ECOLOGICAL AND PERSONAL PREDICTORS
OF SCIENCE ACHIEVEMENT IN AN URBAN CENTER

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This study sought to examine selected personal and environmental factors that predict urban students’ achievement test scores on the science subject area of the Ohio standardized test. Variables examined were in the general categories of teacher/classroom, student, and parent/home. It assumed that these clusters might add independent variance to a best predictor model, and that discovering relative strength of different predictors might lead to better selection of intervention strategies to improve student performance.

This study was conducted in an urban school district and was comprised of teachers and students enrolled in ninth grade science in three of this district’s high schools. Consenting teachers (9), students (196), and parents (196) received written surveys with questions designed to examine the predictive power of each variable cluster. Regression analyses were used to determine which factors best correlate with student scores and classroom science grades. Selected factors were then compiled into a best predictive model, predicting success on standardized science tests.
Students t tests of gender and racial subgroups confirmed that there were racial differences in OPT scores, and both gender and racial differences in science grades. Additional examinations were therefore conducted for all 12 variables to determine whether gender and race had an impact on the strength of individual variable predictions and on the final best predictor model. Of the 15 original OPT and cluster variable hypotheses, eight showed significant positive relationships that occurred in the expected direction. However, when more broadly based end-of-the-year science class grade was used as a criterion, 13 of the 15 hypotheses showed significant relationships in the expected direction. With both criteria, significant gender and racial differences were observed in the strength of individual predictors and in the composition of best predictor models.
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CHAPTER 1

INTRODUCTION

Science education in American public schools has frequently been criticized as inferior relative to that of other countries. For example, The National Commission on Mathematics and Science Teaching for the 21st Century (2000) cites comparative data from the Third International Mathematics and Science Study (TIMSS, 1995) demonstrating that at the eighth grade level, only 15 out of 40 nations scored lower than United States science students and only two countries out of 20 were lower than the United States at the twelfth grade level. This has improved somewhat by the Third International Math and Science Study (TIMSS-R, 1999) where the United States was reported as 18th out of 38 nations. However, further confirmation of this deficiency is evidenced by a report from the International Studies of Educational Achievement (IEA), comparing science achievement among 23 countries (1992). This report demonstrates that performance of United States students was lower than 19 of these countries. The National Assessment of Educational Progress (NAEP, the “Nation’s Report Card”, 1996) reported the alarming conclusion that more than one-third of all U.S. students lack mastery of basic science knowledge and skills required for proficiency at each grade level.
In 2001, the United States government proposed and approved a new education policy entitled the “No Child Left Behind Act of 2001” (NCLB Act of 2001). It included, as one of its provisions, the need for stronger accountability of educational results. President George W. Bush signed the bill and stated in his January 8th, 2001 speech:

(The) first principle is accountability. Every school has a job to do. And that’s to teach the basics and teach them well. If we want to make sure no child is left behind, every child must learn to read. And every child must learn to add and subtract. So in return for federal dollars, we are asking states to design accountability systems to show parents and teachers whether or not children can read and write and add and subtract in grades three through eight.

This increased accountability is directed toward states, school districts and schools and offers parents more flexibility for school choices based on mandated annual reports from their children’s school districts and schools. Additionally, the NCLB Act increases government funds allocated toward education (Title I Funds) and gives successful schools releases from some government regulations. It further provides financial incentives for maintaining successful programs and provides funds for less successful schools to improve through teacher professional development, student tutoring, summer school programs, resources, and administrative assistance. These priorities highlight the existing trend of increasing accountability for national resources allocated toward education.

As new educational accountability measures are operationalized throughout the country, unusual opportunity exists to gather objective evidence about factors that predict
better performance on science criterion measures. This need to define the achievement criteria of students’ understanding has led to the development of a set of nationally recommended standards of educational performance for each academic content area. Various forms of state, district, school, and student assessment have been used to confirm this accountability. This is most often evidenced by a state-specific standardized test of student knowledge, which, in the state of Ohio, was designated as the Ohio Proficiency Test (OPT). This test was given to fourth, sixth, ninth, tenth, and twelfth grade students and was composed of five content areas. These areas are: citizenship, mathematics, reading, writing, and as of the year 2000, science. All students in ninth and tenth grade levels were tested annually by the OPT in the fall of the school year, with an additional test administration in the spring for students who had not passed all sections of the test that year. The results of each school district’s testing were compared to state standards of achievement, and school districts were evaluated to justify how their academic resources were used. This standardized test has since been phased out in favor of a new test called the Ohio Graduation Test (OGT) for high school and the Ohio Achievement Test (OAT) for all grade levels first through twelfth. This new test was first given in the spring of 2005 to tenth grade students. A passing score on the OGT test is required before graduation. Those who do not successfully pass any of the content areas at the tenth grade offering will be given additional opportunities at testing sessions in the eleventh and twelfth grades.

The State of Ohio had previously established a school district report card based on 25 subject OPT scores, attendance, and graduation rates (1989-1999). As of the fall
semester 2004, revisions were adopted to include 23 state performance indicators based on 21 OGT content area test scores, as well as additional attendance and graduation criteria. These content area performance indicators are the reading and mathematics test scores of the third and eighth grades, the reading, writing, mathematics, citizenship, and science test scores of the fourth and sixth grades, the reading test score of the fifth grade, the mathematics score of the seventh grade, and the reading, writing, mathematics, social studies, and science test scores of the tenth grade. Based on this state rating scale, schools are graded as “excellent” if they pass 21 or more, “effective” if they pass 17 to 20 criteria, under “continuous improvement” if they pass 11 to 16 criteria, under “academic watch” if they pass 7 to 10 of the criteria, and under “academic emergency” if they pass 6 or fewer of the criteria. The results are compared to other similar districts and decisions are made by the Ohio Department of Education (ODE) regarding how successful the schools are and what rank they have in the community. As stated by the ODE publication “From Today’s Results to Tomorrow’s Success – 2000 Annual Report on Educational Progress in Ohio” (2000), Ohio school children have not done well:

Based on 1998-1999 data, Ohio met only 11 state performance standards. Before we can become one of the best educational systems in the nation, we must meet all 27 standards. We face a significant challenge… (p. 4)

Problem

The state of Ohio has designated eight urban districts as needing special attention with their education programs. This list, called the “Big Eight”, includes the cities of
Akron, Canton, Cincinnati, Cleveland, Columbus, Dayton, Toledo, and the Youngstown/Warren area. Among the “Big Eight” urban school districts in Ohio, all were on “Academic Emergency” in the school year 1999-2000. In that year, Ohio used 27 performance criteria (OPT test scores of reading, writing, citizenship, mathematics and science at each of the fourth, sixth, ninth, tenth, and twelfth grade levels plus the attendance and graduation rates) and none of the “Big Eight” met more than 5 of the 27 criteria. In the school year 2000-2001, only two of the eight Ohio cities moved from “Academic Emergency” status to “Academic Watch” status. Yet of the five criterion scores in science, only one of the eight school districts passed a single criterion. Cincinnati’s twelfth grade science passing was at 61.6% out of a required 60%. In other words, out of 40 possible science criteria, only one was passed in Ohio’s eight urban centers.

The district examined in this study met only 6 of the 27 performance standards (out of eight schools and four grade levels), and none of these were in the science content area as reported in the 2001 state report of school performance. In this district, the students tested scored highest in writing, reading and citizenship subject areas, respectively. The science subject area scores were consistently lower and have not met state standards for achievement. The science performance standards are based on national science education standards as put forth by the National Research Council (1996). These standards direct policymakers and educators to address science education in areas such as inquiry learning, science and technology, and personal and social perspectives. The state minimum achievement for tenth grade requires that 85% of students taking the test must
pass. In the examined district the percentage of students passing science proficiency are 79.9% (2000-2001 school year), 71.3% (1999-2000), and 62.4% (1998-1999). As a comparison, the 2000-2001 writing, reading, and citizenship scores were 94.7%, 93.2%, and 84.5%, respectively. Although there has been a trend of improvement across the testing years (the tenth grade science passing percentage scores have increased by 17.5% from 1998 to 2001), the district is still significantly below the state’s minimum passing standard in its ninth through twelfth grade science proficiency content areas. This is an issue of critical importance in the district since the current failing of students to achieve state minimum passing percentages has led to the district being classified as in “academic emergency” status for these four years. Continuation of this rating can lead to state takeover of the school district management, state management of district funding, state curricular control, state revoking of tenure and teacher contracts, as well as various administrative positions in the district. A continuation of this concept of state management of education has been seen most recently in Ohio Governor Strickland’s proposed major jobs plan of February 2008 (2008 State of the State Address). In his plan, the Governor proposes to create a new position within his cabinet, that of a Director of the Ohio Department of Education, and take the control of educational decisions away from the office of the Superintendent of Education. This is done with the stated justification being to make Ohio’s education system “more responsible and accountable” and “lead to more jobs and industry”. To avert this system crisis, and most importantly to improve student science achievement, a more thorough awareness of the factors that
relate to students’ content mastery and understanding must be prioritized. Such awareness needs to be grounded in empirical research for each of the major content areas.

Purpose

The purpose of this study was to examine selected personal and environmental factors that predict urban students’ achievement test scores on the science subject area portion of the Ohio standardized test. More understanding of potentially influential variables offers promise of improvements in science education procedures. The variables examined were in the general categories of teacher/classroom, student, and parent/home. These selected predictors pertain to the teacher/classroom, student, and parent/home variables that may influence the OPT science outcomes. The individual variables examined were as follows:

Teacher/Classroom Variables: (a) years teaching experience, (b) science research experience, (c) continuing professional development experiences (hours taken annually in professional development), and (d) number and type of science laboratories performed weekly.

Student Variables: (a) academic ability as measured by a general academic aptitude variable (high school grade point average), (b) school attendance rate, (c) self-reported hours spent weekly on homework, and (d) science attitudes including self-efficacy.
Parent/Home Variables: (a) parent marital status, (b) parent education level, (c) self-reported parent-school involvement, and (d) self-reported parent time helping with homework (hours weekly).

Hypotheses

Of the four variables within each cluster studied, the following central research questions were examined:

(a) What teacher variables predict better scores on the science portion of the OPT?,

(b) What student variables predict better scores on the science portion of the OPT?, and

(c) What parent and home variables predict better scores on the science portion of the OPT?

These research questions then generated the following hypotheses that were tested in this study:

Hypotheses 1 through 4: There is a positive relationship between student science OPT achievement score and the variables of (1) teacher years of teaching experience, (2) teacher research experience, (3) hours taken annually in professional development activities, (4) hours of science experiments performed weekly.

Hypotheses 5 through 8: There is a positive relationship between student science OPT achievement score and the variables of student (5) high school grade
point average, (6) attendance, (7) self-reported hours spent weekly on homework, and (8) science attitudes.

Hypotheses 9 through 12: There is a positive relationship between student science OPT achievement score and the variables of (9) parent education level, (10) intact parent marital status, (11) self-reported parent-school involvement, and (12) self-reported parent time spent assisting with science homework.

Hypothesis 13: There is a positive relationship between science OPT achievement score and the combined teacher variable cluster.

Hypothesis 14: There is a positive relationship between science OPT achievement score and the combined student variable cluster.

Hypothesis 15: There is a positive relationship between science OPT achievement score and the combined parent/home variables cluster.

Hypothesis 16: There are no differences between males and females on any of the three cluster correlations.

Hypothesis 17: There are no differences between African-American and Caucasian populations in this study on any of the three cluster correlations.

While previous research has examined some specific variables within these categories (e.g. Reynolds & Walberg, 1991), this study attempted to refine prediction of science proficiency by exploring three general sources of variance (i.e., parent, teacher, student characteristics), by comparing the relative strength of each predictive cluster, and
by constructing a best predictor model. These variable categories are believed to influence student science proficiency achievement scores based on previous research that has examined general school achievement. The goal of this research was to identify those variables that are strongest in predicting science proficiency scores and, potentially, future success in science courses and careers. Combinations of specific variables within these categories were examined to construct a “best predictive model”. In addition, gender and racial influences were considered.

For example, although the traditional speculation has been that males surpass females on science achievement, this has not been in evidence in the district in this study. Males and females did not appear to obtain different science proficiency scores. For example in the year 2000 total enrollment results, 63.5% of males (15 525 enrolled) passed versus 61.3% of females (14 726 enrolled), and at the state level the comparable figures were 83.5% (898 218 enrolled) and 81.7% (851 340 enrolled) for males and females, respectively (district and state data was provided by the Ohio Department of Education’s iLRC power user reports database and no standard deviation data was provided). Beyond confirmation of the year 2000 results, this study examined possible differences in strength of predictor variables according to gender.

Within the United States, progress in science education is particularly difficult in urban settings. Racial differences continue to be significant, even though some progress has been made during the period of 1982-1994 (Blank & Langesen, 1997). In the city where the studied district is located, the 2000 science proficiency scores for Caucasians and African-Americans differ significantly. At each of the ninth, tenth, and twelfth grade
levels, the percentage of Caucasians passing the proficiency tests exceeds that of African-Americans by margins of 29.1%, 29.5%, and 25.8%, respectively. Clearly, there is a need to improve science achievement for all of our students, particularly those in urban schools which typically include large numbers of African-Americans students.

Too often, racial differences are confounded by socioeconomic status (SES). William Jeynes discusses measurements of SES and states that SES is usually examined by assessing three factors: family income, parental education, and parental occupation (Jeynes, 2002). African-Americans are disproportionately represented in lower SES groups and various explanations for this disproportion have been put forth. For example, family ecological conditions such as family income, family structure, number of children, and maternal education were identified as likely causal factors by Moynihan more than 40 years ago (Moynihan, 1965). Some past reviews of this report have been critical of its political message and the social science research methodology, calling it an outdated frame of reference with updated statistics (Schneider, 1998). More recent studies however, have confirmed the impact of SES and family structure on African-American families. Newcomb et al. (2002) studied SES and racial interactions and correlated SES, ethnicity, and academic performance. In their study, African-American ethnicity was negatively correlated with higher SES. Baer (1999) also demonstrated that SES was strongly correlated with ethnicity in relations to family structure and stability, and Starkey (1996) confirmed Moynihan’s main assertion that unemployment and maternal domination of family structure destabilizes African-American families. Therefore, in order to understand the effects on education, a concerted effort is needed to gain an
empirical understanding of both personal and family ecological factors that predict student success.

In summary, an extensive set of variables might be considered as potential predictors of student achievement; however, a more limited set can be identified using past research as a guide. This study surveyed past research that included single predictors and selected a manageable set that might contribute to an efficient predictor model (Reynolds & Walberg, 1991; Cooper et al., 1999; Manz et al., 2004). It assumed that teacher, student, and parent variables might add independent variance to a best predictor model, and it further assumed that discovering relative strength of different predictors might lead to better selection of intervention strategies to improve student performance.

Reason for Researcher’s Interest in the Problem

My own interest in this topic stems from my experiences as high school science teacher and as a university instructor and college teaching fellow. In these positions I have seen numerous students struggle with science concepts and how they comprehend the topics presented in their courses. My own experiences led me to a few hypotheses regarding why some students are more successful than others in understanding science. During personal examination of my own teaching performance as well as that of my colleagues’ and our school district’s science education resources, I noted that despite our strong efforts to promote science mastery, our students continue to perform poorly on standardized science tests. In searching for answers, I questioned the role of parents, the
characteristics of teachers, and the commitment of students to science education. I have wanted to be able to improve my students’ understanding and appreciation for science. Through courses in my degree program, I gained some insight into the literature and research regarding science learning. I see inconsistencies and gaps in our empirical foundations and only limited application of these research results at the day-to-day level of the public schools in my district. It is my hope that the information provided by a careful analysis of the personal and ecological variables that may influence science education will encourage school personnel to improve science achievement and will serve as a guide for raising the appreciation and understanding of science in the public education setting.
CHAPTER 2

RELATED LITERATURE

Introduction

The relative recency of the Ohio proficiency testing movement has limited available research to assist school personnel in addressing student test performance. However, within the examined school district, one study has previously been conducted to examine factors that relate to successful performance on the re-examination when students fail the OPT initially (Clark, 1997). This study was limited to student performance on the ninth grade mathematics exam. Relevant to the proposed study, this prior research examined, among other variables, gender, race, school attendance and cognitive ability. Race, school attendance, and cognitive ability were related to test performance with African-American students, low-ability students, and frequently absent students performing more poorly on the retest. No effect was noted for gender. This review of literature has not revealed any other studies examining the prediction of OPT scores for urban students. Moreover, the Clark study did not address science test performance, and focused only on those students who had initially failed the math portion of the OPT. The predictor variables in the current study also represent a significant expansion of those used in the prior Clark research.
A wide scale examination of science education was performed internationally in 1995, 1999, and 2003. This study, known as the Third International Mathematics and Science Study (TIMSS, 1995), assessed 4th, 8th, and 12th grade students, teachers and educational programs. When results were examined, the United States showed significant overall science score improvement across all three measurement years. Out of 17 different science content areas, the United States was above the international average for 14 areas. In more detailed analyses of U.S. gender and ethnicity data, both genders and each ethnicity showed science score improvement across the 1995 to 2003 study period. However, females had lower scores than males and African-Americans had lower scores than Caucasians at both the 4th and 8th grade levels (TIMSS, 1995).

Teacher/School Variables

Support for inclusion of the variables utilized in this study can be found in prior research literature. A brief selected review of these references illustrates the potential of the chosen predictors. For example, considering the science teacher variables and their role in student achievement and attitudes for 147 subjects, Wright & Hounsell (1981) concluded that “within the school environment, teachers were the greatest influence” (p. 379). Subsequently, there has been much written about the effect that teaching style, teacher competence, and teacher training have on student achievement. Through examination of these references, the primary teacher factors of (a) years teaching experience, (b) teacher science research experience, (c) time spent in professional development programs, and (d) teacher use of laboratory time have been generally identified as having predictive value for student science achievement.
The first teacher variable, teacher’s years of experience, is noted by several authors as an important variable. Lederman (1999) studied five high school biology teachers of varying years of experience (2-15 years) and examined their rural and urban science classrooms. Years of teaching experience was found to be of critical importance to the teacher’s instructional practices and their students’ understanding of the nature of science. Similarly, Burry-Stock and Oxford (1994) developed an expert science teaching educational evaluation model (ESTEEM) and showed that years of teaching experience correlated with student achievement and teacher expertise on classroom activities (n=46 teachers and approximately 200 students). However, a further study by Yager et al. (1988) utilizing a Chi squared analysis of 6th through twelfth grade science teachers (n=321) with one to more than 20 years of science teaching experience failed to show that increasing years of teacher experience leads to a significant increase in teacher effectiveness. This study was based on the “subjective” rating of these teachers by supervisors and did not correlate teacher effectiveness with actual student science grades.

In examination of questions regarding teacher seniority assignments to classes of “better students”, Bosworth and Caliendo (2007) elaborated on the idea of teacher preferences for classes with “high” or “low” ability students. They used mathematical models that demonstrated that teacher choice to use different instructional methods and/or time toward different ability students was governed by administrative assignments. They demonstrated that these assignments were dictated by administrative goals of either raise the overall academic average or close the achievement gap. Individual teacher choice of which class to teach was not a factor in administrative
assignment (Cohen-Vogel & Osborne-Lampkin, 2007). In my personal experience, I have found that teachers with more seniority often teach earlier grades and will teach lower level classes in order to have fewer classes to prepare for. Thus, they trade off higher student ability for less teacher time requirements. Additionally, administration often will assign both lower level classes and upper level classes to all teachers to avoid personnel or union complaints issues (Vann, 1992).

The second teacher variable, science research experience, has also been suggested to be important in predicting science student achievement. Fraser-Abder and Leonhardt (1996) examined research internships that place science teachers (n=10) with laboratory scientists for extended time periods. They found that these teachers gained valuable insights into how science was conducted and increased their confidence in teaching science. The university faculty involved in the project noted that there was a significant increase in science achievement by students of the intern’s classes. Increases in teacher comfort with inquiry-methodology and understanding of science were also seen in studies by Melear et al. (2000; n=7) where pre-service teachers were given inquiry based experiences during a science education class and Raphael et al. (1999; n=75) that examined the effect of science research experience on pre-service teachers. In both cases the pre-service teachers benefited in their understanding and comfort with science methodologies due to participating in open-ended science research experiences.

The third teacher variable, teacher time spent in professional development programs, has been identified by the current set of national science education standards (National Research Council, 1996) as a major factor in teacher quality and it is implicated
in science teacher abilities and student science achievement. In a review of current reform programs of teacher pedagogical knowledge, van Driel et al., (2001) found that while short-term, intensive workshops improved teacher content knowledge, long-term professional development programs were needed to change teachers’ practical knowledge (defined as knowledge “constructed in the context of their work, practical knowledge integrates experiential knowledge, formal knowledge, and personal beliefs” pg.137). In a large scale study (n=3464), Supovitz and Turner (2000) demonstrated this pattern of teacher competence by examining the effects of professional development on science teaching practices and classrooms. They found that teacher comfort and use of inquiry and investigative classroom methodology increased significantly after 80 and 40-79 hours of professional development, respectively. A further elaboration of this point is made by Yager et al. (1988) who examined differences in teacher effectiveness among 321 teachers and found significant differences between them based on the number of weeks of National Science Foundation (NSF) workshop experiences and the number of in-service experiences during a five-year period.

The fourth teacher variable, hours spent weekly on student classroom laboratory experiences, has been demonstrated to be important in the development of student science attitudes and subsequent science proficiency. A study by Freedman (1997), which included data from a large urban center, demonstrated that students with regular laboratory activities had significantly higher science achievement scores and demonstrated improved science attitudes (n=277, F=39.68, p<.01). Glasson (1989) showed a pattern of improved procedural ability due to hands-on activities when he
examined the differences between student activities and teacher demonstrations (n=44, \( r = .35, p<.05 \)). A 1996 study by Stohr-Hunt investigated the frequency of hands-on science experiences for eighth graders and found that their achievement was significantly higher if they had daily or weekly activities compared to those with monthly, less than monthly, or no science activities. In yet another confirmation of this relationship, Ertepinar and Geban (1996) studied an investigative laboratory approach and its effect on student achievement. They observed a significant improvement in science achievement scores from an investigative laboratory student group as compared to a worksheet group (n=24, 599, F = 6.4, p < 0.001). In contrast to these studies, a study of eighth grade students by George and Kaplan (1998) demonstrated a conflicting pattern, whereby increased science experiments had the negative effect on participation in science activities (\( X^2 = 824.3, p<0.001 \)), yet increased science activities had a positive effect on student science attitudes (\( X^2 = 801.2, p<0.001 \)). This discrepancy may reflect modification of the models they used to relate multiple variables of school, student, and home origins, thus, demonstrating a need for further examination of these factors. While there are many more teacher criteria that may be suggested as predictors of student science achievement, these four give a balance between traditional and more recent factors that have been considered in efforts to improve science teaching.

Student Variables

The second category of science achievement predictors, student variables, is obviously important in order to understand which of these characteristics influence science proficiency, and what emphasis should be placed on interventions to improve
related student behaviors and attitudes. The predictors examined in this study were (a) student academic aptitude as inferred by their general high school grade point average, (b) student high school attendance, (c) hours spent weekly on science homework, and (d) science attitudes including self-efficacy.

