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ABSTRACT

This study investigated the influence of student and classroom characteristics on a sample of 17-year-old students' (N=1955) inquiry ability. The sample was obtained from a 1981/1982 national assessment in science carried out by the Minnesota Science Assessment and Research Project. Specific areas addressed included: (1) the effectiveness of the Model of Educational Productivity (MEP) for predicting students' inquiry skills; (2) whether predictors of science inquiry skills differed for males and females; and (3) whether predictors of science inquiry skills differed for white and nonwhite students. Results indicated that the model was capable of accounting for between 24 and 32 percent of the variance in inquiry skill for the general population of 17-year-olds; more specifically, ability alone accounted for between 17 and 22 percent of the variance in inquiry skill for the general population. Little difference in the prediction of inquiry skill for males and females using the model was found. In addition, for nonwhite students, the MEP accounted for only 18 percent of the variance in science inquiry skill; specifically, ability accounted for only 6 percent of the variance, suggesting that little is known about the factors contributing to the science inquiry skill of nonwhite students. (JN)

PREDICTORS OF SCIENCE INQUIRY KNOWLEDGE

by

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Science inquiry is generally perceived to be a desired outcome of science instruction. Yet more often than not, science teachers, despite new curricula and improved facilities, are ineffective in fostering inquiry behavior in students (Stake and Easley, 1978).

Inquiry is generally defined as the way in which human beings seek information. Science inquiry, then, refers to the processes, such as observing, hypothesizing, experimenting, and concluding, that produce science knowledge. As such, inquiry behaviors are a central focus of science teaching. Not surprisingly, science educators are concerned about what can be done to make students into better scientific inquirers (Harms and Yager, 1981).

Education is concerned with that variety of influences which brings about knowledge, attitude, or values changes in the learner. It is a complex milieu of observable and unobservable events. While classroom interactions, instructional strategies, and the use of instructional media are easily observed and quantified, less tangible events, such as student attitude changes or student cognitive changes are only observable though the use of probes such as achievement tests and attitude questionnaires. Events prior to the classroom interaction, such as teacher training or curriculum development, are often neither seen nor known.

Hence, the educational endeavor can be divided into three related phases or conditions: the context or antecedent conditions (such as teacher and student characteristics, the classroom characteristics, and the social imperatives influencing education), the transactions that occur during instruction (such as instructional techniques, classroom climate, and implementation activities), and the outcomes of instruction (student attitudes and achievement).

Most of the research on inquiry skills in science as well as most of the science education research has focused on transactions and outcomes to the exclusion of context variables. A 1979 survey (Yeany, et al.) of public school personnel identified twelve priority areas for science education research, none of which addressed the issue of context conditions.

Statement of the Problem

This study is designed to investigate the influence of context variables on students' inquiry ability. Specifically, student characteristics and classroom characteristics are examined to determine the influence of these context conditions on students' inquiry skill.

Data were analyzed to answer the following questions:

1. Do measures of the educational context account for a significant amount of the variance in science inquiry skill?
2. Do predictors of science inquiry skill differ for males and females?
3. Do predictors of science inquiry skill differ for white and nonwhite students?

Research Design

This study is based upon the techniques of secondary analysis. Briefly stated, secondary analysis is "the extraction of knowledge on topics other than those which were the focus of the original" study (Hyman, 1972, p. 1).

There are two primary methods for applying secondary analysis to an existing data base. In the first, the data is examined to identify interesting relationships for further study. In the second, a theoretical model serves as the basis for the selection of items or clusters of items from the data base which seem to serve as reasonable measures of the constructs specified in the model. The latter approach was used in this study.

The theoretical model used was the Model of Educational Productivity (Walberg, 1981b). This model identifies several variables which are thought to be associated with academic achievement. The model is based on the argument that four principal correlates, age or developmental level, ability, the social environment for learning, and the home environment, will account for nearly all of the variance in educational achievement.

Learning can be thought of as a function of aptitude, instructional treatment, and environment (equation 1).

$$L = f\ (A,T,E) \qquad (1)$$

The difficulty for educational researchers is two-fold. The first is the problem of specifying appropriate measures for each construct, and the second is the difficulty of constructing a quantitative relationship (that is, an equation) between those measures.

