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A CORRELATIONAL STUDY INVESTIGATING THE RELATIONSHIP BETWEEN PRIOR MATH AND SCIENCE PERFORMANCE AND STUDENT PERFORMANCE IN COLLEGE-PREPARATORY CHEMISTRY

A Thesis
Presented for the
Specialist in Education
Degree
The University of Tennessee, Knoxville

William Allen Strong

August 1990

DEDICATION

I would like to dedicate this research project to my grandmother, Amanda R. Strong (1917-1990). She was a guiding force in my life who always showed concern and care for others.

Most importantly, she greatly influenced my personal commitment to Christ and taught me the importance of helping others- a major factor for me in choosing teaching as a career.

For our proud confidence is this,
the testimony of our conscience,
that in holiness and godly sincerity,
not in fleshly wisdom but in the grace of God,
we have conducted ourselves in the world,
and especially toward you.

II Cor. 1:12

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I also must thank my wife, Beth, for her constant prayers and encouragement along the way. I couldn't have made it without her! I am also indebted to my parents whom I love very much and who have always encouraged me to do my very best.

ABSTRACT

This study was conducted to determine what relationships there were between college-preparatory Chemistry I grades and the Test of Achievement and Proficiency (TAP) scores in mathematics and science, overall grade point average, grade point average in Algebra I, biology grades, and physical science grades.

A correlational study using Pearson r was performed using data collected over a two year period (N=90) from a large rural high school in Tunnel Hill, Georgia. Overall grade point average and physical science grades were found to have substantial positive associations and biology grades and Algebra I averages to have moderate positive associations. TAP scores showed low positive associations with Chemistry I grades.

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CHAPTER I

Introduction

The development of successful problem solving skills, critical and creative thinking, and a concern for societal issues, are important goals for students in the high school chemistry class. To achieve these goals it is important that the students are well prepared for the rigorous curriculum associated with the average college-preparatory chemistry class. Mastery of certain mathematics skills and science background knowledge are especially important in understanding the concepts studied in chemistry. Oftentimes students are not able to understand chemistry topics such as stoichiometry, pH, gas laws, and other formulas because their math and science backgrounds are weak.

As a result, such students achieve below average grades in chemistry. Is it beneficial for students to be placed in chemistry when they are unprepared? This study will consider the relationship between performance in mathematics and science classes, standardized tests, and overall grade point average to student performance in a college-preparatory chemistry class.

The results obtained from this study will be used to develop a screening procedure for advising students on their potential for success in college-preparatory chemistry

Students unprepared for chemistry may decide to forego chemistry until a later time in their high school career.

Statement of the Problem

A high level of mathematics skills and problem-solving abilities are needed for successful completion of college-preparatory chemistry Oftentimes, students feel unprepared for chemistry and high failure rates are not uncommon. This study will focus on the problem of high failure rates in chemistry and investigate previous performance in algebra, physical science, biology, TAP scores, and overall grade point average in order to determine what indicators should be considered when registering students for chemistry.

Significance of the Problem

The requirements for college-preparatory chemistry include a solid background in algebra and related sciences including physical science and biology. High failure rates may be associated with poor performance in math and science classes taken prior to chemistry.

Null Hypotheses

Ho_1 There is no statistically significant relationship between Chemistry I grades and TAP mathematics scores.

Ho_2 There is no statistically significant relationship between Chemistry I grades and TAP science scores.

Ho_3 There is no statistically significant relationship between Chemistry I grades and overall GPA.

Ho4 There is no statistically significant relationship between Chemistry I grades and Algebra I grades.

Ho5 There is no statistically significant relationship between Chemistry I grades and Biology I grades.

Ho6 There is no statistically significant relationship between Chemistry I grades and physical science grades..

Sample

The 90 member intact study group (students enrolled in chemistry during the 1987-88 and 1988-89 school years) consisted of college-preparatory, first year, eleventh and twelfth grade students, ranging in age from fifteen to seventeen years. The variables kept constant included the instructor, textbook, and laboratory activities.

Data Analysis

The relationship between yearly averages in Algebra I, Biology I, and physical science, TAP mathematics and science scores, and overall GPA were compared to the yearly average in Chemistry I using a Pearson r correlational analysis. The level of acceptance for the hypotheses was +.50.

Limitations

The following limitations will apply to this study:

1. The size of the sample in this study was limited to 90 students enrolled in chemistry taught by the same instructor for a complete school year, or who withdrew early;

2. The results of this study can be generalized only to chemistry students at Northwest Whitfield High School.

Definitions of Terms

Specific terms used in this study are defined as follows:

1. Algebra I: College-preparatory class usually taken as a freshman or eighth grader;

2. Biology I: College-preparatory level class usually taken as a sophomore;

3. Chemistry I: College-preparatory level class usually taken as a junior;

4. Physical Science: College-preparatory class usually taken as a freshman;

5. Student Achievement: Measured by the Iowa Test of Basic Skills and yearly averages in chemistry, biology, physical science, and algebra;

6. TAP Mathematics Scores: The Test of Achievement and Proficiency administered by the Iowa Test of Basic Skills, usually taken as ninth and eleventh graders;

7. TAP Science Scores: The Test of Achievement and Proficiency administered by the Iowa Test of Basic Skills, usually taken as ninth and eleventh graders.

