental). Table 4.13 presents the relative weight of each student variable in explaining the performance of that subgroup. The analyses for all subgroups indicated that significant explanations were obtained.

The findings reveal that complex patterns of exposure, parental influence, student expectations, incentives and motivation operate to account for differences in subgroup achievement. The results are instructive in explaining performance differences among gender and ethnic subgroups. For example, the eleventh grade results indicate that male students rely upon both expectations/standards and exposure to courses or study. For female eleventh grade students, expectations/standards do not have similar weight as for their male colleagues. For two female subgroups (white and hispanic), parental effects have influence. In terms of other ethnic differences, male hispanic students place a negative incentive value upon achievement.

These results also confirm those found by Lyle Jones (1984, A.P.A.) and Dr. Andrienne Bailey (1985) linking exposure to subject matter to minority group performance. The data indicate that the lower performance of black students is derived from their lack of exposure and opportunity to learn. In terms of exposure, the Bailey Committee (Equity and Excellence Committee of the College Board) found that "black seniors in 1980 were as likely as whites to have taken at least three years of mathematics, but they were much less likely to have taken algebra, geometry, trigonometry and calculus. Thus, their years of coursework must have been concentrated in areas like general math or business math."

The results in Table 4.13 also reveal a developmental pattern of influences as one moves from fourth to eighth to eleventh grades. The fourth grade pattern indicates a broad range of student predictors of performance. The eighth grade functions as a transition year toward high school through expectations/standards showing up as being quite predictive of performance with exposure as an emerging feature. By eleventh grade, it is clear that the two factors of exposure and expectations account for student performance.

Table 4.13 The Prediction of Science Achievement by Student Subgroup

Grade 4

Student Variables

	Cont. Motiv	Expo	Parent	Expect	Incentive
Male Hispanics		++	-	+	
Male Black	-				
Male White				+	
Male Oriental	-	++	++		-
Female Hispanics	--		+		
Female Black	-				
Female White				+	
Female Oriental	--		+	+	++

Grade 8

	Cont. Motiv	Expo	Parent	Expect	Incentive
Male Hispanics				+	-
Male Black		+		+	
Male White				++	
Male Oriental		+	+	++	-
Female Hispanics		+	-	+	-
Female Black	-	+		+	
Female White				++	
Female Oriental	+			++	-

Grade 11

	Cont. Motiv	Expo	Parent	Expect	Incentive
Male Hispanics		+		++	-
Male Black		+		+	
Male White		+		+	
Male Oriental	-	+		++	
Female Hispanics	--		+	++	
Female Black		++			
Female White		+	++		
Female Oriental	-	++			

Performance of Illinois Students on National Indicators: The ACT/SAT

Illinois high school students in their junior and senior years take the American College Test (ACT) and the Scholastic Aptitude Test (SAT) college entrance tests. Their scores are reported on a standardized scale to determine their predicted capability for college.

Other comprehensive comparisons can be made from 1976 to 1984. If one looks at the composite SAT average for each subgroup for 1976-1984, one notes a decrease only for the American Indian students. The greatest growth was seen for Puerto Rican students with a 72 point increase across the eight years tracked. However, there are only a small proportion of Puerto Rican students who take the SAT. The achievement of white and oriental students was essentially stable. Table 4.14 portrays the Scholastic Aptitude Test data for students in Illinois.

It should be noted that this is the first time the College Board has released these subgroup achievement data. The 1983 State Board Achievement Report dealt with subgroup comparison on the ACT. These complementary results on the SAT are useful to monitor the performance of certain subgroups of students in Illinois.

Table 4.14 Illinois SAT Performance Profile

	1976	1977	1978	1979	1980	1981	1982	1983	1984
TOTAL									
NUMBER OF STUDENTS	26,110	25,901	23,718	22,764	22,119	21,845	21,818	21,533	21,766
SAT V - MEAN	464	459	463	462	459	459	462	462	463
SAT M - MEAN	509	507	511	511	507	508	515	517	518
SAT V+M - MEAN	973	966	974	973	966	967	977	979	981
SAT V+M - STD DEV	(205)	(205)	(204)	(205)	(202)	(202)	(202)	(203)	(203)
AMERICAN INDIAN									
NUMBER OF STUDENTS	17	36	38	54	49	50	58	61	52
SAT V - MEAN	433	429	456	417	404	442	410	419	395
SAT M - MEAN	411	482	484	479	444	475	458	462	440
SAT V+M - MEAN	844	910	940	895	848	916	868	880	835
SAT V+M - STD DEV	(191)	(244)	(271)	(224)	(195)	(238)	(192)	(213)	(173)
BLACK									
NUMBER OF STUDENTS	1,175	1,395	1,354	1,365	1,267	1,318	1,341	1,269	1,379
SAT V - MEAN	378	381	389	384	387	384	392	392	390
SAT M - MEAN	387	398	393	401	403	402	407	414	412
SAT V+M - MEAN	766	778	782	785	790	786	799	806	802
SAT V+M - STD DEV	(187)	(187)	(191)	(196)	(192)	(189)	(185)	(189)	(186)