To accomplish the latter, Walberg has turned to the theories of econometrics to specify these interactions. Cobb and Douglas (1928) proposed a mathematical relationship between output (O) and land subsumed under capital (K), labor (L) and a constant term (a). See equation 2.

$$O = aK^{b}L^{c} \qquad (2)$$

An educational derivative of this equation proposed by Walberg is:

$$\text{Learning}=a(\text{AGE})^{b}(\text{ABL})^{c}(\text{MOT})^{d}(\text{QUL})^{e}(\text{QUN})^{f}(\text{CLS})^{g}(\text{HOM})^{h} \qquad (3)$$

where AGE is the age of the student, ABL is the general academic ability of the student, MOT is the motivation of the student, QUL is the quality of instruction, QUN is the quantity of instruction, CLS is a measure of the classroom environment, and HOM is a measure of the home environment.

Using data from the 1976 National Assessment of Educational Progress, Walberg and others have tested the efficacy of this model for predicting the science achievement of 13-year-olds (Walberg, et al., 1981a) and the social studies achievement of 17-year-olds (Walberg and Weinstein, 1982).

The present study makes use of the data obtained for the 1981/1982 national assessment in science. This modified assessment was carried out by the Minnesota Science Assessment and Research Project under the direction of Wayne W. Welch, and was funded by the National Science Foundation.

18,000 students were assessed. This included approximately 2,000 nine-year-olds, 8,000 thirteen-year-olds, and 8,000 seventeen-year-olds. For the purposes of this paper, a sample of 1955 seventeen-year-olds was selected. This sample was a stratified random sample representing 17-year-olds nation-wide, and stratified to give proportional representation to males and females, racial and ethnic groups and various socio-economic strata (see Figure 1). Demographic characteristics of this sample of 17-year-olds are shown in Table 1.

The selection of variables was guided by the Model of Educational Productivity and by the items available in the test booklet taken by the 1955 students in the sample, in the Principal's Questionnaire, and in the Instuctional Program Questionnaire. The constructs measured were ability, motivation, quality and quantity of instruction, the classroom environment, the home environment, and, as the dependent measure, inquiry skill. The other variable in the Model of Educational Productivity, age, was held constant in this study.

Ability. Ability was measured by a single self-reporting item (see Figure 2). On an eight-point Likert scale, ranging from "mostly A" to "mostly below D", students were asked to describe their grades so far in school.

Motivation. Six items measured students' willingness to voluntarily engage in out-of-school science experiences (see Figure 3). Students responded on each item to a four-point Likert scale ranging from "often" to "never".

Quality of Instruction. Quality of Instruction was measured by the science teaching budget per full time equivalent teacher in science. The school principal was asked to report the school's total instructional budget, the percent devoted to science, and the number of full time equivalent teachers in science.

Quantity of Instruction. The quantity of science instruction was measured by students' self-reporting of the number of semesters of various science classes that they have studied in grades nine through twelve (see Figure 4). For the purposes of this study, quantity of instruction was characterized by enrollment in the traditional college placement sequence of science courses (general science, biology, chemistry, and physics) for students in grades nine through twelve.

Classroom Environment. Attitudes toward the classroom environment were characterized by 11 attitude items (see Figure 5). These items assessed how science classes make the students feel (e.g., uncomfortable, curious, stupid, etc.), how comfortable they are doing science activities, and how interested they are in working on science projects and science problems. Students responded to these items on a five-point Likert scale.

Home Environment. The home environment was measured by two questions, one asking students to report their father's education and the other to report their mother's education (see Figure 6). Students responded on a six-point scale ranging from "did not complete the 8th grade" to "graduated from college."

Inquiry Skill. The dependent measure was a 17 item test of Inquiry skill. Items for this scale were selected by the Minnesota Science Assessment and Research Project from the item pool of the National Assessment of Educational Progress. All items had been given during the 1976/1977 assessment which allowed changes in performance on these items over the past five years to be calculated. These items measured students' understanding of the science process skills of assumptions, communications, measurements, and interpretations of data, as well as their decision-making skills and their awareness of the methods, assumptions, and values in science.

Results of the Analysis

In order to test the utility of the Model of Educational Productivity to predict the inquiry skill of 17-year-olds, the sample of 1955 students was divided into two equivalent samples. This was done using the SPSS sampling procedure with replacement. Hence, the two samples are equivalent, but not independent.

Table 2 shows the summary statistics for each of the scales for both of the subsamples. The calculation of the t-test for the difference between the samples indicates that the two samples were, indeed, equivalent.

Table 3 shows the results of the multiple regression analysis to predict inquiry skill by use of the variables of the Model of

Educational Productivity. Ability is the major predictor of science inquiry, accounting for between 17 and 22 percent of the variance.

The remaining variables accounted for an appreciably smaller amount of the variance. Motivation and classroom environment appear to be behaving differently in the two samples. However, the correlation between these two variables is 0.56, which accounts for the instability between the two variables.