CHAPTER 2

Review of the Literature

Recent studies have shown alarming results concerning academic achievement among United States students compared to foreign students (Coleman, 1985; Ferko, 1989; Jacobson and Doran, 1985; and Travers and McKnight, 1985). A recent special bonus issue of *Business Week* (October 20, 1989) discussed the shortcomings of American schools and student academic achievement. The following statistics were mentioned:

1. dropout rates hover above 25% nationally;
2. SAT scores which fell in the sixties and seventies, have only improved 16 points- and are still 90 points below the all-time high;
3. there are an estimated 25 million illiterate Americans;
4. at age 10, American students rank seventh out of fifteen countries in terms of scientific knowledge, but by the age of fifteen they rank fifteenth out of sixteen nations;
5. in chemistry, the U.S. ranked thirteenth out of fourteen nations;
6. in physics, American students ranked tenth out of fourteen nations;
7. American biology students ranked last out of fourteen nations.

What factors have influenced this poor performance of American students?

What teaching methods should be used to help improve these statistics? What are the best predictors of student academic achievement?

This chapter will review selected studies concentrating on these and other questions relating to academic achievement. Section one will concentrate on factors that affect academic achievement. Section two will examine student academic achievement in science, and section three will discuss literature dealing with predictors of student academic achievement.

Factors Affecting Student Achievement

Resnick and Resnick (1988) offer recommendations for the National Assessment of Educational Progress (NAEP) to help understand achievement and suggest what factors should be studied to help improve achievement. Three criteria were used when selecting factors to be researched:

1. variables of primary interest should be those that educators can do something about;

2. the variables chosen for the study should reflect a reasonable theory or hypothesis about the factors that matter in producing achievement;

3. the amount of time it will take for expected effects to appear should be specified.

Resnick and Resnick, using these criteria suggest studying the following factors: (1) educational background of teachers, (2) Teacher salaries, (3) instructional time, (4) textbooks, (5) class size, (6) homogeneity/heterogeneity of classes, (7) homework, (8) tracking, and (9) courses taken.

Ferko, (1989) analyzed the results from the second IEA science study concerning academic achievement of U.S. advanced students compared to other foreign students. Ferko states that other factors that should be studied to help improve academic performance include socioeconomic status of students, teacher characteristics, student and parent attitudes and perceptions, and instructional methods used.

It would not be practical to address all of the factors associated with student academic achievement, however this review will consider the following: (a) instructional methods used, in particular cooperative learning and peer-tutoring, (b) student and parent attitudes and perceptions, and (c) other factors such as changes in curriculum, homework, and textbooks.

Instructional Methods

Cooperative learning. Numerous studies researching the relationship between cooperative learning and student achievement have been conducted (Johnson, Maruyama, Johnson, Nelson, and Skon 1981; Newmann and Thompson 1987 ; Sharan 1980; and Slavin 1988).

Augustine, Gruber, and Hanson (1989) discussed the effects cooperative learning has on achievement, particularly when used in elementary schools. Gruber stated that heterogeneous cooperative groups have been used in the third grade for over ten years and individual and class spelling scores have improved consistently over time. Achievement among mainstreamed students showed improvement when they were placed in heterogeneous cooperative groups. Mainstreamed students also exhibited improvements in social skills and self-esteem. Researchers also discovered that gifted students enjoyed the heterogeneous groups, creating new friendships which normally would not have occurred.

One researcher divided her students into five base groups, with three pairs of students in each group. A high-achieving student was placed with a lower-achieving student. In most cases, the high-achieving student maintained performance, whereas the lower-achieving students performance increased.

Sharan, Hertz-Lazarowitz, and Ackerman (1980) observed similar results. A three week experiment was conducted comparing academic achievement of pupils in five classrooms (N= 108) taught using small cooperative groups against five classrooms (N= 109) taught in the traditional whole class approach. Achievement tests were constructed and administered to each class. Small group classes excelled on high level items as expected. In addition, pupils in the fifth grade small group class produced superior answers on questions requiring original contributions.

It should be noted that achievement scores for both groups were similar when measuring low level cognitive functioning.

Slavin (1989) states that cooperative learning is one of the most thoroughly researched instructional methods. He investigated over sixty studies that had to meet the following criteria:

1. studies had to have lasted at least four weeks;
2. experimental and control classes had to take identical achievement tests under the same conditions.

Slavin found wide agreements among researchers that cooperative learning produces positive effects on student achievement. Further, he found a strong concensus that cooperative learning depends on two essential features. One, is group goals. The cooperative groups must work together to earn recognition in the form of grades, rewards, and other indicators of group success. the second essential factor is individual accountability. the group's success must depend on the individual learning of all group members. Slavin found a great deal of evidence that cooperative learning methods are effective in grades 2-9, but relatively few studies have examined the effects of cooperative learning in grades 10-12.

Outcomes other than achievement were also identified by Slavin. Cooperative learning improves the social acceptance of mainstreamed students, possibly eases racial tension, improves self-esteem, liking of school, attendance, and time-on-task.

Shevin and Schniedewind (1989) believe strongly that cooperative learning has the potential to transform classrooms, schools, and ultimately society by creating communities of caring and support. Citizens would be able to work better together, communicate, and share common goals.