Student intelligence test scores are often left out of considerations for urban studies due in part to the sensitivities of ethnic groups that feel these measures may show bias against them. This study used the student’s high school grade point average as an inferred measure of general academic aptitude and used this predictor as an index of student cognitive ability as seen in previous literature. However, several authors support the use of IQ tests and note the superior psychometric properties of these instruments (e.g., Neisser et al., 1996; Gage & Berliner, 1984). According to these researchers, general intelligence tests are highly reliable instruments with test-retest reliability coefficients of .85 to .95, and they are generally found to be excellent predictors of school achievement as indicated by school grades ($r = .50$) or standardized achievement tests ($r = .40$ to .70).

Some researchers dispute the genetic component of intelligence and make the assumption that the environment has as much if not more of a role in determining a child’s intelligence and ability. This assumption is contradicted by several studies examining the abilities of twins. One such study by Johnson, McGue, and Iacono (2005) has determined that 75% of the variance seen in ability and grades was genetic ($p<0.01$). Similarly, a study by Segal (1997) of same age, unrelated siblings (adopted children) showed that the IQ correlation of adopted siblings was 0.17 and less than that between
related siblings or twins, thus, asserting that shared environment has a very small correlation with intellectual development. The IQ correlations for monozygotic (of one maternal egg, i.e., “identical”) twins was .86, for dizygotic (of two maternal eggs, i.e. “fraternal”) twins was .60 and for related siblings .50. Such studies lend support to the proposition that the child’s genetic predisposition has a major, stable effect on the child’s academic development.

This is particularly applicable in courses such as science where the subject matter is more academic and abstract and IQ test scores may have correlation coefficients near .70 when predicting achievement (Jensen, 1980 as reported in Berk, 1991). Student intelligence may thus account for as much as 49% of all variability seen in science achievement. Since intelligence test scores were not available for the student sample in this study, the variable of student annual grade point average across all content areas was used as a surrogate index to reflect academic aptitude.

The student predictor of school attendance is also believed to be important to a student’s success on science achievement tests. Since much of high school science is sequentially taught and is based on abstract principles and concepts, missing classes may significantly set a student back in understanding of key science assessment topics. Schneider et al. (1998) reported on science achievement and attendance issues from the National Education Longitudinal Study of 1988 (NELS: 88) data, stating that behavioral problems, including school leavers and those with attendance problems, have a significant negative impact on tenth grade science achievement. A study of 283 subjects by Schinke et al. (2000) looked at the attendance and achievement levels of economically
disadvantaged students living in public housing. They found that an education enhancement program increased grade averages and school attendance \( (F=5.85, p<0.0001) \). A study by Weller (2000; n=1500) examined attendance problems in secondary schools for patterns in their causes and effects. The data revealed that the attendance problems cause students to “miss valuable information resulting from peer and teacher interaction and the benefits of the specific examples teachers use to clarify difficult concepts” (p. 66). These attendance issues may be further manifested in losses of student schoolwork and an inability to complete assignments due to the missed opportunities for understanding and instruction of schoolwork. Therefore, these students could miss valuable content material and understanding that may be used on the standardized test. At certain times, depending on the importance of central science content ideas or proximity to the test data this could have a major influence on the test scores.

The third student predictor variable, hours spent on science homework weekly, has been hypothesized to be related to the two previously described student variables. A large \( (n=26,279) \), world-wide examination of factors that affect public school science achievement by Staver and Walberg (1986) reported that hours of homework and unfinished homework had a combined correlation of \( r=.26 \) \( (p<0.0001) \) with science achievement. The connection between homework quantity and quality and science achievement was also stressed by the U.S. Department of Education (1986). This report noted that with average-ability students, doing 3 to 5 hours of homework a week brings their grades up to levels equal to high-ability students doing less than 1 hour of
homework a week. This study also noted that U.S. students at the twelfth grade level actually work on homework for less than half the time teachers assign and that their amount of outside of school academic work was equal to half that of Japanese students. These data were also examined in the 1992 report on TIMSS. However, in this study the amount of time spent on science homework was not as well related to science achievement. The highest scoring nations of Hungary (70.7% mean science achievement score) and Japan (66.8% mean science achievement score) reported that their students have spent 6.3 and 2.3 hours weekly on science homework, respectively. The United States, with 54.8% mean science achievement score, reported that students have spent 6.7 hours a week on science homework. Clearly, this needs further examination. In a study of 709 students, Cooper et al. (1998) showed that student attitudes about homework and homework completion played a major role in test scores but not overall achievement (r = 0.14, p<0.02). Suggesting that amount of homework and time spent on homework were not related to test scores. However, a meta-analysis by Trautwein and Koller (2003) did show a relationship between time spent on homework and achievement. This relationship was significant even when SES, IQ, and motivation were controlled. Kohn (2007) has also argued that the time spent on homework is related to the amount of frustration a student experiences with school and conflicts with time spent on other activities. He suggests that there needs to be policies to reduce homework amounts in our schools. Finally, a study by Schroeder (2007) examined this homework benefit toward achievement issue and suggested that the amount of homework needs to vary according to student grade level, with the younger grade levels needing less homework and
increasing this amount through successive higher grade levels. As a result of these studies, the importance of homework is questioned as is the amount given. However, Schroeder (2007) states that this is used as an important tool to help prepare students for standardized test. Since this study will examine only one grade level, the inclusion of homework as a variable in this study may need to be tempered with considerations of student attitudes toward science.

The final student variable, science attitude and self-efficacy, is indicated as a strong predictor of science motivation and subsequent science achievement. Numerous studies have investigated this predictor of student achievement in science. George (2000) reported that science self-concept (defined by George as their perceptions of their science abilities) was the strongest predictor of attitudes toward science and that this showed positive correlations between student self-perceptions and learning outcomes. According to George, student self-perception is defined as the perceptions of science as it relates to an interest in science careers, enjoyment of science classes, self confidence in the ability to participate in science careers, as well as the perceived importance of science for the future. As a potential elaboration of this, Germann (1988) found a low correlation between attitude and achievement test results (n=125, r=0.08 to 0.20, p = N.S. to 0.04) but found a moderate correlation between attitude and science grades (n=125, r=.31 to .24, p=0.04). Barrington and Hendricks (1988) confirmed this effect of science attitudes through ANOVA on school grades for both intellectually gifted and average students (n=143, F=28.79, p<0.0001). These studies have examined the effect of science attitudes
on student science achievement. Consequently, this is a student variable that needs to be considered for this study.

Parent/Home Variables

There has been a supposition that these varied effects of student factors are the result of parental role-modeling/stereotyping and home environment. This study also examined selected parent/home ecological factors and their predictive effects on student science achievement. The first of these predictors is the impact of family marital status and resulting family structure. An article by George and Kaplan (1998) investigated the potential effect of family structure on science achievement and found that intact family structure had a slight positive effect on achievement and on parental involvement, which in turn had more significant effects on achievement through interactions with science activities, library/museum visits, and science attitudes. Further study of this predictor and its interactions with gender by Smith (1992), revealed that age and gender were important factors, with ninth grade boys tending to perform equally well with married or separated parents and ninth grade girls performing better with intact families. A further study by McNeal (1999), found that single-headed households have a potential to improve student achievement, possibly through increased parental discussions and involvement with the child over school issues. Kurdek and Sinclair (1998) examined 219 students and found that those from two parent families had higher academic achievement than those with step or single parent families (F(12,418) = 2.01, p=0.02). Similarly, Fantuzzo et al. (2000) studied 641 students and found that children from two parent families had significantly more parental involvement than one parent families
(F(6,1156)= 3.27, p<0.01). Clearly, this predictor requires more examination to clarify its relationship to student academic performance criteria and other possible interactions. Since the parent/home factor of marital status may be important in family income and other socioeconomic variables, it should be included in this study. It may also help address the student’s time for homework and possible parental assistance with homework and school-home communications. These influences on the students’ education will be important to document in terms of the predictability of success on science standardized test scores.

The second parent/home variable of concern in this study is the effect of parent education on achievement. Parent education is one of the most frequently used indices of Socioeconomic Status (SES). Researchers have noted that compared to family income, this SES variable may reveal more about parents’ support for educational objectives for their children, as well as emphasis on learning materials in the home. Several authors have used this as part of their parental/family context group. Smith (1992) reports that parental education level is significantly related to 7th grade science achievement (n=1747, B = 5.282; p < .001) and this variable remains a significant predictor of science achievement throughout the ninth grade as well (n=1747, B = 4.289; p < .01). Using data from the Longitudinal Study of American Youth (LSAY), Wang and Wildman (1995) found similar probability values of 0.001 for both father and mother education parameters (n=3000, b = .957 and 1.850, respectively). Singh et al. (1995) also confirmed this effect and determined that parent education has a correlation of .35 (n=791) on science achievement. George and Kaplan (1998) further investigated the path by which parental
education was significant and noted that the effects on science achievement were manifested through increased home resources, parental involvement, and library/museum visits.

Parental education, and the previous family marital status, are key concepts that researchers use to describe overall family socioeconomic status (SES). Since SES assessments are measures of the financial and cultural resources available to the student, these factors are seen as having a strong influence on the student’s academic performance and abilities. According to Jeynes (2002), SES is traditionally evaluated by family income, parent education, and parental occupation. Jeynes also describes problems with assessing family income and occupation since these are variables that can easily change and may be unreliable in their reporting by the subjects. Parent education is more stable in that marital, job or income changes don’t result in a loss of education.

Turner (1981) examined SES influences on knowledge acquisition and transfer in 288 Caucasian students. SES was measured by parent education and occupation and showed significance in predicting academic performance (n=1,167, F = 3.79, p<0.05). Chappell and Overton (2002) conducted a similar study with 330 African-American students and also found a significant correlation between SES, measured by parent education, and academic performance and grades (r=0.32, p<0.001). This is postulated to be the result of increased home resources available for computers, books, and tutors.

However, the exact mechanism by which SES influences academic performance is unclear. Ginsburg and Pappas (2004) examined 102 students and found that students
with higher SES did have higher academic performance (p<0.01) but there was not a significant difference with underlying knowledge as compared to lower SES students.

A number of other possible interacting factors on SES have also been investigated by researchers. Heffer (1998) examined the effect of religion and SES on the academic performance in 12,200 students. Low SES students were found to benefit from enrollment in a Catholic parochial school as compared to a public high school. Halle et al. (1997) examined 41 low SES students and uncovered a significant relationship between parental expectations and performance (r=0.39, p<0.01) but not between mother education and child academic achievement. Risi et al. (2003) analyzed the impact of peer associations and SES on the academic performance of 524 students. SES was significantly correlated with predicting social influences on academic performance (r=0.38, p<0.01).

Specific interactions of SES on science course grades were examined by Ma (2000) in 6,883 students. The SES gaps in academic achievement were similar between math and science courses (r=0.70) but were different from reading and writing courses (r=0.82). Yang (2003) used a similar analysis of 23,000 TIMSS students and estimated that greater than 35% of math and science achievement is attributed to SES factors (r=0.3 for Caucasians and 0.6 to 0.8 for non-Caucasians). Despite these findings, Cassidy and Lynn (in Jeynes, 2002) state that motivation is more important to academic success than influences by SES factors. These studies reflect the complexity of assessing SES in social research. Jeynes explains this as the result of social scientists trying to control SES by adding SES variables to their study in order to make their models statistically
significant and account for larger amounts of variance. SES is described as a “catch all” variable that attempts to give value to all the human qualities that influence a study. Essentially putting a value on and controlling the “black box” variables of human nature. Social scientists have assumed that these can be summed up by a purely economic and educational variable.

The above two factors—marital status and parent education level--also highlight parent-school involvement as an important predictor of student science achievement. This third variable of the parent/home cluster is often cited in the literature as invaluable to student success. A large-scale study by the National Center for Educational Statistics (Nord, 1997) notes that “In two parent families, involvement of both parents in school is significantly associated with a greater likelihood that their children first through twelfth grades get mostly A’s and that they enjoy school and a reduced likelihood that they have ever repeated a grade”(p. 77). Interestingly, they further note that

Fathers’ involvement has a stronger influence on the children getting mostly A’s than does mother involvement. Among children living in single-father families, high father involvement is associated with a greater likelihood that children in grades 1 through 12 get mostly A’s and is marginally associated with a greater likelihood of their children enjoying school. (p. viii-ix)

A study by Duckworth (1998) confirmed the importance of father involvement. She concluded that increased amount and quality of father involvement had a strong relationship across two years’ time with behavioral adjustment of children with learning disabilities and behavioral handicaps. Among the qualitative descriptors of father
involvement were frequency of assistance with homework and involvement at school meetings.

A study by George and Kaplan (1998) also stressed the importance of parental involvement and examined it in multiple dimensions. Their findings show that parental involvement has a strong predictive value toward science attitudes as well as achievement. McNeal (1999) also notes that parent-child discussions about school, and parent involvement in parent-teacher organizations have significant influences ($r = .150$ and $.115$, respectively; $p < .01$ for both) on cognitive outcomes for some ethnic groups. However, a study by Singh et al. (1995) showed that parental-child communication about school had a moderate positive effect but that parental involvement in school activities had no effect on achievement. They hypothesize that this may be the result of student age and negative peer attention.

Thus, parent education is an important factor in the determination of the SES level of the student and thus, can provide the student with additional resources and time needed for successful education. It has been used to explain other trends in public education and will be used here to provide a predictive factor for the study of student science test score.

The final parental/home predictor of parent help with science homework indicates that the students do want actual direct parental involvement with school science materials. Korpan et al. (1997) reported that parental involvement in conducting science activities and helping with homework was beneficial for younger children (K-6). In contrast to this pattern, Singh et al. (1995) indicate that parent checking of homework has a negative impact on student achievement, possibly reflecting more rigorous household
rules regarding free time and television watching restrictions (n=21835, r=.35, p=.203). The Longitudinal Study of American Youth (LSAY) evaluations by Wang and Wildman (1995) also indicate that helping children with homework has a significant negative effect on student science achievement (n=3000, b = -2.033; p < .001). These authors imply that excessive involvement by parents may deprive their students of personal responsibility and full understanding of the material. As an additional confirmation of this effect, McNeal (1999) reported that in single parent homes, educational support strategies have no impact on achievement. Another study by Cooper et al. (2000) reported that there was a significant interaction between parent homework help and student achievement, with lower achievement resulting from less homework autonomy.

Negative relationships found in these studies may not reflect causality in the direction assumed. Instead of parental help resulting in less student responsibility and therefore poorer achievement outcomes, it is equally plausible to hypothesize that students with poorer academic performance receive more parental homework assistance as an attempted remedy.

All of these predictor variables and their general factor clusters reveal the complex interactions that can exist in education research. This study attempted to clarify some of these relationships by determining the relative predictive power of these personal and ecological variables toward secondary science achievement in an urban setting.

It may be argued that standardized test achievement is not the only form of assessment that may indicate a student’s understanding and comprehension of science concepts. Even so, since current state and federal education funding is closely associated
with proficiency test and graduation results, this study primarily attempted to identify those variables and combinations of variables that can reliably predict success on standardized proficiency tests.

**Additional Factors for Consideration in this Study**

While this study examines the interactions of teacher, student, and home variables contained in the first 15 hypotheses, the additional variables of gender and ethnicity need further discussion. These important personal characteristics may function as mediators of academic performance. In this study, Hypotheses 16 and 17 specifically address gender and ethnicity variables and their correlations with observed academic performance measures.

**Gender**

The broad demographic student characteristics of gender and ethnicity have been previously examined with regard to academic performance. There have been earlier notions that, all things being equal, boys are better in math and sciences and girls are better in language arts and social sciences. However, this simplistic assumption has been vigorously dissected by modern research. The most recent international TIMSS research (TIMSS, 2003) did show that males outperform females in the United States (average overall science score differences in 2003 were 17 points for eighth graders and 5 points for fourth graders). However, this surface examination doesn’t reveal the fact that there were no significant differences for 8th grade science in separate content areas (earth science, life science, physics, chemistry, or nature of science) for the genders. For the 4th
grade science, males were significantly higher in overall science score and in physical and earth sciences. These results are confirmed in an additional study by Beller and Gafni (1996), who examined 3300 students from primary and middle schools and report that males outperform females in science (r=0.26, p<0.05) and that the biggest differences were seen in physics and earth/space science. When the TIMSS study examined 12th graders, males tested significantly higher in all science categories.

When gender attitudes and study skills were examined in the TIMSS study, there were no differences in hours of science studied at the 4th grade level. But female 8th graders showed significantly higher hours than males and this continued through the 12th grade. Females showed significantly better attitudes about science at the 4th grade level but this difference did not exist at the higher grade levels. However, female students report that they study science to understand the topic whereas males state that they work to please their parents, thus, indicating a different locus of control regarding science understanding (TIMSS, 2003).

In 1999, Rebhorn and Miles noted that high stakes tests were not biased to genders but rather teacher expectations may be influencing student expectations of their test performance. Additionally, Ryckman and Peckham (2001) examined 365 students and noted that girls attribute their success or failure to their own efforts, whereas boys attribute it to luck. This is especially the case in math and science where both genders feel less in control as compared to language arts. Newcomb et al. (2002) also examined behaviors and found that of 754 eighth graders, girls had fewer school problems and consequently had better academic competence. A recent 2006 study by Duckworth and
Seligman of 140 urban, middle school students reinforces this idea of locus of control by demonstrating that middle school girls have better self discipline than boys ($r=0.33$, $p<0.001$), and better achievement test scores ($r=0.29$, $p<0.05$), and GPA ($r=0.66$, $p<0.001$).

Baker (1985) studied gender differences in science attitudes and science achievement, and the results showed that females had higher science grades but lower science attitudes as compared to males. He further examined the relationship by including letter grades and, surprisingly, found that males and females with “C” and “D” grades had better science attitudes than males and females with “A” and “B” grades ($n=98, F=7.10, p<0.001$). Debacker and Nelson’s (2000) study of 242 students also showed a gender effect on science attitude but no gender effect on science achievement. A review by Latham (1998) noted that there appears to be no gender gap in math or science in 1990 data. This data was from the Educational Testing Service results on ACT and SAT data on millions of students examining 400 different assessments, 1500 data sets, and with D values ([female mean score-male mean score]/ average standard deviation) for science of -0.2 to +0.2, which is an insignificantly small difference. While this variable appears to have ample evidence of predictive importance, its ability to predict test results as opposed to grades needs further examination.

These studies reveal that there is a growing body of evidence that contradicts the earlier assumptions of gender biased academic content and provides conflicting evidence for the size and scope of the science achievement gap with regards to gender. This also highlights the fluidity of the gender gap in science since it varies between science content
areas, grade levels, and the different years of measurement. The more recent research appears to give evidence that girls have an edge in terms of their study skills and overall attitudes toward science education and that this may be due to a more advanced mental development and attention to compliance with performance skill objectives. Willingham and Cole (1997) provide a reflection on this research consideration:

Exactly how these complex factors interact is still unclear. It does appear safe to say, however, that what gender gaps do exist are probably the result of far more than just differential course taking patterns or culturally defined gender expectations. (p. 177)

Latham (1998) adds to this by stating that:

Willingham and Cole emphasize that individual uniqueness overshadows the impact of any possible gender differences. Students’ natural interests, skills, and aspirations are likely to exert a far greater influence on their academic achievement than will gender. (p. 89)

**Ethnicity**

The characteristic of racial identity is also one that has been implicated as having major impacts on academic achievement in all content areas. There are individuals who believe that the racial achievement gap will never be eliminated since it is a product of standardized testing procedures. This view is stated by English (2002) with his belief that the “schools are agents of the reproduction of an unjust social order” (p. 305) and when he says: “The achievement gap will never be resolved because it is an artifact of the
process of measurement in which flawed tests have been used to assess pupil progress” (p. 298).

However, Weiss and Prifitera (1995) examined 1000 primary through secondary students taking the Wechsler Intelligence Scale for Children (WISC III) and found no bias in predicting IQ for African-Americans and Caucasians.

It has also been proposed that since Caucasians and Asians recognize the value in a successful understanding of math and science content, many African-Americans are not willing to try to compete in these areas and will disidentify with science to avoid “acting white” and denying their racial heritage. This proposition has been put forth by Fordham and Ogbu (1986) when they stated: “That African-Americans have developed a sense of active opposition to European-Americans and thus, studying, performing, and taking science classes are seen as ‘acting white’ and thus betray the African-American group identity” (p. 183).

This concept was examined by Osborne (1997) who studied 24,599 African-American students from the NELS-88 data and showed that the academic disidentification occurred in both males and females and that this existed across all content areas and had significant impacts on academic achievement. He also noted that it occurred earlier in the academic experiences with science for both African-American males (r=0.18, p<0.001) and females (r=0.14, p<0.001). Newcomb et al. (2002) confirmed this in a study of 754 eighth grade students, finding that African-Americans had significantly more behavior disruptions at earlier times in their academic
development and had resulting lower academic competence as compared to Caucasians $(r = -0.18, p<0.001)$.

Despite this concept, however, the 2003 TIMSS study (TIMMS, 2003) shows an increase in African-American science test scores across the 1995 to 2003 period. Caucasian science scores were mixed during this time period and increases were not as dramatic. In United States fourth graders, Caucasian science scores dropped from 572 in 1995 to 565 in 2003, a decrease of 7 points. During the same time, fourth grade African-American science scores rose from 462 to 487, an increase of 25 points. When the data for the eighth grade science scores were examined Caucasian scores increased from 544 in 1995 to 552 in 2003, an increase of 8 points, and African-American scores increased from 422 to 463 during the same time period, an increase of 41 points. Thus, U.S. education is narrowing the achievement gap between Caucasians and African-Americans in both the fourth and eighth grade.

This trend appears to be continuing and a study by Ginsburg and Pappas (2004) that examined 102 students, found no ethnic differences in the logic and reasoning skills in simple addition and subtraction abilities and understanding. Another study by Ma (2000) examined 6883 students and failed to find any academic achievement gaps caused by race. Yet, the gap seen in the TIMSS data still exists and a study by Caldas and Bankstein (1998) found that out of 34 542 students, African-American test scores were lower than Caucasians even when SES factors were controlled for $(t = -6.07, p<0.0001)$. They estimated that race accounts for 30% of the score differences. Chappell and
Overton (2002) also confirm this gap in 330 urban secondary education students and found that the ethnic gap in logical reasoning was significant (F(1, 304) = 6.72, p<0.05).

There have been numerous studies attempting to identify the causal factors of this gap. In keeping with the racial identity theory of Fordham and Ogbu, Midgley et al. (1996) found that African-American students were significantly different from Caucasians in their use of self-handicapping strategies, ego-oriented goals, and negative attitudes to affect grades. Flowers, et al. (2003) showed that in 863 African-American students, a sense of a higher locus of control was significantly more likely to have higher education aspirations. Halle et al. (1997) found that in 41 primary grade African-American students, parental belief in their children’s academic achievement abilities was significantly correlated with actual academic achievement (r=0.33, p<0.01). The social influence of peers in academic achievement of African-Americans was also examined in 524 primary students by Risi et al. (2003). However, positive social relationships with peers did not predict African-American academic achievement as it did for Caucasians.