As a further test of the stability of the Model of Educational Productivity, regression equations were generated for each of the subsamples using the calculated beta weights (see Table 4). Each of the equations was then applied to the opposite subsample to determine the ability of the equation from one subsample to predict inquiry skill in the other subsample. A predicted inqiury score (abbreviated INQPRED in the equation) was calculated for each subsample and compared to the actual inquiry score using the Pearson Product Moment Correlation.

In both cases the percent of variance accounted for by the cross-sample prediction is nearly that accounted for by the Model of Educational Productivity for each subsample. For subsample A, the percent variance accounted for by the cross-sample prediction was 30 percent, while for the application of the Model of Educational Productivity variables to subsample A, the percent of variance accounted for was 32.1 percent. For subsample B, the cross-sample correlation accounted for 23 percent of the variance, while the Model of Educational Productivity variables acounted for 24.2 percent of the variance in inquiry skill. Thus, there was a high degree of stability for the regresssion equations generated by the Model of Educational Productivity.

The final analysis applied to the randomly generated subsamples was a calculation of the ability of race and sex to explain inquiry skill (see Table 5). The first two analyses show the results for subsamples A and B when the Model of Educational Productivity is entered into the equation first. In this case, sex and race contributed only about one percent to the explanation of inquiry skill beyond that explained by the Model of Educational Productivity. The second two analyses show the results for subsamples A and B when sex and race are entered into the equation first. The two variables still only accounted for a small amount of the variance, with the Model of Educational Productivity variables accounting for 23 to 31 percent of the variance in inquiry skill.

Thus, several points are raised by this analysis which are necessary to consider before undertaking the analyses of the regression equations for males and females, and for whites and nonwhites.

Specifically, it is important to note that there appear to be two classes of predictor variables. In both subsamples, ability acted as a "major" predictor of inquiry skill, being associated with between 17 and 22 percent of the variance. After ability, the five remaining predictor variables acted as "minor" predictors, contributing approximately 0 to 4 percent of the variance. Hence, it would be expected in the sex and race brakdown analyses that this same trend of "major" and "minor" predictors would be seen. This is consistent with the literature which indicates that ability is a major predictor of achievement. Thus, in the sex and race breakdown analyses, it would be appropriate to enter ability into the equation first.

It is also important to note that there was a fair degree of instability among the minor predictors. Because they all have similar correlations with the outcome measure, and generally have similar intercorrelations with each other, small differences in these correlations will have a major effect on the order in which the variables enter the equation. Therefore, it will be important to be aware of this instability when interpreting the results of the regression analyses for the sex and race breakdowns.

Finally, one particular pair of predictor variables, classroom environment and motivation, were particularly susceptible to instability caused by their high correlations. The difficulty of interpreting the effects of the variables can be eliminated by combining the two clusters into one. Together, the combined cluster measures students' attitudes about science learning -- both in-class (the former classroom environment scale) and out-of-school (the former motivation scale).

Looking at the analysis for males and females, Table 6 shows the comparison between the males and females for each of the predictor variables and for the outcome measure. The two groups differed significantly on two of the measures -- ability and the newly created classroom environment/motivation scale. While these differences are statistically significant, they are quite small.

As was previously seen in the two subsamples, there are two categories of variables (see Table 7). Ability again functioned as a "major" predictor. For the males, ability was associated with approximately 19 percent of the variance in inquiry skill, and for the females it was associated with approximately 20 percent of the variance. This is comparable to the percent of variance accounted for in the two randomly generated subsamples.

The remaining variables acted as "minor" predictors. For males, this group of minor predictors was associated with 11.9 percent of the variance while for females this same group of variables was assocated with 8.7 percent of the variance.

Thus, it would appear that the results of the regression analyses for the two samples are relatively similar. To test this, regression equations for the two samples were generated from the calculated beta weights (see Table 8). The equation generated from the male sample was applied to the female sample and the equation from the female sample was applied to the male's sample data.

As shown in Table 8, the regression equation calculated from the male sample was capable of explaining 28 percent of the variance in the female sample. This was only slightly less than the amount of variance explained by the full set of variables when applied to the female sample.

The equation calculated from the female sample was nearly as effective in accounting for the variance in inquiry skill of the males. This equation accounted for 29 percent of the variance, as compared to 31 percent of the variance explained by the full set of variables when applied to the male sample.

A similar approach was applied to the prediction of inquiry skill for white and nonwhite samples. Table 9 shows the comparison of these samples for each of the study variables.