Oftentimes, researchers focus on which form of cooperative learning is best for increasing student achievement, what are the best strategies, and how can we compare relative efficacy of various cooperative learning models using standardized test scores? They argue that more penetrating questions should be asked concerning how students relate to each other. They believe we should also consider some opportunities for realizing the power of cooperative learning such as reflecting on content, making content and process compatible, coordinating the approach with other classroom values, giving teachers and students a voice, and eliminating the negative aspects of competition in the classroom.

The benefits of cooperative learning are numerous, especially when using group investigation. Sharan and Sharan (1989) discussed the use of group investigation to expand the effects of cooperative learning. In group investigation, students take an active role in planning what and how they study.

When planning group investigation, students progress through six stages carried out over various time periods. The six stages are:

1. identify the topic to be investigated and organize students into groups;

2. plan the investigation in groups;

3. carry out the investigation in groups;
4. prepare a final report;
5. present the final report to the class;
6. evaluate by the teacher and class.

They found that group investigation was effective primarily because students have more control over learning. Students inquire into those aspects that interest them the most, providing skills that are beneficial.

The structural approach to cooperative learning offers an alternative to just cooperative learning activities. Kagan (1989) differentiates between cooperative activities and structures. Activities almost always have a content-bound objective, whereas structures may be used repeatedly with almost any subject matter or grade level. In the traditional classroom, whole-class question-answer structures are often used. In this structure the teacher asks a question and students who wish to respond raise their hands. The teacher calls on that student who attempts to answer the question. This creates competition among students, not cooperation.

Cooperative structures permit students to work effectively with each other, therefore creating a proper learning environment. Kagan discusses several structures: (1) roundrobin, (2) corners, (3) match mine, (4) numbered heads together, (5) color coded co-op, (6) jigsaw, (7) three-step-interview, (8) team word-webbing, (9) think-pair-share, (10) roundtable, (11) inside-outside circle, and (12) co-op co-op.

Clearly, cooperative learning has a major impact on student achievement. Johnson, Maruyama, Johnson, and Nelson (1981) reviewed 122 studies comparing relative effectiveness of cooperation, in particular cooperation with intergroup competition, interpersonal competition, and individualistic goal structures in promoting achievement.

Three meta-analysis procedures were used: (1) voting method, (2) effect size method, and (3) z-score method. The results of the meta-analysis indicate the following:

1. cooperation is considerably more effective than interpersonal competition;

2. cooperation with intergroup competition is also superior to interpersonal competition and individualistic efforts;

3. there is no significant difference between interpersonal competitive and individualistic efforts.

In summary, cooperative learning was found to have a positive impact on student achievement, as well as social skills. However, further studies need to be conducted at the secondary level.

Peer tutoring. Another effective method of instruction involves peer tutoring. Peer tutoring increases student involvement and creates an atmosphere of cooperation similar to cooperative learning. Clearly, peer tutoring is beneficial to both the tutor and tutee.

Haertig (1988) addressed the issue of students teaching other students.

Peer tutoring was used as a method to challenge gifted students. She recommends assigning bright students to tutor less able students. Haertig proposes offering a unit for gifted students entitled MAT (Making All-of us Teachers). The MAT instructional unit meets the following objectives for gifted education;

1. it provides a hands-on experience where students evaluate their own work;

2. it provides the students with an experience of higher-level risk taking;

3. MAT encourages gifted students to apply content to what is relevant to them;

4. teaching is considered a method of learning.

Greenwood, Carta, and Hall (1988) rationalize the need for alternative types of instruction. They state that many existing procedures provide inadequate evidence of their effectiveness. In addition, classroom procedures fail to be comprehensive enough to solve the original problem. They believe peer tutoring meets these needs.

Greenwood defines peer tutoring as procedures in which peers are used to provide direct instruction to target peers. Strategies should be developed that use peer tutoring to influence direct instruction and classroom management.

Peer tutoring may also be used as a tool to improve school climate and productivity. Hedin (1987) states that one-to-one tutoring provides an effective teaching method.

With a trained tutor, it was found that 98% of students academically outperform those who are taught in two traditional methods. Other expected benefits included the following:

1. increased academic achievement of the tutee;
2. improved social climate of the school;
3. the heightened sense of competence of the tutor;
4. tutors make the teacher's job more manageable by creating a more pleasant environment;
5. peer tutoring helps recruit promising future teachers.

Cohen, Kulik, and Kulik (1982) used meta-analysis to examine the outcomes of tutoring. Sixty-five studies were evaluated, analyzing the effects of tutoring programs on the tutor and tutee on student achievement, student attitudes toward the subject matter, and favorability of student self-concept.

In 45 of the 52 studies, the examination performance of students who were tutored was better than the examination performance in a conventional class. Eight studies reported results related to attitude toward subject matter and all eight studies showed more positive attitudes among tutorial groups versus the conventional classroom students. Nine studies reported effects of tutoring programs, with seven studies showing favorable student self-concepts.

Jenkins and Jenkins (1987) identify a number of characteristics of successful tutoring programs which include:

1. tutoring proceeds smoothly when tutors have a highly structured and carefully planned lesson format;

2. teachers define objectives in terms of their classroom curriculums and evaluate students' competence in relation to success or failure in those materials;

3. teachers select tutoring content carefully and ensure that students master it;

4. frequency and duration of tutoring lessons are considered;

5. systematic training is essential.