The conflicting research shows that there is a need to more precisely identify the factors that predict science achievement test success for all students. While understanding that there may be possible specific differences for gender and racial groups, there is a need to collectively examine the possible factors and interactions that may exist between them.
CHAPTER 3

METHODOLOGY

Introduction

Due to the rise of accountability testing nationwide, researchers and administrators have focused on the ability of single measures to assess student performance parameters as compared to broader based measures of student performances across time. Questions have arisen as to the degree to which a high stakes test can capture the breadth of curriculum knowledge. This topic has sparked considerable nationwide debate toward the use of these tests and the local, state, and national policies of educational accountability.

This study attempted to address these widespread concerns by examining multiple variables that influence the overall student academic performance in science. Multiple predictive regressions were used to assess performance on science portions of mandated standardized tests (Ohio Proficiency Test) and a second criterion variable of student “final grade in science class” was included in the prediction equations. The study also avoided the use of aggregate data techniques such as combining, which can mask subgroup differences in the prediction value of individual variables. Therefore, the
subject characteristics of age, gender, and race may show more significant influences on prediction equations.

Pilot Study

A pilot study was conducted in the spring of 2002 at one of the district’s high schools. This study was conducted with permission from the district’s school board and research department and with permission from Kent State University’s Human Subjects Review Board. One ninth grade teacher was selected with consent to participate. All students in this teacher’s three regular ninth grade science classes received survey packets and consent forms. The pilot study consisted of this teacher’s data and the data from the 30 consenting students and parents who turned the packets in within the three week pilot survey period. This study was used to fine tune the survey instruments, consent forms, and examine data patterns. Questions were examined for gender, racial, financial, and emotionally tense statements. Only minor comments were given and corrections were made based on teacher, parent, and student comments.

Main Study

Subject Selection

Consent to conduct this study was obtained from Kent State University’s Human Subjects Review Board, from the school district’s board of education, and from the school district’s Department of Evaluation and Testing (see Appendix A). School principals were then approached and asked to participate in the study. Principals from four of the eight four-year high schools agreed to participate. Ninth grade science
teachers from those schools were then approached for their consent to participate. Each of these teachers taught at least one section of the mandatory ninth grade science course, physical science. Eleven ninth grade science teachers consented, and survey packets (consisting of questionnaires and a consent form) were made for each teacher and for each student of those teachers. Of the 11 ninth grade science teachers who agreed to participate, two were excluded because one had no ninth grade students during that semester, and the other failed to distribute surveys to the students. In the schools where teachers and principals agreed to participate, the total ninth grade student population was approximately 1,000 students. 700 questionnaire packets were given to teachers and these were given to their students and parents based on their teachers’ active participation in the study. From this group of 700 potential subjects, 215 were returned (approximately 30%) and 196 returned questionnaires were useable. Nineteen subjects were excluded due to incomplete survey packets or student mobility from the district. Thus, the final usable sample represented 196 students and their parents, approximately 20% of the surveyed population, three high schools, and 9 ninth grade physical science teachers.
Table 1

*Breakdown of Surveys Used in the Study*

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate number of ninth graders in the APS district</td>
<td>3,500</td>
</tr>
<tr>
<td>Approximate number of ninth graders in four schools</td>
<td>1,000</td>
</tr>
<tr>
<td>Number of packets sent out</td>
<td>700</td>
</tr>
<tr>
<td>Number of packets returned</td>
<td>215</td>
</tr>
<tr>
<td>Number of packets used by the study</td>
<td>196</td>
</tr>
</tbody>
</table>

*Data Gathering Instruments*

Survey packets (see Appendix B) were sent to each participating teacher, student and parent. These packets contained questionnaires with questions specific to each subject group (teacher, student and parent groups). Teacher questionnaires were piloted with teachers from one of the three participating high schools and from comments made by graduate education students from Kent State University. The questionnaires consisted of questions relating to length of educational experiences, type of certification, amount of research experience, professional development time, and classroom activities used in science instructions. These questions were modifications of surveys items from prior research (Gogolin & Swartz, 1992: German, 1988) as well as comments from experienced education colleagues. Student and parent questionnaires were made in the same way but examined such issues as time spent on education and outside activities, attitudes of science and science education, home life, parent education, marital status, and parent educational involvement with their children. Parental education level was used as
the socioeconomic status (SES) indicator in this study. Income and occupational status are not as stable as parental education level and often are more difficult to determine based on such factors as single parenting, inconsistent child support, recent divorce settlements, reluctance to disclose income, and difficulty in coding occupations. Moreover, parental education level is typically a strong correlate (Smith, 1992; Wand & Wildman, 1995; Singh et al., 1995) of occupational status and income and can usually be determined accurately through questionnaire methodology. All three types of surveys were piloted with consent at one of the three schools and were modified based on the responses and comments by the participating parties. Most of the comments were about the order of the questions and the clarity of certain statements. These pilot surveys included a self-addressed, stamped envelope for returning the packets - a practice that was changed in the actual study by giving each teacher and school main office a sealed drop off box.

In the actual study, teacher survey packets were composed of an introductory letter from the researcher detailing the intent and purpose of the research study, an instruction letter, a consent form, a teacher survey and an envelope for returning the materials to the researcher (see Appendix B). The parent/student survey packets consisted of an introductory letter explaining the research study and its goals, an information letter explaining how to take the survey, consent forms for each participant (parent and student), a parent survey and a student survey, and an envelope for returning the finished forms to the teacher or school (see Appendix C). These surveys were returned in sealed envelopes to a sealed drop box located in either the science teacher’s
classroom or the school’s main office. Participating teachers passed out a parent/student packet to each of their ninth grade science students.

Additional descriptive data about consenting students were collected from records located at the three consenting schools’ main offices and/or guidance counselor offices. Teachers were contacted approximately biweekly by phone call and/or email letter to further facilitate their participation in the study and to assist in any concerns they might have or needs for additional resources and survey packets. The participants were given approximately 3-4 weeks to receive and then fill out and return their packets. Those teachers and student/parent pairs that didn’t return the surveys within an approximately three month period were excluded from the final study. Due to the anonymity requirement of the subjects, teachers were left to their own methods for increasing student participation in the study, however, no material incentives were offered.

Data Analysis

The surveys were centered around three general sets of variables, teacher variables (years teaching experience, science research experience, continuing professional development experiences, and number and type of science laboratories performed weekly), student variables (academic ability, school attendance rate, hours spent weekly on homework, and science attitudes), and parent/home variables (parent marital status, parent education level, parent-school involvement, and parent time helping with homework). Other variables were suggested by reviews of literature, however, these 12 were selected due to implied importance by previous literature, separate area of importance in student academic performance, and ease of obtaining data in this study.
Survey results were analyzed using the Statistical Package for the Social Sciences (SPSS) protocols (SPSS 11.5 for Windows, 2002, SPSS Inc., Chicago, Il.). Zero-order correlations and multiple regressions with criterion data were conducted within each of the three categories of variables to determine the relative predictive power of each variable and to assess their combined predictive power (with p < 0.05 used as the probability criterion). The relative predictive power of each variable cluster was also examined. These analyses of individual student, parent and teacher characteristics were done separately for males and females and African-Americans and Caucasians to determine whether gender or racial differences existed. Further analyses were completed for each gender and race by selecting the most powerful single predictor from each category and combining them into a “best predictive model” regression. The data were continuous with the exceptions of the parental marital status variable that was coded such that it could be analyzed as interval data, and the gender and racial designation variables, which were nominal and were tested by student’s t-tests.

**Coding**

Each survey was composed of multiple Likeart scale questions that asked the respondents to circle values that best fit their answers to the questions. These answers were then coded prior to entry into the SPSS program for analysis.

In the Teacher Survey, the question of years of teaching experience was coded on a one to five scale with more experience having the higher value. The years of research experience question was compiled from a total of the number of years of employment in
a science laboratory and the number of years experience in a non-compensated science research position.

The questions on the Student Survey were also measured with a five choice scale. The questions of time spent on science homework per week was coded with more time being a higher number and the student science attitudes, as measured by the modified science attitude survey (Appendix C), was coded so that the higher the score the more positive the science attitude. Each question was scaled from one to five and these questions were compiled into a final score that showed a possible 95 points expressing positive attitude. Additional coding was done on mother and father education level with more education receiving a higher value, from one to six. And family structure (parent marital status) was coded with a two parent marital status receiving the highest value, followed by divorced single parent, then never married single parent, then widowed single parent, then grand parent or legal guardian. This coding was also used on the Parent Survey marital status question.

The Parent Survey also used a five point scale for time spent helping the student on homework and used a four point scale for school involvement questions. In each case, the more time spent was given the higher value. The responses from both parents were added to give a total value for the homework help and school involvement questions, for a possible total of 10 and 36, respectively. The parent education level was also coded as in the student questionnaire, but the scores of both parents education was added for a total of 12 possible.
These survey responses were then recorded into the SPSS program and analyzed by correlation and regression sub programs as previously stated.

*Descriptions of the School Populations and School Settings*

The three high schools examined were located in the same urban school district. Thus, the schools’ per pupil spending was similar and was approximately $8,374.00 per student from local, state, and federal funding. Similarly, the ninth grade physical science curriculum was consistent for each of the schools and the teachers were all exposed to identical professional development and district training and had identical district provided course materials, including textbooks and resource materials. In the 2002-2003 school year the average family income in the district was $24,314.00 per year, and 43.1 percent had experienced some college. The percentage of the city population with administrative or professional occupations was 25 percent. The total district student enrollment was 29,019 with 15,525 males and 14,726 females. The population was racially mixed with 47.1 percent Caucasian and 47.9 percent African-American. Fifty-six percent of the population was economically disadvantaged and 16.7 percent of the total population had an identified disability. Of the total student enrollment at all grade levels, 601 were retained for the 2002-2003 academic year. The overall district ranking by state standards was “academic emergency”, with only 4 of 22 indicators met. These were 9th grade reading, 9th grade writing, 9th grade reading given at the 10th grade, and 9th grade writing given at the 10th grade.
Table 2

*District Characteristics*

<table>
<thead>
<tr>
<th></th>
<th>District</th>
<th>National</th>
</tr>
</thead>
<tbody>
<tr>
<td>District Spending per Child =</td>
<td>$8,374</td>
<td>$9,881</td>
</tr>
<tr>
<td>Mean Family Income =</td>
<td>$24,314</td>
<td>$47,935</td>
</tr>
<tr>
<td>% Parents with some College Experience =</td>
<td>43.1%</td>
<td>28.1%</td>
</tr>
<tr>
<td>% Parents in Administrative/Professional Occupation =</td>
<td>25%</td>
<td>30%</td>
</tr>
<tr>
<td>Total District Enrollment =</td>
<td>29,019</td>
<td>49,676,964</td>
</tr>
<tr>
<td>% Male/% Female =</td>
<td>53/47</td>
<td>50.9/48.1</td>
</tr>
<tr>
<td>% Caucasian/% African-American =</td>
<td>47.1/47.9</td>
<td>55.9/16.9</td>
</tr>
<tr>
<td>% Economically Disadvantaged =</td>
<td>56%</td>
<td>40.9%</td>
</tr>
<tr>
<td>% with Disability =</td>
<td>16.7%</td>
<td>13.6%</td>
</tr>
<tr>
<td>Total District-wide Grade Retentions =</td>
<td>601 students</td>
<td></td>
</tr>
</tbody>
</table>
The first school to participate in this study was ranked as the best in the district academically and economically. The building was constructed in 1962 and its total enrollment was 1,210 students with 48.8 percent male and 51.2 percent female. It was racially mixed at a 60.4/36.3 Caucasian to African-American ratio and 12.5 percent were economically disadvantaged. Approximately 23 percent were identified as gifted, and 9.5 percent as having some type of disability. Its overall attendance rate was 95.6 for the academic year. There were 37 retentions at this school. This school’s state ranking was “effective” with 11 out of 12 appropriate secondary school indicators met. Only 9th grade mathematics proficiency was not passed (73.8% passing with a state standard of 75% required).

The second school to participate in the study was ranked as second from the bottom (of eight high schools) economically and in the lowest quarter of the district schools in terms of academic ranking. The building was constructed in 1955 and had a total enrollment of 768 students with 53 percent male and 47 percent female. It was the most racially mixed of the three participating schools and had a 50.5 percent to 47.3 percent Caucasian/African-American ratio, respectively and 48.7 percent of the students were economically disadvantaged. Twelve percent were classified as gifted and 18.1 percent were classified as having a disability. In this school, there were 82 retentions during the school year of the survey. Its overall attendance rate was 90.8 percent for the academic year. This school’s state ranking was “academic emergency” with only 3 out of 12 appropriate indicators met. Only 9th grade writing, 9th grade writing at the 10 grade level, and 9th grade reading at the 10 grade level met or exceeded state passing standards.
The third school to participate was ranked number two in the district academically and economically. The building was constructed in 1950 and had a total enrollment of 1,052 students with 51 percent male and 49 percent female. It was the least racially mixed with an 87.4 to 10.9 Caucasian to African-American student ratio, respectively and 18.1 percent were economically disadvantaged. Approximately 18 percent were gifted and 11.7 percent were classified as having a disability. Its overall attendance rate was 93.6 percent for the academic year. There were 56 retentions at this school during the year of the study. This school’s state ranking was “continuous improvement” with 8 out of 12 appropriate state indicators met. With only 9th grade math, 9th grade science, 9th grade math at the 10 grade level, and graduation rate not meeting state performance levels.

It should be noted that the District’s policy of open enrollment means that students have the ability to apply to any of the eight district high schools for enrollment into school specific academic, fine and performing arts, and athletic programs. Thus, students can potentially enroll in schools that offer additional resources for specific programs. Each of the three participating schools had such programs. One school had well developed academic and fine and performing arts programs, one school had technology and work place skills programs, and the third school had fine and performing arts programs.
Table 3

*Participating School Characteristics*

<table>
<thead>
<tr>
<th>a) Demographics:</th>
<th>School</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>School Age =</td>
<td>40 yrs</td>
</tr>
<tr>
<td>Total Enrollment =</td>
<td>1 210</td>
</tr>
<tr>
<td>Male to Female Ratio =</td>
<td>49/51*</td>
</tr>
<tr>
<td>Caucasian to African-American Ratio =</td>
<td>60/36*</td>
</tr>
<tr>
<td>% Economic Disadvantage =</td>
<td>12.5%</td>
</tr>
<tr>
<td>% Gifted =</td>
<td>23%</td>
</tr>
<tr>
<td>% with Disability =</td>
<td>9.5%</td>
</tr>
<tr>
<td>Attendance Rate =</td>
<td>95.6%</td>
</tr>
<tr>
<td>Number Retained =</td>
<td>37</td>
</tr>
<tr>
<td>Science Teachers Participating =</td>
<td>5</td>
</tr>
<tr>
<td>Number of Study Participants =</td>
<td>40</td>
</tr>
<tr>
<td>Participant Racial Ratio =</td>
<td>36/4*</td>
</tr>
<tr>
<td>(Caucasians/African American)</td>
<td></td>
</tr>
<tr>
<td>Participant Gender Ratio (Males/Females) =</td>
<td>11/29*</td>
</tr>
</tbody>
</table>

* Ratios represent actual student numbers involved in the study
Table 3

*Participating School Characteristics (continued)*

<table>
<thead>
<tr>
<th></th>
<th>School</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>State Ranking =</strong></td>
<td>Effective</td>
</tr>
<tr>
<td>Standards Met =</td>
<td>11/12</td>
</tr>
<tr>
<td><strong>9th Grade</strong></td>
<td></td>
</tr>
<tr>
<td>Citizenship</td>
<td>80.7</td>
</tr>
<tr>
<td>Math</td>
<td>73.8</td>
</tr>
<tr>
<td>Reading</td>
<td>89.1</td>
</tr>
<tr>
<td>Writing</td>
<td>87.9</td>
</tr>
<tr>
<td>Science</td>
<td>76.4</td>
</tr>
<tr>
<td><strong>9th Grade (at 10 grade)</strong></td>
<td></td>
</tr>
<tr>
<td>Citizenship</td>
<td>94.0</td>
</tr>
<tr>
<td>Math</td>
<td>85.1</td>
</tr>
<tr>
<td>Reading</td>
<td>97.2</td>
</tr>
<tr>
<td>Writing</td>
<td>95.0</td>
</tr>
<tr>
<td>Science</td>
<td>87.2</td>
</tr>
<tr>
<td><strong>Attendance Rate</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>95.6</td>
</tr>
<tr>
<td><strong>Graduation Rate</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>95.3</td>
</tr>
</tbody>
</table>
In summary, this study was conducted in an urban school and was comprised of teachers and students enrolled in ninth grade science in three of this district’s high schools. Consenting teachers, students, and parents received written surveys with questions designed to examine the following research study areas:

(a) What teacher variables predict better scores on the science portion of the OPT?, (b) What student variables predict better scores on the science portion of the OPT?, and (c) What parent and home variables predict better scores on the science portion of the OPT?

These surveys and data of student gender, race, attendance, student OPT science scores, science course grades, and general student grade point average were examined through the use of regression analyses to determine which factors best correlate with improved student scores and grades. These selected factors were then compiled into a best predictive model that could correlate their presence with success on standardized science tests.
CHAPTER 4

RESULTS

Introduction

This study was designed to assess factors involved in secondary student achievement on the science portion of “high–stakes” state standardized tests. These tests are increasingly important for student educational advancement, especially in Ohio and other states where passage of the test is directly tied to graduation from the K12 public education system. As a result, future education in post-secondary institutions and possible employability are potentially withheld until successful test passage.

Data were collected through the use of surveys given to teachers, parents, and students and by examining the existing school district data records to obtain descriptive student information. These data were analyzed using the Statistical Package for Social Sciences (SPSS) software to determine descriptive statistics and to perform correlation analyses between different sets of variables.

Since accountability testing was initiated nationwide, a considerable amount of concern has been raised about the suitability of a single measure of subject competence rather than a broader based criterion of student performances across time. The degree to which a high stakes test can capture the breadth of curriculum knowledge in a subject
appears to be a topic of considerable nationwide debate. To address these widespread concerns, a second criterion variable of student “final grade in science class” was included in the prediction equations.

Too often in studies that attempt to predict student academic performance, aggregate data are used that mask differences among subgroups in the prediction value of individual variables (Jackson, Best & Richardson, 2006; Raghunathan, Diehr & Cheadle, 2003; O’Brien, 1990). Frequently, subject characteristics of age, gender, and race are found to exert considerable influence on prediction equations. In this study, age was minimized as a factor since only 9th grade students were used as subjects. To determine if gender and race should be analyzed separately, t tests of differences on the two criterion variables were used.

Hypothesis 16: There are no differences between males and females on any of the three cluster correlations. Table 4 illustrates that males and females had significantly different results on the criterion of end of the year science grade ($t = 2.1, p < .05$), with females obtaining better grades.

Hypothesis 17: There are no differences between black and white populations on any of the three cluster correlations. Table 4 shows that Caucasian students in this study had higher scores than African American students on the Ohio Proficiency Science Test ($t = 4.4, p < .001$), and also on science grade ($t = 4.9, p < .001$). Thus, all prediction analyses included consideration of both total group and gender and racial subgroup categories.
Table 4

*T Test Comparisons of Gender and Racial Subgroups for Ohio Proficiency Test Science Score and Science Grade*

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
<th>African-American</th>
<th>Caucasian</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n=82)</td>
<td>(n=108)</td>
<td>(n=28)</td>
<td>(n=161)</td>
</tr>
<tr>
<td>Criterion</td>
<td>m</td>
<td>m</td>
<td>t</td>
<td>m</td>
</tr>
<tr>
<td>OPT</td>
<td>211.6</td>
<td>209.4</td>
<td>-.66 ns</td>
<td>198.3</td>
</tr>
<tr>
<td>Science Grade</td>
<td>2.45</td>
<td>2.79</td>
<td>2.07*</td>
<td>1.70</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.80</td>
</tr>
</tbody>
</table>

Note: m = mean of data set. * p < .05 significance, and *** p < .001 significance

Subject Characteristics

Review of the 196 returned survey forms and collection of corresponding school office data revealed patterns in the demographics and subject traits for teacher, student and parent participants.

Teacher Characteristics

Hypotheses 1 through 4: There is a positive relationship between student science OPT achievement score and the variables of (1) teacher years of teaching experience, (2) teacher research experience, (3) hours taken annually in professional development activities, (4) hours of science experiments performed weekly.

Considering the nine teachers with ninth grade students and the teacher variable of years teaching experience, three of the teacher respondents had 0-2 years teaching experience, three had 2-5 years, one had 5-10 years, and two had 15 or more years.
The variable of science research experience shows that two had completed a science research thesis or dissertation and eight had at one time, been employed in a science laboratory setting. To further qualify this employment, three of those employed in a science laboratory setting had been employed two or fewer years, three were employed for three to ten years, and two were employed for more than ten years. However, only two had published articles in a scientific journal.

The variable of teacher time spent in professional development showed that nine had participated in a professional development activity in the last year. Of these, nine participated in a school district workshop, four in a college or university workshop, and two in a company or industry workshop. It should be noted that these were self-reported values for research hours and professional development time, a possible limitation that will be further discussed in Chapter 5.

The final teacher variable of science classroom laboratory experiences shows that all nine offered laboratories to their students, two offered laboratories 1-2 times per month and seven offered laboratories 1-2 times per week. To further qualify the laboratory experiences that were offered, four offered one hour of laboratories per week, three offered one and a half hours of laboratories per week, one offered two hours of laboratories per week, and one offered less than one hour per week. When examining the type of experience offered, seven said these laboratories were student-directed inquiry laboratories, seven were teacher-directed inquiry laboratories, two were student confirmation of previously existing results, eight said the laboratories were “cookbook” or worksheet laboratories, and three said the laboratories were teacher demonstration
laboratories. To further breakdown these laboratory experiences, four of the teacher respondents said the students engaged in hands-on activities one to two times per month and five said this occurred weekly. Two of the teacher respondents said the students never designed their own experiments or investigations; three said the students did design their own experiments but that it occurred one to two times a semester; three said this was one to two times per month; and one teacher respondent did not answer this question. (See Table 5).

**Student Characteristics**

Hypotheses 5 through 8: There is a positive relationship between student science OPT achievement score and the variables of student (5) high school grade point average, (6) attendance, (7) hours spent weekly on homework, and (8) science attitudes.

There were 196 total respondents with gender and racial information and of these 110 (56.1%) were female, 86 (43.9%) were male. Their racial makeup included 30 (15.7%) who were African-American and 161 (84.3%) who were Caucasian. Five of the respondents were either Asian or of mixed race and were not included in the racial analyses. Class enrollment data were available for 192 students who were enrolled in honors physical science classes (74 students, 38.5%) or in general physical science classes (116 students, 60.4%).

Examination of 192 students’ general academic aptitude data (annual grade point average) showed that 11 (5.6%) students had a 1.0 or lower grade point average, 30 (15%) students had a grade point average between 1.0 and 2.0, 56 (28.3%) students had a
## Table 5

*Teacher Demographics*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender:</strong></td>
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<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>male</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td></td>
</tr>
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<td>female</td>
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<td>X</td>
<td>X</td>
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</tr>
<tr>
<td><strong>Race:</strong></td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>African American</td>
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<td></td>
</tr>
<tr>
<td><strong>Years of experience:</strong></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>0-2</td>
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<td>X</td>
<td>X</td>
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<td></td>
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<td>&gt;15</td>
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<td></td>
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Table 5

*Teacher Demographics (continued)*

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<td>1-2/semester</td>
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</tr>
<tr>
<td>1-2/month</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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grade point average between 2.0 and 3.0, and 95 (51.1%) students had a grade point average between 3.0 and 4.0.