The white and nonwhite samples differed significantly (at the .001 level) on five of the six study variables. Only on quantity of instruction did they not differ at that level.

Table 10 shows the results of the multiple regression analyses for the white and nonwhite samples. The white sample behaved as expected from previous analyses on the two randomly generated subsamples and on males and females. Again, two sets of variables are evident. Ability accouted for the greatest amount of variance in the inquiry skill of white students at 20.7 percent. This is comparable to levels obtained from previous analyses of other samples. The classroom environment/motivation variable entered the equation second, accounting for 6.0 percent of the variance. The remaining variables accounted for three percent or less of the variance.

The results of the multiple regression analysis for the nonwhite students did not behave as predictably. While there still appears to be two categories of predictor variables, the distinction between the "major" and "minor" predictors is much less distinct. When ability was entered into the equation first, it accounted for only 6.4 percent of the variance in inqury skill. This is substantially less than the contribution of ability to the explanation of inquiry skill for white students. Quantity of Instruction, a variable which accounted for little of the variance in previous analyses, entered the equation second, accounting for 4.9 percent of the variance. The other variables each contributed to less that three percent of the explained variance.

Thus it would appear that for most students their general academic ability, rather than any particular activity or exposure to science instruction, would account for the greater amount of their science inquiry skill. This is not true for nonwhite students. For this population, their exposure to science classs has an important relationship with their skill in science inquiry.

As before, the efficacy of the generated prediction equations for predicting the science inquiry skill of another sample was tested (see

Table 11). The regression equation generated from the sample of white students was applied to the data from the sample fo nonwhite students. This equation accounted for 15 percent of the variance in the inquiry skill of nonwhite students. This is compared to 18 percent of the variance accounted for when the Model of Educational Productivity is applied to the nonwhite sample. When the regression equation generated from the nonwhite sample was applied to the white data set, it was able to account for 26 percent of the variance in the inquiry skill of white students. This compares to 32 percent of the variance acocunted for when the full Model of Educational Productivity is applied to the white sample.

Conclusions

The first purpose of this study was to test the effectiveness of the Model of Educational Productivity for predicting the inquiry skill of 17-year-olds. The results of this study indicate that this model is capable of accounting for between 24 and 32 percent of the variance in inquiry skill for the general population of 17-year-olds. More specifically, ability alone accounts for between 17 and 22 percent of the variance in inquiry skill for the general population.

The second question posed by this study asked whether the prediction of inquiry skill differed for males and females. While was some difference in the contribution of the minor predictors, there was very little difference in the prediction of inquiry skill for males and females using the Model of Educational Productivity.

The third question posed by this study asked whether the prediction of inquiry skill differed for white and nonwhite students. For nonwhite students, the Model of Educational Productivity accounted for only 18 percent of the variance in science inquiry skill. More specifically, for nonwhite students, ability accounted for only 6 percent of the variance in science inquiry skill. Thus, it would appear that there is a great deal that we do not know about the factors that contribute to the science inquiry skill of nonwhite students.

A practical outcome of these results is the question, how can science classes or science materials be structured to account for the differences in factors which predict inquiry skill? If this latter goal can be achieved, then the ethnic disparity in science achievement which has been so well documented ober the past two decades may well be on the way to being eliminated and the goal of science literacy foi all citizens on the way to being achieved.

REFERENCE

Cobb, C. W., & Douglas, P. H. A theory of production. American Economics Review, 1928, 18, 139-165.

Harms, N. C. & Yager, R. E. (Eds.) What research says to the science teacher, volume 3. Washington, DC: National Science Teachers Association, 1981.

Hyman, H. Secondary analysis of sample surveys: Principles, procedures, and potentialities. New York: John Wiley and Sons, 1972.

Stake, R. E. & Easley, J. A., et al. Case studies in science education. Urbana, IL: Center for Instructional Research and Curriculum Evaluation, University of Illinois, 1978.

Walberg, H. J., Haertel, G. D., Pascarella, E., Junker, L. K., and Boulanger, F. D. Probing a model of educational productivity in science with national assessment samples of early adolescents. American Educational Research Journal, 1981, 18(2), 233-249 (a)

Walberg, H. J. A psychological theory of educational productivity. In F. H. Farley and N. J. Gordon (Eds.), Psychology and education: the state of the union. Berkely, CA: McCutchan Publishing Corporation, 1981, 81-108. (b)

Walberg, H. J., and Weinstein, T. The production of achievement and attitude in high school social studies. Journal of Educational Research, 1982, 75(5), 285-293.