MEXICAN AMERICAN									
NUMBER OF STUDENTS	121	138	124	150	148	160	193	167	167
SAT V - MEAN	428	434	422	43[illegible]	427	436	437	436	432
SAT M - MEAN	460	463	462	469	457	481	475	463	474
SAT V+M - MEAN	887	897	885	902	884	917	912	897	907
SAT V+M - STD DEV	(217)	(192)	(209)	(202)	(193)	(199)	(194)	(196)	(215
ORIENTAL									
NUMBER OF STUDENTS	248	288	336	387	459	482	607	716	798
SAT V - MEAN	477	466	451	449	455	453	466	462	471
SAT M - MEAN	557	548	562	561	557	554	569	569	566
SAT V+M - MEAN	1034	1014	1012	1009	1012	1008	1035	1031	1037
SAT V+M - STD DEV	(213)	(221)	(219)	(215)	(227)	(214)	(224)	(219)	(221
PUERTO RICAN									
NUMBER OF STUDENTS	56	50	43	42	61	61	62	61	77
SAT V - MEAN	413	415	415	410	409	433	417	417	436
SAT M - MEAN	437	434	441	442	447	481	452	481	486
SAT V+M - MEAN	850	849	856	852	856	915	869	898	922
SAT V+M - STD DEV	(244)	(173)	(168)	(215)	(221)	(232)	(195)	(212)	(211
WHITE									
NUMBER OF STUDENTS	20,491	21,149	20,185	19,411	18,657	18,530	18,301	17,856	17,756
SAT V - MEAN	472	467	469	469	466	466	469	469	470
SAT M - MEAN	520	517	520	520	515	516	523	525	527
SAT V+M - MEAN	992	984	990	989	981	982	992	994	997
SAT V+M - STD DEV	(196)	(197)	(196)	(197)	(195)	(195)	(194)	(195)	(194
OTHER									
NUMBER OF STUDENTS	247	294	327	317	291	249	263	279	279
SAT V - MEAN	457	445	459	460	445	440	452	439	449
SAT M - MEAN	497	490	507	499	487	486	503	495	497
SAT V+M - MEAN	954	935	966	959	932	926	955	935	946
SAT V+M - STD DEV	(247)	(223)	(229)	(244)	(232)	(229)	(220)	(224)	(227
NO RESPONSE									
NUMBER OF STUDENTS	3,755	2,551	1,311	1,038	1,187	995	993	1,125	1,258
SAT V - MEAN	449	440	449	449	443	445	446	444	445
SAT M - MEAN	489	484	483	485	484	484	493	491	487
SAT V+M - MEAN	938	923	933	934	928	929	939	935	932
SAT V+M - STD DEV	(212)	(211)	(214)	(216)	(209)	(212)	(214)	(210)	(214

In Table 4.14, "V" stands for performance on the verbal subtest, "M" for performance on the mathematics subtest, and "V & M" for the total composite score.

Breland and his associates at the College Board have recently reanalyzed the trend lines in the Scholastic Aptitude Testing and ascribed a good deal of its fluctuation to the size of the American family. Breland et al., 1985, provide substantial data indicating, that as families increased in size during the era of the "baby-boom," a subsequent decline in performance was noted. Their prediction is that as family size declines, subsequent increases in achievement on the College Entrance Examination will be noted (as is now being seen). Their prediction is based on the theoretical foundation of the Zajonc model at the University of Michigan (1978).

These same patterns were studied here in Illinois with the IIEP. The following table details the findings.

Table 4.15 Performance Differences Due to Family Size

Grade Eleven

Family Size	Geometry	Mathematics	Science	Reading
Only Child	30.87 A	37.44 A	36.53 A	13.23 A
Two Children	28.02 B	35.09 B	35.16 AB	13.10 A
Three Children	21.76 C	28.59 C	31.63 B	11.47 B
Four Children	18.10 D	23.94 D	28.80 C	10.51 C
Five or More	15.91 E	21.46 E	25.80 C	9.69 D

These are data coming from the student cohort who would respond similarly to the SAT their junior year. The findings in the above table do indeed parallel the findings from the Breland study. There are dramatic differences in performance from students of families of different sizes. For geometry, students of families of five or more score almost one-half as well as students who are only children. If the trend of decreasing family size continues across time, there may be increased SAT scores.

The American College Test (ACT) was taken by 106,580 Illinois students in 1984. The typical student in this group had an ACT composite score of 18.7 (group mean) and a high school grade point average of 2.8. These compare favorably to national averages of 18.5 and 2.9, respectively. At the time of testing, the responding student felt he or she would obtain a first year college grade point average of about 2.8.

Responses of Illinois students taking the 1983-84 ACT to certain background survey questions in terms of satisfaction versus dissatisfaction with their high school are as follows.

Table 4.16 Student Attitudes toward Aspects of High School

	Satisfied	Dissatisfied
High School Instruction	62%	13%
High School Course Offerings	62%	22%
High School Grading	53%	20%
High School Testing	55%	11%
High School Guidance	53%	20%
High School Policies	41%	32%
High School Library Facilities	59%	16%
High School Laboratories	50%	15%
High School Special Needs Assistance	39%	15%
High School Gifted Needs Assistance	57%	11%
High School Career Education and Planning Programs	45%	22%

In terms of high school extracurricular activities, the students were asked to indicate the average number of out of class accomplishments in nine areas. The averages for Illinois students were Athletics (2.9), Work Experience (1.9), Leadership (1.4), Music (1.4), Community Service (1.1), Art (0.9), Writing (0.9), Speech (0.8), and Science (0.6). Given the current national emphasis on achievement, it is interesting to note that students are spending their extracurricular time not on science and writing accomplishments, but in athletics and work experiences.

Of the entire Illinois student population taking the ACT, 50,106 were males and 56,474 were females. In response to possible college majors, 3[illegible]% of the total were "very sure" of their college major, while 45% were "fairly sure." Approximately 40% aspired to a Bachelor's level degree, while 46% wanted to attain at least some graduate school training or a professional degree. The most typically planned college major and vocational choices were business and commerce.

In terms of needs for special help and assistance in the upcoming college years, Illinois students indicated they needed special help in the following areas: educational and occupational plans (51%), study skills (45%), mathematics (44%), reading (36%), writing (29%), and personal concerns (14%). Approximately 42% of the students expressed interest in independent study, 27% in honors courses, 26% in foreign study, and 57% in advanced placement. Sixty-six percent of the students expressed expectations of working at a job during their first college year, while 78% expected to apply for financial aid.