School absence data for this sample revealed that 49 students (25.5%) had one or fewer days absent for the school year, 73 (38.0%) students had between one and five days absence, 29 (15.1%) students had between five and ten days, 20 (10.4%) students had between 10 and 15 days, 12 (6.3%) students had 15 to 20 days, and 16 (8.3%) students missed more than 20 days of school.

Considering homework patterns, we find that of the 193 respondents, 73 (37.8%) students put less than one hour a week into their science homework. 55 (28.3%) students put in 1-2 hours weekly, 34 (17.6%) students spent 2-3 hours, 17 (8.8%) students spent 3-4 hours, and 14 (7.3%) students spent more than four hours a week on science homework.

The data on science attitudes as measured by the modified science attitude survey (Appendix C) showed that of a possible 95 points expressing positive attitude, 15 students (10.5%) had a score from 86 to 95, 34 students (17.3%) were from 76 to 85, 60 students (30.6%) were from 67 to 75, 49 students (25%) were from 57 to 75, 27 (13.8%) students were between 48 and 56, and 11 students (5.6%) were below 48 on their science attitude scale (see Table 6).

*Parent Characteristics:*

Hypotheses 9 through 12: There is a positive relationship between student science OPT achievement score and the variables of (9) parent education level, (10) intact parent marital status, (11) parent-school involvement, and (12) parent time spent assisting with science homework.
Table 6

*Student Demographics*

<table>
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<th></th>
<th>86/110</th>
<th>161/30</th>
<th>74/116</th>
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<td>Male to Female Ratio</td>
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<td></td>
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<tr>
<td>Caucasian to African American Ratio</td>
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<td></td>
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<td>Honors to Regular Class Ratio</td>
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<th>3-4</th>
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<tbody>
<tr>
<td>GPA</td>
<td>5.6%</td>
<td>15%</td>
<td>28.3%</td>
<td>51.1%</td>
</tr>
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<td></td>
<td>0-1</td>
<td>1-5</td>
<td>5-10</td>
<td>10-15</td>
</tr>
<tr>
<td>Absences</td>
<td>25.5%</td>
<td>38%</td>
<td>15.1%</td>
<td>10.4%</td>
</tr>
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<td>28.5%</td>
<td>17.6%</td>
<td>8.8%</td>
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<td></td>
<td>95-86</td>
<td>85-76</td>
<td>75-66</td>
<td>65-56</td>
</tr>
<tr>
<td>Science attitude score</td>
<td>10.5%</td>
<td>17.3%</td>
<td>30.6</td>
<td>25%</td>
</tr>
</tbody>
</table>

(out of 95)

One hundred and eighty six surveys were returned by parents and matched with student survey respondents. Of these total parent respondents, 150 (80.6%) were filled out by the mother, 28 (15.1%) by the father, 5 (2.7%) by step parents, and 3 (1.6%) by grandparents or guardians. Fifty (27.5%) respondents maintained single parent homes, and 132 (72.5%) were two parent homes. Of the single parent homes, 79.8% were mother-headed households and 19% were father-headed households. For this variable, two-biological parents were given the highest coding number, followed by stepparent
family coding number, then unwed single parents coding, and the lowest coding was given to families with no biological parent present.

Parent education data were available for 181 cases. Of these, 10 parents (5.5%) did not have a high school diploma, 68 (37.6%) parents had a high school diploma or GED equivalent, 65 (35.9%) parents had some college experience, 23 (12.7%) parents had completed a four year college degree, 14 (7.7%) parents had a masters degree or equivalent, and 1 (.6%) parent had completed a doctorate or equivalent.

When examining 183 surveys detailing annual total parent involvement (total occurrences in one year) in any school activity (parent volunteering, parent-teacher organizations, school meetings) the data show that one (0.5%) parent had five or fewer interactions with the school, 91 (49.4%) parents had between six to ten interactions with their child’s school, 56 (30.6%) parents had between ten and 15 interactions, 26 (14.2%) parents had between 15 and 20 interactions, and nine (4.9%) parents had more than 20 parent-school interactions.

Finally, examination of parents’ report of their assistance with student’s homework shows that out of 184 respondents for this variable, two (1.1%) parents helped their children with homework less than two hours per week, 132 (71.8%) parents helped their children two to five hours per week, 46 (25%) parents helped their students five to ten hours per week, and four (2.2%) parents helped their students more than ten hours per week with homework (see Table 7).

The following sections of this chapter report the results of the three variable sets (teacher, student, and parent). The first section presents individual zero-order correlations
with the primary criterion variable, OPT science scores. The three subsets of this section address hypotheses specific to each variable cluster. These correlations are also performed with the end of year science class grade criterion. Additional gender and race analyses are also performed. The next section of this chapter utilized step-wise multiple analyses.

Table 7

*Parent Demographics*

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<tr>
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<th>Mother</th>
<th>Father</th>
<th>Step parent</th>
<th>Grandparent</th>
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<tr>
<td>Survey Completion</td>
<td>80.6%</td>
<td>15.1%</td>
<td>2.7%</td>
<td>1.6%</td>
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<tr>
<td>1 vs 2 parent homes Ratio</td>
<td>50/132 (27.5% to 72.5%)</td>
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</tr>
<tr>
<td>Gender of head of 1 parent homes</td>
<td>female = 79.8%, male = 19%</td>
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</tr>
<tr>
<td>No HS</td>
<td>HS/GED</td>
<td>some Univ</td>
<td>4 yrs Univ</td>
<td>masters</td>
</tr>
<tr>
<td>Parent education</td>
<td>5.5%</td>
<td>37.6%</td>
<td>35.9%</td>
<td>12.7%</td>
</tr>
<tr>
<td>0-5</td>
<td>6-10</td>
<td>11-15</td>
<td>16-20</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Parent-school involvement</td>
<td>0.5%</td>
<td>49.4%</td>
<td>30.6%</td>
<td>14.2%</td>
</tr>
<tr>
<td>&lt;2</td>
<td>2-5</td>
<td>6-10</td>
<td>&gt;10</td>
<td></td>
</tr>
<tr>
<td>Hours weekly homework help</td>
<td>1.1%</td>
<td>71.8%</td>
<td>25%</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

combined relationship to the science proficiency test score of the students and then the end of year science class grade of the students. These were also examined by gender and racial subgroups. The next section of the chapter reports analyses that incorporated the most predictive factors from each variable cluster in an overall, best predictive model for
positive student achievement on the science portion of the OPT by total group and gender and racial subgroups. The final section of this chapter examines the best predictors from these three variable clusters for the total group, gender, and race subsets to determine their relationships to the additional outcome variable of student science class grade.

Section I: Pearson r Correlations for Individual Variables

Ohio Proficiency Test Relationships:

Appendix D presents a compilation of Pearson r correlation results for all clusters combined. In the teacher cluster, the predictor variable of teacher attendance in professional activities has been omitted because it lacked sufficient variability. All but one of the teachers surveyed had attended such activities which are mandated by the school district for all teachers.

A) Teacher Variable Cluster

Hypotheses 1 through 4: There is a positive relationship between student science OPT achievement score and the variables of (1) teacher years of teaching experience, (2) teacher research experience, (3) hours taken annually in professional development activities, (4) hours of science experiments performed weekly including teacher demonstrations and student hands-on activities (see Appendix B).

Despite the limitation of small teacher sample size, teacher data from these three major urban schools reveal a consistent pattern of positive relationship between teacher characteristics and ninth grade student OPT scores.
Table 8 illustrates that, for the total group, OPT scores are significantly predicted by years of teaching experience ($r = .30, p < .001$) and teacher’s research experience ($r = .28, p < .001$). Number of laboratory hours was not significant and, as noted above, the remaining variable, teacher attendance in professional development activities, showed no relationship to student OPT science performance. Gender and racial analyses generally indicate substantial correlations for both genders, but only for Caucasian students. Both males and females show strong predictive relationships between OPT and years of teaching experience ($r = .32, p < .01$; and $r = .41, p < .001$, respectively). Years of teacher research experience similarly shows significant predictive relationships with the OPT criterion ($r = .21, p < .05$; and $r = .44, p < .001$, respectively). For males, the number of science class laboratory hours was also a significant predictor ($r = .19, p < .05$).

Table 8

*Teacher Cluster Pearson r Correlations with Ohio Proficiency Test Science Scores for Total Group and Gender and Racial Subgroups*

<table>
<thead>
<tr>
<th>Teacher Cluster:</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
<th>African-American</th>
<th>Caucasian</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>n=193</td>
<td>n=83</td>
<td>n=96</td>
<td>n=26</td>
<td>n=149</td>
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<tr>
<td>Years Teaching Experience</td>
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<td>.32**</td>
<td>.41***</td>
<td>-.05</td>
<td>.40***</td>
</tr>
<tr>
<td>Years Research Experience</td>
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<td>.21*</td>
<td>.44***</td>
<td>-.02</td>
<td>.43***</td>
</tr>
<tr>
<td>Number of Laboratory Hours</td>
<td>.14</td>
<td>.19*</td>
<td>.08</td>
<td>-.19</td>
<td>.17*</td>
</tr>
</tbody>
</table>

Note: *$p < .05$, **$p < .01$, and ***$p < .001$*
B) Student Variable Cluster

Hypotheses 5 through 8: There is a positive relationship between student science OPT achievement score and the variables of student (5) high school grade point average, (6) attendance, (7) hours spent weekly on homework, and (8) science attitudes.

These hypotheses anticipate that student science OPT scores are respectively related to academic aptitude (annual grade point average), annual number of absences, hours spent weekly on homework, and science attitudes as measured by a science attitude scale. Student’s intelligence quotient (IQ) test data was not available because of the school district’s limitations on usage of these data; therefore, as noted earlier, this cluster used the student’s 2002 grade point average as a measure of general academic achievement. As a result of this restriction on intelligence test scores (aptitude), the achievement variable of student annual grade point average across all content areas was used as a surrogate index to reflect academic aptitude.

Table 9 reports results from the student variable cluster demonstrating that for the total group, student science achievement on the OPT is positively related to the student’s 2002 grade point average ($r = .47, p < .001$), negatively related to the number of absences ($r = -.16, p < .05$), and not related to time spent weekly on homework ($r = .11, ns$), or science attitude score ($r = .14, ns$). This cluster shows only one predictive relationship with OPT for males, that of GPA ($r = .42, p < .01$). Females, however, show significant prediction on all four cluster variables. GPA prediction of OPT is particularly strong ($r = .57, p < .001$). Females’ science attitude is related at $r = .20 (p < .05)$, their number of absences at $r = -.27 (p < .001)$, and their amount of homework hours at $r = .30 (p < .01)$. 
Table 9

*Student Cluster Pearson r Correlations with Ohio Proficiency Test Science Scores for Total Group and Gender and Racial Subgroups*

<table>
<thead>
<tr>
<th>Student Cluster:</th>
<th>Total</th>
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<th>Female</th>
<th>African-American</th>
<th>Caucasian</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=193</td>
<td>n=83</td>
<td>n=106</td>
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<td>n=158</td>
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<tr>
<td>2002 GPA</td>
<td>.47***</td>
<td>.42**</td>
<td>.57***</td>
<td>.63***</td>
<td>.50***</td>
</tr>
<tr>
<td>Science Attitude</td>
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<td>.09</td>
<td>.20*</td>
<td>.13</td>
<td>.15*</td>
</tr>
<tr>
<td># of Absences</td>
<td>-.16*</td>
<td>-.13</td>
<td>-.27***</td>
<td>-.38*</td>
<td>-.16*</td>
</tr>
<tr>
<td># Homework Hours</td>
<td>.11</td>
<td>-.03</td>
<td>.30**</td>
<td>.15</td>
<td>.18*</td>
</tr>
</tbody>
</table>

Note: *p < .05, ** p < .01, and ***p < .001

African-Americans show a very strong prediction between 2002 GPA and OPT (r = .63, p < .001), and another significant OPT prediction for the absence variable (r = -.38, p < .05). Caucasians show significant predictions of OPT from all four student cluster variables: GPA (r = .50, p < .001), science attitude (r = .15, p < .05), number of absences (r = -.16, p < .05), and number of homework hours (r = .18, p < .05).

C) Parent Variable Cluster

Hypotheses 9 through 12: There is a positive relationship between student science OPT achievement score and the variables of (9) parent education level, (10) intact parent marital status, (11) parent-school involvement, and (12) parent time spent assisting with science homework.
These hypotheses respectively suggest that student science OPT performance is positively related to parental education level, intact marital status, parent-school involvement, and time spent helping the student with homework. As reported in Table 10, results from this home variable cluster show that for the total group, OPT scores are positively related to parent education level (r = .27, p < .001). The other three variables of this cluster (parent intact marital status, total parent-school involvement, and total parent time spent helping with homework) had no significant relationship to the criterion for the total group.

The parent cluster shows no significant predictions for male students, but three for female students. Parent education level, parental intact marital status, and parental school involvement each significantly predicted OPT scores (r = .48, p < .001; r = .22, p < .01, and r = .18, p < .05 respectively). For this cluster, African-Americans show no predictive relationships to OPT. Caucasians have only one significant predictor, that of parent education (r = .35, p < .001) (see Table 10).
Table 10

*Parent Cluster Pearson r Correlations with Ohio Proficiency Test Science Scores for Total Group and Gender and Racial Subgroups*

<table>
<thead>
<tr>
<th>Parent Cluster:</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
<th>African-American</th>
<th>Caucasian</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=181</td>
<td>n=76</td>
<td>n=103</td>
<td>n=27</td>
<td>n=148</td>
</tr>
<tr>
<td>Parent Education</td>
<td>.27***</td>
<td>.12</td>
<td>.48***</td>
<td>-.02</td>
<td>.35***</td>
</tr>
<tr>
<td>Marital Status</td>
<td>.12</td>
<td>.06</td>
<td>.22**</td>
<td>.11</td>
<td>.11</td>
</tr>
<tr>
<td>School Involvement</td>
<td>.08</td>
<td>.01</td>
<td>.18*</td>
<td>-.20</td>
<td>.05</td>
</tr>
<tr>
<td>Parent Homework Help</td>
<td>.05</td>
<td>.00</td>
<td>.13</td>
<td>-.24</td>
<td>.06</td>
</tr>
</tbody>
</table>

Note: * p < .05, **p < .01, and *** p < .001

In summary, correlation analysis of the three variable clusters for the total group show that the following variables positively relate to student science OPT scores: teacher years of teaching experience, teacher research experience, student 2002 grade point average, student attendance and total parent education level. Subgroup analyses for gender and race help to explain total group findings. The OPT criterion is predicted only by female Caucasians for the parent variable cluster. Only male and female Caucasians contribute significantly to the correlations found in the teacher variable cluster, and both Caucasian and African-American students contribute to the significant correlations of GPA and attendance found in the student variable cluster. The female subgroup of the study was the overall most significant contributor to total group predictions and, in fact,
showed significant relationships to the OPT criterion on some occasions when the total group correlations were not significant.

*Science Class Grade Relationships:*

The additional outcome criterion variable of science class grade also shows predictive relationships with variables in the three clusters. These relationships are based on the same teacher, student, and parent cluster variables and provide a useful view of the more comprehensive index of performance which the student’s end-of-year class grade allows. The compilation of Pearson r correlations for all clusters is presented in Appendix E.

A) Teacher Variable Cluster

Hypothesis 13: There is a positive relationship between science class grade and the combined teacher variable cluster.

This cluster reveals additional significant relationships not seen in the OPT data. The same three teacher cluster hypotheses were used in these elaborative analyses and all assume a positive relationship with the student class grade criterion.

Table 11 describes these relationships for the total group and subgroups and shows that science class grades are strongly predicted by teacher years of teaching experience (r = .37, p < .001), teacher years of research experience (r = .37, p < .001), and the number of science classroom laboratory hours (r = .18, p < .01). Again, the variable of teacher attendance in professional development activities has been dropped
from consideration since there was not enough variability in the results to detect any significant relationships.

Table 11

*Teacher Cluster Pearson r Correlations with Science Class Grade for Total Group and Gender and Racial Subgroups*

<table>
<thead>
<tr>
<th>Teacher Cluster:</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
<th>African-American</th>
<th>Caucasian</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=193</td>
<td>n=83</td>
<td>n=96</td>
<td>n=26</td>
<td>n=149</td>
</tr>
<tr>
<td>Years Teaching Experience</td>
<td>.37***</td>
<td>.44**</td>
<td>.39***</td>
<td>-.09</td>
<td>.38***</td>
</tr>
<tr>
<td>Years Research Experience</td>
<td>.37***</td>
<td>.32**</td>
<td>.41***</td>
<td>.17</td>
<td>.40***</td>
</tr>
<tr>
<td># Laboratory Hours</td>
<td>.18**</td>
<td>.21*</td>
<td>.14</td>
<td>-.14</td>
<td>.23**</td>
</tr>
</tbody>
</table>

Note: *p < .05, **p < .01, and *** p < .001

The teacher cluster variables show that both genders have strong predictive relationships with regard to teacher years of teaching experience, with $r = .44$ ($p < .001$) for males and $r = .39$ ($p < .001$) for females. This trend is also seen when examining the teacher years of research experience relationship with science class grades. Both males and females have a strong relationship ($r = .32$, $p < .01$ and $r = .41$, $p < .001$, respectively). Males show an additional significant relationship with the number of hours spent in science class laboratories ($r = .21$, $p < .05$) but females have a non-significant relationship between this variable and the criterion. For Caucasian students, science grade was predicted by years of teaching experience ($r = .38$, $p < .001$), years of research experience
(r = .40, p < .001) and number of laboratory hours (r = .23, p < .01). As was observed
with the OPT criterion, African-American students again show no significant predictions
when using this broader criterion measure.

B) Student Variable Cluster

Hypothesis 14: There is a positive relationship between science class grade
and the combined student variable cluster.

The student hypotheses have also been used to predict the relationships of the
student cluster variables with science class grades. The results from Table 12 for this
cluster showed that, for the total group, each of the variables significantly predicted the
criterion. GPA shows the strongest relationship, with an r value of .91 (p < .001).

Table 12

Student Cluster Pearson r Correlations with Science Class Grade for Total Group and
Gender and Racial Subgroups

<table>
<thead>
<tr>
<th>Student Cluster:</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
<th>African-American</th>
<th>Caucasian</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=193</td>
<td>n=83</td>
<td>n=106</td>
<td>n=27</td>
<td>n=158</td>
</tr>
<tr>
<td>2002 GPA</td>
<td>.91***</td>
<td>.92***</td>
<td>.89***</td>
<td>.88***</td>
<td>.90***</td>
</tr>
<tr>
<td>Science Attitude</td>
<td>.26***</td>
<td>.17</td>
<td>.35***</td>
<td>.04</td>
<td>.22**</td>
</tr>
<tr>
<td># of Absences</td>
<td>-.56***</td>
<td>-.53***</td>
<td>-.61***</td>
<td>-.46**</td>
<td>-.54***</td>
</tr>
<tr>
<td># Homework Hours</td>
<td>.19**</td>
<td>.16</td>
<td>.18*</td>
<td>.12</td>
<td>.20**</td>
</tr>
</tbody>
</table>

Note: *p < .05, **p < .01, and ***p < .001
Science attitude relates to this criterion with $r = .26$ ($p < .001$), and the number of absences showed a strong negative relationship with science grades with an $r = -.56$ ($p < .001$). The number of weekly homework hours by the student also showed a significant predictive relationship with this broader criterion measure ($r = .19$, $p < .01$).

Subgroup analysis for this cluster shows that both males and females have significant relationships with the science grade criterion. Both genders show strongly significant correlations between overall grade point average and science grade ($r = .92$, $p < .001$; $r = .89$, $p < .001$, for males and females, respectively). Similarly, examination of the number of absences variable reveals that for both males and females, attendance strongly predicts science class grade ($r = -.53$, $p < .001$; $r = -.61$, $p < .001$, respectively). For females, science grades are also strongly related to science attitudes ($r = .35$, $p < .001$), and moderately related to amount of homework done ($r=.18$ ($p < .05$), though these predictors were not significant for males.

Racial groups both show a strong relationship between science grades and overall grade point average ($r=.90$, $p < .001$; $r = .88$, $p < .001$ respectively for Caucasians and African-Americans). Attendance is also an important predictor for each racial group ($r = -.54$, $p < .001$; $r = -.46$, $p < .01$ respectively for Caucasians and African-Americans). Science attitudes and amount of homework related to this criterion for Caucasians ($r = .22$, $p < .01$; and $r = .20$, $p < .01$ respectively), but neither of these predictors was significant for African-Americans.
C) Parent Variable Cluster

Hypothesis 15: There is a positive relationship between science class grade and the combined parent/home variables cluster.

Hypotheses parallel to the OPT predictors 9, 10, 11, and 12 relate to this cluster analysis. These predict that student science class grade is positively related to parental education level, intact marital status, parent-school involvement, and time spent helping the student with homework. Table 13 shows the results from these parent variables and demonstrates that student science achievement as measured by science class grades is strongly related to total parent education level ($r = .46, p < 0.001$), parent intact marital status ($r = .28, p < .001$), and parent school involvement ($r = .34, p < .001$). These are all positive predictive relationships and reveal additional interactions not seen in the OPT data. The remaining variable of this cluster, parent time spent helping with homework, had no significant relationship to the criterion.

Table 13 also exhibits the gender and racial comparisons of the parent cluster variables and these again show some significant relationships not seen in the OPT correlations. For example, both males and females have strong significant relationships between the parent education cluster variable and the science grade criterion ($r = .40, p < .001; r = .50, p < .001$, respectively). Parent marital status is also significant for males and females ($r = .28, p < .01; r = .27, p < .01$, respectively), demonstrating higher grades for intact families’ children. And, parent involvement in school is also significant for males ($r = .33, p < .01$) and females ($r = .33, p < .001$). The parent cluster variable of parent homework help was not significant for either gender.
Finally, the Caucasian racial group shows more relationships with the parent cluster variables as compared to the African-American group. Caucasians show strong significant predictive correlations with parent education ($r = .46, p < .001$), parent school involvement ($r = .32, p < .001$), and a slightly less significant relationship with parent marital status ($r = .18, p < .01$). African-Americans only show a significant relationship with parent education ($r = .37, p < .05$).

Table 13

*Parent Cluster Pearson r Correlations with Science Class Grade for Total Group and Gender and Racial Subgroups*

<table>
<thead>
<tr>
<th>Parent Cluster:</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
<th>African-American</th>
<th>Caucasian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent Education</td>
<td>.46***</td>
<td>.40***</td>
<td>.50***</td>
<td>.37*</td>
<td>.46***</td>
</tr>
<tr>
<td>Marital Status</td>
<td>.28***</td>
<td>.28**</td>
<td>.27**</td>
<td>.28</td>
<td>.18**</td>
</tr>
<tr>
<td>School Involvement</td>
<td>.34***</td>
<td>.33**</td>
<td>.33***</td>
<td>.27</td>
<td>.32***</td>
</tr>
<tr>
<td>Parent Homework Help</td>
<td>.06</td>
<td>-.03</td>
<td>.09</td>
<td>-.25</td>
<td>.10</td>
</tr>
</tbody>
</table>

Note: * $p < .05$, ** $p < .01$, and *** $p < .001$

Section II: Stepwise Cluster Relationships to Criterion Variables

The previous section examined the relationship of each individual variable to the student’s achievement on the science portion of the Ohio Proficiency Test and science class grades. This section examines the combined relationship of all variables within the
cluster on the same outcome variables by using stepwise linear regression analyses, as can be seen in Table 14. Hypotheses 13, 14, and 15 respectively, predict a positive relationship between student science OPT achievement and the combined teacher variable cluster, the combined student variable cluster, and the combined parent variable cluster. Similarly, predictive relationships were calculated for the science class grades and the three variable clusters.