In summary, peer tutoring was found to have a positive effect on student performance. Students exhibited improved social skills and more concern for others.

Student attitudes and perceptions Student attitudes and perceptions are another factor in student academic achievement. Labonty and Danielson (1988) concluded from their study that students rank teachers with effective teaching behaviors as the ones they liked best. The findings supported a hypothesis that if teachers display behaviors considered effective at "changing pupil behaviors", they will be people students would like to have as teachers.

Enthusiastic teaching also is considered effective among students and promotes student achievement. Mastin (1963) manipulated teacher enthusiasm by having 20 teachers present one lecture with enthusiasm and one lecture with indifference to their sixth and seventh grade classes. Class average achievement scores for the lessons taught with enthusiasm were higher in nineteen of the twenty classes.

Student perceptions of classroom climate also appear to have an effect on student achievement. Walberg and Anderson (1972) reported a positive relationship between cognitive learning and those classes students perceive as cohesive, satisfying, environmentally rich, and challenging. Conversely, negative relationships were found between achievement and classes perceived as exhibiting student apathy, friction, and favoritism.

Chiappetta, Waxman, and Sethna (1990) surveyed 20 physical science teachers hoping to explain why students were disinterested in class. Experimental and control groups were selected from classes who had achieved similar grades. The experimental class used a new physical science resource manual that included many demonstrations, experiments, and activities.

A questionnaire was administered to each class after six weeks. The experimental group indicated that they enjoyed science more than the control group. Achievement was found to be higher in one teacher's experimental group (80.3 average versus 75.4) which was indicative of most participating teachers.

In summary, student attitudes and perceptions were found to an important factor in student academic achievement. Students preferred teachers who were enthusiastic and interesting. Student achievement was found to be higher in classrooms that were perceived as satisfying, environmentally rich, and challenging.

Science Achievement

Recent studies have focused on the decrease of American students selecting mathematics or science as a major field of study in college (Grandy, J. 1987 a; Grandy, J. 1987 b). Grandy conducted a study exploring the major fields of study of the top-scoring SAT examinees over the past decade.

Major findings included:

1. the proportion of top-scoring examinees planning to major in mathematics, science, and engineering is greater than the proportion of the rest of the examinee population planning to major in any of those fields;
2. those top-scoring examinees planning to major in mathematics, science, and engineering increased until 1982 and then declined slightly;
3. there is a considerable difference in the major field selections of males and females with females planning to major in mathematics, science, and engineering declining.

Student attitude and perceptions of science. Why are America's top students exhibiting a decreased interest in science, mathematics, and engineering? Yager and Bonnstetter (1984) investigated student perceptions of science teachers, classes, and course content. The follow-up study of the 1977 assessment in science by the NAEP surveyed over 2500 persons consisting of nine, thirteen, and seventeen year olds.

Common questions asked included:

1. Does studying science make you feel happy?
2. Do you find your study of science interesting?
3. Does science make you feel excited?
4. Does studying science make you feel stupid?
5. Does your teacher know a lot about science?

Some generalizations from the study included:

1. secondary science teachers are perceived as knowing the answers and seldom admitting their ignorance about science in their teaching situation;

2. only a third of elementary teachers communicate a liking of science to their students;

3. fewer than half of the secondary science teachers are able to make science learning exciting;

4. only 40% of secondary teachers were considered successful in encouraging their students to share ideas and experiences;

5. only 28% of senior high school students reported science classes as fun;

6. the longer students remain in school, the more uncomfortable they become with science.

When considering the perceptions American students have of science, it is no wonder that the IEA science results were so low. Napier and Riley (1985) collected data from seventeen year olds who were involved in the NAEP 1976-1977 survey (N=3135).

The type of science class that fosters achievement was characterized by teachers who encouraged students to do extracurricular work, watch science shows, have science hobbies, and discuss science topics with others. In addition, teachers who establish a classroom where the coursework is not too difficult, students feel comfortable and happy, and students are not made to feel stupid were also found to improve achievement.
Napier and Riley conclude that these factors are limited to the correlational results found, and these factors may not "cause" achievement but should be studied further.

Lawrenz (1975) investigated the relationship between science teacher characteristics and student achievement and attitude and found a strong correlation between selected teacher characteristics and science student achievement. These teacher characteristics include formality, self-improvement, knowledge of science, and goal direction.

Factors affecting student academic achievement in science. Ferko (1989) analyzed U.S. advanced science student achievement compared to advanced science students from Australia, China, Canada, England, Finland, Japan, the Republic of Korea, Mexico, the Netherlands, Nigeria, Norway, Papua New Guinea, the Philippines, Poland, Singapore, Sweden, Tanzania, Thailand, and Zimbabwe.

Results from the Second International Science Study (SISS) were alarming.

United States advanced science students consistently performed at lower levels than students from other participating countries.

Table I

Preliminary SISS Comparisons of U.S. Results With Japan, England, and International Composite for Population 3 Students (% Correct)

Country	Biology	Chemistry	Physics
U.S. 2nd Year	44	41	44
Japan	48	62	59
England	71	73	58
International Composite (9 Countries)	62	55	51
Number of Items Common to All Countries	25	25	26

Source: Jacobson, W. J. and Doran, R. L. Preliminary Results for the U.S.A. Participation in the Second IEA Science Study—1987.