The performance results on the ACT are given in Tables 4.17 to 4.21. A significant comparison can be noted if one compares the percentages of males versus females in each of the test score intervals (Quartiles) for each subtest. One would expect 25% of each group to be in each of these test score intervals (Quartiles) for each subtest. However, for natural science a 16% difference in the number of male versus female students is noted for the highest interval. Thirty-five percent of the males but only 19% of the females are found in the interval. For mathematics, a ten percent male/female difference is noted in this highest test score interval.

Perhaps the most striking results are in the subtest of English. Looking at the percentage of students in the highest test score interval for the English subtest on Table 4.17, one finds 7% of the students. Table 4.18 and 4.19 indicate that only 8% of the females and 6% of the males fall in the interval. While none of the ACT subtests have 25% of the students in this interval as would be expected from statistical theory, these percentages for English are surprisingly low. There are dramatically fewer of the best and the brightest in English skills. This illustrates unexpected low performance in communication and articulation skills of Illinois college-bound students. These findings may reflect unavailability of advanced studies in high school English vis a vis the advanced complete offerings in mathematics and science.

Table 4.20 presents the trend lines in achievement for Illinois students on the ACT. There has been an essential plateau effect since 1974-1975. However, in 1983-1984, the performance levels did reach 21.0 standard points in natural science. The ACT scores have not been at that level since 1975.

Table 4.21 presents the parallel ACT trend data for the national population. For 1983-84, Illinois students were at the national average in English and natural science and slightly higher than the national average in mathematics and social studies. In terms of Illinois versus the nation gender comparisons, the largest gender difference is found for males, with a 0.50 difference in mathematics. Illinois males performed higher than males from other states.

The ACT has also been used to study patterns in science and mathematics giftedness across the State of Illinois. A county by county analysis was conducted of the incidence of students scoring at or above the 97.5 percentile on the mathematics or natural science subtests of the ACT. The results indicated that giftedness in these areas is not uniformly distributed across the state.

Summary

Student achievement is related to student and school factors. Taken together, student and school variables account for approximately half of the variance in student achievements. Among the variables studied here, school size is the most important school variable and a student's personal expectations and standards are the most influential student variables.

Table 4.17 Distributions of ACT Score Frequencies, Percentile Ranks, and Percentages for Men and Women Combined 1983-1984 School Year

SCORE	English FREQ	English PR	Mathematics FREQ	Mathematics PR	Social Studies FREQ	Social Studies PR	Natural Science FREQ	Natural Science PR	Composite FREQ	Composite PR
36	0	99	788	99	0	99	0	99	0	99
35	0	99	619	99	0	99	257	99	4	99
34	0	99	882	98	147	99	784	99	59	99
33	274	99	496	98	629	99	1135	98	204	99
32	22	99	1493	97	1109	99	2557	97	517	99
31	268	99	967	96	885	98	3702	94	857	99
30	359	99	1569	94	2149	96	4095	90	1404	98
29	878	99	1989	93	2902	94	3420	87	2089	96
28	1351	98	3293	90	1898	92	2844	84	2748	94
27	1474	96	3820	87	2980	89	3076	81	3520	91
26	3250	94	5357	83	4003	86	6048	77	4199	87
25	3338	91	3937	78	5049	82	5488	71	[illegible]	83
24	4370	87	5369	74	4013	78	6637	66	5251	78
23	8004	82	4398	69	5012	73	6410	59	5627	73
22	8491	74	6265	64	4470	68	5071	54	5818	68
21	8447	66	3932	59	3963	64	5134	49	5789	62
20	7433	58	4284	56	[illegible]	60	5002	44	5907	57
19	6777	52	3872	52	5182	56	4854	40	5905	51
18	5938	46	3787	48	4020	52	5963	35	5998	46
17	7303	40	3786	45	4484	48	7165	29	5819	40
16	6312	33	1795	42	2177	45	5509	23	5629	35
15	4493	28	4127	39	4532	41	3446	18	5382	30
14	4947	24	3617	36	4621	37	3971	15	5051	25
13	4070	20	3767	32	3881	33	3475	12	4773	20
12	4913	15	4363	28	4837	29	2966	8	4377	16
11	2971	12	3530	25	5036	24	2292	6	3874	12
10	3527	9	2840	22	6255	19	1813	4	3403	9
9	2362	6	3679	19	4110	14	1434	3	2712	6
8	1518	4	1890	16	4526	10	1041	1	2063	3
7	1070	3	2859	14	2870	7	439	1	1426	2
6	1095	2	3725	11	2381	4	388	1	749	1
5	719	1	2183	8	1344	3	103	1	319	1
4	405	1	1014	6	1045	1	44	1	115	1
3	142	1	1768	5	555	1	13	1	28	1
2	47	1	983	4	277	1	3	1	5	1
1	9	1	3537	2	171	1	1	1	0	1

Percentages of Students in Various Test Score Intervals

26-36	7876	7	[illegible]	20	16702	16	27918	26	15601	15
21-25	32650	31	[illegible]	22	23507	22	28740	27	27444	26
16-20	33763	32	17524	16	19930	19	28493	27	29258	27
1-15	32291	30	43882	41	46441	44	21429	20	34277	32
(MEAN)	18.1		17.6		17.5		21.0		18.7	
S.D.	5.5		8.5		7.3		6.4		6.1	

Total Number of Students - 106,580

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Table 4.18 Distributions of ACT Score Frequencies, Percentile Ranks, and Percentages for Women 1983-1984 School Year