Yeany, R. A study of the research priorities as perceived by public school personnel. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Atlanta, GA, March, 1979.

FIGURE 1

SAMPLING STRATIFICATION SCHEME

STAGE ONE - GEOGRAPHIC STRATA

PRIMARY SAMPLING UNITS (PSU's) - COUNTIES OR CONTIGUOUS COUNTIES

REGION

STATE

SIZE OF COMMUNITY

SES - OR SMALLER COMMUNITY SIZES

STAGE TWO - SCHOOL DATA

ALL PUBLIC AND PRIVATE SCHOOLS WITHIN EACH STRATA

SES - FOR LARGER COMMUNITIES

STAGE THREE - STUDENT STRATA

RANDOM SAMPLING OF ALL STUDENTS

RANDOM ASSIGNMENT OF AN ASSESSMENT BOOKLET

FIGURE 2

ITEM MEASURING ABILITY

Which one of the following best describes your grades so far in high school?

8.8	Mostly A
19.4	About half A and half B
19.1	Mostly B
28.2	About half B and half C
13.0	Mostly C
8.2	About half C and half D
1.2	Mostly D
1.5	Mostly below D

FIGURE 3

ITEMS MEASURING MOTIVATION

How often have you done each of the following activities when not required for science classes?

Item	Often	Sometimes	Seldom	Never
A. Read science articles in magazines	14.7*	36.8*	30.6	17.7
B. Read science articles in newspapers	10.8*	36.3*	34.6	18.0
C. Watched science shows on TV	21.5*	42.2*	24.2	11.9
D. Gone to hear people give talks on science	1.6*	5.4*	23.5	69.3
E. Read books about science or scientists	6.3*	20.5*	34.9	38.1
F. Talked about science topics with your friends	7.6*	31.5*	37.3	23.5
G. Done science projects	10.7*	32.6*	29.5	26.9
H. Worked with science-related hobbies	9.1*	24.1*	36.3	30.3

FIGURE 4

ITEMS MEASURING QUANTITY OF INSTRUCTION

How much have you studied the following subjects in the 9th, 10th, 11th, and 12th grades?

		Studied 1 school year	Studied ½ school year	Studied less than ½ year	Not studied	I don't know.
A.	General Science	59.7	5.5	2.4	27.5	2.6
B.	Life Science	24.2	9.1	4.8	49.8	7.3
C.	Biology	73.8	5.5	2.1	15.0	0.8
D.	Health	33.3	35.2	9.8	16.1	1.4
E.	Environmental Science	11.0	8.3	8.1	60.3	7.2
F.	Chemistry	29.1	5.1	3.6	57.5	1.6
G.	Physical Science	30.4	6.1	5.5	48.5	4.6
H.	Physics	10.6	2.4	2.4	76.6	3.2
I.	Earth Science	26.2	8.0	7.8	51.6	2.9
J.	Geology	3.5	3.1	4.4	80.7	4.3
K.	Other Science Courses (specify)					
	1. ________	5.8	2.2	0.3	14.1	0.7
	2. ________	1.2	0.7	0.2	13.2	0.5
	3. ________	0.4	0.1	0.3	13.6	0.4
	4. ________	0.2	0.0	0.1	13.4	0.4
	5. ________	0.1	0.0	0.0	13.5	0.7

FIGURE 5

ITEMS MEASURING THE CLASSROOM ENVIRONMENT

How often have science classes made you feel

A. uncomfortable?

Always	Often	Sometimes	Seldom	Never
5.0	14.3	37.5	27.1*	15.9*

B. curious?

Always	Often	Sometimes	Seldom	Never
12.7*	40.5*	34.3	9.6	2.6

C. stupid?

Always	Often	Sometimes	Seldom	Never
3.9	10.2	28.2	28.9*	28.6*

D. confident?

Always	Often	Sometimes	Seldom	Never
4.2*	22.8*	43.8	21.5	7.4

E. successful?

Always	Often	Sometimes	Seldom	Never
4.8*	25.2*	43.8	17.8	8.1

F. unhappy?

Always	Often	Sometimes	Seldom	Never
5.6	13.5	27.8	30.9*	22.1*

FIGURE 5, CONT.

ITEMS MEASURING CLASSROOM ENVIRONMENT
(CONTINUED)

How do you feel about each of the following statements? Fill in only one oval on each line.