Ferko also discusses factors that affect science achievement including: student background, conditions of learning, science curriculum, homework, school facilities, teacher characteristics, student characteristics, and time allocation for science instruction.

There are some factors associated with student achievement in science which Ferko believes the school has little or no control over. These include: parent education levels and occupations, parent aspirations for the student, parent attitudes toward school and science, the type of community in which the student lives, student family socioeconomic status, and student sex.

Several important factors over which the school can exert force were also mentioned, including type of school, kind of educational program in which the student is placed, the curricular and instructional policies of the school, the degree to which the school provides the opportunity to learn, models for educational and career aspirations of the students, and competent teachers.

Science curriculum and instruction. Several studies have been conducted investigating the relationship between science curriculum and student achievement in science. (Anderson, Kahl, Glass, and Smith 1983; Penick and Yager 1986; Shymansky, Kyle, and Alport 1982; and Wise and Okey 1983). Penick and Yager (1986) address the concerns and issues in science education that erupted after the SISS findings in 1984. They believe the public is ready to accept the crisis in science education by realizing the following:

1. a shortage of science and mathematics teachers;
2. a decline in standard test scores;
3. a lack of rigor in U.S. schools—especially in science and mathematics;
4. too few rules and requirements in schools;

5. Japanese successes in the area of electronics when compared to the U.S.

Leading researchers, concerned with the crisis, consolidated their efforts, forming Project Synthesis. Basic to Project Synthesis was the identification of four reasons for inclusion of science in every school program. The four reasons are:

1. science education should prepare students to utilize science for improving their own lives;

2. science education should produce informed citizens who are able to deal with societal issues;

3) science education should give all students an awareness of careers open to students in science and technology;

4) science education should allow students who wish to pursue science academically the appropriate background necessary to succeed.

Harms and Yager (1981), working with Project Synthesis, stated the following:

1. there is a mismatch between the science curriculum found in schools and that which 90% of the students need and want;

2. nearly 90% of all science teachers emphasize goals for school science that are directed only toward preparation for further formal study of science;

3. nearly all science teachers (99%) have a philosophical orientation only toward a specific discipline of science;

4. over 90% of science teachers use textbooks 95% of the time;

5. there is virtually no evidence of science being learned by direct experience.

Aldridge (1989) suggests changes be made in secondary science. After researching science programs in other nations, particularly in the USSR and the People's Republic of China, he recommends changing the present sequence of science courses. Oftentimes, students who are not enrolled in the proper sequence of mathematics and sciences courses early in their education are not allowed to study advanced science courses such as chemistry and physics. Aldridge proposes altering the present science curriculum by studying biology, chemistry, and physics each year in grades 10-12. In addition, a wide variety of topics in science would also be covered in grades 7-9, including earth science, space science, geology, and computer science.

In summary, science achievement of U.S. students compared to international students was poor. Lack of interest in science, parental influences, and teacher competency were found to be factors contributing to poor student performance.

Predictors of Academic Achievement in Science

Limited research has been conducted concerning predictors of academic achievement in science, with the main emphasis centering on predictors of achievement in college science courses.

Harris (1983) conducted a study over a ten year period (N=1008) using a questionnaire asking students to report their previous backgrounds in chemistry, physics, and mathematics.

Harris defined success in physics as receiving a grade of B- or better. No scaling was used. Results showed that 62.4% of all students in the successful group had taken at least one year of physics in secondary school, with over 60% earning grades of C or better.

Ewing (1986) conducted a correlational study using over 600 students from New Mexico State University. High school GPA and ACT scores were obtained to determine their relationship to successful completion of general college chemistry. It was found that students who had a high school GPA below 3.3 or a composite ACT score below 19 had less than a 50% chance of earning a grade of C or better.

One additional study investigated the factors contributing to achievement in physics of secondary students. Harpole (1986) investigated selected variables which may serve as predictors of achievement in physics, including:

1. teacher characteristics such as teacher certification, number of undergraduate hours in physics, and teaching load;

2. physics students whose teacher also taught chemistry achieved at a higher level;

3. students from schools in municipal districts achieved higher in physics;

4. classes with a larger percentage of females than males achieved lower in physics than classes composed largely of males.

Summary

The review of literature found several factors relating to student academic achievement. Clearly, teacher characteristics and methods of instruction have large impacts on student achievement. Student perceptions and attitudes, as well as parental influence, were other factors found related to student academic achievement.

Academic achievement in science among U.S. students was found to be much lower when compared to other nations. Science curriculum and instructional methods used in the U.S. may contribute to lower achievement In addition, more parental involvement was found to be a key in increasing student academic achievement.

CHAPTER 3

Methodology

The purpose of this ex post facto study was to determine the relationship between performance in math and science courses taken prior to enrollment in college-preparatory chemistry and final grade in chemistry.

Population

The population from which the sample was drawn was in Whitfield County, Georgia. This northwest county lies in a natural valley in the foothills of the Blue Ridge Mountains.