SCORE	English FREQ	English PR	Mathematics FREQ	Mathematics PR	Social Studies FREQ	Social Studies PR	Natural Science FREQ	Natural Science PR	Composite FREQ	Composite PR
36	0	99	193	99	0	99	0	99	0	99
35	0	99	184	99	0	99	24	99	0	99
34	0	99	256	99	26	99	98	99	16	99
33	175	99	174	99	195	99	211	99	52	99
32	13	99	520	98	349	99	662	99	162	99
31	158	99	331	97	314	99	1190	97	270	99
30	215	99	576	97	819	98	1539	95	506	99
29	530	99	747	95	1245	96	1342	92	744	98
28	783	97	1398	93	844	94	1292	90	1110	96
27	878	96	1672	91	1318	92	1356	88	1446	94
26	1909	93	2513	87	1868	89	2872	84	1881	91
25	1923	90	1835	83	2426	85	2735	79	2391	87
24	2510	86	2691	79	1993	82	3464	73	2573	83
23	4537	80	2248	75	3064	77	3482	67	2897	78
22	4819	72	3284	70	2256	72	2829	62	3005	72
21	4613	63	1998	65	2084	69	2924	57	3079	67
20	4040	56	2252	61	2185	65	2808	51	3228	61
19	3672	49	2070	58	2773	60	2930	46	3217	56
18	3110	43	1974	54	2267	56	3498	41	3277	50
17	3835	37	2111	50	2536	52	4473	34	3238	44
16	3223	30	915	48	1187	48	3285	27	3126	39
15	2274	25	2338	45	2516	45	2206	22	3092	33
14	2442	21	2107	41	2590	41	2538	18	2982	28
13	1937	17	2157	37	2156	36	2153	14	2752	23
12	2394	14	2509	33	2730	32	1878	10	2615	18
11	1405	10	2078	29	2918	27	1438	7	2356	14
10	1698	7	1721	26	3636	21	1157	5	2100	10
9	1106	5	2180	22	2485	16	865	3	1630	6
8	705	3	1186	19	2676	11	647	2	1232	4
7	500	2	1778	17	1704	7	264	1	838	2
6	481	1	2374	13	1377	5	226	1	424	1
5	312	1	1369	10	767	3	58	1	163	1
4	185	1	657	8	588	2	25	1	57	1
3	68	1	1132	6	339	1	4	1	12	1
2	18	1	627	5	145	1	1	1	3	1
1	6	1	2319	2	98	1	0	1	0	1

Percentages of Students in Various Test Score Intervals

26-36	4661	8	8564	15	6978	12	10586	19	6187	11
21-25	18402	33	12056	21	11823	21	15434	27	13945	25
16-20	17880	32	9322	17	10948	19	16994	30	16086	28
1-15	15531	28	26532	47	26725	47	13460	24	20256	36

	English	Mathematics	Social Studies	Natural Science	Composite
(MEAN)	18.5	16.4	16.7	19.9	18.0
S.D.	5.4	8.3	7.1	6.0	5.9

Total Number of Students - 56,474

Table 4.19 Distributions of ACT Score Frequencies, Percentile Ranks, and Percentages for Men 1983-1984 School Year

SCORE	English FREQ	English PR	Mathematics FREQ	Mathematics PR	Social Studies FREQ	Social Studies PR	Natural Science FREQ	Natural Science PR	Composite FREQ	Composite PR
36	0	99	595	99	0	99	0	99	0	99
35	0	99	435	98	0	99	233	99	4	99
34	0	99	626	97	121	99	686	99	43	99
33	99	99	322	96	434	99	924	97	152	99
32	9	99	973	95	760	98	1895	94	355	99
31	110	99	636	93	571	97	2512	90	587	98
30	144	99	993	92	1330	95	2556	85	898	97
29	348	99	1242	90	1657	92	2078	80	1345	95
28	568	98	1895	86	1054	89	1552	77	1638	92
27	596	97	2148	82	1662	87	1720	73	2074	88
26	1341	95	2844	77	2135	83	3176	69	2318	84
25	1415	92	2102	73	2623	78	2753	63	2568	79
24	1860	89	2678	68	2020	73	3173	57	2678	73
23	3467	84	2150	63	2948	68	2928	51	2730	68
22	3672	76	2981	58	2214	63	2242	46	2813	62
21	3834	69	1934	53	1879	59	2210	41	2710	57
20	3393	62	2032	49	1882	55	2194	37	2679	52
19	3105	55	1802	45	2409	51	1924	33	2688	46
18	2828	49	1813	42	1753	47	2465	28	2721	41
17	3468	43	1675	38	1948	43	2692	23	2581	36
16	3089	37	880	36	990	40	2224	18	2503	30
15	2219	31	1789	33	2016	37	1240	15	2290	26
14	2505	27	1510	30	2031	33	1433	12	2069	21
13	2133	22	1610	26	1725	30	1322	9	2021	17
12	2519	17	1854	23	2107	26	1088	7	1762	13
11	1569	13	1452	20	2118	22	854	5	1518	10
10	1829	10	1119	17	2619	17	656	3	1303	7
9	1256	7	1499	15	1625	13	569	2	1082	5
8	813	5	704	12	1850	9	394	1	831	3
7	570	3	1081	11	1166	6	175	1	588	2
6	614	2	1351	8	1004	4	162	1	325	1
5	407	1	814	6	577	2	45	1	156	1
4	220	1	357	5	457	1	19	1	58	1
3	74	1	636	4	216	1	9	1	16	1
2	29	1	356	3	132	1	2	1	2	1
1	3	1	1218	1	73	1	1	1	0	1

Percentages of Students in Various Test Score Intervals

26-36	3215	6	12709	25	9724	19	17332	35	9414	19
21-25	14248	28	11845	24	11684	23	13306	27	13499	27
16-20	15883	32	8202	16	8982	18	11499	23	13172	26
1-15	16760	33	17350	35	19716	39	7969	16	14021	28
(MEAN)	17.7		19.1		18.3		22.3		19.5	
S.D.	5.5		8.4		7.5		6.6		6.2	

Total Number of Students - 50,106

Table 4.20 ACT Score Means & Standard Deviations for Successive Years of ACT-Tested College-Bound Students
Illinois