The results of this section show that each cluster’s total group regression has a strong positive relationship to the student’s achievement on the science portion of the Ohio Proficiency Test, thus verifying Hypotheses 13, 14, and 15. For the total sample, the combined teacher cluster variables predicted OPT scores with a multiple R = .32 (F = 20.44, p < .001). The student cluster predicted with a multiple R = .49 (F = 49.84, p < .001), and the parent cluster predicted with a multiple R = .27 (F = 14.42, p < .001). For the teacher cluster only one variable entered the equation -- that of years of teaching experience. Similarly for the parent cluster only parent education entered significantly. However, for the student cluster, both GPA and number of absences entered with absences adding 3% of the explained variance.
Table 14

*Stepwise Multiple Regressions Predicting Ohio Proficiency Test Science Scores for Total Group and Gender and Racial Subgroups*

<table>
<thead>
<tr>
<th>Teacher Cluster:</th>
<th>r</th>
<th>R</th>
<th>R²</th>
<th>Increase R²</th>
<th>Improving F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Group (Years teaching experience)</td>
<td>.32</td>
<td>.32</td>
<td>.10</td>
<td></td>
<td>20.44***</td>
</tr>
<tr>
<td>Male (Years teaching experience)</td>
<td>.32</td>
<td>.32</td>
<td>.10</td>
<td></td>
<td>8.95**</td>
</tr>
<tr>
<td>Females (Years research experience)</td>
<td>.44</td>
<td>.44</td>
<td>.20</td>
<td></td>
<td>23.20***</td>
</tr>
<tr>
<td>African-American (No Significant Variance)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian (Years research experience)</td>
<td>.43</td>
<td>.43</td>
<td>.18</td>
<td></td>
<td>33.05***</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Student Cluster:</th>
<th>r</th>
<th>R</th>
<th>R²</th>
<th>Increase R²</th>
<th>Improving F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Group (2002 GPA)</td>
<td>.46</td>
<td>.46</td>
<td>.21</td>
<td></td>
<td>49.84***</td>
</tr>
<tr>
<td>(# Absences/Year)</td>
<td>-.16</td>
<td>.49</td>
<td>.24</td>
<td>.03</td>
<td>7.29**</td>
</tr>
<tr>
<td>Males (2002 GPA)</td>
<td>.42</td>
<td>.42</td>
<td>.18</td>
<td></td>
<td>17.71***</td>
</tr>
<tr>
<td>Females (2002 GPA)</td>
<td>.57</td>
<td>.57</td>
<td>.32</td>
<td></td>
<td>48.78***</td>
</tr>
<tr>
<td>(Weekly Science Homework)</td>
<td>.30</td>
<td>.60</td>
<td>.36</td>
<td>.04</td>
<td>5.72*</td>
</tr>
<tr>
<td>African-American (2002 GPA)</td>
<td>.63</td>
<td>.63</td>
<td>.40</td>
<td></td>
<td>16.38***</td>
</tr>
<tr>
<td>Caucasian (2002 GPA)</td>
<td>.50</td>
<td>.50</td>
<td>.25</td>
<td></td>
<td>50.98***</td>
</tr>
<tr>
<td>(# Absences/Year)</td>
<td>-.16</td>
<td>.53</td>
<td>.28</td>
<td>.03</td>
<td>6.35*</td>
</tr>
</tbody>
</table>

Note: * p < .05 significance, **p < .01 significance, and ***p < .001 significance
Table 14

Stepwise Multiple Regressions Predicting Ohio Proficiency Test Science Scores for Total Group and Gender and Racial Subgroups (continued)

<table>
<thead>
<tr>
<th>Parent Cluster:</th>
<th>r</th>
<th>R</th>
<th>R²</th>
<th>Increase R²</th>
<th>Improving F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Group (Parent education)</td>
<td>.27</td>
<td>.27</td>
<td>.08</td>
<td></td>
<td>14.42***</td>
</tr>
<tr>
<td>Males (No Significant Variance)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females (Parent education)</td>
<td>.48</td>
<td>.48</td>
<td>.23</td>
<td></td>
<td>31.17***</td>
</tr>
<tr>
<td>African-American (No Significant Variance)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian (Parent education)</td>
<td>.35</td>
<td>.35</td>
<td>.12</td>
<td></td>
<td>20.05***</td>
</tr>
</tbody>
</table>

Note: * p < .05 significance, **p < .01 significance, and ***p < .001 significance

These relationships were further examined by gender and racial subgroups for their predictive correlations with the OPT score criterion. For males only single variables entered the stepwise multiple regression equations. No additional cluster variables added significant amounts of individual variance. The dominant cluster variables were years of teaching experience (R = .32, F = 8.95, p < .01) and GPA (R = .42, F = 17.71, p < .001). Only the teacher cluster and the student cluster showed significant cluster predictions to the OPT score criterion.

For females, all three clusters predicted the OPT criterion significantly. The single variables of years of teacher research experience (R = .44, F = 23.20, p < .001) and parent education (R = .48, F = 31.17, p < .001) were responsible for significant cluster
predictions in the teacher and parent clusters. For the student cluster, two variables entered the stepwise equation, GPA (R = .57, F = 48.78, p < .001) and weekly time spent on homework (R = .60, F = 5.72, p < .05), with homework adding 4% independent variance to the prediction.

African-American students show no significant predictors from teacher cluster variables or parent cluster variables. Their only significant cluster relationship for OPT prediction is seen in the student cluster with the single variable of GPA, for which R = .63 (F = 16.38, p < .001). This is contrasted by the Caucasian racial group which has predictors from each variable cluster. Teacher cluster variable of teacher years of research experience (R = .43, F = 33.05, p < .001) singly accounted for the significant prediction (18% of variance). Student cluster variables of GPA (R = .50, F = 50.98, p < .001) and number of absences per academic year (R = .53, F = 6.35, p < .05) entered significantly for a total cluster prediction of 28% of the variance. The parent cluster variable of parent education (R = .35, F = 20.05, p < .001) was the only significant predictor in that cluster. Thus, the clusters were effective predictors of the OPT criterion test score for the total sample and for selected subgroups. For females, but not males, all clusters were effective predictors, and similarly for Caucasians, but not African-Americans, all clusters were effective predictors.

Table 15 demonstrates the same information for the science class grade criterion with total, gender and racial groups examined for their stepwise regression predictive relationships.
Table 15

*Stepwise Multiple Regressions Predicting Science Class Grade for Total Group and Gender and Racial Subgroups*

<table>
<thead>
<tr>
<th>Teacher Cluster:</th>
<th>r</th>
<th>R</th>
<th>$R^2$</th>
<th>Increase $R^2$</th>
<th>Improving F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Group (Years teaching experience)</td>
<td>.42</td>
<td>.42</td>
<td>.17</td>
<td></td>
<td>36.94***</td>
</tr>
<tr>
<td>Males (Years teaching experience)</td>
<td>.44</td>
<td>.44</td>
<td>.19</td>
<td></td>
<td>18.95***</td>
</tr>
<tr>
<td>Females (Years research experience)</td>
<td>.41</td>
<td>.41</td>
<td>.17</td>
<td></td>
<td>19.19***</td>
</tr>
<tr>
<td>African-American (No Significant Variance)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian (Years research experience)</td>
<td>.40</td>
<td>.40</td>
<td>.16</td>
<td></td>
<td>27.38***</td>
</tr>
<tr>
<td>(# Laboratory Hours)</td>
<td>.23</td>
<td>.42</td>
<td>.18</td>
<td>.02</td>
<td>4.05*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Student Cluster:</th>
<th>r</th>
<th>R</th>
<th>$R^2$</th>
<th>Increase $R^2$</th>
<th>Improving F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Group (# Absences/year)</td>
<td>.55</td>
<td>.31</td>
<td>.31</td>
<td></td>
<td>82.06***</td>
</tr>
<tr>
<td>(Science Attitude)</td>
<td>.25</td>
<td>.60</td>
<td>.36</td>
<td>.05</td>
<td>14.95***</td>
</tr>
<tr>
<td>Males (# Absences/year)</td>
<td>-.53</td>
<td>.53</td>
<td>.28</td>
<td></td>
<td>31.66***</td>
</tr>
<tr>
<td>(Science Attitudes)</td>
<td>.17</td>
<td>.58</td>
<td>.33</td>
<td>.05</td>
<td>6.01*</td>
</tr>
<tr>
<td>Females (# Absences/year)</td>
<td>-.61</td>
<td>.61</td>
<td>.38</td>
<td></td>
<td>62.56***</td>
</tr>
<tr>
<td>(Science Attitudes)</td>
<td>.35</td>
<td>.64</td>
<td>.41</td>
<td>.04</td>
<td>5.74*</td>
</tr>
<tr>
<td>African-American (# Absences/year)</td>
<td>-.46</td>
<td>.46</td>
<td>.21</td>
<td></td>
<td>6.82*</td>
</tr>
</tbody>
</table>

Note: * p < .05 significance, **p < .01 significance, and ***p < .001 significance
Table 15

*Stepwise Multiple Regressions Predicting Science Class Grade for Total Group and Gender and Racial Subgroups (continued)*

<table>
<thead>
<tr>
<th>Parent Cluster:</th>
<th>r</th>
<th>R</th>
<th>R²</th>
<th>Increase R²</th>
<th>Improving F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian (# Absences/year)</td>
<td>-.54</td>
<td>.54</td>
<td>.30</td>
<td></td>
<td>65.60***</td>
</tr>
<tr>
<td>(Science Attitudes)</td>
<td>.22</td>
<td>.59</td>
<td>.35</td>
<td>.05</td>
<td>12.40***</td>
</tr>
<tr>
<td>(Time on Homework)</td>
<td>.20</td>
<td>.61</td>
<td>.37</td>
<td>.02</td>
<td>4.40*</td>
</tr>
<tr>
<td>Total Group (Parent education)</td>
<td>.46</td>
<td>.46</td>
<td>.22</td>
<td></td>
<td>48.63***</td>
</tr>
<tr>
<td>(Marital Status)</td>
<td>.50</td>
<td>.50</td>
<td>.25</td>
<td>.03</td>
<td>28.96***</td>
</tr>
<tr>
<td>(School Involvement)</td>
<td>.52</td>
<td>.52</td>
<td>.27</td>
<td>.02</td>
<td>21.76***</td>
</tr>
<tr>
<td>Males (Parent Education)</td>
<td>.40</td>
<td>.40</td>
<td>.16</td>
<td></td>
<td>14.01***</td>
</tr>
<tr>
<td>Females (Parent education)</td>
<td>.50</td>
<td>.50</td>
<td>.25</td>
<td></td>
<td>34.21***</td>
</tr>
<tr>
<td>(Marital Status)</td>
<td>.27</td>
<td>.53</td>
<td>.28</td>
<td>.03</td>
<td>19.61***</td>
</tr>
<tr>
<td>African-American (No Significant Variance)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian (Parent education)</td>
<td>.46</td>
<td>.46</td>
<td>.22</td>
<td></td>
<td>39.91***</td>
</tr>
<tr>
<td>(School Involvement)</td>
<td>.32</td>
<td>.49</td>
<td>.24</td>
<td>.03</td>
<td>5.56*</td>
</tr>
</tbody>
</table>

Note: * p < .05 significance, **p < .01 significance, and ***p < .001 significance

The total group stepwise regression shows that significant factors for prediction of science class grade are the teacher cluster variable of teacher years of teaching experience (R = .42, F = 36.94, p < .001), the student cluster variables of number of absences (R =
and science attitudes (R = .60, F = 14.95, p < .001), and the parent cluster variables of parent education (R = .46, F = 48.63, p < .001), intact marital status (R = .50, F = 28.96, p < .001), and parent school involvement (R = .52, F = 21.75, p < .001). Thus, each of the clusters significantly predicted this criterion, accounting for 17%, 36%, and 27% of the total variance for the three clusters, respectively.

When gender groups are examined for significant cluster predictors, the teacher cluster is significant for the male group, with teacher years of teaching experience accounting for 19% of the variance (R = .44, F = 18.95, p < .001). For males, student number of absences (R = .53, F = 31.66, p < .001) is the most significant student cluster predictor with 28% of the variance. Student GPA (R = .58, F = 6.01, p < .05) adds an additional 5% of variance making this a significant cluster for science grade prediction. For males, parent education (R = .40, F = 14.01, p < .001) is the single predictor from the parent cluster accounting for 16% of the variance in prediction of science class grade.

Females have even more significant predictive variables in the three clusters with the teacher cluster variable of years of teacher research experience (R = .41, F = 19.19, p < .001) accounting for 17% of the teacher cluster variability. The student cluster shows that the female variable of number of absences (R = .61, F = 62.56, p < .001) accounts for 38% of the significant variance and science attitude (R = .64, F = 5.74, p < .05) adds an additional significant cluster variance of 4%. For females, the parent cluster variables of parent education (R = .50, F = 34.21, p < .001) and parent marital status (R = .53, F = 19.61, p < .001) account for significant variances of 25% and 3%, respectively. All of
these above variables contribute significantly to the science class grade prediction for this
gender group.

The African-American racial subgroup has only one significant predictor in the
three clusters. This student cluster variable, number of absences, has an $R = .46$ ($F =
6.82, p < .05$) and accounts for 30% of the class grade variance.

In contrast to this subgroup, the Caucasian racial subgroup has a number of
significant cluster variables for each cluster. In the teacher cluster, the significant
predictive variables for Caucasian science class grade are the years of teacher research
experience ($R = .40, F = 27.38, p < .001$) with 16% of the cluster variability predicted
and the variable of number of science class laboratories ($R = .42, F = 4.05, p < .05$) for an
additional significant cluster variance of 2%. The student cluster variable of number of
absences ($R = .54, F = 65.60, p < .001$) is the bulk of the 30% significant cluster
variability and the science attitudes ($R = .59, F = 12.40, p < .001$), and time spent on
homework ($R = .61, F = 4.40, p < .05$) are significant and predict additional 5% and 2%
of the variance in Caucasian science class grades. The significant Caucasian parent
cluster variables of parent education ($R = .46, F = 39.91, p < .001$) and parent school
involvement ($R = .49, F = 5.56, p < .05$) are both significant and account for 22% and 3%
of the science class variance. Thus, these findings lend additional support for the
acceptance of hypotheses 13, 14, and 15.

**Section III: Overall Best Predictor OPT Science Score Model**

The three variable clusters were each examined individually by zero-order and
stepwise correlations in the previous two sections, which examined the relationships
between the variables in the clusters and the Ohio Proficiency Test score. When the strongest correlation variables of each cluster were combined, a best predictor model of student science achievement was constructed. A linear regression was then performed for the total group and again for each of the different gender and racial subgroups. This was done for each criterion variable and thus, ten best predictor models were generated.

Table 16 shows amounts of variance predicted for the total class group, as well as gender and racial subgroups when best predictor models were related to both criteria. The three cluster variable of teacher years of teaching experience, student 2002 grade point average, and total parent education level were included in the total group best predictor model for OPT score. The results of this regression showed an R value of 0.55 ($R^2 = 0.30$), an F value of 17.77 ($p < 0.001$). This indicates that 30% of the overall variance in OPT science scores can be predicted by these three variables. OPT score variance was further explained by the separate best predictor models for males, females, African-Americans, and Caucasians.

The male OPT best predictor model included the cluster variables of teacher years of teaching experience and student’s grade point average. The results of this model are $R = .46$ ($R^2 = .21$), $F = 10.63$ ($p < .001$). Thus, 21% of the OPT science score variance for males is predicted by these two variables.

The female model uses the four cluster variables of teacher years of research experience, student GPA, student time spent on science homework, and parent education. The model has an $R = .67$ ($R^2 = .45$), $F = 17.90$ ($p < .001$) and predicts 45% of the variance seen in female OPT science scores.
### Table 16

*Best Predictor Models for Total Group and Gender and Racial Subgroups*

<table>
<thead>
<tr>
<th>Model:</th>
<th>R</th>
<th>$R^2$</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Group:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPT</td>
<td>.55</td>
<td>.30</td>
<td>17.77***</td>
</tr>
<tr>
<td>Science Grade</td>
<td>.71</td>
<td>.50</td>
<td>27.48***</td>
</tr>
<tr>
<td><strong>Males:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPT</td>
<td>.46</td>
<td>.21</td>
<td>10.63***</td>
</tr>
<tr>
<td>Science Grade</td>
<td>.63</td>
<td>.40</td>
<td>11.77***</td>
</tr>
<tr>
<td><strong>Females:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPT</td>
<td>.67</td>
<td>.44</td>
<td>17.90***</td>
</tr>
<tr>
<td>Science Grade</td>
<td>.72</td>
<td>.51</td>
<td>18.11***</td>
</tr>
<tr>
<td><strong>African-Americans:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPT</td>
<td>.67</td>
<td>.44</td>
<td>20.65***</td>
</tr>
<tr>
<td>Science Grade</td>
<td>.47</td>
<td>.22</td>
<td>7.28*</td>
</tr>
<tr>
<td><strong>Caucasians:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPT</td>
<td>.62</td>
<td>.38</td>
<td>20.09***</td>
</tr>
<tr>
<td>Science Grade</td>
<td>.70</td>
<td>.49</td>
<td>20.79***</td>
</tr>
</tbody>
</table>

Note: * p < .05 significance, **p < .01 significance, and ***p < .001 significance
The model for the African-American racial group uses only the grade point average as its sole significant predictor. This model has an $R = .67$ ($R^2 = .44$) and $F = 20.65$ ($p < .001$) and thus, this one variable predicts 44% of the variance seen in African-American OPT science score. In contrast, the Caucasian best predictor model uses the four variables of teacher years of research experience, student GPA, number of absences, and parent education. The model’s $R = .62$ ($R^2 = .38$) and $F = 20.09$ ($p < .001$) and accounts for 38% of the variance seen in Caucasian OPT science scores.

Section IV: Overall Best Predictor Science Class Grade Model

While these best predictor models give important information about factors that account for variance in OPT scores, the arguments against the “short duration” test criterion require a more comprehensive look at long term measures of student science achievement as demonstrated by science class grades. Thus, best predictor models using this criterion variable are warranted. Table 16 shows the data for the total group model for science class grade prediction. This model used six significant cluster variables in its construction. These variables were teacher years of teaching experience, student number of absences, student science attitude, parent education, parent marital status, and parent school involvement. The variable of student GPA, while a strong predictor in the OPT model, was eliminated since it has confounding effects due to the fact that the science class grade is used as one of the component parts of the GPA. The above six cluster variables, thus, combine in the total group model to produce an $R = .71$ with an $F = 27.48$ ($p < .001$) and account for 50% of the variance seen in the students’ science class grades.
To further examine gender relationships, male and female best predictor models of science class grades were also constructed. The male model used the significant variables of teacher years of teaching experience, number of absences, student attitude, and parent education. The model’s R value was .63 and $F = 11.77 \ (p < .001)$, thus accounting for 40% of the variance seen in male science class grades. In comparison, the female best predictor model used the five cluster variables of teacher years of research experience, student number of absences, student science attitude, parent education level, and parent marital status for its construction. The model has an $R = .72$ and an $F = 18.11 \ (p < .001)$, therefore predicting 51% of the variance seen in science class grades of females.

The examination of racial group models shows that the African-American model uses only one significant cluster variable – student number of absences. This model has an $R = .47$ and an $F = 7.28 \ (p < .05)$ and predicts 22% of the science class grade in African-Americans. By comparison, the Caucasian racial subgroup’s model used seven significant predictor cluster variables. These variables are the teacher’s years of research experience, the number of hours spent in science class laboratories, the student GPA, the number of absences, the student science attitude, the parent education, and the parent involvement in school. The Caucasian science grade model’s R value is .70 and F value is 20.79 ($p < .001$). Thus, 49% of the variance seen in Caucasian students’ science class grade can be accounted for by these variables.
Table 17

*Summary of Significant Correlations of Student Gender and Race with Outcome Variables of Ohio Proficiency Test Science Score and Science Class Grade*

<table>
<thead>
<tr>
<th>Gender:</th>
<th>OPT Score</th>
<th>Class Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Teacher Variable Cluster</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years of Teaching Experience</td>
<td>**</td>
<td>***</td>
</tr>
<tr>
<td>Years of Research Experience</td>
<td>*</td>
<td>***</td>
</tr>
<tr>
<td>Weekly Hours of Laboratory</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Student Variable Cluster</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade Point Average</td>
<td>*</td>
<td>***</td>
</tr>
<tr>
<td>Science Attitude</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Absences</td>
<td></td>
<td>***</td>
</tr>
<tr>
<td>Weekly Hours of Homework</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>Parent Variable Cluster</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent Education</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Parent Marital Status</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Parent School Involvement</td>
<td>*</td>
<td>**</td>
</tr>
</tbody>
</table>

Weekly Hours of Homework Help

Note: * p < .05 significance, **p < .01 significance, and ***p < .001 significance
Table 17

*Summary of Significant Correlations of Student Gender and Race with Outcome Variables of Ohio Proficiency Test Science Score and Science Class Grade (continued)*

<table>
<thead>
<tr>
<th></th>
<th>OPT Score</th>
<th>Class Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Race:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Teacher Variable Cluster</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years of Teaching Experience</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Years of Research Experience</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Weekly Hours of Laboratory</td>
<td>*</td>
<td>***</td>
</tr>
<tr>
<td><strong>Student Variable Cluster</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade Point Average</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Science Attitude</td>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td>Absences</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Weekly Hours of Homework</td>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td><strong>Parent Variable Cluster</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent Education</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>Parent Marital Status</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>Parent School Involvement</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td><strong>Weekly Hours of Homework Help</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * p < .05 significance, **p < .01 significance, and ***p < .001 significance
Conclusions

The hypotheses of this study were initially designed to examine the relationships between 12 variables in three clusters and the science test scores of the Ohio Proficiency Test. While the study did analyze these variables, it also performed additional tests which examined the relationships between the 12 variables and the additional outcome variable of student final science course grade.

In the course of the study, students t tests of gender and racial subgroups confirmed that there were racial differences in OPT scores and both gender and racial differences in science grades. Thus, due to adequate size of the student sample, additional examinations were possible and were conducted for all 12 variables in terms of these new subdivisions. These examinations were made to confirm whether gender and racial designations had an impact on the strength of individual variable predictions and on the final best predictor model.