The city of Dalton, the county seat, has a population of approximately 22,000: the entire county, approximately 73,000. The major industry in Whitfield County is carpet manufacturing which consists of over 200 manufacturing plants and over 200 carpet outlets. Some revenue is derived from agriculture, especially from poultry and poultry products.

The community is served by a regional library with bookmobile services, a major medical center and a daily newspaper. The Creative Arts Guild and various recreational facilities provide enrichment activities.

Dalton Community College provides a full two-year academic and vocational program. The Dalton College facility is also used by West Georgia College for junior-and senior-level classes as well as for a master's program in education.

Sample

Whitfield County has two public school systems. The Dalton City School System has six elementary schools, one junior high school, and one high school. Whitfield County School System has ten elementary schools, four middle schools, and two high schools.

The subjects for this research were drawn from the Whitfield County school system which employs approximately 1,000 people and serves approximately 10,000 students.

The 90 member study group (students enrolled in chemistry during the 1987-88 and 1988-89 schools years) consisted of college-preparatory, first year, eleventh and twelfth grade students, ranging in age from fifteen to seventeen years. The variables kept constant include the instructor, textbook, and laboratory activities.

Procedures

All students who had a given instructor for an entire year of chemistry during the 1988 and 1989 school years were selected for this study. Students who withdrew from chemistry during the school year were also included in the study to help determine the relationship between the student's background in math and science and the reason for withdrawing.

Yearly averages in physical science, biology, chemistry, algebra, TAP math and science scores, and overall GPA through the middle of the sophomore year were collected for each student. Algebra grades were converted to letter grades (A =4) due to the fact that a large number of students as eighth graders had completed algebra and were assigned letter grades. Overall GPA was calculated through the middle of the sophomore year to obtain an average that could be used in the future when students register for chemistry as sophomores.

<u>Statistics</u>

A measure of correlation using Pearson r will be used to measure the relationship between chemistry achievement and physical science, biology, algebra, TAP math and science scores, and overall GPA through the middle of the sophomore year.

CHAPTER 4

Results

In order to investigate the relationships between student performance in chemistry and (1) physical science grades,(2) biology grades, (3) Algebra I grades, (4) TAP mathematics scores, (5) TAP science scores, and (6) overall GPA, a correlational analysis using Pearson r was performed. Davis (1971) recommends the strength of correlation be judged according to the following scale:

A Very Strong Positive Association	+.70 or higher
A Substantial Positive Association	+.50 to +.69
A Moderate Positive Association	+.30 to +.49
A Low Positive Association	+.10 to +.29
A Negligible Positive Association	+.01 to +.09
No Association	.00
A Negligible Negative Association	-.01 to -.09
A Low Negative Association	-.10 to -.29
A Moderate Negative Association	-.30 to -.49
A Substantial Negative Association	-.50 to -.69
A Very Strong Negative Association	-.70 or lower

The level of acceptance for the hypotheses will be +.50

Findings

The hypotheses investigated in this study were as follows:

Ho_1 There is no statistically significant relationship between Chemistry I grades and TAP mathematics scores.

Ho_2 There is no statistically significant relationship between Chemistry I grades and TAP science scores.

Ho_3 There is no statistically significant relationship between Chemistry I grades and overall GPA.

Ho_4 There is no statistically significant relationship between Chemistry I grades and Algebra I grades.

Ho_5 There is no statistically significant relationship between Chemistry I grades and Biology I grades.

Ho_6 There is no statistically significant relationship between Chemistry I grades and physical science grades.

There was a correlation of 0.1946 between Chemistry I grades and TAP mathematics scores. The coefficient of determination is 3.786% with an error of 96.214%. Therefore Ho_1 was accepted.

There was a correlation of 0.0408 between Chemistry I grades and TAP science scores. The coefficient of determination is 16.64% with an error of 83.36%. Therefore, Ho_2 was accepted.

There was a correlation of 0.6198 between Chemistry I grades and overall grade point average through five quarters. The coefficient of determination is 38.415 with an error of 61.585%. Therefore, Ho_3 was rejected.

There was a correlation of 0.3665 between Chemistry I grades and Algebra I grades. The coefficient of determination is 13.43% with an error of 86.57%. Therefore, Ho_4 was accepted.

There was a correlation of 0..4592 between Chemistry I grades and biology grades. The coefficient of determination is 21.086% with an error of 78.914%. Therefore, Ho_5 was accepted.

There was a correlation of 0.6014 between Chemistry I grades and physical science grades. The coefficient of determination is 36.168% with an error of 63.832%. therefore, Ho_6 was rejected.

Discussion

Within the limitations of this study, the results of the data indicate that chemistry grades have a substantial positive association with overall GPA (r = .6198) and physical science grades (r = .6014). Biology scores (r = .4592) and Algebra I scores (r = ..3665) showed only a moderate positive association.

It should be noted that TAP mathematics scores (r = .1946) showed a low positive association and TAP science scores (r = .0408) showed negligible positive association.

Overall GPA was found to have a high positive correlation (r= 0.6198) with chemistry grades. Perhaps, students who have high grade point averages have developed good study habits and note-taking skills. The importance of achievement among students with high GPAs may be another factor explaining this high correlation. It also may be possible that students with low GPAs may become discouraged and consider grades unimportant.

The correlations between GPA and other subject areas show similar correlations: (a) Algebra I grades (r= 0.6760), (b) biology grades (r= 0.6612), and (c) physical science grades (r= 0.7143).