SCHOOL YEAR	English MEAN	English (SD)	Math MEAN	Math (SD)	Soc. Studies MEAN	Soc. Studies (SD)	Natural Sci. MEAN	Natural Sci. (SD)	Composite MEAN	Composite (SD)
				TOTAL (MEN AND WOMEN COMBINED)						
1966-67	20.0	--	20.5	--	21.0	--	21.3	--	20.9	--
1967-68	19.8	5.0	20.4	7.4	21.0	6.3	21.1	6.3	20.7	5.3
1968-69	19.8	5.0	21.2	6.8	20.6	6.3	21.2	6.2	20.8	5.2
1969-70	19.2	5.2	21.1	6.8	20.5	6.4	21.5	5.9	20.7	5.2
1970-71	18.7	5.6	20.3	7.3	19.4	7.0	21.2	6.2	20.0	5.6
1971-72	18.4	5.5	20.1	7.4	19.2	7.1	21.2	6.3	19.8	5.6
1972-73	18.5	5.5	20.2	7.5	19.0	7.6	21.3	6.3	19.9	5.8
1973-74	18.1	5.3	19.1	7.7	18.4	7.7	21.1	6.3	19.3	5.8
1974-75	18.1	5.4	18.1	8.2	17.8	7.6	21.2	6.3	18.9	6.0
1975-76	17.4	5.5	17.7	7.8	17.0	7.3	20.6	6.6	18.3	6.0
1976-77	17.7	5.4	17.7	8.0	17.6	7.3	20.7	6.5	18.6	6.0
1977-78	17.8	5.6	17.5	7.9	17.0	7.3	20.6	6.5	18.4	6.0
1978-79	17.7	5.5	17.5	7.8	17.1	7.2	20.9	6.2	18.4	5.8
1979-80	17.8	5.5	17.6	7.8	17.3	7.3	20.9	6.2	18.5	5.9
1980-81	17.8	5.5	17.6	8.1	17.3	7.4	20.9	6.0	18.5	5.9
1981-82	17.9	5.5	17.6	8.4	17.5	7.4	20.7	6.3	18.6	6.0
1982-83	17.9	5.7	17.3	8.5	17.2	7.3	20.7	6.5	18.4	6.1
1983-84	18.1	5.5	17.6	8.5	17.5	7.3	21.0	6.4	18.7	6.1
				MEN						
1966-67	19.1	5.0	21.6	7.1	21.1	6.2	22.3	6.2	21.2	5.3
1967-68	18.7	5.1	21.5	7.3	21.4	6.3	22.0	6.4	21.0	5.4
1968-69	18.9	5.1	22.1	6.8	21.2	6.3	22.1	6.2	21.2	5.3
1969-70	18.4	5.3	22.2	6.8	21.2	6.4	22.3	6.1	21.1	5.3
1970-71	17.7	5.7	21.4	7.4	19.7	7.1	21.9	6.4	20.3	5.7
1971-72	17.6	5.6	21.2	7.4	19.8	7.1	22.1	6.4	20.3	5.7
1972-73	17.8	5.4	21.4	7.5	19.8	7.6	22.3	6.4	20.5	5.9
1973-74	17.4	5.2	20.5	7.7	19.3	7.6	22.5	6.4	20.1	5.9
1974-75	17.5	5.3	19.7	8.2	19.1	7.6	22.4	6.4	19.8	6.0
1975-76	16.9	5.5	19.4	7.8	17.9	7.4	21.7	6.7	19.1	6.0
1976-77	17.2	5.3	19.4	8.0	18.6	7.4	22.1	6.6	19.4	6.0
1977-78	17.4	5.6	19.1	7.9	17.8	7.5	21.8	6.7	19.1	6.1
1978-79	17.4	5.5	19.1	7.9	18.2	7.3	22.1	6.4	19.3	5.9
1979-80	17.3	5.5	19.0	7.9	18.2	7.4	22.2	6.3	19.3	5.9
1980-81	17.3	5.4	19.1	8.2	18.3	7.5	22.0	6.2	19.3	6.0
1981-82	17.4	5.4	19.0	8.3	18.4	7.5	22.1	6.4	19.4	6.1
1982-83	17.5	5.7	18.7	8.5	18.1	7.4	22.0	6.6	19.2	6.2
1983-84	17.7	5.5	19.1	8.4	18.3	7.5	22.3	6.6	19.5	6.2

Table 4.20 (Con't)

SCHOOL YEAR	English MEAN	(SD)	Math MEAN	(SD)	Soc. Studies MEAN	(SD)	Natural Sci. MEAN	(SD)	Composite MEAN	(SD)
				WOMEN						
1966-67	21.1	4.5	19.3	7.1	20.8	6.1	20.2	5.8	20.5	5.0
1967-68	21.0	4.6	19.3	7.3	20.6	6.2	20.1	6.0	20.4	5.1
1968-69	20.7	4.7	20.2	6.6	19.8	6.3	20.1	5.9	20.4	5.0
1969-70	20.1	5.0	20.0	6.6	19.8	6.4	20.7	5.6	20.2	5.0
1970-71	19.6	5.3	19.3	7.1	19.2	6.9	20.4	5.9	19.8	5.4
1971-72	19.2	5.3	18.9	7.3	18.7	7.1	20.3	6.1	19.4	5.5
1972-73	19.2	5.4	19.0	7.3	18.1	7.5	20.4	6.0	19.3	5.7
1973-74	18.8	5.2	17.8	7.5	17.6	7.6	19.8	5.8	18.6	5.6
1974-75	18.5	5.4	16.7	7.9	16.6	7.4	20.2	6.0	18.1	5.8
1975-76	17.9	5.5	16.3	7.5	16.2	7.2	19.7	6.4	17.6	5.8
1976-77	18.2	5.4	16.3	7.7	16.7	7.2	19.5	6.2	17.8	5.8
1977-78	18.2	5.6	16.2	7.6	16.3	7.1	19.6	6.2	17.7	5.8
1978-79	18.0	5.4	16.2	7.5	16.2	7.0	19.9	5.9	17.7	5.6
1979-80	18.2	5.5	16.3	7.5	16.6	7.2	19.9	5.9	17.8	5.7
1980-81	18.3	5.5	16.3	7.9	16.5	7.2	19.9	5.7	17.9	5.7
1981-82	18.3	5.5	16.4	8.2	16.8	7.3	19.6	5.9	17.9	5.9
1982-83	18.3	5.6	16.1	8.2	16.4	7.0	19.5	6.1	17.7	5.9
1983-84	18.5	5.4	16.4	8.3	16.7	7.1	19.9	6.0	18.0	5.9