Of the 15 original OPT and cluster variable hypotheses, eight showed significant positive relationships that occurred in the expected direction. Seven showed no significant relationships with the OPT criterion. However, when more broadly based end-of-the-year science class grade was used as a criterion, 13 of the 15 hypotheses showed significant relationships in the expected direction. With both criteria, significant gender and racial differences were observed in the strength of individual predictors and in the composition of best predictor models. Thus, it was important to examine the relationships between the 12 cluster variables and both criterion variables in terms of gender and racial subgroups.
CHAPTER 5

DISCUSSION

Introduction

Accountability in our nation’s schools is arguably the most frequently debated educational issue in our country today. High stakes testing has been widely implemented throughout the nation, with accompanying controversy about the adequacy of a single-measure criterion, and confusion about effective interventions to remedy identified poor performance. Attempts to discover possible remedies have typically focused on limited correlational studies that utilize few predictors and ignore subgroup differences in the predictive power of these selected variables.

This study was designed to add to the existing knowledge base by, (a) examining a wider set of predictive factors that includes home, school and student characteristics, (b) predicting both high stakes test scores and the more broadly based end of the year science grade, (c) performing correlation analyses separately for gender and race, and (d) constructing best predictor models for each gender and racial group. The primary impetus for this study was that educators’ increased knowledge of Ohio Proficiency Test score predictors might enhance their ability to improve performance of all students. An assumption of this study is that these analyses can inform science educators about
potential precursors of student performance on tests such as the Ohio Proficiency Test (OPT), the Ohio Graduation Test (OGT), and the Ohio Achievement Test (OAT), as well as on final average classroom grade in science. The study asked the following:

a) What are the teacher variables that predict better student scores on the science portion of the OPT?

b) What are the student variables that predict better student scores on the science portion of the OPT?

c) What are the parent variables that predict better student scores on the science portion of the OPT?

One of the goals of today’s educational reform programs is accurate documentation of students’ educational understanding. This has recently been interpreted as a need for more objective testing of student content understanding as measured by standardized tests. Over the past eight years, the “No Child Left Behind Act”, related federal revisions to mandatory testing plans, and subsequent state level adoptions have promoted large scale testing of student performance as compared to more subjective teacher-based evaluations. This has led to repeated revisions and modifications in the way that student educational performance is measured and the importance placed on these tests. Thus, educational systems are investing large amounts of financial and personnel resources to meet the standards for understanding and academic achievement set by the state Department of Education. This climate of accountability causes schools to depend on their student scores on multiple sections of these standardized tests for their school’s academic responsibility “grade”. Schools not making the grade and/or not showing
satisfactory improvement in student understanding and learning can face serious consequences including the most extreme of having their charter revoked and being managed by state officials.

Currently, math and science portions of the standardized tests pose the most challenging sections of these accountability measures. The need for emphasis on science is illustrated by a recent Harris Interactive survey of 1,304 adults. This poll, conducted on behalf of the Chicago Museum of Science and Industry, revealed that 70% of those surveyed believed the USA is no longer the world leader in science achievement, and 79% believe that science education isn't receiving enough attention in schools. Presidential candidates should make improving science education a national priority according to 76% of these respondents. Walter Massey, a board member of the Chicago Museum stated that, “People will respond to demagoguery if they don’t believe they have sufficient knowledge and sufficient confidence in their ability to weigh arguments and assess what’s behind them…The danger is that we move increasingly toward being a society where the most important decisions are ultimately made by fewer and fewer people.” (MacDonald, 2008).

To help explain the teacher, student, and parent factors involved in the student science performance on the science portion, this study has examined 12 variables that previous literature suggested might have an impact on student science achievement and understanding. As described in Chapter 2, a large number of research and opinion articles have examined one or more of the predictors considered in this study. For several of these variables, there is no clear consensus about the role that it plays in science
achievement. For example, Latham’s (1998) conclusions about the lack of a gender gap in science achievement raise questions about test versus achievement grade criteria and are contradictory to other studies that find considerable difference (e.g., Beller & Gafni, 1996). Other authors attempt to expand the search for underlying factors that may explain the gender gap discrepancy, and several conclude that attitudinal factors such as science interest, self discipline and behavioral compliance may account for differences on criteria (e.g., Duckworth & Seligman, 2006; Debacker & Nelson, 2000; Ryckman & Peckham, 2001).

The intent of this study was to examine and further elaborate several relationships among the science test score criterion and clusters of teacher, student, and parent variables. Considering the substantial criticism of “high stakes testing” among many educators, a second criterion variable, that of overall ninth grade science class grade, was also examined. This criticism stems from educator’s frustration that their students’ abilities in science (and therefore, the educators’ ability to perform their jobs and teach science) are measured by a single, one-day event. Clearly, some teacher, student, and/or parent variables may predict day-to-day science performance, even though they do not reliably relate to a single test score at a particular point in time. A best predictor model was constructed by combining the single variables that were the strongest predictors from each cluster. Additional analyses were conducted to examine gender and racial differences and to compare the relative predictive power of each variable according to the subjects’ gender and race.
The results of this study offer some insight for better use of limited academic resources, and could result in improved teacher professional development programs, better college training for pre-service science teachers, improved parent-school communication, better home-based intervention programs, as well as new initiatives for student attendance and improving school science attitudes. Thus, the findings from this study yield information about personal and environmental factors that may have the power to influence science achievement. While correlational data cannot be construed as causal, they can provide direction for further experimental interventions and instructional modifications. Of particular interest are the comparisons of “best predictor” models for gender and race. Total group analyses often obscure important variability of subgroups as illustrated by the different prediction patterns for gender and race seen in this study. Clearly, one of our nation’s educational priorities should be the improvement of science education and that mission is most critically needed in our urban centers. As stated by the National Research Council (1998), the goals for science education are to: “Educate students who are scientifically literate and capable of understanding the natural world, using science principles to make decisions, engage intelligently in science discussions, and to be more productive through the use of science skills and knowledge.”

General Findings of the Study:

The interpretations of this study can best be understood when separated by prediction cluster. Findings are therefore discussed for each cluster as they predict each of the two criteria and as they are influenced by gender and racial subgroup membership. To reiterate the clusters and variables examined in this study:
Teacher Variables include: (a) years teaching experience, (b) science research experience, (c) continuing professional development experiences (hours taken annually in professional development), and (d) number and type of science laboratories performed weekly.

Student Variables include: (a) academic achievement as measured by a general academic aptitude variable (high school grade point average), (b) school attendance rate, (c) hours spent weekly on homework, and (d) science attitudes including self-efficacy.

Parent/Home Variables include: (a) parent marital status, (b) parent education level, (c) parent-school involvement, and (d) parent time helping with homework (hours weekly).

**Teacher Cluster**

A major question that this research examined was that of what are the teacher variables that predict better student scores on the science portion of the OPT, and by extension, other high-stakes science tests? As illustrated by multiple regression analyses, the teacher cluster was a strong predictor of both OPT and science class grade. For the total group, this cluster predicted both OPT scores and science class grade at a highly significant level of confidence and accounted for 10% and 17% of the observed variance in OPT and science grade, respectively. The cluster predictions held for both males and females and for Caucasians, but not for African-Americans, who may have other classroom factors that affect their learning that are not considered in this study. For males, females and Caucasian subgroups, the strongest predictors of OPT scores and
science grade were years of teaching experience and teacher’s years of research experience. None of the variables in the teacher cluster predicted performance of African-American students for either OPT score or class science grade. These results suggest that more experienced teachers may improve classroom environment both in academic and behavioral ways that ultimately improve Caucasian student science understanding. The dynamics of this influence may be complex and may vary based on individual school environments. However, it is useful to speculate on how this variable may translate to improved student science performance. Teacher experience may reflect an ability of more experienced teachers to understand difficult science concepts more thoroughly and to have a wider repertoire of teaching strategies and classroom control mechanisms. Based on more extensive past experiences, veteran teachers may have a better grasp of which science topics require extra instructional time or special teaching methods to ensure student comprehension. Research by Lederman (1999) and Burry-Stock and Oxford (1994) elaborate upon this teacher experience variable and support this variable’s importance in student science achievement. Johnson (2001) also proposed that this may be due to the depth of the teacher’s subject matter knowledge. Bodenhausen (1988) reported that years of teaching experience and subject area college grade point average were found to have a significant interaction with student scores on advanced placement tests. Summers and Wolf (1977) found that increasing teacher years of teaching experience had a positive effect with high-achieving students but a negative effect on low-achieving students. These results were somewhat confirmed by Murname (1975) who found that student achievement was positively effected by
teachers with one to three years of experience but no significant effect found with teachers with more than five years of experience. Additional researchers have also found that teacher experience has a positive effect on student academic performance (Darling-Hammond, 1998; Fergusson, 1991; Greenwald, Hedges, & Laine, 1996). Generally speaking, the findings of this current study support and confirm the results of prior research. However, when final analyses are done by subgroups, variations in predictive power of this variable are noted.

Teacher experience specifically in a science research setting was the second most powerful predictor in this cluster. This finding may reflect a positive relationship in which teachers who have engaged in science research, have a better understanding of how science is done and are more familiar with the need for science laboratories, conveying this value to their students. These teachers may also feel more comfortable with the equipment, timing, classroom management, and ambiguities often experienced in the outcomes and results of laboratory research (Fraser-Abder & Leonhardt, 1996; Melear et al., 2000; Raphael et al., 1999). Several researchers have reported that the hands-on learning found in science laboratories has a positive relationship with the student internalization of science concepts and leads to a better understanding of science. Johnson (2001) examined the National Assessment of Educational Progress (NAEP) scores and found that science students who used laboratory tasks in their science classes, scored 40% ahead of their grade level peers. Thus, the results of this study demonstrated that Caucasian student standardized test scores and science grades both show a positive relationship to this teacher predictor variable, science research.
These results taken together suggest that teacher variables are predictive for both the one-day test event and year long class grade events measuring student science understanding. It should be noted that compared to the OPT criterion, the science class grade relationships tended to show higher correlations for teacher years of teaching experience, teacher research experience, and laboratory hours. Research has been conducted on the reliability of large scale testing and found that one day tests show reliability over the course of several years as compared to the more subjective teacher graded tests given over the course of the school year (Kazelskis et al., 2005). While a student’s health can affect a single standardized test score (Dietel, 2004) these tests provide a reliable measure not influenced by the region in which it is given (North Carolina Department of Public Instruction, 1996). Additionally, the use of intelligence tests to measure intelligence quotient shows great reliability over the course of an individuals’ lifetime (Williams T.O. et al., 2007; Neisser et al., 1996; Gage and Berliner, 1984).

The absence of any significant predictions for the African-American group is worthy of note. It may be a function of some other more powerful predictor that minimizes the teacher experience variables. The need to explore other teacher characteristics that may relate to science competency for this group is evident. The teacher’s own race might seem to be a reasonable teacher characteristic that might increase student identification and consequent performance. This is consistent with studies by other researchers (Dee, 2004; Oates, 2003; Pigott & Cowen, 2000) who have reported that teacher racial identity does affect student motivation when considering the
African American students. This is most often seen in urban settings where the students are taught by a Caucasian teacher. This has not been shown to affect Caucasian students taught by African American teachers. This appears to affect the feelings of cultural identity and has an effect on student motivation and self-efficacy with regard to the course content. However, the effect is small. The effect is also strongest when examining minority students of lower social economic strata. However, at least one researcher disputes this interpretation (Viadero, 2001) and found that the teacher ethnicity influences were dependent on class size and that the influences disappeared with small class sizes. This is especially important when the students are in poor urban settings. The effect is that the students are able to develop a rapport with the teacher when there are small class sizes and that this can offset any racial discontinuity.

These teacher findings suggest that in a climate of increasing accountability by testing, there is a need to attract and retain more experienced teachers and to recruit more teachers with specific scientific research backgrounds. The goal of these education policies is to help students succeed as measured by their scores on standardized achievement tests such as the Ohio Graduation Test and the Ohio Achievement Test. As deficiencies are identified by test score drops as compared to other similar school districts, additional funding can be directed to programs designed to alleviate these lower scores. This demonstrates the goal of being able to improve student knowledge and understanding of the content by bringing more educational resources into use during the education process. This may be accomplished by offering additional financial and responsibility incentives. Additionally, the need for more research-experienced science
teachers suggests that university teacher education programs may benefit by incorporating a long-term, content-area research project requirement into their studies, and it further suggests that school districts should include this type of teacher activity into their professional development plans (Aiello-Nicosia et al, 1984; Fraser-Abdner and Leonhardt, 1996; Raphael et al, 1999; Melear et al, 2000). An example of this is the National Aeronautics and Space Administration’s teacher-researcher program.

**Student Cluster**

A second major question asked by this study was, what student variables predict better scores on the science portion of the OPT, and by extension, other high-stakes science tests? The student cluster multiple regression predictions of OPT and class grade were highly significant for the total group and all subgroups (accounting for 24% and 36% of the total variability seen in OPT and science grade, respectively), although substantially less variance in class grade prediction was again noted for African-American students. Considering the magnitude of Pearson r correlations, it was evident that GPA was the most powerful predictor of both criteria, probably resulting from the underlying intellectual capacity and academic diligence reflected by this predictor. The strong relationship between GPA and science class grade was obviously expected since one of the components of GPA is science grade. School attendance was also a powerful predictor of class grade and OPT scores, and it was the dominant predictor of class grade in multiple regressions for students of both gender and racial groups. All variables were significant predictors of both criteria for females and Caucasians, but not for males and African-Americans. Only GPA and absences were significant predictors for these two
groups, whereas science attitudes and homework hours were additional significant predictors for females and Caucasians.

The relationship of class absence to class grade and its relative strength of prediction for class grade rather than OPT score is probably attributable to the importance of daily attendance in order to acquire the requisite knowledge to perform well on teacher-made tests and projects (Weller, 2000; Duckworth & Seligman, 2004; Koshal et al., 2004). While class attendance is of importance to content understanding and mastery, it is important to consider whether student absence is a result of a lack of mastery of the content and student avoidance of an uncomfortable environment where their self esteem and social image is threatened. Monk and Ibrahim (1984) investigated this phenomenon and found that there was a pattern of absence reflected in a student’s test score performance. However, the question of the reasons for the lack of sufficient class attendance was not researched by this study and could serve as an important follow-up topic of investigation (Dillon, 1998). Are students more likely to be absent on days when major evaluation events occur in difficult classes as compared to classes where the student feels confident of their understanding of that course content? This may reflect on the other variables of teacher years of experience, parent education, parent marital status, and potential student extra curricular activities. Is the student occupied with other non-academic activities that cause them to be tired or unprepared for school? Is there a need for a job to help with family or personal finances? This may be particularly important in urban areas with lower SES or single-parent homes since students may have to offset parents working multiple jobs by helping with household chores and financial
obligations. Science course performance would be particularly vulnerable to the absence 
deficiencies since so much of the sciences is sequential learning with previous terms and 
concepts being the vital building blocks for later more complex topics. This finding could 
also relate to teacher perceptions of a student’s motivation and compliance with school 
regulations, which would be more likely to affect class grade than OPT score. The 
observed relative unimportance of homework hours and science attitude for males and 
African-Americans may be the result of low predictor variability for these subgroups. 
This could occur, for example, if the prevailing science attitudes and homework were 
generally low for these students (Cooper et al., 1998). Homework has traditionally been 
used to reinforce skills and content mastery of topics covered during the academic day. 
However, there is conflicting evidence as to the influence on grades that homework has. 
A meta-analysis of homework studies from 1987 to 2003 by Cooper, Robinson, and 
Patall (2006) shows that for some grade levels there was no relationship. They 
recommend more research into this discrepancy. The current study also did not show a 
strong relationship between homework time and the outcome variables of OPT test score 
or science class grade. One possibility of this may be that there has been an increasingly 
critical view of homework by students, parents, and researchers who feel that it interferes 
with their social development by restricting time for social interactions with family 
members, peers, exercise activities, and leisure activities (i.e. play). There is evidence to 
suggest that parent perceptions and reinforcement of homework are important in 
developing positive attitudes towards homework in students (Leung, 1993). However, 
there may also be a push by parents to minimize homework due to the negative family
interactions involved when the parents must enforce homework completion as opposed to other student motivations. Additionally, parents may want help with household responsibilities and homework time competes with this. Some researchers have argued against homework on the grounds that it affects student self esteem by inhibiting student social self growth by preventing enjoyable activities and thereby casting a negative image on academic achievement and school (Kohn, 2007A, 2007B, 2006, 1999). Kohn argues for a decrease in the amount of homework and even avoiding the giving of homework for students under the age of 14. The rationale being the amount of homework given demoralizes students and causes frustration which can lead to negative school image and poor performance. This may be particularly important in urban settings where students are faced with more survival needs due to lower SES levels of many families and may additionally be cast as something not needed for peer acceptance and future success. Especially when seen in minority students, this can be a cause of a dis-identification with the established means for financial advancement and success. The current research recommends that a more detailed examination of this relationship be conducted with special attention given the affects of motivation by parents and peers for each subgroup.

Parent Cluster

The third major question of this study was, what parent and home variables predict better scores on the OPT and, by extension, other high-stakes science tests? The parent cluster multiple regressions predicted the OPT criterion for the total group (8% of total variance) and for female (23%) and Caucasian (12%) subgroups, but not for males and African-Americans. The only variable entering into the prediction equations was
parent education, but this predictor was highly significant. Pearson r correlations for this criterion showed that parental marital status and parental school involvement were also significant predictors, but for the female subgroup only.

A very different picture emerged when the criterion of science class grade was examined. Multiple correlations for this cluster were all significant, with the exception of the African-American group. For the total group, parent education, marital status, and parental school involvement were all significant predictors and accounted for 27% of total variance. For females, parent education and marital status entered the equation significantly (28% of variance), and for males, parent education was the only significant predictor in the regression (16% of variance). For Caucasians, parent education again entered significantly followed by parental school involvement and accounted for 24% of total observed variance. This is likely due to the emphasis that educated parents place on the means by which they became successful. These parents may have seen their children as an extension of themselves and want their children to succeed as they have. Additionally, educated parents may see the school system as a tool to be used to gain their child’s future success and feel that they have a vested interest in their child’s future economic independence. The same may not be the case of parents with less education if they do not have a higher SES level since they may see their children as a means to improve the family’s economic status by monetary or care responsibilities that the child can bring to the household. This may be akin to previous agricultural generations where the children were viewed as additional labor to help the family survive. Educated parents may also feel that their child’s school system is paid for by their tax dollars and,
therefore, see the administrators and teachers as working in their interests. They may feel that it is important to contribute to the school functioning and make their interests known to their child’s teachers. Whereby, parents in lower paying jobs or working multiple jobs may feel that the school is a way to keep their child busy at a minimal cost to them and thereby use the school as a “baby sitting” agency (Zitterkopft, 2006; Gordon, Kaestner, & Cuny, 2008; Barney & Koford, 1987).

Examination of Pearson r correlations showed that all predictors in this cluster, with the exception of parental homework help were significant predictors of class grade for males, females, Caucasians, and the total group. Only parent education was a significant predictor for African-Americans. Apparently, some of these variables did not enter the multiple regressions because of shared variance. For example, marital status and school involvement may be highly related to level of parental education.

The greater number of significant predictions for the science grade criterion may be due to the fact that many of these family conditions exert their influence over a more lengthy time period, sustaining daily student behavior over grading periods, whereas they may not have as profound an effect on a single-day OPT test experience. Parental factors may, for example, influence student attendance, which was found to relate more to science grade than OPT score. A separate correlation was run to examine the relationship between parent factors and student absence rate and revealed a significant positive relationship between intact marital status and student attendance (p<0.01, Appendix 5). The influence of other parent factors would be a topic for future study and may shed
more light on the effects of more detailed parental variables on student science achievement.

**Best Predictor Model**

Overall, the examination of the three variable clusters reveals that for standardized test science score, the most significant variables that predict success are the teacher’s years of teaching experience, which accounts for 10% of the variability, the student’s academic aptitude (measured by annual GPA) which accounts for 21% of the variability, and the parent’s total education level which accounts for 8% of the test score variability.

When examining the three most important variables that predict science class grade, the teacher’s years of research experience accounts for 17% of the variability, the number of absences accounts for 31% of the variability, and the parent’s total education level accounts for 22% of the variability.

Thus, as a total best fit prediction model, teacher experiences (hypothesis 1) play a major role, as does student grade point average (hypothesis 5), school attendance (hypothesis 6) and parent education (hypothesis 19). There is an expectation that as teachers gain more experience they become better able to maintain control of their classrooms and have a better understanding of their content matter as a result of having read about it or experienced the activities more often. Additionally, there is an expectation that with more years of experience, the teacher has had more opportunities to gain knowledge and skills as a result of having had more workshops and professional development activities that reinforce existing skills and knowledge and give new ones
(Arzi & White, 2008). The possibility of improved teacher experience is also present as a result of teachers gaining more education by acquiring additional college degrees. This would serve to potentially give the teachers both updated content knowledge and educational skills for classroom development and management. The question of what is truly measured by the teacher experience variable, content or classroom management skills, was not specifically addressed by this study and consequently, deserves more detailed study. When taking into account the different racial and gender subgroups, different patterns of predictability are evident. This is especially seen in the lack of many measured variables for predicting the African-American student test scores and class grades as compared to Caucasian students. Female science achievement on the OPT is predicted by teacher years of research experience (20% of the variability, hypothesis 2), student GPA (hypothesis 5) and hours of weekly homework (36%, hypothesis 7), and parent education (23%, hypothesis 9). Males OPT scores, however, are best predicted by teacher years of teaching experience (10%, hypothesis 1) and student GPA (18%, hypothesis 5).

When considering science grades, female scores are again predicted by teacher years of research experience (17%, hypothesis 2), but also by attendance (hypothesis 6) and attitude toward science (41%, hypothesis 8) and by both parent education (hypothesis 5) and marital status (28%, hypothesis 10). Science grade in males is also predicted by a greater number of variables as compared to OPT score. They are again predicted by teacher years of teaching experience (19%, hypothesis 1), but also by attendance
Comparing the racial groups, Caucasian scores are predicted by years of teaching experience and the number of student hands-on/teacher demonstration weekly hours spent in science laboratories (18%, hypothesis 4), the attendance (hypothesis 6), attitude toward science (hypothesis 8), and weekly time spent on homework (37%, hypothesis 7) and their parent’s education (hypothesis 9) and school involvement (24%, hypothesis 11). This contrasts with the African-American group which only has their school attendance as a significant predictor (21%, hypothesis 6).

These patterns reveal best predictor models for OPT score and science grades that account for much of the variance seen in these measures of student science achievement. The best predictor model for the total group accounts for 30% of the OPT score and 50% of the science grade variances. When examined by gender, the male best predictor model for OPT score and science grade accounts for 21% and 40%, respectively. The female model accounts for 44% and 51% of the OPT score and science grade, respectively. When examining the racial groups, the Caucasian model for OPT and science grade account for 38% and 49% of the observed variance, respectively, and the African-American model accounts for 44% of their OPT score and 22% of their science grade.