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
C.	I usually have been at ease during science tests.	7.0*	33.8*	16.3	34.1	8.3
E.	I look forward to attending science classes.	6.4*	23.4*	25.3	26.8	17.6
H.	I feel uneasy about science labs.	3.1	16.5	22.1	44.8*	13.2*
L.	I enjoy science and science projects.	17.6*	36.1*	21.1	20.7	4.5
P.	I do not enjoy working science problems.	11.9	28.0	22.5	29.9*	7.5*

FIGURE 6

ITEMS MEASURING THE HOME ENVIRONMENT

32. How much school did your father complete?
(FILL IN THE ONE OVAL which best shows how much school your father completed.)

4.5	Did not complete the 8th grade
5.0	Completed the 8th grade, but did not go to high school
12.5	Went to high school, but did not graduate from high school
28.4	Graduated from high school
18.4	Some education after graduation from high school
22.5	Graduated from college
8.2	I don't know.

33. How much school did your mother complete?
(FILL IN THE ONE OVAL which best shows how much school your mother completed.)

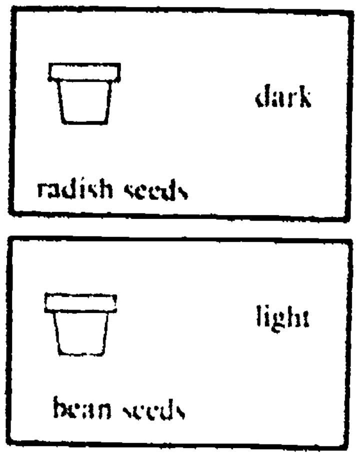
2.4	Did not complete the 8th grade
2.7	Completed the 8th grade, but did not go to high school
13.9	Went to high school, but did not graduate from high school
39.3	Graduated from high school
18.7	Some education after graduation from high school
17.1	Graduated from college
5.2	I don't know.

FIGURE 7

SAMPLE INQUIRY ITEM

Science Process

Tom wanted to find out whether plants can grow better in the dark or in the light. He put a pot with 6 radish seeds in a dark room and a pot with 6 bean seeds on the window sill.



He added the same amount of water to both pots. The bean seeds grew better than the radish seeds, so Tom said his plants grow best in the light.

To be able to say this, he should have

- ☐ watered both pots more.
- ☐ watered the radish seeds more.
- ■ put the same kind of seeds in both pots.
- ☐ grown the seeds in water instead of soil.
- ☐ I don't know.

Decision Making

The city council must decide whether to use a piece of land to build a factory or a park. There is a conflict between those who favor economic growth and those concerned with environmental quality. Is each of the following a statement of a goal or desired outcome of the solution chosen, or a statement of a barrier or obstacle to the solution of the problem?

	Goal	Barrier	I don't know
A. Both purposes cannot be achieved on the same land at the same time	☐	■	☐
B. There is no other land available that is as good for either purpose.	☐	■	☐
C. The decision should be acceptable to a majority of the citizens.	■	☐	☐
D. The decision should not greatly increase air pollution or unemployment	■	☐	☐
E. The local newspaper is pushing strongly for using the area for a park and will fight any compromise.	☐	■	☐

TABLE 1

DEMOGRAPHIC CHARACTERISTICS OF THE SAMPLE OF 17-YEAR-OLDS (N = 1955)

SEX	
MALE	46.4
FEMALE	53.6
ETHNICITY	
WHITE	80.1
NONWHITE	19.9
REGION	
NORTHEAST	25.8
SOUTHEAST	21.8
CENTRAL	29.2
WEST	23.2
CITY SIZE	
BIG CITY	25.2
MEDIUM CITY	9.0
SMALL CITY	37.0
FRINGE AREA	28.8
TYPE OF CITY	
ADVANTAGED URBAN	11.7
DISADVANTAGED URBAN	13.1
RURAL	10.9
OTHER	64.3

TABLE 2

Means, Standard Deviations, Tests of Differences Between the Means, and Reliability Coefficients for the Measures Used in the Study for Randomly Generated Half Samples

Variable	No. of Items	Sample	Mean	S.D.	Δ Mean	t	p	Rel.
Ability	1	A	5.43	1.65	0.07	0.94	0.65	NA
		B	5.36	1.66				NA
Classroom Environment	11	A	3.21	0.71	0.03	0.95	0.65	0.81
		B	3.18	0.70				0.81
Home Environment	2	A	4.62	1.13	0.05	0.98	0.64	NA
		B	4.57	1.13				NA
Motivation	8	A	2.18	0.60	0.00	0.00	1.00	0.72
		B	2.18	0.60				0.74
Quality of Instruction	1	A	1125.69	1446.92	-14.00	-0.22	0.85	NA
		B	1140.68	1513.12				NA
Quantity of Instruction	4	A	3.71	1.76	-0.03	-0.38	0.78	NA
		B	3.74	1.78				NA
Inquiry Skill	17	A	10.70	3.10	0.03	0.22	0.85	0.63
		B	10.67	3.04				0.58