TABLE 4.21

ACT Score Means & Standard Deviations for Successive Years
of ACT-Tested College-Bound Students
National

SCHOOL YEAR	English MEAN	(SD)	Math MEAN	(SD)	Soc. Studies MEAN	(SD)	Natural Sci. MEAN	(SD)	Composite MEAN	(SD)
		TOTAL (MEN AND WOMEN COMBINED)								
1969-70*	18.5	5.1	20.0	6.6	19.7	6.6	20.8	5.9	19.9	5.1
1972-73	18.1	5.3	19.1	7.2	18.3	7.4	20.8	6.3	19.2	5.7
1973-74	17.9	5.2	18.3	7.4	18.1	7.6	20.8	6.4	18.9	5.7
1974-75	17.7	5.3	17.6	7.9	17.4	7.5	21.1	6.3	18.6	5.8
1975-76	17.5	5.4	17.5	7.6	17.0	7.3	20.8	6.6	18.3	5.9
1976-77	17.7	5.2	17.4	7.8	17.3	7.3	20.9	6.5	18.4	5.9
1977-78	17.9	5.4	17.5	7.7	17.1	7.3	20.9	6.5	18.5	5.9
1978-79	17.9	5.4	17.5	7.6	17.2	7.2	21.1	6.3	18.6	5.8
1979-80	17.9	5.4	17.4	7.6	17.2	7.3	21.1	6.2	18.5	5.8
1980-81	17.8	5.4	17.4	7.9	17.2	7.3	21.0	6.1	18.5	5.8
1981-82	17.9	5.3	17.2	8.0	17.3	7.3	20.8	6.3	18.4	5.8
1982-83	17.8	5.5	16.9	8.2	17.1	7.3	20.9	6.5	18.3	6.0
1983-84	18.1	5.3	17.3	8.0	17.3	7.3	21.0	6.3	18.5	5.9

*The data were unavailable for 1970-71 and 1971-72.

				MEN						
1969-70*	17.6	5.2	21.1	6.5	20.3	6.6	21.6	6.1	20.3	5.2
1972-73	17.3	5.3	20.2	7.2	19.0	7.5	21.7	6.5	19.7	5.8
1973-74	17.1	5.2	19.7	7.4	19.1	7.6	22.2	6.5	19.7	5.8
1974-75	17.1	5.2	19.3	7.9	18.7	7.5	22.4	6.4	19.5	5.9
1975-76	16.8	5.4	19.2	7.7	17.9	7.4	22.0	6.7	19.1	5.9
1976-77	17.0	5.2	18.9	7.8	18.2	7.4	22.3	6.6	19.2	6.0
1977-78	17.4	5.4	19.1	7.7	18.0	7.4	22.3	6.6	19.3	6.0
1978-79	17.4	5.4	19.1	7.6	18.1	7.4	22.3	6.5	19.3	5.9
1979-80	17.3	5.4	18.9	7.7	18.2	7.4	22.4	6.3	19.3	5.9
1980-81	17.3	[illegible]	18.9	7.9	18.3	7.5	22.3	6.3	19.3	5.9
1981-82	17.3	5.	8.6	8.0	18.1	7.5	22.2	6.4	19.2	6.0
1982-83	17.3	5.5	18.4	8.2	18.0	7.5	22.4	6.6	19.1	6.1
1983-84	17.5	5.4	18.6	8.0	18.1	7.5	22.4	6.5	19.3	6.1
				WOMEN						
1969-70*	19.4	4.9	18.8	6.4	19.0	6.5	20.0	5.7	19.4	5.0
1972-73	18.9	5.1	18.0	7.0	17.7	7.4	19.9	6.0	18.8	5.5
1973-74	18.6	5.1	17.1	7.2	17.3	7.5	19.6	5.9	18.2	5.5
1974-75	18.3	5.2	16.2	7.6	16.4	7.3	20.0	6.0	17.8	5.6
1975-76	18.0	5.3	16.0	7.3	16.2	7.1	19.7	6.3	17.6	5.7
1976-77	18.2	5.2	16.1	7.5	16.5	7.1	19.6	6.2	17.8	5.7
1977-73	18.3	5.4	16.2	7.4	16.4	7.0	19.8	6.2	17.8	5.7
1978-79	18.4	5.3	16.2	7.2	16.4	7.0	20.2	5.9	17.9	5.5
1979-80	18.3	5.4	16.2	7.3	16.4	7.1	20.0	5.9	17.9	5.6
1980-81	18.2	5.4	16.0	7.6	16.4	7.1	20.0	5.8	17.8	5.7
1981-82	18.4	5.3	16.0	7.7	16.6	7.1	19.7	5.9	17.8	5.7
1982-	18.2	5.4	15.7	7.9	16.4	7.1	19.6	6.2	17.6	5.8
1983	18.6	5.2	16.1	7.8	16.5	7.1	19.9	5.9	17.9	5.7

*The data were unavailable for 1970-71 and 1971-72.