It is interesting that TAP mathematics scores (r= .0506) and TAP science scores (r= 0.2059) show a low relationship to grade point average, but show moderate positive relationship between each other (r= 0.4062). When considering the low associations found between Chemistry I grades and the TAP mathematics and science scores it should be noted that the objectives covered on the TAP examination were unrelated to material covered in either physical science or chemistry.

The moderate positive relationship between Chemistry I grades and Algebra I grades (r= 0.3665) was surprising. The quantitative nature of chemistry requires the student to possess algebra skills. The relationship found may be explained by the method used to collect Algebra I grades.

Nearly half of the sample completed Algebra I as eighth graders where they received letter grades. Other students in the sample completed Algebra I as ninth graders and received numerical grades. Numerical grades were converted to letter grades and then averaged for the year. This method could have effected the outcome of the statistical study.

When comparing Chemistry I grades with biology grades a Pearson r of 0.4592 was found, showing a moderate positive association. The qualitative nature of biology may explain why the relationship was not higher.

The relationship between Chemistry I grades and physical science grades had the highest positive association (r= 0.6014) among subject matters. The objectives covered in physical science are closely related to Chemistry I and also require problem-solving skills. Approximately one half of the physical science curriculum involves the study of chemistry, whereas the remaining material covers physics.

Based on the data collected in this study, it was found that overall GPA and physical science grades should be considered when counseling students in regard to predicting satisfactory completion of Chemistry I. These suggestions are based totally on past performance of students during the 1987 and 1988 school years and in no way should the results of this study be used to exclude students from taking chemistry. Clearly, other factors affect performance in Chemistry I. Among these are absences from school, student jobs, and parental involvement.

Table 2
Intercorrelations Among The 7 Variables

	1	2	3	4	5	6	7
1. Chemistry I Grades		0.1946	0.0408	0.6198	0.3665	0.4592	0.6014
2. TAP Mathematics Scores			0.4062	0.0506	0.2646	0.1905	0.0276
3. TAP Science Scores				0.2059	0.02555	0.1936	0.2260
4. Overall GPA					0.6760	0.6612	0.7143
5. Algebra I Grades						0.3924	0.5079
6. Biology Grades							0.5099
7. Physical Science Grades							

CHAPTER 5

Conclusions, Implications, and Recommendations

Conclusions

This study was undertaken to determine what factors should be considered when counseling students in regard to registering for college-preparatory chemistry. Yearly averages in chemistry, biology, algebra, physical science, overall GPA, and performance on the TAP test in mathematics and science were used in this study.

The purpose of this study is not to exclude students from taking college-preparatory chemistry. Rather, it is hoped that information gained in this study will be used to offer alternatives to students who are not yet ready for the demands of a quantitative science course such as chemistry. The possibility of developing a qualitative chemistry course as an alternative should be considered. Students also have the option of pursuing the quantitative chemistry course as a senior-- after taking additional mathematics courses.

Implications

Based on this study, the following are implications for chemistry students:

1. Physical science grades and overall grade point average should be considered when counseling students in regard to registering for college-preparatory chemistry.

2. Poor performance in any of the above-mentioned areas may indicate that the student is not ready for college-preparatory chemistry and should opt to take chemistry at a later date.

3. Students performing poorly in any of the above-mentioned areas who decide to take Chemistry I may require additional tutoring from the instructor or his peers.

Recommendations

Based on this study, the following recommendations are made for further research:

1. It is recommended that additional research be conducted with larger sample sizes.

2. It is recommended that this study be expanded to include physics and advanced chemistry students.

3. It is recommended that a qualitative chemistry class using the Chemistry in the Community (ChemCom) program developed by the American Chemical Society be established as an alternative to Chemistry I. Data collected showed high correlations between Chemistry I and quantitative courses.

4. It is recommended that a student survey be conducted at the end of Chemistry I to determine personal opinions in regard to what best prepared them for college-preparatory chemistry.

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APPENDIX

CHEMISTRY I GRADES	TAP MATHEMATICS SCORES	CHEMISTRY I GRADES	TAP MATHEMATICS SCORES
94	89	77	57
93	75	77	39
93	45	77	65
91	84	76	75
90	89	76	39
89	81	76	84
89	63	75	31
89	65	75	65
88	70	75	27
87	60	74	60
87	49	74	92
87	67	74	63
85	57	74	45
85	27	74	70
85	70	73	65
84	42	72	87
84	31	72	49
84	73	72	13
84	75	71	79
84	83	65	39
84	70	63	67
84	60	63	73
84	53	61	49
83	60		
83	60		
82	89		
81	70		
81	63		
81	87		
80	67		
80	39		
80	60		
80	36		
79	89		
79	49		
79	65		
78	65		

Chemistry I Grades	TAP Science Scores	Chemistry I Grades	TAP Science Scores
94	62	77	56
93	94	77	45
93	47	76	56
91	80	76	30
90	90	76	45
89	87	75	52
89	74	75	84
89	70	75	56
88	45	74	77
87	90	74	93
87	45	74	17
87	65	74	87
85	65	74	74
85	70	73	52
84	74	72	77
84	30	72	70
84	62	72	30
84	74	71	74
84	87	65	65
84	99	63	93
84	93	63	80
84	62	61	77
83	77		
83	35		
82	93		
81	77		
81	52		
81	52		
80	56		
80	30		
80	74		
80	82		
79	87		
79	80		
79	41		
78	65		
77	52		