Sample A, N=1018
Sample B, N=959

TABLE 3

Results of Multiple Regression Analysis
For Randomly Generated Half Samples

Subsample A (N=1018)

Outcome Measure	Variables Entered	Multiple R	R^2	% Added Variance	F	p
Inquiry Skill	Ability	.47	.22	22.0	287.0	.001
	Home Environment	.51	.26	3.7	50.9	.001
	Motivation	.53	.28	2.5	35.0	.001
	Quality of Instruc.	.55	.30	1.7	25.4	.001
	Quantity of Instruc.	.56	.31	1.4	21.0	.001
	Classroom Environ.	.57	.32	0.7	10.1	.002

Subsample B (N=959)

Outcome Measure	Variables Entered	Multiple R	R^2	% Added Variance	F	p
Inquiry	Ability	.41	.17	16.6	190.2	.001
	Quality of Instruc.	.44	.19	2.6	31.1	.001
	Classroom Environ.	.46	.21	2.3	26.9	.001
	Home Environment	.48	.23	1.9	23.5	.001
	Quantity of Instruc.	.49	.24	0 8	9.5	.002
	Motivation	.49	.24	0.2	2.2	.139

TABLE 4

Cross-Sample Prediction for Randomly Generated Half Samples

Source of Prediction Equation	Source of Sample	r	r^2
SUBSAMPLE A[1]	SUBSAMPLE B	.48	.23
SUBSAMPLE B[2]	SUBSAMPLE A	.55	.30

SUBSAMPLE A EQUATION[1]

INQPRED=1.12+(.62*ABL)+(.49*HOM)+(.43*MOT)+(.0003*QUL)+(.22*QUN)

SUBSAMPLE B EQUATION[2]

INQPRED=.308+(.58*ABL)+(.75*CLS)+(.0003*QUL)+(.38*HOM)

TABLE 5

Results of Multiple Regression Analysis
For Randomly Generated Half Samples
With Race and Sex

Subsample A (N=1018)

Outcome Measure	Variables Entered[1]	Multiple R	R^2	% Added Variance	F	p
Inquiry Skill	Productivity Model	.57	.32	32.1	79.5	.001
	Race	.57	.33	0.9	13.9	.001
	Sex	.58	.33	0.1	2.7	.098

Subsample 3 (N=959)

Outcome Measure	Variables Entered[1]	Multiple R	R^2	% Added Variance	F	p
Inquiry Skill	Productivity Model	.49	.24	24.2	50.8	.001
	Race	.50	.25	0.9	11.7	.001
	Sex	.50	.25	0.2	2.3	.128

Subsample A (N=1018)

Outcome Measure	Variables Entered[2]	Multiple R	R^2	% Added Variance	F	p
Inquiry Skill	Race	.13	.02	1.7	17.3	.001
	Sex	.13	.02	0.1	0.6	.447
	Productivity Model	.57	.33	31.3	62.1	.001

Subsample B (N=959)

Outcome Measure	Variables Entered[2]	Multiple R	R^2	% Added Variance	F	p
Inquiry Skill	Race	.13	.02	1.7	16.2	.001
	Sex	.13	.02	0.0	0.1	.789
	Productivity Model	.50	.25	23.3	39.7	.001

TABLE 6

Means, Standard Deviations, Tests of Differences Between the Means, and Reliability Coefficients for the Measures Used in the Study for Male and Female Samples

Variable	No. of Items	Sample	Mean	S.D.	Δ Mean	t	p	Rel.
Ability	1	M	5.16	1.63	-0.49	-6.82	.001	NA
		F	5.65	1.55				NA
Classroom/ Motivation	19	M	3.29	0.62	0.17	6.10	.001	0.90
		F	3.12	0.62				0.90
Home Environment	2	M	4.58	1.14	-0.06	-1.10	.272	NA
		F	4.64	1.14				NA
Quality of Instruction	1	M	1121.36	1458.62	-7.56	-0.11	.909	NA
		F	1128.92	1473.15				NA
Quantity of Instruction	4	M	3.72	1.81	0.04	0.54	.588	NA
		F	3.68	1.76				NA
Inquiry Skill	17	M	10.90	3.22	0.24	1.75	.084	0.71
		F	10.66	2.84				0.63