APPENDIX A.1
Grade Four
Mean Achievement Scores by School Characteristics

Size of School	Geog. Region	Socio-Economic Status	Reading	Mathematics	Science	Geometry
1	1	1	8.93	25.37	16.93	10.50
1	1	2	11.67	26.44	20.59	12.22
1	1	3	7.55	19.55	13.65	7.85
1	2	4	7.94	27.44	17.59	10.75
1	2	1	10.34	24.24	16.64	9.65
1	2	2	10.15	25.39	18.57	10.24
1	2	4	9.71	24.38	17.58	9.70
1	3	1	10.79	27.7	16.88	9.44
1	3	2	10.15	24.82	18.47	11.07
1	3	3	9.35	21.31	16.69	8.42
1	4	2	9.74	22.82	16.70	9.70
1	4	3	9.73	24.14	17.95	8.18
1	5	1	9.07	23.05	16.35	10.28
1	5	3	6.24	19.00	12.29	7.65
1	6	1	6.57	15.71	11.88	6.85
2	1	1	10.52	27.45	19.27	11.28
2	1	3	7.87	22.27	15.37	8.33
2	1	4	8.46	20.88	13.45	8.54
2	2	1	12.20	24.90	17.65	9.85
2	2	3	10.18	25.93	18.67	11.42
2	2	4	8.85	23.90	18.55	9.15
2	3	2	9.80	25.35	18.95	9.15
2	3	3	8.74	22.41	15.33	8.65
2	4	1	11.01	25.14	17.14	9.10
2	4	2	9.53	22.58	17.05	9.68
2	4	3	9.05	21.45	17.82	8.92
2	4	4	8.13	26.26	13.78	8.30
2	5	2	9.77	28.58	19.57	10.13
2	6	3	11.57	24.52	19.40	10.22
3	1	1	10.05	27.22	18.10	11.06
3	1	2	9.80	25.00	19.40	11.12
3	1	3	9.91	17.78	16.95	9.35
3	1	4	8.40	26.65	12.72	7.98
3	2	1	10.31	25.10	17.47	9.77
3	2	3	9.23	24.95	17.98	10.61
3	3	2	9.70	17.55	17.00	8.35
3	3	4	6.45	21.44	10.55	7.00
3	4	2	10.10	26.22	16.94	9.61
3	5	2	10.10	25.91	18.95	9.70
4	1	1	10.13	25.78	17.80	9.72
4	1	2	9.87	28.90	18.11	10.70
4	1	3	11.50	19.74	17.07	10.15
4	2	1	10.80	26.10	12.72	7.67
4	2	2	11.90	18.40	18.90	10.55
4	2	3	8.10	19.50	12.50	8.70
4	2	4	7.25	26.35	14.75	7.35
4	3	3	10.85	26.50	18.65	8.90
4	4	3	12.70	19.05	20.05	11.25
4	6	2	10.35	22.30	18.10	8.70
4	6	3	10.80	22.30	16.35	8.35

APPENDIX A.2

Grade Eight

Mean Achievement Scores by School Characteristics

Size Of School	Courses Offered	Geog. Region	Socio-Economic Status	Reading	Mathematics	Science	Geometry
1	1	1	1	12.85	28.75	25.08	15.50
1	1	1	4	12.91	22.61	21.56	12.94
1	1	2	1	14.93	28.14	28.57	17.14
1	1	3	1	13.93	27.71	27.75	15.71
1	1	3	3	13.85	32.25	27.20	21.00
1	1	4	1	12.77	29.19	24.40	18.07
1	1	4	2	13.13	26.47	24.97	16.33
1	1	5	3	13.25	26.31	23.69	14.25
1	1	6	1	10.75	22.58	22.50	12.25
1	2	1	1	13.85	24.35	26.10	16.60
1	2	3	2	14.30	30.05	26.30	17.90
1	2	2	2	14.08	30.58	27.68	18.45
1	2	3	1	12.98	28.22	27.70	15.74
1	2	3	2	14.30	28.32	27.45	18.25
1	2	3	3	13.73	27.15	25.30	16.03
1	2	4	1	13.90	32.94	28.65	21.90
1	2	4	2	15.55	32.55	29.70	20.85
1	2	4	3	13.00	23.00	24.00	12.20
1	2	5	2	12.45	30.15	26.45	16.45
1	2	5	3	11.47	24.05	23.37	12.74
1	2	6	3	14.52	26.85	25.79	14.92
2	1	1	1	14.38	32.22	28.05	19.69
2	1	1	2	12.95	23.13	24.25	13.90
2	1	1	3	12.75	22.44	24.12	12.56
2	1	1	4	12.63	22.58	21.88	13.87
2	1	2	2	12.95	28.15	25.75	16.60
2	1	2	3	11.00	19.15	21.00	1[illegible].20
2	1	3	2	13.38	28.90	26.85	17.58
2	1	4	2	13.10	26.75	26.90	14.25
2	1	4	3	13.10	28.15	26.00	16.25
2	1	6	2	13.60	24.25	26.75	16.20
2	2	1	1	14.18	29.75	27.05	15.80
2	2	1	3	11.00	20.65	19.70	7.45
2	2	3	3	13.35	29.15	24.45	12.40
2	2	5	2	13.60	29.10	26.20	16.15
2	2	2	2	13.90	26.25	26.00	16.85
2	2	3	3	12.55	27.50	24.55	14.75
2	3	1	1	15.55	38.00	30.35	24.00
2	3	1	3	11.35	23.90	20.70	11.80
2	3	2	2	12.55	30.15	25.35	18.00
2	3	4	3	14.25	28.55	28.16	20.20
3	1	1	2	13.85	26.88	27.35	14.18
3	1	1	3	12.03	21.10	23.93	11.93
3	1	1	4	12.29	22.34	20.89	12.61