In summary, correlation analysis of the three variable clusters for the total group show that the following variables positively relate to student science OPT scores: teacher years of teaching experience, teacher research experience, student 2002 grade point
Table 18

*Best Predictors of Science Ability: Accounted for Variance*

<table>
<thead>
<tr>
<th></th>
<th>Ohio Proficiency Test Score</th>
<th>Science Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Total Grade Point</td>
<td>30%</td>
<td>50%</td>
</tr>
<tr>
<td>Gender:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>21%</td>
<td>40%</td>
</tr>
<tr>
<td>Female</td>
<td>44%</td>
<td>51%</td>
</tr>
<tr>
<td>Race:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>38%</td>
<td>49%</td>
</tr>
<tr>
<td>African American</td>
<td>44%</td>
<td>22%</td>
</tr>
</tbody>
</table>

average, student attendance and total parent education level. Subgroup analyses for gender and race help to explain total group findings. The OPT criterion is predicted only by female Caucasians for the parent variable cluster. Only male and female Caucasians contribute significantly to the correlations found in the teacher variable cluster, and both Caucasian and African-American students contribute to the significant correlations of GPA and attendance found in the student variable cluster. The female subgroup of the study was the overall most significant contributor to total group predictions and, in fact, showed significant relationships to the OPT criterion on some occasions when the total group correlations were not significant.

Thus, these best predictor models account for a substantial amount of the variance in both OPT scores and end of year science grade. Additionally, they provide information that might be used by education professionals at academic institutions as well as those at district and state levels. Better understanding of the predictive relationships of these
variables may be useful in designing better curriculum and education policies to meet the science understanding needs of all students, as well as in fine-tuning science learning for different gender and racial subgroups. The information gained in this study needs to be continued with attention given to the findings concerning the predictive factor differences between the genders and the two racial groups studied.

It must be noted that this study didn’t initially consider the effects of gender and race on the use of science test variables to assess a best fit model for prediction of science achievement. The initial study proposed the gender and race variables as null hypotheses. However, after data collection and analysis, it was discovered that there were masking effects of the data caused by the lumping of all students together. When the data was disaggregated into separate gender and racial subgroups, significant correlations were found. These correlations revealed better construction of best-fit models of school, student, and home variables that were specific for separate gender and racial subpopulations. The revised best fit models may have better predictability for school personnel in determining the success of students on standardized science tests and science classes.

Limitations of the Study

This study sought to gain data from as many different science students as possible to make its conclusions. However, some limitations were necessary to avoid confounding the results by adding too many additional variables and due to time and financial issues. First, in an attempt to control for student age, this study only examined ninth grade students taking the Ohio Proficiency Test for the first time. This eliminated
the inclusion of 10th, 11th, and 12th grade students who may have had additional science classes and who may have had previous exposure to the test in earlier failed attempts. This also would control for previous exposure and familiarity with the test and question formats so that all students would start with the same levels of potential confusion and time delays to prepare for completing Scantron cards. This may also help to minimize variations in psychological maturity and development issues since these students were similar by grade. While this may be considered a limitation when generalizing the results to standardized science testing at the secondary level as a whole, it is important to consider that the first testing period for the sophomore OPT test was in the October of the sophomore year and the students would have only had their tenth grade teacher for a month and a half prior to the test administration. This study examined their experiences in their freshman year and was done at the end of their academic year (surveys were given in May of the year) and therefore, would have reflected on a year of their education with that teacher. This was a control for variables of student age and teacher cluster variables that would have reflected a limited time exposure. A future study may wish to examine standardized science testing in all secondary education grade levels to determine if there are differences in the predictive influences of the variables of this study.

This study also is limited in that it used only one of Ohio’s big eight urban school districts and yet attempts to generalize its findings to all state and ultimately, national urban school districts. However, since Ohio allocates financial resources based on student enrollment numbers, this minimizes concerns about the equivalence of financial support in Ohio’s urban centers. The urban district examined showed similar
standardized test score passage as compared to others in the state. Furthermore, on a nationwide basis, today’s urban schools face similar problems and this study should, therefore, be representative of most other urban districts and their educational difficulties.

The study was limited by time since it was important that all students experience a similar test. Thus, this study had to be conducted in the same school year and students needed to be surveyed in a relatively close time period to avoid additional influences caused by increased exposure time to their science teacher and to avoid possible changes in school district science curricula. Another, possible limitation of this study is that the Ohio Proficiency Test (OPT) score is the product of the demographics of all the science teachers that the students have had for the past nine years of their education, not just the most recent year (ninth grade). This study only examined the most recent teacher’s information and therefore is limited in examining the cumulative effects that teacher education levels, total laboratory time, teacher research experience, and teacher professional development on student test performance. This would also influence student attitude toward science and potential motivation toward science homework and class grades. A further longitudinal study may answer these questions.

The overall use of this particular test as a measure of future versions of this and other forms of standardized science tests is also a possible limitation. However, since the basic national science benchmarks and achievement standards are fairly stable and are represented by the state versions of the standardized tests, the current study should be applicable to understanding future tests with the same basic science academic goal.
Additionally, the national benchmarks also help to generalize this study’s findings with urban districts nationwide.

This study attempted to avoid sampling bias by looking at all eight secondary education high schools in the district. However, after initial study approval by the school board and district research office, only four of the eight high school principals gave their approval. This limitation since the numbers of students in this study could have been larger and more inclusive of the whole school district. It may be argued that this was not representative of the whole urban district since only three schools out of eight were examined. However, due to open enrollment, the students at these three schools were drawn from the entire district and would still represent all of the neighborhoods within the district’s public education population. The limitation is that more teachers of ninth grade science were not included in this study.

The study was further limited by the fact that the study used only ninth grade physical science teachers and that not all of these teachers agreed to participate. Ultimately, in these four schools, 11 science teachers participated and this was further reduced to nine since some teachers did not have sufficient numbers of students and parents fill out and return their survey packets. The final study consisted of nine teachers in three schools and 196 student-parent sets of data. This study relied on the teacher, student, and parent results of nine teachers in three schools. Fortunately, these schools represented the best ranked, a middle ranked and a lower ranked school in terms of economic and academic environments. While the number of teachers used in this study was not optimal and should be increased in future studies of the teacher variables, the
final number of students and parents represented approximately 10% of the overall ninth grade student population in the district and an approximately 30% return of the surveys sent out.

This study additionally attempted to minimize respondent bias by using questions that had been modeled after those in previously reported literature. Additionally, the survey was used in a pilot study and additional corrections were made and incorporated in the final full study. Questions were examined for gender, racial, financial, and emotionally tense statements. Further inputs were gained by utilizing teacher, parent and college professor comments regarding the format and number of questions asked. Despite these corrections and inputs there was a lower turnout for African-American students and parents as compared to Caucasian students and parents. The overall district has an almost 50/50 ratio of these racial groups, yet in this study, only 19% of the sample was African-American. As far as student gender ratios, there was an approximately equal respondent ratio of girls to boys, which reflects the actual school district population.

Further respondent bias may also be seen in the parent responder trends with 81% of the parent surveys completed by the maternal parent versus 15% by the paternal parent. This may be affected by the marital status, where 73% of the surveys were from two-parent households and 27% were from single-parent households, of which 80% were headed by the maternal parent. These percentages, however, are likely to be representative of respondent gender in other urban studies, since mothers are much more likely than fathers to be the recipients and responders to requested surveys.
This may result in self reporting bias and potential errors in self reporting and may reveal a need to gain information from pre-test/post-test methodologies and from both parents to crosscheck reported variable values. Data from single parent homes may be biased against the time spent by the non-custodial parent’s involvement in school activities, homework help, and education activities. Additionally, employment and financial data may be misreported intentionally by non-custodial parents to avoid legal actions by one parent against the other. And thus, SES data based on financial assets may not be reliable. For that reason, this study examined the educational level of the parent as a more stable and more reliable measure of SES qualities of the parents. Additional issues may come from perceived threats of the survey questions with regard to child’s grades or educational achievement, racial or gender threats to the child’s development within the school, and teacher and administrative bias against the parent due to a fear of potential leaked information contained within the survey (Bradburn et al., 1978) Errors in self reporting and responder bias accounted for as much as 20 percent in some studies and was attributed to faulty recollections and survey population characteristics (Takalkar, 1993). Since most of the surveys of both two-parent and single-parent families were answered by the maternal parent (81 percent and 80 percent, respectively) the interaction of gender in survey responses can also have an impact on survey respondent bias. Williams et al. (2001) reported that mothers will attribute their own emotional issues to their children in the completion of survey questions and that this differs depending on the gender of the child. Female children are reported to have more internalizing (internal locus of control) behaviors and male children have more externalizing (external locus of
control) behaviors when reported by maternal parents. As a final consideration for future survey construction in this research, parent respondents have been shown to overreport help for the children due to strong feelings of familial obligations (Mandemakers & Dykstra, 2008). The authors also found that reporting accuracy is higher with parents of higher educational level.

Implications for Future Research and Educational Policies:

This study highlights the need to better understand what factors are important to improve student performance in science courses, and ultimately, the standardized test scores that measure this success. A further examination of the significant predictive factors in terms of their individual components is warranted. Since this study looked at four main variables in each of the three general clusters, it would be appropriate to conduct a more detailed study of the individual factors that make up the cluster variables. For example, the factor of student attendance could be further examined to understand possible reasons for these absences and how to decrease the problem. While the study didn’t examine behavior and discipline, it is possible that students with multiple discipline referrals will have more days absent due to suspensions and removal from academic classroom settings. A study by Johnson et al. (2005) reported that disruptive behavior had an influence on school grades and that approximately 75% of the variance was related to genetic factors. This suggests a need to relate behavior to IQ of the student and innate abilities to perform well in academic matters.

A further example relates to the variable of science attitude. As noted previously, this predictor entered significantly into several regression analyses for science class grade
but not for OPT score. This suggests that strategies for improving student science attitude are an important priority for improving daily science performance even though these attitudes do not predict performance on the mandatory “high-stakes” tests. Increased opportunities for science field trips, science clubs and organizations, science fairs, science awards, and other visible reinforcements for quality science performance would be reasonable implications from these analyses. It would be a logical examination to determine the science attitude and motivating abilities of such reinforcements. This study also did not examine the effects of student peers on academic performance.

Suggestions for Further Study

When examining the implications of the three variable clusters and the predictive abilities of their variables, a number of suggestions emerge for science educators. For the teacher cluster variables, it was observed that teacher years of teaching experience was important. As noted earlier, this suggests that the more experienced teachers may improve classroom environment both in academic and behavioral ways that ultimately improve student science understanding. Thus, school district policies could be amended to take this into consideration and could result in incentives to hire experienced teachers and retain existing ones. Teacher research experience was also of importance. It is logical to propose that this increased understanding of science would only help improve student scores on standardized science tests. Especially, since these recent science tests have changed their focus from simple memorization and recall of facts to the inclusion of more higher-order thinking skills and the use of inquiry. Thus, the recommendation of long term research projects and courses for teachers may be a district consideration.
Additional requirements for teacher certification could be made at the college level, state level or at the level of a national education association for courses that stress research in the sciences and individual investigation with research professionals in the hard sciences. The final teacher variable of weekly number of hours spent in science laboratory experiences also shows importance and may provide incentives to give additional teaching time for laboratory classes and to implement forms of block-scheduling where laboratory classes are given more class time and resources. This could be expanded to include resources needed to teach science methodology and philosophy to science teachers and could facilitate research by the teacher on science education and science content. Future study of these topics would be a worthwhile goal and of importance may be the type of research conducted by the teacher and the content knowledge gained as compared to the teacher’s classroom assignment and student achievement in that specific science content.

When examining student variables, student GPA, attendance, and science attitudes account for the majority of the observed variances. These results suggest that programs designed to increase student science understanding should address these factors. Overall academic aptitude was used in this study as a measure of general intelligence, and it has been widely acknowledged that a student’s innate intelligence is very stable despite educational programs or environmental interventions (Neisser et al., 1996; Gage & Berliner, 1984). However, academic performance is clearly malleable when motivational incentives and other non-intellectual factors are improved. These intellectual factors may be variables such as poor diet, the use of prescribed medications,
drug or alcohol dependence, mental stress, physical tiredness caused by a lack of sleep or by physical exertion, and others identified by psychologists as important for effective mental development (Sigfusdottir, Kristjansson, & Allegrante, 2007; Matalon et al., 2003; Neil & Saril, 2001; Kenyon, 2000; Vogel, 1997; Shock & Jones, 1941). These non-intellectual factors are reasonable goals for school intervention policies. Moreover, several factors related to the attendance variable can be addressed. Programs could be initiated to address this attendance issue by having more school supported transportation, more school-parent communication (calls home or to the parent’s place of employment), in-school babysitting services, increased sibling child care services, as well as others designed to bring the student into the school building and increase classroom time.

While, this is already a major factor in many existing school programs, this study lends additional justification for an increased use of school resources to improve student and parent compliance with attendance requirements. A future focus of additional research could be to examine the factors influencing the absences and whether uncomfortable classroom and school experiences increase in science classes and cause a differential rate of absences during days with important evaluations.

The variables of the parent cluster may be some of the hardest or easiest to address. While it may be unlikely to adjust parent marital status or increase parent education levels, the other variable of parent school involvement is one that has stronger success possibility, and more options for implementation.

Parental educational level would, of course, be difficult to alter without massive infusion of new funds and a new commitment to adult education programs. However, this
variable may exert its predictive power through underlying factors rather than through the simple number of years of academic experience. For example, parents with more educational experience may value academic performance on the part of their children, and may provide encouragement and guidance to study science in order to understand their world. Having more experience with the study of science themselves, they may also have more confidence in their children’s ability to master science curriculum and may convey this optimism to their children. Attitudes such as these, may be encouraged in parents, regardless of their own limited educational experience.

It would be even more difficult to address parental marital status; however, local support groups and social organizations may be able to devote resources to helping families cope with stresses related to divorce, and encouraging effective co-parenting for both divorced and unwed families. Children and adolescents who have the two-parent advantage have been shown in numerous studies (Casanova et al., 2005; Jeynes, 2002; Key, 2006) to perform better academically and socially.

Regardless of parental marital status, school policies should inform both parents of a student’s academic progress, attendance rates, and general behavioral compliance with school expectations.

The variable of parent school involvement may be the most reasonable variable to address. Overall, this variable cluster may also be one that can have the most impact on other related student variables such as educational attitudes and attendance. The involvements range from increasing incentives for parental membership in school organizations, volunteering at school functions and school meetings, and meetings with
the student’s teachers and counselors. Additional resources could be devoted to improving the channels of communication between the parents and teachers. Schedules of classroom assignments and student performances are routinely posted online for some teachers but not others. Often the more comprehensive Advanced Placement (APcentral, 2008) and International Baccalaureate programs (IB) (IBO, 2008) have these resources already devoted to this task, but these are usually at the Senior and Junior levels of a student’s high school experience. Some schools have extended the IB program downward into the middle and elementary grades but this must occur more regularly at all schools using the IB program and it needs to be applied at the underclassmen levels of Freshmen and Sophomore for the communication to be successful in improving student science test scores. Additional consideration could be given to increased mailings to parents if there is a lack of computer technology available in the home or at the parent’s place of employment.

The findings of this study pertaining to science class grade reflect a greater need for communication between parents and the school. For example, to encourage parent-student communication about science, schools might offer parents a monthly calendar of recommended television programs that relate to science topics on such channels as Discovery, Nova, or NASA. The effect of science media exposure is to increase the abilities of students to achieve well in cognitive skill areas relating to the media’s content (Kirkorian, Wartella & Anderson, 2008). This effect may even be stronger with students with lower initial abilities and may have a differentiation by gender (Giancola, 2001; Caldwell, 1983). With advanced notification of program content, it may even be possible
to dovetail some of these at-home learning experiences with existing curricular topics for that month. Examples might be the examination of home meal preparation while learning food nutritional values, learning about erosion while taking a trip to the beach, or a test of which plants grow best in our gardens while studying photosynthesis and botany in the classroom. Schools might also create a lending library of science books, videos, CDs, and other materials that could be loaned to parents on a weekly basis for enrichment, remediation, or simply to enhance the parent’s own understanding of the science topics being covered in the student’s class. The district could facilitate academic and business connections with local universities and companies. Additionally, schools could include more parents in science field trips or offer workshops for parents on topics that their children might cover in science classes. This may help them assist their children in homework and generally stimulate further discussion of science topics at home.

Summary

This study examined the relationships between science achievement and 11 predictor variables, taken separately, grouped into clusters, and compared within cluster in multiple regression equations. These variables considered teacher, student, and parent influences that were previously discussed in literature but were never considered jointly in a large scale study of science achievement in urban schools. This study was able to examine the relative predictive power of these variables within their clusters and was further able to generate best predictor models for the total group and for gender and racial subgroups. Because of the widespread concern about “high-stakes” testing, a second
criterion variable, that of school class grade, was added to the original intent to predict scores on the Ohio Proficiency Test (OPT).

Results of this study found that the teacher, student, and parent variable clusters all had important predictive abilities for both science OPT score and class grade. Most of these relationships were of strong significance and accounted for large portions of the observed variances in science test scores and class grades. The constructed best predictor models for total student group were highly significant as were the models for Caucasians and females. The models for males and African-Americans were less predictive and often had few component variables that were significant. Thus, suggesting that, most of the variables examined were predictive for Caucasian females. This is important for educational policy since this study has identified criteria variables that can be used to address science educational goals for females and Caucasians. What is even more important is that this research suggests that the “one size fits” all approach of some science education policies does not reach all students evenly. This relates to the national educational policy of “No Child Left Behind” (NCLB) in that in the interests of better science understanding for all students, several modifications need to be made for the improved science achievement scores of males and African-American students. Since the initiation of the NCLB, seven years have passed and evaluations have been made of the program and it’s mandate for accountability and standardized testing. Some educational groups have endorsed the program (Samuels, 2006) for the options of school choice vouchers, school report cards, and additional resources for supplemental programs. Other researchers feel that these educational policies have not yet successfully closed the
achievement gap between racial groups in the reading and math scores of these groups (Olson & Manzo, 2005). These authors argue for continued data gathering and testing by National Assessment of Educational Progress tests and for a reexamination into the variables that are responsible for the slowing of the gap closure.

This research highlights the need for continued research in this area. This study identifies some key predictive variables that future research needs to take into consideration in their focus and experimental design. Thus, the current study suggests a deeper investigation into the reasons why the examined variables are not predictive for males and African-Americans and hints at a more detailed set of variables for survey and data gathering.

This study found that the variables that were the strongest in predicting both science achievement criteria were teacher years of teaching and research experience, student grade point average and attendance, and parent education and school involvement. The teacher use of laboratories, student science attitudes, and parent marital status were predictive as well but to lesser degrees. The total group analyses showed expected predictive abilities for the key variables, but the predictive patterns for the gender and racial subgroups revealed a more detailed and complicated set of interactions with the variables examined in the three clusters. The relatively lower level of prediction for males and African-Americans may be a function of lower variability in such predictors as marital status, parent education, parent school involvement, homework hours, and science attitude. Clearly, higher OPT scores and class grades are obtained by Caucasian girls with higher ratings on these variables.
These results suggest changes to existing educational policies pertaining to hiring and retention of teachers, and suggest that additional resources may be needed to address the science learning of the different subgroups. The study also suggested changes to existing science teacher certification and professional development programs and made additional recommendations for parent school involvement activities. From these findings, it is also clear that schools need to increase emphasis on student attendance policies that increase percentages of students attending school.

Overall, this study determined that science learning as measured by scores on a standardized science test, such as the OPT, and science class grades is a complex phenomenon that involves the interplay of multiple variables. This study also found that the prediction of the success of this learning as based on high-stakes tests requires the disaggregation of different gender and racial groups from the total student body and that the observed predictor variables show significant variations based on these subgroup classifications. The current study recommends additional research into these and other variables not considered here, in order to further establish relationships between science learning and the criteria used to measure this learning as well as the different ways that the gender and racial groups perceive science and demonstrate this knowledge to local and state educational agencies. Hopefully, the information gained through this study will direct this future research, as well as give justification to school, district, and state educational professionals to design and implement new educational programs that address the variations in science learning seen in our urban student populations. Ample
evidence exists to document inadequate science performance of urban students throughout our country. Empirically grounded changes are critically needed.
APPENDICES
APPENDIX A

APPROVAL FORMS
October 9, 2002

Mr. John M. Guidubaldi
3737 Saneca Street
Stow, Ohio 44224

Dear Mr. Guidubaldi:

The Proposal Review Team examined your request to conduct a research project with the District entitled: “Home, School, and Learner Predictors of Science Achievement in an Urban Center.” Of those who responded, approval is granted with the following stipulations:

- high schools have agreed to participate. agrees with the stipulation that the Learning Specialist for Science survey the Science teachers on their willingness to participate.
- Only voluntary participation.
- Information obtained without any new or additional programming on the part of our Information Management Department.
- All state, federal and guidelines are to be followed.
- No identity of participants, or the system, will be revealed in any report or publication resulting from this research project.
- Upon completion of the project, a copy of the study/research must be provided to the Department.

I have enclosed a copy of the district’s Guidelines on Conducting Research in the and would draw your attention to the highlighted area, sections VIII and IX.

If you need additional information, please do not hesitate to contact me at.

We appreciate your interest and involvement with the.

Sincerely,

Enclosure
KENT STATE UNIVERSITY INSTITUTIONAL REVIEW BOARD
APPLICATION FOR APPROVAL TO USE HUMAN RESEARCH PARTICIPANTS

Please type all information. HANDWRITTEN FORMS CANNOT BE ACCEPTED.

Name: John M. Guidubaldi
Telephone: 330-686-2081
Address: 3737 Seneca Street, Stow, OH 44224
Email: dinojrm@aoe.com

Department: Teaching, Leadership, and Curriculum Studies
Faculty Rank/Student Status: Doctoral Student (ABD)

Project Title: Home, School, and Learner Predictors of Science Achievement in an Urban Center

Type of Project: FACULTY RESEARCH ___ Externally Funded ___ (Agency ____________________________)
* Include copy of proposal
STUDENT DIRECTED RESEARCH (Advisor: Dr. J. David Keller and Trish Koontz)
Thesis ___ Dissertation X Course Requirement ___ (course # ____________________________)
Other ___ (Specify: ____________________________)

Duration of Project: Starting Date: May 2002, but not before approval is obtained. Ending Date: December 2002

I certify that the research procedures for this project and the method of obtaining consent (if any), as approved by the Kent State University Institutional Review Board, will be followed during the period covered by this research project. Any future changes will be submitted for Board review and approval prior to implementation.

If this project involves approval/permission from other institutions, the principal investigator (and the faculty advisor if the PI is a student) must sign below to certify the following statement: "I/we will not begin research at other institutions before having obtained their permission to do so."