Male Sample, N=919
Female Sample, N=1036

TABLE 7

Results of Multiple Regression Analysis for Male and Female Samples

Male Sample (N=919)

Outcome Measure	Variables Entered	Multiple R	R^2	% Added Variance	F	p
Inquiry Skill	Ability*	.43	.19	18.8	212.3	.001
	Classroom/Motiv.	.49	.24	5.4	64.8	.001
	Home Environment	.53	.28	4.3	54.6	.001
	Quantity of Instr.	.55	.30	1.4	18.4	.001
	Quality of Instr.	.55	.31	0.8	10.6	.002

Female Sample (N=1036)

Outcome Measure	Variables Entered	Multiple R	R^2	% Added Variance	F	p
Inquiry Skill	Ability*	.45	.20	20.0	259.3	.001
	Home Environment	.48	.23	3.4	46.0	.001
	Quantity of Instr.	.51	.26	2.2	30.9	.001
	Quality of Instr.	.52	.28	1.8	25.8	.001
	Classroom/Motiv.	.54	.29	1.3	19.0	.001

*Ability was entered first. The other variables were entered using the step-wise procedure

TABLE 8

Cross-Sample Prediction for Male and Female Samples

Source of Prediction Equation	Source of Sample	r	r^2
MALE SAMPLE[1]	FEMALE SAMPLE	.53	.28
FEMALE SAMPLE[2]	MALE SAMPLE	.54	.29

MALE SAMPLE EQUATION[1]

INQPRED=0.85+(.55*ABL)+(.53*HOM)+(.23*QUN)+(.0002*QUL)+(1.13*CLSMOT)

FEMALE SAMPLE EQUATION[2]

INQPRED=2.47+(.61*ABL)+(.41*HOM)+(.20*QUN)+(.0003*QUL)+(.58*CLSMOT)

TABLE 9

Means, Standard Deviations, Tests of Differences Between the Means, and Reliability Coefficients for the Measures Used in the Study for White and Nonwhite Samples

Variable	No.of Items	Sample	Mean	S.D.	Δ Mean	t	p	Rel.
Ability	1	W	5.50	1.62	0.42	4.55	.001	NA
		N	5.08	1.50				NA
Classroom/ Motivation	19	W	3.17	0.62	-0.23	-5.20	.001	0.91
		N	3.34	0.56				0.87
Home Environment	2	W	4.71	1.08	0.49	6.81	.001	NA
		N	4.22	1.30				NA
Quality of Instruction	1	W	1202.14	1594.72	398.78	7.83	.001	NA
		N	803.36	608.11				NA
Quantity of Instruction	4	W	3.75	1.78	0.24	2.32	.020	NA
		N	3.51	1.81				NA
Inquiry Skill	17	W	11.07	2.98	1.56	9.17	.001	0.68
		N	9.51	2.90				0.60

TABLE 10

Results of the Multiple Regression Analysis for White and Nonwhite Samples

White Sample (N=1579)

Outcome Measure	Variables Entered	Multiple R	R^2	% Added Variance	F	p
Inquiry Skill	Ability*	.45	.21	20.7	410.6	.001
	Classroom/Motiv.	.52	.27	6.0	128.4	.001
	Home Environment	.54	.30	3.0	66.7	.001
	Quantity of Instr.	.55	.31	1.1	25.5	.001
	Quality of Instr.	.56	.32	0.9	21.8	.001

Nonwhite Sample (N=376)

Outcome Measure	Variables Entered	Multiple R	R^2	% Added Variance	F	p
Inquiry Skill	Ability*	.25	.06	6.4	25.4	.001
	Quantity of Instr.	.34	.11	4.9	20.5	.001
	Classroom/Motiv.	.38	.14	2.9	12.5	.001
	Home Environment	.40	.16	2.0	6.4	.003
	Quality of Instr.	.42	.18	1.4	6.4	.012

*Ability was entered first. The other variables were entered using the step-wise procedure.

TABLE 11

Cross-Sample Prediction for White and Nonwhite Samples

Source of Prediction Equation	Source of Sample	r	r^2
WHITE SAMPLE[1]	NONWHITE SAMPLE	.39	.15
NONWHITE SAMPLE[2]	WHITE SAMPLE	.51	.26

WHITE SAMPLE EQUATION[1]

INQPRED=1.51+(.59*ABL)+(1.06*CLSMOT)+(.43*HOM)+(.19*QUN)+(.0002*QUL)

NONWHITE SAMPLE EQUATION[2]

INQPRED=3.90+(.27*ABL)+(.93*CLSMOT)+(.32*QUN)