Size	Courses	Region	Wealth	Read Mean	Mathematics	Science	Geometry
3	1	4	2	11.70	23.90	25.40	12.70
3	1	4	3	13.55	27.25	26.20	14.90
3	1	6	2	13.05	30.10	28.25	17.60
3	2	1	2	11.17	27.16	24.22	14.33
3	3	1	1	15.20	31.08	29.05	16.00
3	3	1	2	14.26	33.00	27.81	19.00
3	3	1	3	12.60	20.75	19.35	20.48
3	3	2	3	15.30	35.90	29.65	10.85
3	3	1	1	13.30	27.13	26.63	21.50
4	1	1	1	14.15	25.45	28.45	17.05
4	1	1	3	12.25	23.80	23.80	16.90
4	1	1	4	11.58	20.40	18.87	11.35
4	3	2	3	13.03	24.47	24.05	11.24
4	3	3	4	10.55	22.35	20.70	14.33
4	3	4	3	13.70	28.05	28.85	12.95
4	3	4	4	10.95	16.75	16.90	17.75
4	3	1	1	13.78	27.15	25.56	17.48
4	3	1	2	15.23	33.48	28.33	21.35
4	3	1	3	13.75	25.72	26.75	16.85
4	3	2	3	12.41	23.48	23.80	13.25
4	3	5	3	11.85	19.80	21.65	10.10
4	3	3	3	12.60	25.25	24.00	16.90

APPENDIX A.3

Grade Eleven

Mean Achievement Scores by School Characteristics

Size of School	Courses Offered	Commun-ity Type	Geo-graphic Location	Social-Economic Status	READING	MATHEMATICS	SCIENCE	GEOMETRY
1	1	3	3	1	10.30	25.85	29.50	18.75
1	1	4	2	1	11.82	30.46	34.26	23.28
1	1	4	3	1	11.39	31.82	34.27	24.47
1	1	4	3	2	12.45	32.08	33.16	25.68
1	1	4	4	1	11.73	30.16	33.41	24.40
1	1	4	4	2	11.89	29.77	33.09	23.94
1	1	4	4	3	10.15	24.45	30.25	20.55
1	1	4	5	1	12.50	28.80	33.75	23.60
1	1	4	5	2	11.03	29.93	33.85	22.25
1	1	4	6	2	12.25	30.32	31.55	21.30
1	1	4	6	3	10.22	22.72	29.07	15.83
2	1	4	4	1	12.20	27.95	33.10	21.90
2	2	2	2	3	11.10	26.75	32.48	20.88
2	2	2	5	3	11.11	29.63	29.32	19.05
2	2	2	5	4	10.40	22.20	23.90	17.50
2	2	3	2	1	12.85	33.45	35.15	29.55
2	2	3	2	2	10.75	30.05	28.95	23.15
2	2	3	3	2	13.50	33.20	34.10	27.25
2	2	3	4	2	12.15	30.55	32.45	21.35
2	2	3	4	3	11.74	28.18	31.91	21.78
2	2	4	1	4	11.95	29.65	30.25	18.95
2	2	4	2	2	10.50	32.00	35.85	25.15
2	2	4	3	1	11.65	28.90	32.45	22.80
2	2	4	3	2	12.08	29.10	31.58	20.93
2	2	4	3	3	11.85	34.00	34.15	24.00
2	2	4	4	2	11.75	31.10	32.73	26.53
2	2	4	5	3	10.33	25.74	30.82	19.38
2	2	4	6	1	11.74	24.16	29.37	16.47
2	2	4	6	2	10.75	22.40	29.78	18.35
2	2	4	6	3	11.55	26.70	30.05	20.50
2	3	4	3	3	10.90	21.15	28.50	17.55
3	2	4	2	2	12.80	35.45	34.10	27.20
3	3	1	1	4	10.05	27.55	26.40	18.70
3	3	1	3	4	10.57	23.00	26.86	12.71
3	3	2	1	1	12.10	35.03	24.55	28.33
3	3	2	1	2	12.36	30.12	33.35	24.45
3	3	2	1	3	11.32	27.03	29.45	19.10
3	3	2	5	3	12.10	34.65	35.85	28.35
3	3	2	5	4	12.50	30.90	32.50	21.20
3	3	3	2	3	11.80	37.95	34.90	29.75
3	3	3	3	4	11.27	28.70	33.08	23.13
3	3	3	4	2	12.25	30.45	34.85	26.40
3	3	3	4	3	11.60	28.10	32.50	21.15
3	3	3	4	4	10.75	27.30	31.10	21.30

Size of School	Courses Offered	Community Type	Geographic Location	Social-Economic Status	READING	MATHEMATICS	SCIENCE	GEOMETRY
3	3	3	5	3	12.40	28.55	32.80	22.80
3	3	3	6	3	11.78	27.13	31.55	23.30
3	3	3	6	4	11.60	27.63	31.23	19.78
3	3	4	1	1	12.25	37.80	33.55	29.80
3	3	4	2	1	13.50	34.85	36.15	28.25
3	3	4	2	2	11.50	34.80	34.90	25.70
3	3	4	3	3	11.85	24.45	31.40	19.65
3	3	4	5	3	12.50	35.75	33.80	25.45
4	4	1	1	4	9.01	16.93	20.87	11.97
4	4	1	2	4	12.72	29.79	32.72	25.60
4	4	1	3	4	14.20	34.80	34.80	29.10
4	4	1	4	4	9.56	20.46	23.19	13.82
4	4	2	1	1	12.72	34.06	34.11	27.01
4	4	2	1	2	12.24	33.15	33.14	26.49
4	4	2	1	3	12.66	35.09	34.28	28.56
4	4	2	1	4	10.87	28.24	29.76	21.68
4	4	2	2	4	12.31	32.50	33.69	26.38
4	4	2	4	2	12.60	30.45	32.40	24.95
4	4	2	5	4	10.95	23.40	30.85	20.05
4	4	3	6	3	11.90	31.65	33.75	23.30

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