Principal Investigator: ____________________________ Date: 4/23/02
Faculty Advisor (If PI is a student): ____________________________ Date: 4/23/02

REVIEWER
Level I, Category __________________________________________
Level II, Category __________________________________________
Level III, To Full Board _______________________________________

KSU INSTITUTIONAL REVIEW BOARD
Approved, Level I
Approved, Level II

Project Involves:
[ ] Deception
[ ] Waiver of Consent

Primary Reviewer: ____________________________ Date: 4/21/02
Co-Reviewers: ____________________________ Date: 4/25/02

Administrator, IRB: ____________________________ Date: ____________________________

IRB ACKNOWLEDGEMENT OR APPROVAL:
____ Approved by Board ______ Contingent ______ Disapproved

Chairperson, IRB:

COMMENTS OR CONTINGENCIES:
ATTENTION:
1. YOU MUST ATTACH A COPY OF YOUR CURRENT CONSENT FORM.
2. IF THIS FORM IS NOT APPROVED BY 5-5-03 YOU ARE OUT OF COMPLIANCE AND YOUR RESEARCH MUST STOP. IF YOU CONTINUE TO USE PARTICIPANTS, A COMPLAINT OF MISCONDUCT MAY BE FILED AGAINST YOU (PER KSU POLICY #33423-23).
3. YOU MUST FILL OUT THE "PROGRESS REPORT" ON THE BACK OF THIS FORM FOR CONTINUING OR FINISHED PROJECTS

KENT STATE UNIVERSITY INSTITUTIONAL REVIEW BOARD

LOG NUMBER 02-452

PERIODIC REVIEW AND END OF PROJECT FORM

<table>
<thead>
<tr>
<th>Name</th>
<th>John Guidubaldi</th>
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<tr>
<td>Department</td>
<td>TLCS</td>
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<tr>
<td>Faculty Rank/Student Status</td>
<td>Graduate student</td>
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<tr>
<td>Project Title:</td>
<td>Home, School and Learner Predictors of Science Achievement in an Urban Center</td>
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<td>Expected End Date</td>
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Please answer the following questions and return form to Research and Graduate Studies. If you need to review your original Application to Use Human Research Participants (HRPs) or if you have any questions, call Judith Jagger at 20700.

1. Project Status:
   ☐ Continuing with no changes in procedure, risk, or class of human participants as outlined in the approved protocol. A pink "Change Form" is required for any changes.
   
   Research is expected to be done by ___________________________. PLEASE FILL OUT AND SIGN OTHER SIDE.
   
   ☐ Research has not started yet, but is expected to begin on ___________________________.
   
   ☒ Completed. No more research to be done. PLEASE FILL OUT AND SIGN OTHER SIDE.
   
   ☐ Research will not be done

2. This project involves: (Please check all that apply.)
   ☒ Not legally competent adults
   ☐ Prisoners
   ☐ Taking tissue samples
   ☐ Mentally disabled
   ☐ Pregnant women
   ☐ Giving injections
   ☐ Physically challenged
   ☐ Drawing blood
   ☐ Administering alcohol
   ☐ Administering nutritional supplements
   ☐ Administering drugs

Principal investigator: John Guidubaldi, Date: 10/4/04

Faculty Advisor (if PI is a student): Date: 10/4/04
APPENDIX B

TEACHER INFORMATION LETTER, CONSENT FORM
AND SURVEY PACKET
TEACHER INFORMATION LETTER

Investigator: John M. Guidubaldi
East High School
80 Brittain Road
Akron, Ohio 44305

Phone (office): (330) 794-4100
Phone (home): (330) 686-2961

Advisors:
Dr. J. David Keller
Phone (office): (330) 672-2580

Dr. Trish Koontz
Phone (office): (330) 672-2580

Dr. Dimiter Dimitrov
Phone (office): (330) 672-7918

Title: Study of Home, School and Learner Predictors of Science Achievement in an Urban Center

Dear Teacher:

My name is John Guidubaldi. I am a science teacher in the school district and a doctoral student at Kent State University. I want to study ways to improve student grades in science. As you may know, science topics are often difficult for students to understand, and school districts across our nation are looking for ways to address this problem. My research may help to identify what some of the important factors are in science learning and may aid our teachers, school administrators, and parents to improve science education. This study will request information from teachers, parents, and students and will examine issues such as amount of time spent in-class science investigations, time spent on science homework and parent involvement in school.

I would appreciate your help in this study by participating in the research. This study has been approved by the school district and Kent State University and all information will be kept confidential and under locked security. There will be no tests given except for the Ohio Proficiency Test, which all ninth grade students will take in the fall. Your role in this study will be as a facilitator and you will be asked to aid with the distribution of the consent forms and questionnaires to the students and parents and collection of the returned materials. Additionally, the teacher information for this study will be gathered by a brief questionnaire, which takes no longer than 15 minutes. This questionnaire is composed of items relating to teacher experience and use of science laboratory instruction.

If your take part in this study, the results may allow us to better understand how students study for and learn science and may provide insight into how the school district can improve student performance as measured by the Ohio Proficiency Test. Taking part in this project is entirely up to you and no one will hold it against you if you decide not to participate. If you do decide to participate, you may stop at any time.

If you want to learn more about this research project, please call me at the number listed above. If you have any questions about Kent State University’s rules for research, please call Dr. Rathindra Bose, Vice Provost and Dean, Division of Research and Graduate Studies (tel. 330-672-0700).

You will receive a copy of this consent form.

Sincerely,

John M. Guidubaldi
TEACHER CONSENT FORM

Investigator: John M. Guidubaldi        Phone (office): (330) 794-4100
        East High School            (home): (330) 686-2961
        80 Brittain Road            80 Brittain Road
        Akron, Ohio 44305          Akron, Ohio 44305

Advisors:    Dr. J. David Keller       Phone (office): (330) 672-2580
            Dr. Trish Koontz         Phone (office): (330) 672-2580
            Dr. Dimiter Dimitrov     Phone (office): (330) 672-7918

Title: Study of Home, School and Learner Predictors of Science Achievement in an Urban Center

Consent Statement:

Teacher consent:

1. I agree to take part in this project. I know what I will have to do and that I can stop at any time.

________________________________________
Signature

________________________________________
Date

________________________________________
Please Print Your Name

________________________________________
School

If you decide to participate, please return this form and the questionnaire as soon as possible to Mr. John Guidubaldi by putting it into the enclosed envelope and place it into the collection box located in the main office.
TEACHER SURVEY PACKET

Teacher Questionnaire:  Teacher Name______________________

Directions: Please circle the best answer or use the blank space provided in the question.

1. How many years have you taught science at the secondary level? (Circle the best answer)
   0-2 years  2-5 years  5-10 years  10-15 years  more than 15 years

2. What science courses do you teach? (Circle all that apply)
   Biology   Chemistry   General Science   Physical Science   Physics
   Environmental Science   Anatomy/Physiology   Astronomy/Space Science
   Microbiology   Other_________________

3. How long have you taught ninth grade science?
   0-2 years  2-5 years  5-10 years  10-15 years  more than 15 years

4. What is your current science teaching certification? ___________________________

5. What science research experience have you had?
   Have you conducted a science thesis or dissertation? Yes  No
   Have you been employed in a science laboratory setting? Yes
   No
      If so, how many years? ____________
   Have you published an article in a scientific journal Yes  No
      If yes, how many? ________________
      Please list journals______________________________________________
   Have you ever had non-compensated experiences in science research Yes  No
      If so, please describe and indicate length of time involved
6. In the last year, have you attended a professional development experience?
   (Professional development experience is defined as: district workshop, college
   credit course, N.S.F. workshop, etc…) Please list and describe, including number
   of hours attended.

7. How often do you read scientific journals?
   Never Once or twice/semester Once or twice/month
   Once or twice/week Almost daily

8. Approximately how many science laboratories do your students perform weekly?
   (Give average number and the hours involved)
   Number of laboratories_______ Hours per week____________

9. What type of science laboratories are these? (List all that apply. Examples are student-
    directed inquiry, teacher directed discovery, student confirmation of established
    results, worksheet or book directed “cookbook” activities, etc…)

10. How frequently do your students engage in hands-on laboratory activities?
    Never Once or twice/semester Once or twice/month
    Once or twice/week Almost daily

11. How frequently do your students design or implement their own investigations?
    Never Once or twice a semester Once or twice a month
    Once or twice a week Almost daily

This survey is to be completed by the participants of the study and this research is
conducted by independent investigators for Kent State University. The questions in and
responses to this questionnaire in no way represent the philosophy and beliefs of the
school district.
APPENDIX C

PARENT AND STUDENT INFORMATION LETTER, CONSENT FORM AND SURVEY PACKET
PARENT INFORMATION LETTER

Investigator: John M. Guidubaldi  Phone (office): (330) 794-4100
East High School  (home): (330) 686-2961
80 Brittain Road
Akron, Ohio 44305

Advisors:  Dr. J. David Keller  Phone (office): (330) 672-2580
Dr. Trish Koontz  Phone (office): (330) 672-2580
Dr. Dimiter Dimitrov  Phone (office): (330) 672-7918

Title: Study of Home, School and Learner Predictors of Science Achievement in an Urban Center

Dear Parent(s):

My name is John Guidubaldi. I am a science teacher in the school district and a doctoral student at Kent State University. I want to study ways to improve student grades in science. As you may know, science topics are often difficult for students to understand, and school districts across our nation are looking for ways to address this problem. My research may help to identify what some of the important factors are in science learning and may aid our teachers, school administrators, and parents to improve science education. This study will request information from teachers, parents, and students and will examine issues such as amount of time spent in-class science investigations, time spent on science homework and parent involvement in school.

I would appreciate your help in this study by allowing your child to participate in the research. This study has been approved by the school district and Kent State University and all information will be kept confidential and under locked security. There will be no tests given except for the Ohio Proficiency Test, which all ninth grade students will take in the fall. The information for this study will be gathered by a brief questionnaire, which takes no longer than 15 minutes. The questions on the student form will examine factors such as amount of time spent on science homework and outside activities as well as the attitudes that these students have toward science and their science classes. There may also be a few questions asking about the child’s home and the help available from parents and other adults in the child’s home. The parent questionnaire is composed of similar home-related questions and also asks parents about their school participation and the amount of homework support they give their children. Information will also be gathered from existing school records regarding the student’s general academic ability and attendance patterns.

If your child takes part in this study, the results may allow us to better understand how students study for and learn science and may provide insight into how the school district can improve student performance as measured by the Ohio Proficiency Test. Taking part in this project is entirely up to you and your child, and no one will hold it against you or your child if you decide not to participate. If you and your child do decide to participate, you may stop at any time.

If you want to learn more about this research project, please call me at the number listed above. If you have any questions about Kent State University’s rules for research, please call Dr. Rathindra Bose, Vice Provost and Dean, Division of Research and Graduate Studies (tel. 330-672-0700).

You will receive a copy of this consent form.

Sincerely,

John M. Guidubaldi
PARENT CONSENT FORM

Investigator: John M. Guidubaldi
East High School
80 Brittain Road
Akron, Ohio 44305

Phone (office): (330) 794-4100
(home): (330) 686-2961

Advisors: Dr. J. David Keller
Dr. Trish Koontz
Dr. Dimiter Dimitrov

Phone (office): (330) 672-2580
Phone (office): (330) 672-2580
Phone (office): (330) 672-7918

Title: Study of Home, School and Learner Predictors of Science Achievement in an Urban Center

Consent Statement(s):

Parent consent:

1. I agree to take part in this project. I know what I will have to do and that I can stop at any time.

__________________________________________     __________________________
Signature                                     Date

Please Print Your Name                          Child’s Name

Parent consent for children under age 18:

2. I agree to let my child take part in this project. I know what he/she will have to do and that he/she can stop at any time

__________________________________________     __________________________
Signature                                     Date

If you decide to participate, please return this form and your parent questionnaire as soon as possible to Mr. John Guidubaldi by putting it into the enclosed envelope (Please also include your child’s consent form and student questionnaire) and either have your child return it to his/her science teacher or place it into the collection box located in the high school’s main office.
PARENT SURVEY PACKET

Parent Questionnaire:                        Parent’s Name_____________________
                        Student’s Name__________________

Directions: Please circle the best answer or use the blank space provided in the question.

1. What is your relationship to the student?
   Mother    Father    Stepmother    Stepfather    Grandparent    Guardian

2. What is your current marital status?
   Married to the student’s other birth parent
   Married to the student’s stepparent
   Divorced, single parent, mother-headed household
   Divorced, single parent, father-headed household
   Never married, mother headed-household
   Never married, father headed-household
   Widowed, single parent, mother-headed household
   Widowed, single parent, father-headed household
   Grandparent as legal guardian
   Other legal guardian

3. If the child does not reside with both birth parents in one home, who has primary residential custody of this student?    Mother ____  Father____
   Mother has for _____ hours/week    Father has for _____ hours/week
   Shared parenting, Mother has for _____ hours/week,
   Father has for _____ hours/week
   Guardian had for _____ hours/week

4. How much time do you spend weekly sitting down and helping your child with homework?
   Less than 1 hr    From 1 to 2 hrs    From 2 to 3 hrs    From 3 to 5 hrs    More than 5 hrs

5. How much time does your child’s other parent spend weekly sitting down and helping your child with homework?
   Less than 1 hr    From 1 to 2 hrs    From 2 to 3 hrs    From 3 to 5 hrs    More than 5 hrs

6. How much time do you spend weekly sitting down and helping your child with science homework?
   Less than 1 hr    From 1 to 2 hrs    From 2 to 3 hrs    From 3 to 5 hrs    More than 5 hrs
7. How much time does your child’s other parent spend weekly sitting down and helping your child with science homework?

Less than 1 hr   From 1 to 2 hrs   From 2 to 3 hrs   From 3 to 5 hrs   More than 5 hrs

8. In the last year, how many times have you taken your child to a museum, zoo, or science activity?

None   Once or Twice   Three or Four Times   More than Four Times

9. In the last year, how many times has your child’s other parent taken your child to a museum, zoo, or science activity?

None   Once or Twice   Three or Four Times   More than Four Times

10. In the last year, how much time have you volunteered to work at your child’s school?

None   Once or Twice   Three or Four Times   More than Four Times

11. In the last year, how much time has your child’s other parent volunteered to work at your child’s school?

None   Once or Twice   Three or Four Times   More than Four Times

12. In the last year, have you or your child’s other parent or guardian been a member of a Parent-teacher organization? (Please circle the appropriate answer)

Has Mother?   Yes   No   Has Father?   Yes   No

13. In the last year, how many times have you attended a meeting at your child’s school?

None   Once or Twice   Three or Four Times   More than Four Times

14. In the last year, how many times has your child’s other parent attended a meeting at your child’s school?

None   Once or Twice   Three or Four Times   More than Four Times

15. In the last year, how many times have you been to a parent-teacher organization meeting?

None   Once or Twice   Three or Four Times   More than Four Times

16. In the last year, how many times has your child’s other parent been to a parent-teacher organization meeting?

None   Once or Twice   Three or Four Times   More than Four Times
17. In the last year, how many times have you spoken to a teacher or counselor about your child?

   None    Once or Twice    Three or Four Times    More than Four Times

18. In the last year, how many times has your child’s other parent spoken to a teacher or counselor about your child?

   None    Once or Twice    Three or Four Times    More than Four Times

19. What is your education level?

   Didn’t Finish High School
   High School Graduate or GED
   More than High School but less than Four-Year College
   Four-Year College Graduate
   Masters degree or Equivalent
   Doctorate degree or Equivalent

20. What is the student’s other birth parent’s education level?

   Didn’t Finish High School
   High School Graduate or GED
   More than High School but less than Four-Year College
   Four-Year College Graduate
   Masters degree or Equivalent
   Doctorate degree or Equivalent

21. If remarried or residing with significant other, what is this person’s education level?

   Didn’t Finish High School
   High School Graduate or GED
   More than High School but less than Four-Year College
   Four-Year College Graduate
   Masters degree or Equivalent
   Doctorate degree or Equivalent

This survey is to be completed by the participants of the study and this research is conducted by independent investigators for Kent State University. The questions in and responses to this questionnaire in no way represent the philosophy and beliefs of the school district.
STUDENT INFORMATION LETTER

Investigator: John M. Guidubaldi
East High School
80 Brittain Road
Akron, Ohio 44305

Phone (office): (330) 794-4100
Phone (home): (330) 686-2961

Advisors:
Dr. J. David Keller
Phone (office): (330) 672-2580

Dr. Trish Koontz
Phone (office): (330) 672-2580

Dr. Dimiter Dimitrov
Phone (office): (330) 672-7918

Title: Study of Home, School and Learner Predictors of Science Achievement in an Urban Center

Dear Student:

My name is John Guidubaldi. I am a science teacher in the school district and a doctoral student at Kent State University. I want to study ways to improve student grades in science. As you may know, science topics are often difficult for students to understand, and school districts across our nation are looking for ways to address this problem. My research may help to identify what some of the important factors are in science learning and may aid our teachers, school administrators, and parents to improve science education. This study will request information from teachers, parents, and students and will examine issues such as amount of time spent in-class science investigations, time spent on science homework and parent involvement in school.

I would appreciate your help in this study by participating in the research. This study has been approved by the school district and Kent State University and all information will be kept confidential and under locked security. There will be no tests given except for the Ohio Proficiency Test, which all ninth grade students will take in the fall. The information for this study will be gathered by a brief questionnaire, which takes no longer than 15 minutes. The questions on the student form will examine factors such as amount of time spent on science homework and outside activities as well as the attitudes that you have toward science and their science classes. There may also be a few questions asking about the your home and the help available from parents and other adults in the your home. Information will also be gathered from existing school records regarding the your general academic ability and attendance patterns.

If you take part in this study, the results may allow us to better understand how students study for and learn science and may provide insight into how the school district can improve student performance as measured by the Ohio Proficiency Test. Taking part in this project is entirely up to you and no one will hold it against you if you decide not to participate. If you do decide to participate, you may stop at any time.

If you want to learn more about this research project, please call me at the number listed above. If you have any questions about Kent State University’s rules for research, please call Dr. Rathindra Bose, Vice Provost and Dean, Division of Research and Graduate Studies (tel. 330-672-0700).

You will receive a copy of this consent form.

Sincerely,

John M. Guidubaldi
STUDENT CONSENT FORM

Investigator: John M. Guidubaldi
East High School
80 Brittain Road
Akron, Ohio 44305

Phone (office): (330) 794-4100
Phone (home): (330) 686-2961

Advisors:
Dr. J. David Keller
Dr. Trish Koontz
Dr. Dimiter Dimitrov

Phone (office): (330) 672-2580
Phone (office): (330) 672-2580
Phone (office): (330) 672-7918

Title: Study of Home, School and Learner Predictors of Science Achievement in an Urban Center

Consent Statement(s):

Consent for children over age 18:

1. I agree to take part in this project. I know what I will have to do and that I can stop at any time

______________________________     __________________________
Signature                        Date

____________________________________
Please Print Your Name

Your Teacher and School

Consent for children under age 18:

2. I agree to take part in this project. I know what I will have to do and that I can stop at any time. My parent(s) has (have) given consent for me to participate.

______________________________     ________
Signature                        Date

____________________________________
Please Print Your Name

Please Print Your Parent’s Name

Your Teacher and School

If you decide to participate, please return this form and the questionnaire as soon as possible to Mr. John Guidubaldi by putting it into the enclosed envelope (Please also include your parent’s consent form and parent questionnaire) and either place it into the collection box located in your school’s main office or give it to your science teacher.
STUDENT SURVEY PACKET

Student Questionnaire:
Student’s Name____________________
Teacher Name_____________________
School ___________________________

Directions: Please circle the best answer or use the blank space provided in the question.

1. Within the past 12 weeks (3 months), how many hours did you spend on science homework per week? (Circle the best answer)
   Less than 1 hr    From 1 to 2 hrs    From 2 to 3 hrs    From 3 to 5 hrs    More than 5 hrs

2. Approximately how many hours do you spend a week on the following out of school activities?
   Work_____    Band_____    Drama Club_____    Science Club_____    Sports_____    Entertainment (TV, video games, talking with friends, etc…)_____    Other_____ (please list activity)_______________

Directions: Please circle the statement that best describes how you feel for that question:

3. Science is valuable to society.
   Strongly Agree    Agree    Neither Agree or Disagree    Disagree    Strongly Disagree

4. Science is fun.
   Strongly Agree    Agree    Neither Agree or Disagree    Disagree    Strongly Disagree

5. I do not like science and it bothers me to have to study it.
   Strongly Agree    Agree    Neither Agree or Disagree    Disagree    Strongly Disagree

6. During science class, I usually am interested.
   Strongly Agree    Agree    Neither Agree or Disagree    Disagree    Strongly Disagree

7. I would like to learn more about science.
   Strongly Agree    Agree    Neither Agree or Disagree    Disagree    Strongly Disagree

8. If I knew I would never go to science class again, I would feel sad.
   Strongly Agree    Agree    Neither Agree or Disagree    Disagree    Strongly Disagree
9. Science is interesting to me and I enjoy it.
   - Strongly Agree  Agree  Neither Agree or Disagree  Disagree  Strongly Disagree

10. Science makes me feel uncomfortable, restless, irritable, and impatient.
    - Strongly Agree  Agree  Neither Agree or Disagree  Disagree  Strongly Disagree

11. Science is fascinating and fun.
    - Strongly Agree  Agree  Neither Agree or Disagree  Disagree  Strongly Disagree

12. The feeling that I have toward science is a good feeling.
    - Strongly Agree  Agree  Neither Agree or Disagree  Disagree  Strongly Disagree

13. When I hear the word science, I have a feeling of dislike.
    - Strongly Agree  Agree  Neither Agree or Disagree  Disagree  Strongly Disagree

14. Science is a topic which I enjoy studying.
    - Strongly Agree  Agree  Neither Agree or Disagree  Disagree  Strongly Disagree

15. I feel at ease with science and I like it very much.
    - Strongly Agree  Agree  Neither Agree or Disagree  Disagree  Strongly Disagree

16. I feel a definite positive reaction to science.
    - Strongly Agree  Agree  Neither Agree or Disagree  Disagree  Strongly Disagree

17. Science is boring.
    - Strongly Agree  Agree  Neither Agree or Disagree  Disagree  Strongly Disagree

18. I understand the things we discuss in science class.
    - Strongly Agree  Agree  Neither Agree or Disagree  Disagree  Strongly Disagree

19. Science is useful for the future.
    - Strongly Agree  Agree  Neither Agree or Disagree  Disagree  Strongly Disagree

20. In my future, I will use science.
    - Strongly Agree  Agree  Neither Agree or Disagree  Disagree  Strongly Disagree
21. I would enjoy a career in science.

Strongly Agree   Agree     Neither Agree or Disagree     Disagree     Strongly Disagree

Directions: Please circle the best answer for the following questions about your family:

22. Currently, what is your family structure where you live most of the time?

   Two birth parents at your home   Mother with Step Dad at home
   Single parent home, Mother-headed   Dad with Step Mom at home
   Single parent home, Father-headed   Grandparent’s home
   Guardian’s home

23. What is your mother’s education level?

   Didn’t Finish High School
   High School Graduate or GED
   More than High School but less than Four-Year College
   Four-Year College Graduate
   Masters degree or Equivalent
   Doctors degree or Equivalent

24. What is your father’s education level?

   Didn’t Finish High School
   High School Graduate or GED
   More than High School but less than Four-Year College
   Four-Year College Graduate
   Masters degree or Equivalent
   Doctors degree or Equivalent

This survey is to be completed by the participants of the study and this research is conducted by independent investigators for Kent State University. The questions in and responses to this questionnaire in no way represent the philosophy and beliefs of the school district.
APPENDIX D

PEARSON R CORRELATIONS FOR ALL OHIO PROFICIENCY TEST VARIABLE CLUSTERS
Pearson r Correlations with Ohio Proficiency Test Science Scores  
Total Group and for Gender and Racial Subgroups

Teacher Cluster:  

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Note:  * > .05 significance, ** > .01 significance, and *** > .001 significance
APPENDIX E

PEARSON R CORRELATIONS FOR ALL SCIENCE
GRADE VARIABLE CLUSTERS
Pearson r Correlations with Science Class Grade for Total Group and Gender and Racial Subgroups

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Note: * > .05 significance, ** > .01 significance, and *** > .001 significance
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