Chemistry I Grades	Grade Point Average	Chemistry I Grades	Grade Point Average
94	3.26	84	3.23
93	3.63	84	3.50
93	3.53	84	2.73
93	3.56	84	3.00
91	3.46	83	3.50
90	3.73	83	2.73
90	1.70	83	3.23
90	2.30	82	2.93
89	3.73	82	2.60
89	3.13	82	3.13
89	3.10	82	2.13
89	3.70	82	2.97
88	3.40	81	3.40
88	3.03	81	2.57
88	3.36	81	2.77
87	3.30	81	2.57
87	2.90	80	2.80
87	2.60	80	2.33
87	3.30	80	2.60
87	3.06	80	3.70
86	3.45	79	1.87
85	2.76	79	2.63
85	3.23	79	2.50
85	3.53	78	2.10
85	3.00	78	2.20
85	2.96	78	2.60
85	2.97	77	3.13
85	2.60	77	3.07
84	2.97	77	2.56
84	2.33	76	2.60
84	2.87	76	2.40
84	2.50	76	2.16
84	2.50	76	2.70
84	2.73	75	2.93
84	3.37	75	2.73

Chemistry I Grades	Grade Point Average
75	3.00
74	3.33
74	2.66
74	2.86
74	2.20
74	3.06
74	1.83
73	1.91
73	2.33
72	2.00
72	1.83
72	1.86
71	2.10
67	3.30
67	1.29
65	2.00
63	1.40
63	2.23
61	2.26
54	1.90

Chemistry I Grades	Algebra I Grades	Chemistry I Grades	Algebra I Grades
94	3.67	84	2.67
93	3.67	83	4.00
93	3.33	83	3.33
93	3.67	83	3.00
91	4.00	82	3.33
90	4.00	82	2.33
90	2.00	82	4.00
90	3.50	82	1.67
89	4.00	82	3.67
89	3.33	81	4.00
89	3.67	81	1.66
89	3.33	81	3.00
88	4.00	80	3.00
88	3.00	80	1.67
88	3.67	80	3.00
87	3.67	80	3.67
87	1.33	79	1.00
87	2.33	79	1.67
87	3.00	79	2.33
87	3.33	78	2.00
86	3.00	78	2.00
85	2.33	78	4.00
85	2.33	77	2.33
85	3.33	77	3.33
85	1.67	77	2.67
85	2.67	76	2.00
85	3.00	76	1.67
85	1.67	76	1.67
84	2.33	76	3.33
84	2.50	75	3.67
84	2.00	75	1.33
84	3.00	75	3.50
84	2.67	74	3.00
84	3.00	74	2.00
84	3.00	74	3.67

Chemistry I Grades	Algebra I Grades
74	1.67
74	3.00
74	2.33
73	1.00
73	2.33
72	3.00
72	1.67
72	1.00
71	2.67
67	2.67
67	0.00
65	2.33
63	1.00
63	2.33
61	2.67
54	0.33

Chemistry I Grades	Biology Grades	Chemistry I Grades	Biology Grades
94	90	84	90
93	91	84	80
93	93	84	86
93	92	83	89
91	90	83	81
90	97	83	91
90	87	82	84
90	85	82	87
89	96	82	78
89	82	82	78
89	86	82	76
89	95	81	87
88	86	81	81
88	83	81	85
88	90	81	83
87	87	80	81
87	87	80	82
87	72	80	80
87	93	80	87
87	88	79	80
86	89	79	83
85	78	79	85
85	86	78	70
85	96	78	80
85	89	78	78
85	82	77	81
85	79	77	83
85	90	77	90
84	88	76	81
84	82	76	82
84	89	76	76
84	67	76	74
84	79	75	84
84	89	75	83
84	91	75	79
84	89	74	87

Chemistry I Grades	Biology Grades
74	89
74	80
74	83
74	79
73	75
73	73
72	79
72	77
72	74
71	84
67	83
67	66
65	73
63	79
63	84
61	74
54	93

Chemistry I Grades	Physical Science Grades	Chemistry I Grades	Physical Science Grades
94	83	84	86
93	88	84	77
93	92	84	86
93	92	84	93
91	94	84	85
90	92	84	88
90	92	84	74
90	93	84	86
89	92	83	83
89	86	83	82
89	84	83	83
89	93	82	87
88	89	82	89
88	92	82	92
88	88	82	74
87	86	82	77
87	78	81	91
87	86	81	89
87	86	81	80
87	82	81	81
86	97	80	86
85	84	80	78
85	89	80	76
85	89	80	91
85	84	79	75
85	89	79	80
85	86	79	77
85	74	78	80
84	87	78	76
84	82	78	82
84	87	77	82

Chemistry I Grades	Physical Science Grades
77	79
77	78
76	84
76	78
76	76
76	79
75	82
75	81
74	85
74	90
74	78
74	77
74	88
74	74
73	75
73	81
72	79
72	78
71	75
67	89
67	67
65	76
63	73
63	83
61	75
54	72

VITA

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